

Deloitte Access Economics

# Advancing Australia

## Harnessing our comparative energy advantage

Australian Petroleum  
Production & Exploration  
Association Limited

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# Acronyms

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ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
APPEA	Australian Petroleum Production and Exploration Association Limited
BREE	Bureau of Resources and Energy Economics
CAPEX	Capital expenditure
CSG	Coal Seam Gas
DAE-RGEM	Deloitte Access Economics computable general equilibrium model
DFAT	Department of Foreign Affairs and Trade
DRET	Department of Resources Energy and Tourism
FIFO	Fly-in, Fly-out
FTE	Full-time equivalent worker
GDP/GSP	Gross domestic/state product
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MFP	Multifactor productivity
NPV	Net present value
OPEX	Operational expenditure
PJ	Petajoules
PRRT	Petroleum Resource Rent Tax
R&D	Research and development
RBA	Reserve Bank of Australia
SWF	Sovereign Wealth Fund

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## Executive summary

Australia's oil and gas sector is embarking on a sequence of major new investments — the largest in the history of the industry. Over the next years, substantial additions to production capacity are set to propel Australia towards becoming the world's second largest exporter of liquefied natural gas. Of the 14 gas liquefaction plants under construction or firmly committed around the world, eight are in Australia.

Underpinning this expansion is Australia's position at the cusp of a major shift in the world's economic weight from west to east. The rapid industrialisation of structurally large Asian economies, predominantly China, has driven world economic growth over recent times and changed the dynamics of key international resource, product and capital markets.

For Australia, this has translated into strong demand and elevated prices for our energy and mineral resources, and is driving massive investment by the oil and gas industry and hard rock miners.

While the economic advance of our region is overwhelmingly positive for Australia, playing as it does to our comparative advantages as a secure and reliable energy exporter and also our proximity to markets, the continuing development of Australia's oil and gas industry should not be taken for granted. Indeed, developing our world class energy resources will help underpin future prosperity.

### **An energy keystone: promoting macroeconomic performance and resilience**

#### **The industry's 'snapshot' economic contribution**

By any standards, the wave of oil and gas investments currently in train is impressive. Separately, these represent some of the biggest projects ever undertaken in Australia; and collectively, they account for around 35.4% of all business investment. Further, if all oil and gas investments are realised, they will comprise over 64% of all committed investment.

The oil and gas industry's production profile directly and indirectly represents around 2.0% of current gross domestic product (GDP), with value added of approximately \$28.3 billion in 2011. Despite the record increase in production associated with new LNG projects, a significant exploration effort will still be needed in order to continually extract resources from new and existing reserves. This essentially adds to the overall value added created through oil and gas operations. Therefore, the total forward contribution of the combined oil and gas and exploration sectors is projected to double to approximately \$66 billion in 2020 and \$61 billion in 2025 (see Table i).

In 2020, when production (on the basis of current and forthcoming capacity) and prices are expected to peak, the industry's total economic contribution is projected to be around 3.5% of the national economy.

**Table i: The economic contribution of the oil and gas industry**

	NPV (2011-25)	2011	2020	2025
<b>Oil and gas</b>				
Value added (\$b)	420.0	28.3	64.7	60.2
Direct value added (\$b)	356.7	24.0	55.1	51.1
Indirect value added (\$b)	63.3	4.3	9.8	9.1
Direct value added, share of GDP (%)		1.7	2.9	2.3
Total value added, share of GDP (%)		2.0	3.5	2.7
<b>Exploration</b>				
Value added (\$b)	9.1	1.1	0.8	1.1
<b>Total</b>				
Value added (\$b)	429.1	29.4	65.5	61.2
Share of GDP (%)		2.1	3.5	2.8

Note: NPV uses a discount rate of 7%

Source: Deloitte Access Economics

*The industry's economic linkages are both broad and deep*

Importantly, the industry's economic linkages are broader and deeper than commonly appreciated. Of total industry value added, about \$4.3 billion is generated by supplying industries across the economy — including the resource support services, maintenance and construction and professional services sectors. These linkages are particularly visible in the thriving resource service hubs which have emerged in Brisbane and Perth. Over the period of the analysis, value added in supply industries is projected to increase to \$9.8 billion in 2020 when production peaks. In addition, the oil and gas sector has a strong track record of delivering reliable supplies of energy to Australian industries for half a century.

At a more indirect level the oil and gas industry, in conjunction with other commodity exporters, is driving a range of positive economic and 'hip pocket' spillovers. For instance, the higher Australian dollar has meant that the price of manufactured goods has remained relatively constant over the last decade, while at the same time household incomes have risen on average by around 60% (RBA 2012).

The confluence of these factors has meant that households have more disposable income to spend. Importantly, large portions of this expenditure funnel through to restaurants, bars and other services in capital cities and towns far removed from the remote outposts where much of the resource boom is centred. In this way, there is a tangible but largely unrecognised economic linkage between the wellheads, pipes and compressors and broader community welfare.

## The economic impact of the oil and gas industry

The economic contribution analysis above is undertaken in a static ‘snapshot’ framework which captures the overall footprint of the industry’s production profile at certain points in time.

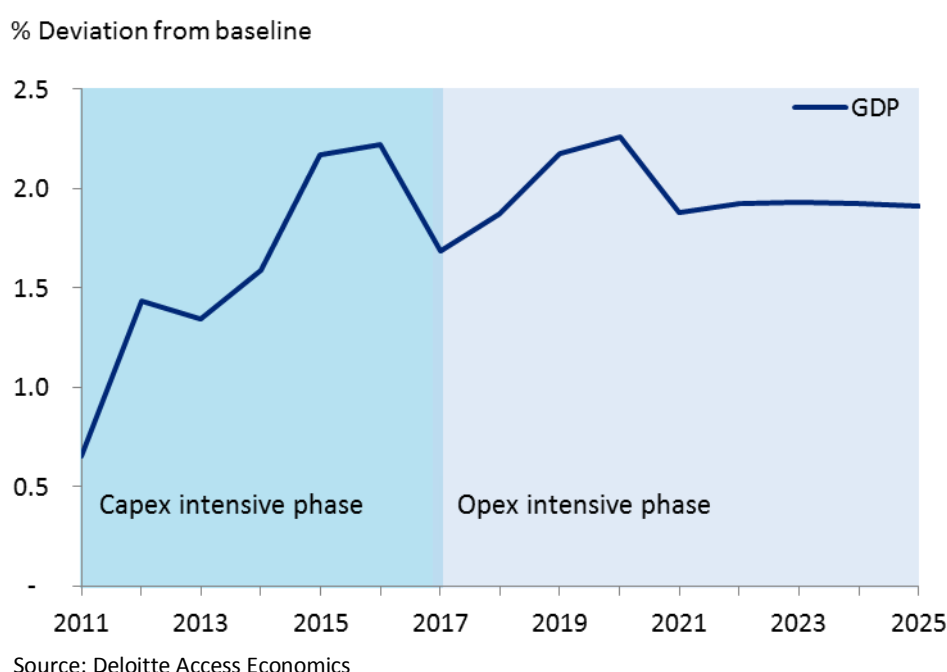
In order to capture the more dynamic and forward looking aspects of industry activity, which incorporates the wave of flow-on impacts throughout the economy, an economic impact analysis has also been undertaken using the Deloitte Access Economics computable general equilibrium model (DAE-RGEM). This analysis integrates each of the oil and gas projects underway or committed across the country and the value of production. Importantly, it captures the industry’s contribution over and above its significant production and export profile.

### *Estimating the economy-wide impacts*

It is anticipated that proposed oil and gas projects will spend on average \$23 billion in capital outlays per year over the period 2009 to 2017, or about \$210 billion (this excludes ongoing operational expenditures). During the operational phase of the modelling, these projects are projected to increase oil and gas output to a peak of \$46 billion in 2020 and just over \$41 billion at the end of the modelling period to 2025.

As a result of the capital expenditure and operational activity generated by additional oil and gas projects, Australia’s GDP is projected to increase significantly above the reference case. Specifically, over the capital expenditure-intensive phase, GDP is estimated to peak at around 2.2% in 2016 coinciding with the height of the current industry investment program (see Chart i). From about 2017 the bulk of activity in the sector switches from a capital-intensive phase to a ramp-up in oil and gas output.

**Chart i: Investment and operational modelled impacts, GDP deviation from the baseline**



Over the period to 2025 GDP, in NPV terms, is projected to increase by just over \$260 billion above the reference case (see Table ii). This means that Australians can look forward to an increase in GDP equivalent to 20% of the economy's current annual output over the next decade-and-a-half — solely as a result of the proposed oil and gas investments and their projected output over this period.

The substantial increase in economic output is largely concentrated in the resource-rich parts of the country — namely, Western Australia, Queensland and the Northern Territory. In fact, Western Australia on its own provides for just over half of the gains with an increase in economic output of \$135 billion in net present value terms.

Two states, namely New South Wales and Tasmania, report reductions in GDP from the baseline. This suggests resources and activity are being reallocated from those states to the resource intensive states. This occurs as part of the broader and national welfare-enhancing structural adjustments needed to capitalise on the resources boom.

**Table ii: GDP and employment modelled impacts, selected years and NPV**

	<b>NPV (2012 – 25)</b>	<b>2012</b>	<b>2015</b>	<b>2025</b>
<b>GDP (\$b)</b>	261.4	21.0	34.3	37.9
<b>Employment ('000 FTE)</b>		103.1	77.8	11.5

Note: NPV uses a discount rate of 7%

Source: Deloitte Access Economics

Employment as measured in full-time equivalent (FTE) terms is also, unsurprisingly, concentrated in the oil and gas rich states. Over the investment phase national employment peaks at about 103,000 FTEs in 2012. Over the less labour-intensive operational phase, employment moderates to about 11,500 FTEs by 2025. This demonstrates the significant need for temporary workers during the period in which substantial industry capacity is being installed.



### Box i: LNG tankers: an economic anatomy

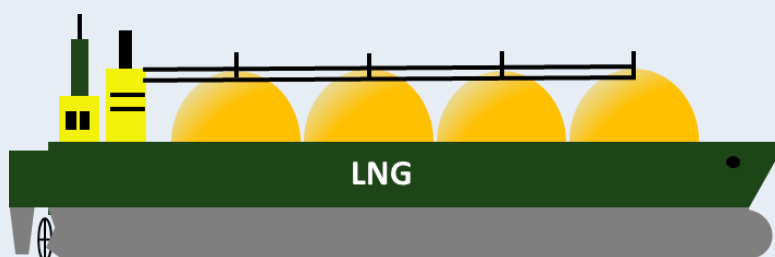
Current and future LNG facilities in the North West Shelf, Darwin or from the soon-to-be-developed export terminals in northwest Australia and Gladstone involve a continual flow of LNG tankers to overseas customers. These specialised vessels, which carry all seaborne trade in LNG, form an integral part of the world's 'energy superhighways'.

Australia is providing the lion's share of growth in the world's gas trade over the next decade.

In aggregate trade terms, this flow of LNG (and related liquids) from Australia makes an important contribution to national export income. An economic breakdown of these tankers is shown below.

#### Key economic breakdown

- A standard LNG tanker holds around 140,000 cubic metres of LNG. At present production levels, around one tanker leaves Australia's shores every day destined for export markets — this will increase substantially as additional LNG terminals come on line over the next five years.
- Each tanker cargo contains an export value of LNG equal to approximately \$33 million at current prices, with a value added economic contribution of around \$31 million.
- Each cargo provides a total tax contribution of about \$8.7 million (based on industry averages), comprising \$4.9 million in company tax and \$3.8 million in associated production taxes such as royalties and resource rent payments.



#### Industry's fiscal contribution

On the back of considerable production growth, the oil and gas industry will make a substantive contribution to government revenues. By 2025, the industry is projected to contribute just over \$12 billion in taxation revenues (see Table iii). These tax projections should be considered indicative given the volatility of commodity prices and cost structures for individual projects. In reality, these amounts could be considerably higher.

**Table iii: Oil and gas tax payments, selected years and NPV**

Contribution (\$b)	NPV (2011-25)	2011	2020	2025
Corporate	61.2	4.4	9.1	8.5
Production taxes	32.4	3.5	3.7	3.6
Total	93.6	7.9	12.8	12.1

Note: NPV uses a discount rate of 7%

Source: Deloitte Access Economics

## Strategic policy issues: securing the industry's potential

The rapid growth of the oil and gas industry, coupled with expansion in broader resources activity, is generating some important challenges for industry and policymakers. This includes dealing with the complexities of the patchwork economy such as those associated with the appreciation of the Australian dollar and consequent weakness in areas such as manufacturing, tourism and education.

Some key policy principles are presented below which are essential to securing the benefits of the resources boom to the maximum extent possible.

### Managing the process of structural adjustment

Managing the process of structural adjustment to accommodate the sizeable increases in resource investments will be crucial to harnessing the proceeds of the boom. While these changes can involve some economic dislocation and cost, they need to be kept in perspective.

Structural change is a pervasive and necessary feature of modern economies; it is part and parcel of economic advancement and rising living standards. In the context of a resource boom, higher oil and gas activity attracts inputs from lower productivity uses, with relevant prices such as the exchange rate and returns to capital and labour effectively determining which sectors are most affected. Overall gains to the economy are determined by the extent to which factor inputs can produce more highly valued output. Certainly, the real income and wealth effects can be seen in the above economic analysis.

In terms of economic and policy management, the adjustment pressures and disruptions caused by resources shifting from lower to higher productivity sectors should not be resisted but do need to be well-managed — and often in the face of substantial political pressure.

Attempting to slow the structural changes emanating from the resources boom would be costly and ineffective, ultimately lowering the economic dividends for all Australians.

**Policy principle: Overall policy settings should have a supportive posture and facilitate the adjustments needed to maximise the economic gains from the resources boom.**

Any new policy rigidities or constraints, such as explicit industry protection measures, mandated local content requirements, onerous project approvals frameworks and additional fiscal imposts will ultimately sacrifice economic welfare and intensify adjustment pressure on other sectors.

### Engagement with China

The narrative of the present resources boom has mostly emphasised China's tremendous growth as it lays down the building blocks of industrialisation. This is a transformative change which is only partly complete and it represents the largest shift in the global centre of economic gravity in at least the past century.

Given Australia's proximity to the region and capacity as a world class energy exporter, the shift in the global economy towards Asia will have an enduring effect on the oil and gas

industry. Indeed, there is a natural complementarity between China's considerable requirements for a stable supply of commodities and Australia's abundance of high-quality resources and proven export performance.

Because of this relationship, Australia will continue to have a deep stake in China's ongoing economic development. As is clear from the analysis in this report, growth in our oil and gas trade over the medium term, largely driven by Chinese and regional economic development, is set to deliver an enormous economic benefit to the Australian community.

Australia has always been reliant on foreign capital to develop its major energy export platforms and, accordingly, it is important that relevant policy frameworks and industry's broader engagement with the community focus on the merits of encouraging new sources of foreign capital which reflect changing global economic structures.

Our exposure to China's development trajectory presents some vulnerabilities, especially should China's growth unexpectedly falter. Nonetheless, the upside factors far outweigh those on the downside. China has selected Australia as a preferred but not exclusive supplier, and many of the major LNG projects underway would not be commercially viable in the absence of Chinese demand.

Further, the development pattern currently underway in China is intrinsically structural in nature. There is bound to be some cyclical turbulence along the way but the nature of energy contracts is long term, which benefits both parties.

**Policy principle: To help support the phenomenal market opportunities from industrialising Asian economies, relevant policy frameworks should recognise and accommodate new sources of regional foreign capital, while protecting legitimate sovereignty interests.**

The oil and gas industry's 'economic dialogue' with China and other industrialising Asian economies, along with that of other resource producers more generally, has set in place a strong and resilient foundation for pursuing a range of national interests in the region. From this position, Australia is fortuitously placed to continue building a long term energy partnership with the region.

## **Addressing workforce skills**

Accessing skilled labour is a pivotal concern for the oil and gas industry. Given the rapid expansion trajectory and largely concurrent project scheduling, there are significant demands on industry to source and place workers to ensure that the pace of development can be sustained. These challenges are compounded by relatively low levels of unemployment and labour demand from buoyant activity across the wider resources sector.

Importantly, workforce pressures are extending beyond traditional trades and key regional centres heavily exposed to new mining and gas investment activity. The different stages of capital-intensive oil and gas developments require workforces of varying sizes. During the project capital expenditure ('capex') phase, there is a far greater labour requirement as large-scale civil works and facility development occurs. Conversely, project operations typically require fewer and often more specialised workers to manage the operation and

maintenance of production facilities. Using temporary workers to fill temporary jobs during the construction phase makes sense.

Deploying ‘fly-in, fly-out’ (FIFO) workers represents a broad-based solution to this workforce issue, allowing workers to operate in regional areas without the need to relocate or spend extended periods away from their families. While in many respects FIFO arrangements showcase an effective and rapid response by producers (and the aviation industry) to substantial workforce challenges, they are by no means a perfect solution to the industry’s needs. Skilled labour requirements must also be met at reasonable cost to be of benefit to the industry. Further, the need to transport workers to and from remote areas can drive up development costs and lead to other social pressures.

Enterprise Migration Agreements have also emerged as a flexible option to address skills shortages for short-term resource construction works. This policy, which has been the focus of intense political scrutiny, offers many advantages. It allows developers to staff large resource developments (valued at more than \$2 billion) using overseas workers on 457 visas during the intense up-front construction period under an administratively streamlined framework. Importantly, such a policy — especially given its ‘Australians first’ safeguard — provides a win-win proposition. Many large resource projects might struggle or be substantially delayed without securing an adequate supply of workers. And these projects, as demonstrated by the analysis in this report, yield an economic return and further employment spillovers which are enjoyed by all Australians.

**Policy principle: Accessing skilled labour is a pivotal concern for the industry given its rapid expansion and as such this issue demands closer policy attention.**

For large capital-intensive projects, the up-front capex phase necessarily involves greater reliance on temporary workers. This emphasises the need to improve labour mobility and flexibility for workers to be deployed in their most productive capacity.

Various innovative solutions are available and a mix of strategies will be needed to manage sensitivities around FIFO workers and higher levels of skilled migration.

## Domestic development issues

The development of Australia’s resources occurs with an implicit ‘social licence’, that reflects, among other things, the general public’s acceptance of resource projects and the various economic benefits and impacts they involve. While these factors are typically well recognised by the broader community given Australia’s successful and longstanding experience as a leading commodity exporter, there are areas where substantial uncertainties remain.

Some parts of the business community and union groups have been critical of the use of overseas workers and firms to undertake significant elements of new project development. In considering local content issues, it is important to recognise the complexities and commercial realities of developing world-scale oil and gas projects.

Even by the standards of most resource projects, oil and gas developments are capital-intensive, especially when projects involve liquefaction or refining facilities. Much of the key capital equipment is manufactured by a small number of major international suppliers, often using proprietary technologies. Due to long lead-times, there are also major

scheduling challenges to be addressed. These are typically managed through turnkey arrangements with lead contractors, which often place considerable emphasis on securing scale and cost efficiencies, modularisation of key components and reducing interface risks. These factors, in isolation and conjunction, have a significant impact on project procurement strategies and development processes. There is often limited flexibility, with changes having significant impacts on project economics.

Securing such cost savings and reducing third-party risks are crucial to advancing world class resource projects in a competitive market, especially in the context of rising domestic costs. Developers typically weigh up the merits of competing projects, many of which are located in other (lower cost) parts of the world, and it is therefore important that they can extract the maximum benefit from access to global supply chains.

#### *Domestic gas reservation*

Another issue which has received considerable industry and policy attention concerns the effective management of Australia's gas resources for domestic use as well as export. While policy mandating domestic gas reservation is currently restricted to Western Australia, there have been calls to establish similar arrangements on the east coast, particularly with the present wave of large export-focused LNG developments in Queensland.

The potential broadening of this policy by other jurisdictions presents a number of important issues for industry.

- At a fundamental level, such a policy has the potential to impose additional uncertainty, regulatory costs and risk on producers. It also reduces the financial returns to developers by requiring them to sell a portion of their production at (typically) lower domestic gas prices. In this way, the domestic reservation policy essentially acts as a subsidy to other industries and a tax on developing gas reserves.
- This regulation (or quasi-regulation) may not adversely affect investment in the largest gas developments, but it will present a risk to more marginal developments. It is important to recognise that this policy sits alongside a raft of other regulations that developers are required to navigate. The marginal impact of market interventions of this type can be much higher than the absolute impact.

Many of the current calls for continuation and extension of the reservation scheme appear to have a legacy element. A form of domestic gas commitment was a feature of the State Agreement which covered the North West Shelf Project. If subsidy arrangements are longstanding, they can become deeply entrenched, making any policy change and accompanying price adjustments more difficult to effect.

This stands as a key risk associated with any broader application of a domestic gas reservation scheme on the east coast. Like other forms of industry assistance, once such a policy is in place, it can be very difficult to unwind, whatever its merits or demerits.

### *A rising cost environment*

The core decision facing many developers is whether or not to commit to the large capital costs associated with constructing new (mainly LNG) production facilities.

With the costs of labour, fuel, and capital equipment and lead times rising significantly over recent times, additional pressure has been placed on developers. Cost over-runs and slippage of development schedules represent substantial risks to projects, especially given the considerable scale of investment involved.

The critical point is to ensure that government policy does not unduly contribute to the overall development cost and risk profile. In this regard, two areas where the regulatory burden could be reduced include:

- Environmental approvals, especially regarding CSG production and integrating changes in project scope. While ensuring adequate environmental protection is clearly necessary, it appears that key aspects of the legislative framework could be improved to deliver greater certainty to industry and better integrate the requirements of the Commonwealth Government's new Independent Scientific Panel.
- State and Commonwealth Government policies facilitating local content for major project development. There are currently a range of different measures in place for oil and gas projects, which typically have both State and Federal requirements. At the Commonwealth level, there have been recent changes to bolster Australian Industry Participation Plans, particularly those required to access relevant tariff concessions. It is important that these requirements appropriately recognise the long lead-times of investments and the complexity of attendant engineering, feasibility and procurement processes.

Arguably, given current commodity prices, Australia is somewhat shielded from the worst cost effects. But this could well change if prices take a 'non-linear' path and project margins tighten. In such a case, there is the real risk that Australia could be bypassed as oil and gas producers seek higher capital returns in other countries.

**Policy principle: Australia's reputation as a world class energy exporter should be protected and enhanced.**

Australia has many advantages as a developed country with proven resource prospectivity and supply performance. But rising development costs and risks of unwarranted regulatory interference could potentially undermine the economic payoffs from the boom and lead to long term supply contracts being lost to other energy exporting nations.

### **Establishing a sovereign wealth fund**

Various options have been canvassed to secure the proceeds of the resources boom. These include introducing a resource rent tax (which the government has implemented and which will commence on 1 July 2012) and establishing a specialised sovereign wealth fund (SWF).

A SWF can serve a variety of aims so the exact policy rationale for its establishment needs to be defined in order to evaluate its effectiveness.

A SWF can assist with:

- moderating exchange rate appreciations (such as occur during a resources boom);
- smoothing national spending — consumption — so that swings in national income have a more limited impact on the wellbeing of families and businesses and the volatility of the business environment they face;
- saving (quarantining funds) for future fiscal imbalances for example an ageing population or public sector pension funds;
- fiscal revenue stabilisation (smoothing volatile revenue flows), which can be important for countries such as Australia whose government revenues are influenced by swings in commodity prices.

It should be noted that, whatever its merits, a SWF need not be funded by the resources industry alone — indeed, Australia's Future Fund has been financed through general government surpluses and proceeds from the sale of public assets.

That is an important point — there are two different questions here: whether Australia should have a SWF and, if so, how it should be financed.

Hence the debate around a SWF goes to the timing of when the nation spends the proceeds of the tax system, rather than how those taxes are raised in the first place.

However, there is a risk that, in practice, these two issues could be conflated and that a SWF explicitly linked to the current resources boom may be financed, at least in part, from additional imposts on the petroleum and wider resources sector (especially given the current state of Commonwealth finances).

If so, that could have serious implications for the industry — all the more so given its existing tax burden. Depending on how any such tax is designed, it could create distortions in the allocation of inputs between sectors of the economy and may restrict the level of growth emerging from the resources boom.

Other countries are sometimes lauded for their foresight in establishing SWFs. These plaudits need to be considered with some caution as there are significant differences between countries. In the case of Norway, for example, the resources sector comprises a larger share of the Norwegian economy than is the case in Australia and Norwegian oil reserves are expected to have a shorter economic life than Australia's overall energy and mineral resources endowment. Norway also faces a larger fiscal gap over the long term than does Australia. Furthermore, the fragile economics and challenges of developing gas projects are different from oil projects.

While SWFs can help a country to achieve specific policy objectives, they need to be carefully designed, with particular attention to minimising distortions in the economy. In particular, the value of a resource-related SWF needs to be weighed against the use of general budget surpluses as an instrument to reduce public sector debt.

**Policy principle: Policymakers should guard against backsliding on broader policy and institutional settings.**

Australia's fiscal and broader institutional settings have led to this resource boom being (largely) well managed, especially compared to previous booms. The petroleum resource rent tax has provided a stable and relatively predictable fiscal regime.

There have been calls for Australia to reframe aspects of its fiscal settings through establishing a (new) sovereign wealth fund to capture the benefits from high resource prices. A SWF can be used to meet particular policy objectives but needs to be carefully designed to minimise distortions between sectors and to ensure that funds are appropriately quarantined. Given the current budget position, it is difficult to see the establishment of a SWF as an immediate policy priority.

## **Conclusions**

In many respects, the toughest phase of the resources boom may be behind us. This is not to say that buoyant market conditions are ending — quite the contrary — but that the growth rates beyond the current phase of investment activity may well be slower.

There are many unknown dimensions of the present resources (super) cycle. History shows that disruptive events do happen — perhaps things we have yet even to imagine or conceive. The key is to be able to respond and adapt to changed circumstances and events. A crucial requirement is to remain an efficient, low-risk and competitive resources supplier to the world. This will provide Australia with a 'buffer' against adverse market conditions and reinforce our reputation as a preferred supplier.

This once-in-a-century resources boom could yield an economic dividend well into the future or be seen, in retrospect, as an opportunity at least partially wasted. Harnessing Australia's prodigious comparative energy advantage and spreading the economic benefits of the resources boom widely within the community represent the single most important policy challenge for governments over the coming decade.

## **Deloitte Access Economics**



# 1 Introduction

Australia is currently positioned at the cusp of a major shift in the world's economic weight from west to east. The rapid and pervasive industrialisation of structurally large Asian economies, predominantly China, has driven world economic growth over recent times and changed the dynamics of key international resource, product and capital markets.

These developments are perhaps the largest systemic shift in the world economy in 60 years and, for Australia, are being most prominently channelled through strong demand for our mineral and energy resources. In the oil and gas industry, sizeable developments — indeed some of the largest projects ever undertaken in Australia — are being progressed squarely focused on new and existing energy customers in Asia.

The rapid growth of Australia's oil and gas sector is not without challenges. Certainly, managing the impacts on non-resource parts of the Australian economy, so as to secure balanced development and a sustainable lift in Australia's prosperity over the longer term, raises significant policy issues and has been subject to considerable public and media commentary.

In this context, Deloitte Access Economics was commissioned by APPEA (Australian Petroleum Production & Exploration Association Limited) to assess the economic contribution of Australia's oil and gas industry. The study examines the industry's role in Australia's economic development — both over recent years and looking forward over the medium term. A key focus has been to draw out the specific economic implications of industry investment and operations and the commercial linkages with other sectors, essentially as industry activity reverberates through the broader economy.

As a complement to the more empirical aspects, the study also provides an analysis of 'bigger picture' economic issues of relevance to the industry and policymakers. In essence, it sets out those policy settings which will be necessary to fully harness the benefits of the resources boom.

## Report structure

The report is divided into the following chapters:

- **Chapter 2, Australia's oil and gas sector** — This chapter provides a brief profile of oil and gas operations across the country. It discusses the industry's development path, which has seen a transition from the exclusive development of conventional oil and gas reserves into a range of at-scale unconventional gas projects over the last decade or so. The regulatory framework covering the development and operation of oil and gas fields is also set out.
- **Chapter 3, A keystone of the economy** — The economic contribution made by Australia's oil and gas industry is explored in this chapter. In setting out the extent to which the industry has and will continue to elevate national income, the analysis takes a 'coast-to-coast' approach which examines the full spectrum of activities being undertaken across the country, including major project developments within northern Australia and the more mature parts of the industry, as well as substantial exploration activities.

- **Chapter 4, Strategic policy issues: securing the industry's potential** — Following on from the preceding analysis, this chapter canvasses the most pressing development and policy issues facing the industry. This includes: how the industry is supporting productivity performance; how best to manage the structural adjustments needed to secure sustainable economic gains from development in Australia's region; managing the proceeds of the resources boom; addressing workforce and skills shortages; and ensuring policy settings do not unduly contribute to broader development cost pressures.
- **Chapter 5, Conclusions** — This chapter provides some concluding remarks which emphasise the profound opportunities available for the industry, and indeed the country, from the efficient and globally-engaged development of Australia's resources endowment.

## 2 Australia's oil and gas industry

Australia is recognised as a leading energy exporter. The increasing industrialisation of the global economy, which is being driven by high growth Asian countries, has seen Australia's energy production increase in both value and quantity over recent years. There is soon to be a seismic shift in Australia's gas export performance with the development of various CSG to LNG facilities in Queensland. This will open up large export markets to east coast gas for the first time.

This chapter provides an overview of Australia's oil and gas industry and situates it within the broader context of the Australian economy as a whole.

### 2.1 Industry snapshot

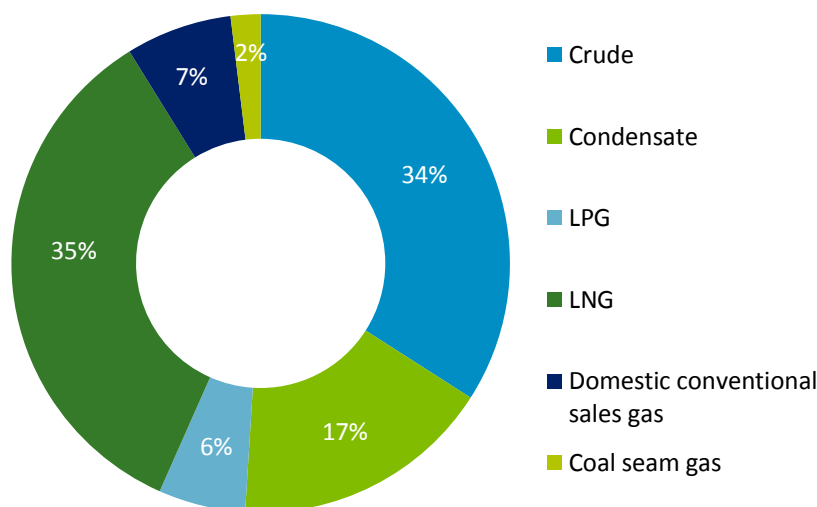
#### Product markets

The petroleum sector encompasses the exploration, appraisal, development, construction and production of natural gas and petroleum liquid resources. The upstream segment of the petroleum sector involves the processing and delivery of products to either export terminals or domestic gas transmission pipelines.

Over the past two decades, Australia's main petroleum product has alternated between crude oil and natural gas. However, in recent years the value of natural gas production has outweighed crude oil production. This reflects the combination of ongoing natural gas project expansions and less buoyant oil output.

In addition, natural gas is viewed as an environmentally efficient energy source as it has lower greenhouse gas and other emissions than coal. This aspect is a considerable advantage in the promotion of natural gas use in the context of Australia's clean energy future. In spite of upward trends, natural gas also remains a cheap energy source in Australia relative to areas such as Europe.

**Chart 2.1: Product segments in the oil and gas industry, 2011**



Source: BREE and APPEA

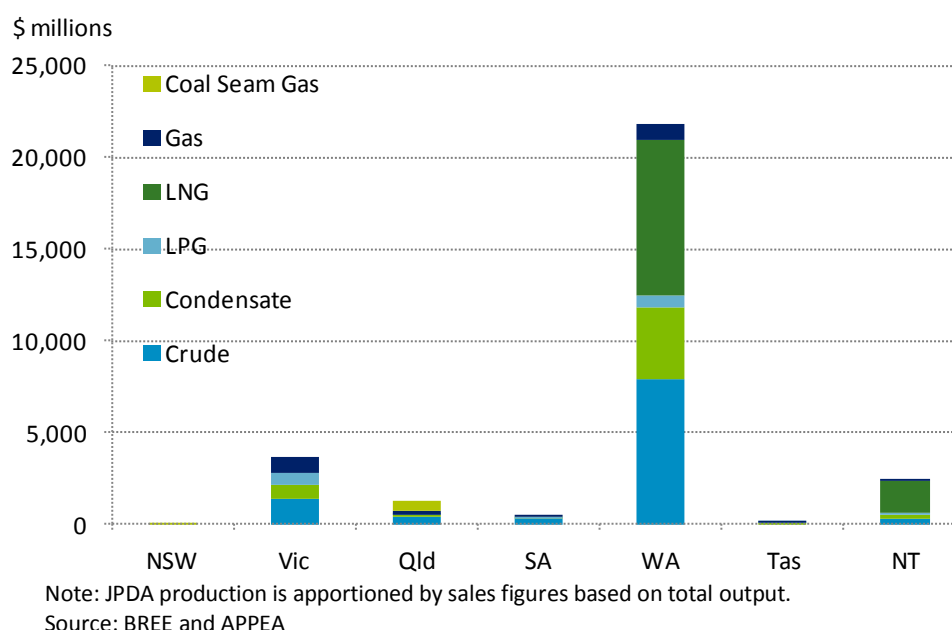
Much of the growth in the Australian natural gas sector has been due to the rapid increase in demand for LNG in global energy markets. In 2011, it is estimated that around 35% of upstream petroleum industry sales were attributed to LNG alone, compared to 34% for crude oil (Chart 2.1). It is likely that demand for natural gas and processed LNG will continue to expand. For instance, recently there have been notable increases in gas demand from Japan as it seeks to meet energy requirements by using less (or no) nuclear power.

## Geographic diversity

Most of Australia's oil and gas reserves (78% of crude oil and 92% of natural gas) are located off the coast of Western Australia in Commonwealth Waters, in the Bonaparte, Browse, Carnarvon and Perth Basins.

In 2011, it is estimated that about \$21.8 billion or 73% of industry sales originated from output produced in the offshore Commonwealth waters surrounding Western Australia (see Chart 2.2). Victoria accounts for the second largest share of petroleum sales, contributing around \$3.6 billion to industry sales, most of which is sourced from the Gippsland Basin. The Amadeus Basin in the Northern Territory and the Bowen-Surat Basin in Queensland also support a number of oil and gas fields.

**Chart 2.2: Sales from production by region, 2010-11**



Despite the high levels of oil and gas activity in parts of Australia, there are still extensive areas of land (onshore and offshore) that remain either unexplored or are presently underexplored. Therefore, it is likely that the geographic diversity of the industry will increase over time as more mature sites reach capacity and the search for untapped resources in other regions is initiated.

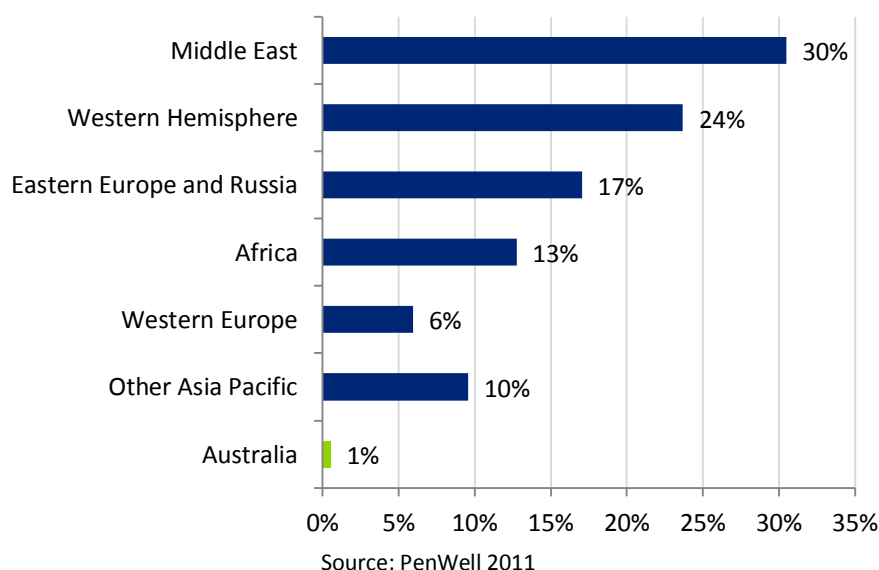
## Industry production and trade profile

Around half of upstream petroleum industry production is exported. The remainder of production is purchased and distributed by domestic firms operating in the midstream and downstream petroleum refinery, oil and gas supply and electricity generation markets.

### *Oil production and trade*

The country's oil production peaked in 2000, and since then has fallen almost 40% due to maturing oil wells in the Bass Strait and the basins off Western Australia. Australia's oil production accounts for a small share of world production, with the country's reserves also modest by global standards. As indicated in Chart 2.3, Australia's crude oil production of about 465,000 barrels per day represented approximately 1% of the worldwide total in 2011.

**Chart 2.3: Estimated share of world oil production, 2011**

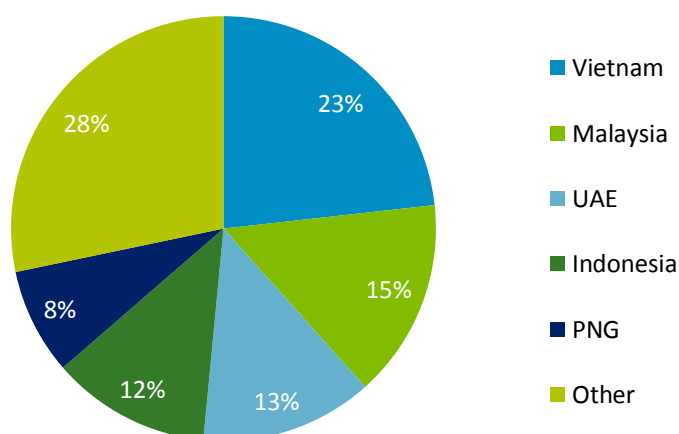


The trade profile of the domestic petroleum industry has changed in recent years. Australia has moved from its traditional position of being a net exporter of oil products to becoming a net importer in 2002. This is attributable both to an increase in the domestic demand for crude oil and a decline in Australian light grade oil production.

High global oil prices have led to crude oil becoming Australia's largest import in terms of value since 2006, accounting for around 6% of total imports (DFAT 2011). Much of the oil exported from Australia is light crude, a higher value product that is used for the manufacture of premium petroleum products such as automotive gasoline.

On the other hand, the heavy grade crudes used for the manufacture of fuel oils, diesel oil, lubricating oils and bitumen are imported. Crude oil exports are dominated by output from remote fields off the north western coastline, which can be more readily exported rather than being processed domestically. The trade profile of Australia's oil imports is shown in Chart 2.4.

**Chart 2.4: Oil import profile by value, 2011**



Source: ABS and RBA 2011

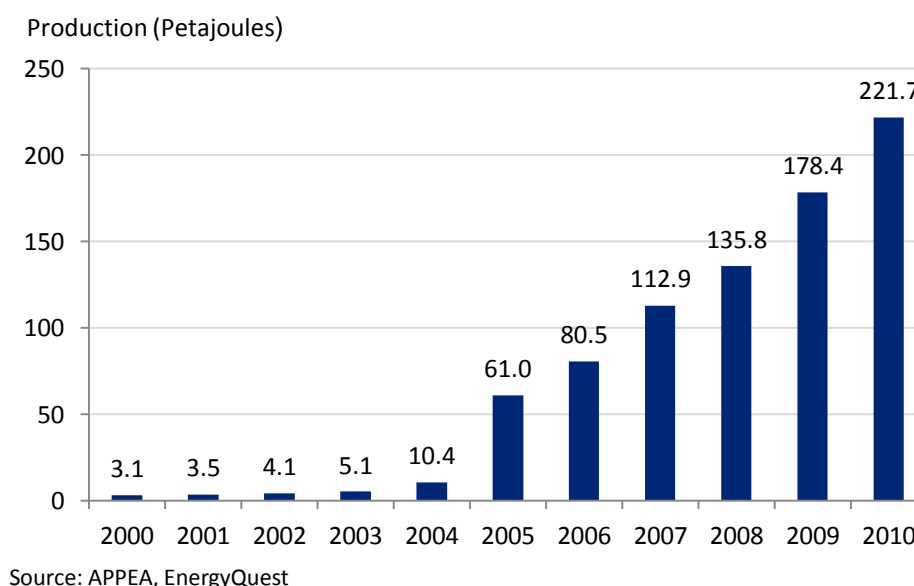
### *Gas production and trade*

Australian natural gas production has increased steadily since the 1970s, while the production of LPG has been more stable. The bulk of Australia's gas resources are located long distances from the large and urbanised eastern states (comprising Queensland, New South Wales, Victoria, Tasmania and South Australia).

Over the past decade, the CSG sector has shown remarkable growth (see Chart 2.5). Since 2000, production has increased from around 3 petajoules (pj) to about 222 pj in 2010. Importantly, the newer gas fields in the Gippsland, Bass and Otway Basins, located offshore to Victoria are relatively close to the major centres of population in eastern Australia. The further development of CSG reserves in New South Wales will also become a major source of gas for eastern Australia.

Despite these developments, production is still somewhat concentrated in the Queensland region, with output from the Bowen-Surat Basin representing approximately 30% of the Eastern Australian gas market. The continued growth of CSG production in Queensland has the potential to support a new large scale export industry based on LNG in addition to supplying domestic gas users. These developments will transform the eastern Australian gas sector, which until now — has entirely focussed on domestic supply — by establishing a major export industry. In addition, the extraction of gas for export markets is greatly supporting the economics of the supply of gas into domestic markets.

**Chart 2.5: Australian CSG production, 2000-2010**



Of the 46% of natural gas production which is exported, around half is sold to growing Asian economies (ABS 2011). Largely driven by Chinese growth and industrialisation, gas consumption this year is expected to reach 110 billion cubic metres, up more than 37% from 80 billion cubic metres only two years ago.

A similar dynamic is developing in India. Analysis conducted by McKinsey & Co (2010) found that India's natural gas demand is set to nearly double to 320 mcmd by 2015 from

the current 166 mcmd making the country a larger gas market than Japan. In 2030, India is also expected to increase LNG imports from 8 Mtpa to 26 Mtpa over the same period.

These growth rates offer huge commercial opportunities for oil and gas companies to entrench Australia as a major player in the global gas market. Vast deposits of CSG in Queensland, as well as large conventional gas reserves off the coast of Western Australia, are viewed as critical to meeting future Asian energy demand. Going forward, it is anticipated that liquid rich LNG developments (for instance, Ichthys and Prelude) will boost condensate and LPG production significantly.

## Oil and gas industry structure

The upstream petroleum sector is comprised of a diverse range of companies in terms and size and type of ownership. Petroleum products are then sold to downstream customers, such as oil refineries, gas retailers, and overseas markets. Specifically, the oil and gas industry encompasses two main phases: exploration and production.

The exploration sector comprises close to 300 companies which hold exploration permits. The higher number of market participants in this segment is congruent with the lower costs associated with the exploration phase of petroleum operations, especially when compared to the production phase. As a result, the petroleum exploration sector is characterised by lower barriers to entry and a relatively higher share of smaller businesses.

There are over a 100 companies across Australia who hold oil and gas production permits. The industry has traditionally been dominated by large businesses (with varying degrees of domestic ownership). The leading participants in the national oil and gas industry include companies such as BHP Billiton, Chevron Australia, ExxonMobil, Santos and Woodside — which together account for around 60% of oil production. Other mid-tier producers such as ROC, Beach Energy and AWE also play a considerable role in the oil and gas industry.

The upstream oil and gas sector is open to competition from domestic and foreign companies and attracts investment from a number of other large international business including Apache Energy, BP, ConocoPhillips, ENI, Inpex and Shell.

The majority of projects in the oil and gas industry are very large — an LNG development in Commonwealth waters with onshore processing can involve capital expenditures of well over \$10 billion. Reflecting the scale of projects, the production segment is also characterised by a higher number of joint ventures, with most onshore and offshore production licences issued to multiple parties.



## 2.2 Overview of industry development

### A brief history of development

Given the vast landscape of the Australian continent, there are still many underexplored sedimentary basins that may have substantial oil and gas resources. For the majority of these areas, the potential extraction levels are ambiguous. Accordingly, reserves are typically classified on a spectrum of certainty according to the terms ‘proved’, ‘probable’ and ‘possible’. Figure 2.1 illustrates that much of the known oil and gas reserves are concentrated in clusters across Australia.

**Figure 2.1: Identified oil and gas reserves in Australia, 2011**



Source: Geoscience Australia 2011

Currently, over 80% of Australia’s gas reserves and over 95% of oil reserves are located offshore, with reserves concentrated in the Bonaparte, Browse, Carnarvon and Gippsland Basins (DRET 2011). Other offshore resources include the Bass Basin, which contains Australia’s fifth largest reserves of LPG. Smaller oil reserves have also been identified in the Perth Basin while the Otway Basin contains small reserves of gas. The most substantial onshore petroleum reserves are located in the Cooper and Eromanga Basins.

Over time, the location of industry production has changed, reflecting the discovery of new reserves across Australia. For instance, earlier oil and gas discoveries in the Cooper, Eromanga and Gippsland Basins have reduced in their production profile while the contribution of newer discoveries in the Bonaparte, Browse and Carnarvon Basins to industry revenue has grown substantially. Importantly, these newer basins are yet to be fully exploited and represent a key source of future capacity for the sector.

As can be seen in Figure 2.1, basins often span multiple jurisdictions, especially where they extend more than three nautical miles offshore. A prime example is the Bonaparte Basin which straddles Western Australia and the Northern Territory, as well as Commonwealth waters and the Joint Petroleum Development Area with East Timor.

## Massive pipeline of new investments

Like any resource commodity, once oil and gas resources are extracted and sold, its direct revenue potential to Australia ends. Put simply, petroleum is a non-renewable resource. As Australia's petroleum resources are gradually depleted, the economic profile of oil and gas industry may also taper off — unless there is a continual pipeline of new investment to find and develop new resources.

This pattern of development is not isolated to Australia, but also applies to mature oil and gas producers around the world. Assuming petroleum demand continues to rise in line with rapid increases in world energy consumption, any supply pressures faced by global petroleum producers will drive up the market price for both oil and gas. Connected to this, higher prices will incentivise greater exploration and the discovery of untapped resources. Certainly, this is a point very much exemplified by the current investment and resources boom which has materialised due to the supply shortage and high price of resources Australia produces.

As such, much like the broader business community, the oil and gas industry is highly dependent on a continual stream of investment to underpin future growth. Therefore the forward contribution of the industry will be largely determined by:

- Underexplored frontier areas that will become attractive commercial investments.
- The consistent release of new exploration acreage covering a range of regions, including mature and frontier sites.
- Technological developments that will help unlock the full potential of new and existing discoveries (especially for gas reserves such as new unconventional gas production techniques).

There are many significant oil and gas investments which have been committed or are under construction around Australia. The Deloitte Access Economics Investment Monitor provides information on major (project costing over \$20 million) non-residential investment projects across Australia.

The Deloitte Access Economics Investment Monitor was used in conjunction with the Bureau of Resource and Energy Economics Major Mining Investments database to identify major oil and gas projects which are either currently under construction or have been committed. In total, 19 projects were identified and have been listed in Table 2.1. The total capital expenditure associated with these projects exceeds \$210 billion with over \$150 billion attributable to projects which are already under construction or where construction has recently finished.

**Table 2.1: Under construction and committed oil and gas projects**

Project	State	Type	CAPEX (\$b)	Operational start*
<b>APLNG</b>	Qld	CSG/ LNG	19.6	2016
<b>GLNG</b>	Qld	CSG/ LNG	16.0	2016
<b>QCLNG</b>	Qld	CSG/ LNG	20.4	2015
<b>Arrow Energy</b>	Qld	CSG/ LNG	15.0	2018
<b>Ichthys</b>	NT	Conventional LNG, LPG and condensate	30.8	2017
<b>Gorgon</b>	WA	Conventional LNG, domestic gas	43.0	2015
<b>Wheatstone</b>	WA	Conventional LNG, domestic gas	29.0	2017
<b>Prelude</b>	WA	Floating conventional LNG and LPG	8.9	2018
<b>Pluto (train 1)</b>	WA	Conventional LNG and condensate	15.3	2012
<b>Montara oil field</b>	NT	Oil	0.7	2013
<b>Kipper gas project</b>	Vic	Gas and crude oil condensate	1.7	2013
<b>Turrum oil field</b>	Vic	Gas and crude oil condensate	2.6	2014
<b>Balnaves</b>	WA	Oil and domestic gas	0.4	2015
<b>Fletcher Finucane</b>	WA	Oil	0.5	2014
<b>Macedon</b>	WA	Domestic gas	1.5	2014
<b>NWS North Rankin</b>	WA	Domestic gas	5.0	2014
<b>NWS Greater Western Flank</b>	WA	Domestic gas, condensate	2.5	2016
<b>Coniston</b>	WA	Oil	0.5	2013
<b>Devil Creek</b>	WA	Domestic gas	1.1	2011

Note: \*In some cases, the assumed start dates may differ slightly from other available sources. This is done because the start dates for some projects were insufficiently defined across data sources. In other cases, where start dates were specified to occur at the end of a particular financial year, production was assumed to reach the market in the following year.

Source: Deloitte Access Economics, BREE

Many of the large investments occurring in the oil and gas sector have been due to the rapid development of LNG operations in Australia. At present, there are several LNG projects at various stages of commercial development. Of projects under construction, four draw from gas fields in the north Western Australia (Gorgon, Prelude, Ichthys and Wheatstone) and three are in Queensland (Queensland Curtis LNG, Gladstone LNG and Australia Pacific LNG). A fourth major LNG facility at Gladstone (Arrow LNG plant) is at an advanced stage of commercial assessment, with a final investment decision expected later this year.

Other projects include the expansion of existing facilities to better extract previously unreachable resources. Case study 1 highlights an example in which Santos is using new extraction technologies to extend the economic life of its mature Cooper Basin resource.

### Case study 1: Breathing new life into mature reserves

The Cooper Basin in South Australia has been a cornerstone of Santos' Eastern Australian operations for over 40 years. Traditional conventional drilling techniques have been used for the majority of this time. However, over the last ten years, research and development of infill techniques have allowed Santos to extend the economic life of this world class resource.

It was observed that the Cooper Basin was materially under-drilled compared to North American standards. Following testing and pilot drilling in South Australia, Santos has introduced new drilling rigs and multi-pad drilling to develop new wells at closer spacing to improve gas recovery from existing reservoirs. Initial results from the drilling have led to the largest reporting of reserves at Cooper Basin in over a decade.



In addition to increasing the viable reserves at Cooper Basin, this technology is expected to reduce costs and improve cycle time. Other key benefits of the new 'game changing' technology includes the ability to undertake simultaneous operations, and continuous logistics, as well as reduced surface impact, cost reduction from shared surface facilities and reduced flowline connections (Santos 2012).

Santos is planning larger pads by the end of 2012, including trials of simultaneous drilling and production operations to further improve efficiencies, including Australia's first 20+ well pad. Under Santos' long term Cooper growth plans, the life of the Cooper Basin could conceivably be extended well into the coming decades.

## 2.3 Growth and changes in the sector

### Production technologies and techniques

Oil and gas resources have more often than not, been located in hostile and hard-to-reach environments, including in deep offshore waters or in the high temperature and pressure conditions encountered at the bottom of a reservoir. As a result, technology has always played a pivotal role in facilitating the efficient extraction and production of hydrocarbons.

Since the 1990s, innovations have enabled the development of natural gas from shale and other formations previously considered to be 'unconventional', as well as the development of traditional offshore and onshore formations. In fact, following the recent commercial viability status of CSG deposits across the country, Australia has become a leader in CSG technology and production. The reliance on technological innovations has been compounded by the growing trade intensity of the Australian oil and gas industry. More than ever, new oil and gas supplies are located at increasing distances from consuming markets. This has put greater emphasis on developing creative methods to transport output in a safe and effective manner to export (and domestic) markets.

In response to higher resource prices and the depletion of existing reserves, oil and gas companies have been prompted to undertake exploration in vaster and uncharted regions across Australia. This has meant that newly found resources are typically located in difficult terrain, increasing the complexity of the corresponding extraction and production techniques. Box 1 provides further detail about recent technological improvements in the oil and gas industry.

These technologies have not only expanded the potential volume of output that can be extracted and produced, but the efficiency with which these resources are lifted and processed. In addition, there has also been a concerted effort made by industry participants to enhance the safety and environmental outcomes associated with operations.

#### **Box 1: Technology advancements in the oil and gas industry**

A vast array of other techniques and technologies has been developed to provide greater access to mineral resources while increasing efficiency and accuracy. As a major resource exporter, Australia has been involved in designing new methods of exploration, extraction and production. These include:

- **Hydraulic Fracturing** — Operators open the gas-bearing layers by pumping fluids under controlled pressure into the targeted formations. Pressure exerted by the fluids creates fissures or ‘fractures’ in the rock. The fractures allow natural gas that would otherwise remain trapped in low-permeability rock formations to flow to the wellbore.
- **3D and 4D seismic imaging** — By amalgamating computer technology with traditional seismic imaging, it is possible for exploration teams to build a three dimensional model of below ground deposits, leading to quicker, easier and less costly identification of prospects. By adding time as a fourth dimension, teams are able to observe the change in underground characteristics over time.
- **Measurement while drilling** — These systems allow for real-time transmission of data collected from the bottom of a well as it is being drilled, particularly information on the rock formations that the drill is encountering. This increased information allows engineers to alter their drilling strategies where necessary, increasing accuracy and reducing the chance of damage to the underlying rock formation.
- **Slimhole drilling** — New technologies have allowed for wells to be drilled with bits of less than six inch diameter, providing access to deposits while being less than half the diameter of traditional drill-bits. This decreases the environmental impact of drilling, as well as increasing efficiency.
- **Offshore drilling technology** — Improved offshore rigs can drill deeper than was traditionally possible, allowing access to resources which were previously unattainable.

### *The future of technological developments*

As global energy consumption continues to rise, further technology advancements will be vital to ensuring that the production of oil and gas keeps in pace with demand growth. The relatively high cost operating environment in Australia compared to other major supply regions has also encouraged investment in oil and gas research and development (R&D) activities as a potential means of remaining competitive in export markets.

Though a number of tests are conducted before a new technology can be proven viable for market acceptance, it is envisioned that in future, new and innovative technologies can help businesses remotely and automatically monitor wells and fields. This will ensure that preventative measures can be taken more readily and minimise production downtime. Such innovations have the potential to raise production through better finding and recovery rates, reduced lifting, operational and overhead costs.

Where CSG was once perceived as a by-product of mining, energy companies and investors have focused on the significant economic potential of harnessing this resource. Already more than 4,000 km of transmission pipelines have been built for the transport of CSG for processing. A further 16,000 pj of proved and probable reserves have been identified, equating to around 15 trillion cubic feet of gas. Put into context, this amount is enough to power an average Australian city of one million people for almost 300 years (Deloitte Energy and Resources).

Most predominantly, there has been growing interest in the conversion of CSG to LNG. Cooling natural gas to about -161°C at normal pressure results in the condensation of gas into liquid form (or LNG), effectively reducing its volume by more than 600 times. In this way, liquefaction provides an economic means for transporting natural gas over long distances. LNG is typically transported by a specialised tanker with insulated walls, and is kept in liquid form by auto-refrigeration. This brings production from remote gas reserves in Australia closer to market. Advances in technology will reduce the costs associated with the liquefaction and regasification of LNG, further supporting its imminent significant trade profile. Across Australia there are four prospective CSG to LNG projects currently in development in Australia.

To develop the remote Prelude gas fields in the Browse Basin off Western Australia, Shell is currently constructing the world's first floating LNG (FLNG) facility, expected to begin producing 3.6 mtpa from 2017 onwards. Further information about the cutting-edge technology employed by the Shell Prelude FLNG facility is provided in Case study 2.

## Case Study 2: Shell Prelude FLNG: a new frontier for the LNG industry

Much of Australia's discovered world class petroleum reserves are located offshore and far from the mainland. The development of such resources requires a range of innovative and cost-effective engineering solutions, which must overcome the challenges of distance and operating in a demanding marine environment.

New exploration and extractive technologies will become increasingly important as most of the world's (and Australia's) largest and easy-to-find gas reserves have been discovered. Smaller and more remote fields will therefore become essential components for future supply.

To develop the remote Prelude gas fields in the Browse Basin off Western Australia, Shell is currently developing what is anticipated to be the world's first floating LNG (FLNG) facility. The gas field is located in Commonwealth waters, over 200 km from the nearest point on Western Australia's coastline and approximately 475 km north-northwest off Broome.

### *A floating LNG train*

Shell's proposed FLNG facility would be one the largest floating structures ever built. It will be 488 m long by 74 m wide, and weigh 600,000 tonnes when fully ballasted. The facility will be moored to the seabed via a rotating turret that will enable the facility to manoeuvre in synchrony with sea and wind movements (similar to a weathervane).

The facility can also stay on location, its sheer size allowing it to withstand very severe weather conditions. The hull of the facility is designed to have a 50-year life and the topsides around 40 years. Shell expects to have the facility at one location for around 20-25 years before bringing it back to dry dock to refurbish the topsides and then potentially moving it to new development.

Shell's FLNG facilities will be built in Samsung's shipyards in South Korea, one of the few places in the world large enough to accommodate construction of a facility of this size, as part of a consortium between Shell, Technip and Samsung (TSC).

### *Operational profile*

The facility is designed to produce approximately 3.6 million tonnes per annum of LNG, as well as LPG and condensate. The facility will stay over the Prelude field for approximately 25 years.

Shell's FLNG facility will be able to receive production fluids from the field and process and treat the gas to produce LNG, condensate and LPG. The main gas liquefaction process uses steam-driven refrigerant compressors and utilises cold seawater from a depth of around 150 m for cooling.

Frequent vessel traffic to and from the facility is anticipated. This will include around four LNG tankers per month, one LPG tanker per month, and two condensate tankers per month, as well as supply vessels and supporting tugs.

FLNG technology is an important development for the LNG industry. It reduces both the project costs and environmental footprint of an LNG development because there is no need for long pipelines to shore; compression platforms to push the gas to shore; nearshore works such as dredging and jetty construction or onshore developments.

The development illustrates the industry's ability to continually push the technical envelope to enable development of very remote (possibly 'stranded') or smaller gas reserves that otherwise would not be financially viable using a conventional onshore approach.

*(continued next page)*



### **Continued: Shell Prelude FLNG: a new frontier for the LNG industry**

#### *Key facts*

- The Prelude FLNG facility will be 488 m long and 74 m wide — one of the largest floating structures ever constructed
- The FLNG facility will stay moored in water 250 m deep for 25 years
- The FLNG facility is designed to be capable of withstanding a 1 in 10,000 year weather event, which is more extreme than a category 5 cyclone



### **A growing LNG export market**

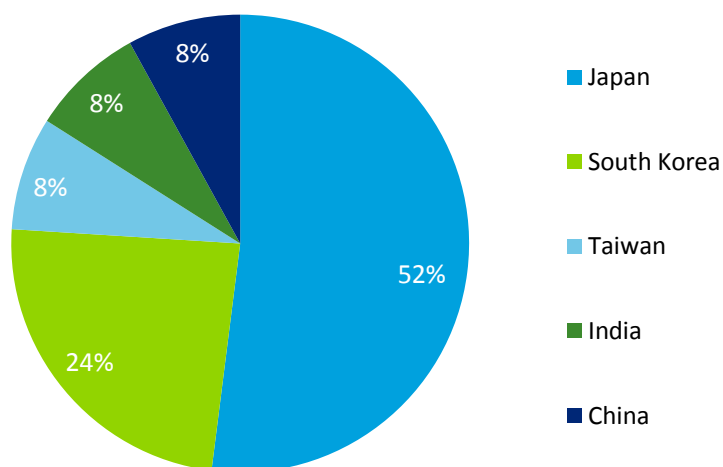
While the international pipeline-based natural gas trade is about twice the size of LNG trade, a considerable expansion of LNG global trade is underway, with Australia likely to emerge as the second largest supplier in the coming years, behind Qatar.

Around \$165 billion of capital investment has been pledged for LNG projects that are either under construction or are classified as committed, under consideration and possible (Deloitte Access Economics Investment Monitor 2012). If all these projects proceed as planned, Australia's LNG exports are likely to increase more than three-fold over the next five years (Christie et al 2011). In terms of actual output, LNG is expected to grow by around 250% between 2011 and 2018.

It is therefore possible that LNG exports may well approach the likes of coal and iron ore in terms of their contribution to total export earnings in the longer term. Driving this extraordinary increase in capacity is strong demand from LNG export markets in the Asia-Pacific region (see Chart 2.6).



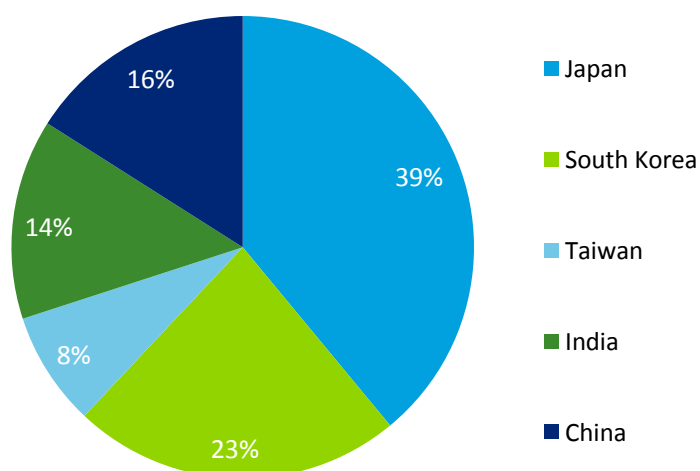
**Chart 2.6: Asia-Pacific LNG demand (mtpa), 2011**



Source: BP 2011

The composition of LNG demand in the Asia-Pacific region is expected to change significantly over the next 20 years. Currently, the LNG market is dominated by traditional buyers in Japan, Korea and Taiwan. However, due to the slower economic growth predicted for this group, LNG exports to these countries are forecast to be flat over the period to 2030. As China and India continue to expand at rapid rates, their energy consumption will increase accordingly. China for example, is expected to increase imported LNG from around 3 mtpa in 2010 to close to 30 mtpa in 2030 (see Chart 2.7).

**Chart 2.7: Asia-Pacific LNG demand (mtpa), 2030**



Source: IEEJ 2011

## 2.4 Regulatory framework

The oil and gas exploration and extraction industry is subject to a substantial amount of legislation and regulation from both state and federal bodies. These regulations surround occupational health and safety, structural integrity, resource management and land access, taxation and environmental issues, amongst others. There has been significant regulatory reform in the upstream petroleum market in the last decade, aimed at increasing transparency and decreasing regulatory burdens and associated costs.

### *Offshore operations*

In the upstream petroleum market, including offshore crude oil drilling, the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) has been established to consolidate the regulation of environment and safety around Australia outside of state waters (and within state waters for jurisdictions that have conferred their legitimate powers). The *Maritime Transport and Offshore Facilities Security Act (2003)* was amended to provide more certainty for regulators and companies by establishing a legislative basis for approving security plans for offshore oil and gas facilities.

Offshore petroleum activities are primarily taxed under the Petroleum Resource Rent Tax (PRRT), which is levied at the rate of 40% on taxable profits of petroleum projects. The PRRT is to be extended to onshore projects from 1 July 2012 although royalties and production excise can be credited against a project's PRRT liability.

### *Gas markets*

Domestic gas market reform over the past decade has increased transparency and competition in the sector, as well as brought industry regulation under the national energy framework. Standing Council on Energy and Resources (formerly Ministerial Council on Energy) initiatives such as the National Gas Law and National Gas Rules, National Gas Market Bulletin Board (BB) and the Short Term Trading Market (STTM) for gas have provided a framework for greater transparency.

### *Environment and heritage*

While not petroleum specific, environmental legislation affects the oil and gas sector as it regulates its interaction with the surrounding environment, including biodiversity. The *Environment Protection and Biodiversity Conservation Act 1999* is the key piece of Commonwealth legislation governing environmental issues. States and Territories also have their own laws concerned with the protection of the environment in onshore areas, coastal waters and provisions for heritage areas and development.

The Commonwealth *Aboriginal and Torres Strait Island Heritage Protection Act 1984* also ensures that heritage areas and significant cultural areas and objects are protected in accordance with tradition.

### *Native title laws*

There are no native title rights to minerals, petroleum or gas, however, in many cases land access must be negotiated with Indigenous people. This includes access to land for exploration as well as for mining. All jurisdictions are subject to the *Native Title Act 1993*, which establishes the way in which dealings with native title may proceed.

Indigenous land use agreements (ILUAs) and the 'right to negotiate' (RTN) procedure are applicable to current and future uses of land respectively, where they are suitable to the circumstances. The National Native Title Tribunal may be asked to arbitrate and determine the outcome of an application under the RTN procedure where parties cannot reach agreement.

### *Occupation Health and Safety*

OHS regulation varies depending on whether operations are onshore or offshore. Offshore activities are managed by the National Offshore Petroleum Safety Authority (NOPSA) with the major piece of legislation being the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGSA) which is administered and enforced by NOPSA.

On the other hand, onshore operations vary according to jurisdictional OHS regimes. This may be under principal OHS acts, industry-specific regimes or regulation via dangerous goods or major hazards legislation.

### *Taxation*

There are a range of taxes and royalty rates on petroleum production in Australia. Commonwealth taxes include the PRRT, crude oil and condensate excise tax, company tax and resource rent royalty. State and Territory royalties are also applicable for onshore resources and those in coastal waters.

## 3 A keystone of the economy

This chapter examines the economic contribution made by Australia's oil and gas industry. It takes a nation-wide approach, incorporating the range of major project developments across northern Australia and the industry's more established operations. The analysis also integrates the substantial expenditures in exploration activities being undertaken by the industry to discover and prove up the next components of our natural resource endowment.

### 3.1 Modelling approach

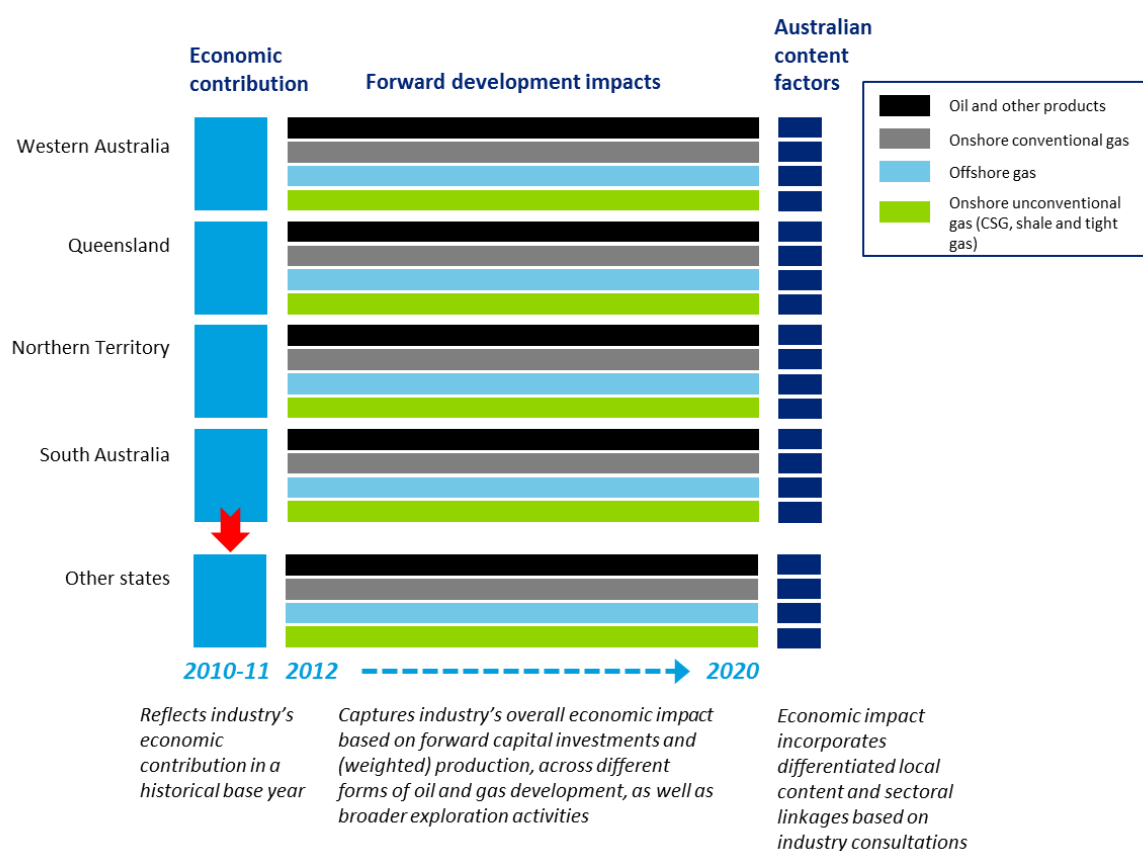
In order to highlight the oil and gas industry's overall contribution to the Australian economy, the analysis comprises of two discrete components:

- **A 'snapshot' economic contribution of oil and gas operations** — Quantifies the value of the industry's output in the 2011 reference year. As part of this analysis we have also included how this contribution will grow over the modelling period.
- **A forward looking economic impact analysis** — This part of the analysis recognises the unprecedented level of capital investment which is currently committed by the industry, and the value of production once this additional capacity comes online. Importantly, this captures the industry's contribution over and above its significant production and export profile. This empirical analysis is undertaken within a general equilibrium modelling framework using the DAE-RGEM model.

The economic impact analysis is undertaken using a 'mezzanine' approach (see Figure 3.1), which effectively layers various aspects of the industry's activities across the country.

- It distinguishes between projects in different states and territories, allowing results to be reported on a state and national basis.
- It recognises diverse project extraction methods (eg offshore LNG or onshore CSG production) and key differences in development profiles.
- It recognises that there are different inherent levels of local content for projects — based on factors such as capital intensity, whether projects are land based or offshore, and whether conventional or unconventional extractive techniques are employed.

Figure 3.1: Stylised empirical framework

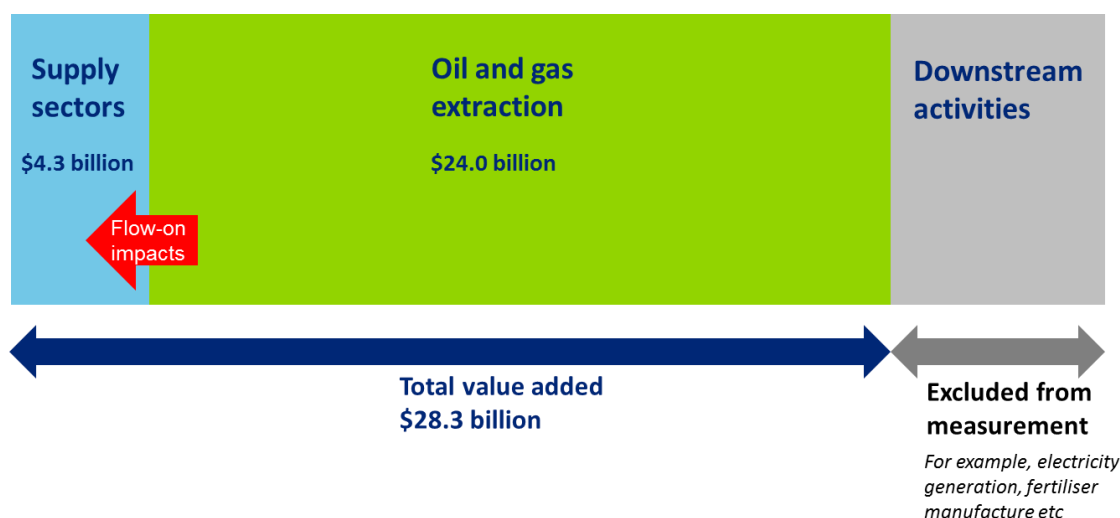


## 3.2 Economic contribution analysis

The extraordinary level of investment and growth in the oil and gas industry is exerting significant influence within the regions in which these resources are located and indeed on the broader Australian economy. This analysis measures two dimensions of the oil and gas industry's current (or 'snapshot') economic contribution:

- The first measures the direct impact of oil and gas operations. This is based on the value added through the sales of production from individual projects. The direct impacts are usually the largest component of an industry's economic contribution as they represent the primary commercial benefits associated with its core operations.
- The second aspect involves measuring the flow-on, or indirect contribution of oil and gas projects. This is the value added generated in other sectors of the economy through the upstream oil and gas sector's intermediate demand linkages. The flow-on contribution is based on the profits and wages paid in other sectors, namely supply sectors, where the benefits associated with increased oil and gas activity are typically highest.

Figure 3.2 outlines which elements are quantified within the economic contribution analysis.

**Figure 3.2: Profile of the industry's current economic contribution**


Source: Deloitte Access Economics

### A snapshot of the current flow-on economic contribution

Overall, the oil and gas industry contributed around \$28.3 billion to the Australian economy in 2011. This accounts for around 2.0% of the national economy. A considerable portion, around \$24.0 billion, of these overall gains are accrued by core oil and gas operators. In essence, what this means is that the extractive processes and related refining operations themselves are both extremely capital-intensive and value added. While in absolute terms there are extensive linkages with other sectors of the economy involving the provision of critical support services (see below), in a relative sense most of the economic value is created directly by industry (ie 'in-house').

The remaining \$4.3 billion of the economic contribution is distributed among supplying industries across the economy. Such industries include exploration support and professional services, maintenance and construction, transport and storage and wholesale trade (see Table 3.1).

**Table 3.1: Linkages with other sectors in the economy**

Sector	Flow-on contribution (\$b)
Maintenance and construction	0.8
Exploration support and professional services	0.8
Transport and storage	0.4
Wholesale trade	0.1
Other downstream	2.2
<b>Total</b>	<b>4.3</b>

Source: Deloitte Access Economics

It is also important to recognise that linkages between sectors have regional, interstate and international dimensions. Therefore, the place in which goods and services for the oil and gas industry are procured has significant implications for the dispersion of economic activity, whether this occurs within Australia or involves overseas companies which

specialise in oil and gas equipment. At the local level, for example, opportunities in the resource industry have allowed a range of innovative resource service companies to emerge and fill niche requirements in global supply chains.

The economic activity around the oil and gas industry has led to the development of significant commercial clusters servicing it, notably those in Perth and Brisbane. This is illustrated in Case study 3 below. Moreover, the large financial services sector in Sydney and Melbourne are also heavily linked to the oil and gas industry, providing key support for transactions, capital raising and debt management functions.

### Case study 3: Creating new city service hubs

The significant economic activity associated with Australia's oil and gas industry has led to the emergence of significant clusters of commercial services firms, most notably in Perth and Brisbane.

These hubs have largely developed 'organically' to help support the rapid advancement of oil and gas projects, providing a range of commercial, legal, environmental, logistics and other services. In many areas these hubs have involved the growth of dedicated teams within existing services firms, but other more specialised service providers and high-value manufacturers have also emerged in line with the broader industry. Importantly the existence of these core hubs (especially in Brisbane) has helped support commercial property markets during the global downturn.

More broadly, other services which support the oil and gas industry include companies related to warehousing, electricity, gas water and waste services, construction, wholesale trade, accommodation and food services, rental, hiring and real estate services, education and training and health care and social assistance. The International Mining for Development Centre (2012) notes a number of requirements for successful clusters in mining services:

- diverse, deep and long life customer base;
- existence of market leading/large firms — both customers and leaders;
- existence of an entrepreneurial ethos amongst leading firms;
- networking and partnership relationships;
- access to innovation and R&D capacity — through regional institutions or other companies;
- existence of a skilled workforce (strong human capital base), plus training infrastructure;
- business infrastructure, and community infrastructure for workforces; and
- access to adequate sources of finance.

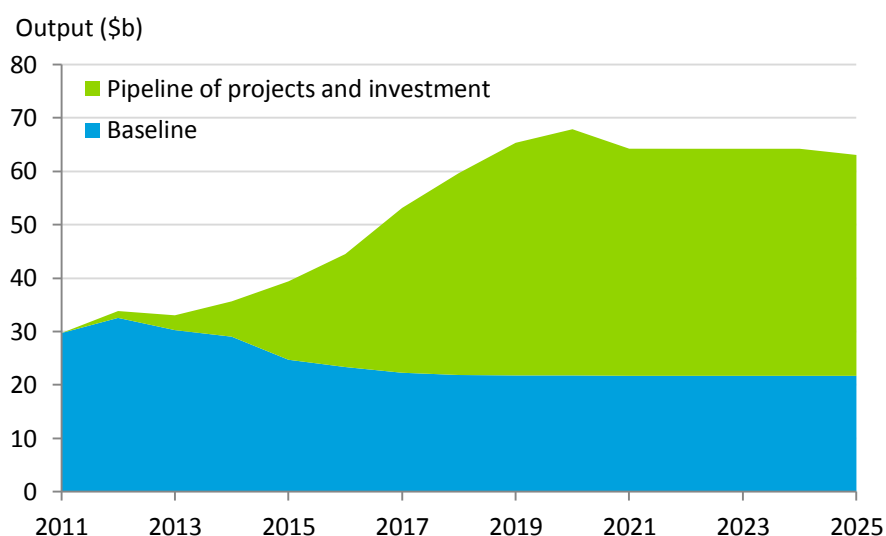
The emergence of a thriving mining services hub, associated with the oil and gas industry and the hard rock mining sector, stands as a concrete example of the industry spillover benefits emanating from the resources boom. In many ways, the ongoing development of these forms of clusters will play a large role in advancing Australia not only as an efficient producer of resources but as a world class provider of high value services to resource projects globally.

## A forward economic snapshot

While the current contribution of the oil and gas industry is already substantial, given the scale and number of investments being made by the sector — the ongoing and future economic contribution of the sector is estimated to be much more significant. Going forward, the dispersion and timing of gains across the national economy depends on the stage of development of individual projects.

At present, the oil and gas industry is in the midst of an unprecedented expansion phase due to the redevelopment of current projects and the construction and development of new sites. In total the sector is forecast to increase output to about \$68 billion in 2020 and \$63 billion by 2025 (see Chart 3.1). Over the same period existing developments are projected to decrease in output value from \$29.7 billion today to about \$22 billion in 2025 as reserves are generally depleted and production slows.

**Chart 3.1: Oil and gas industry output profile, existing and new developments**



Source: Deloitte Access Economics

Despite the record increase in production associated with new LNG projects, a significant exploration effort will still be needed in order to continually extract resources from new and existing reserves. Based on projected levels of expenditure, the value added generated by exploration activities is estimated to be around \$1 billion over the period 2011-2025. This essentially adds to the overall value added created through oil and gas operations. Therefore, the total forward contribution of the combined oil and gas and exploration sectors are forecast to be approximately \$66 billion in 2020 and \$61 billion in 2025.

The share of the oil and gas industry (and associated exploration activities) to Australian GDP also increases from 2.1% to 2.8% in 2025, with a peak contribution of 3.5% in 2020 as additional industry production reaches its maximum level.

The majority of the economic contribution is projected to stem from direct oil and gas operations, representing \$55.0 billion and \$51.1 billion in 2020 and 2025 respectively. Core oil and gas activity also accounts for 2.3% of the increase in the sector's contribution to national output.

Further estimates around the future economic contribution of the industry can be seen in Table 3.2.



**Table 3.2: The economic contribution of the oil and gas industry**

	NPV (2011-25)	2011	2020	2025
<b>Oil and gas</b>				
Value added (\$b)	420.0	28.3	64.7	60.2
Direct value added (\$b)	356.7	24.0	55.1	51.1
Indirect value added (\$b)	63.3	4.3	9.8	9.1
Direct value added, share of GDP (%)		1.7	2.9	2.3
Total value added, share of GDP (%)		2.0	3.5	2.7
<b>Exploration</b>				
Value added (\$b)	9.1	1.1	0.8	1.1
<b>Total</b>				
Value added (\$b)	429.1	29.4	65.5	61.2
Share of GDP (%)		2.1	3.5	2.8

Note: NPV uses a discount rate of 7%

Source: Deloitte Access Economics

### *Broader flow-on benefits*

The indirect or flow-on contributions also increase over time. The amount of value added generated in supplying industries increases to \$9.8 billion in 2020 and \$9.1 billion in 2025. The spread of these flow-on gains largely depend on the location and timing of project delivery. For instance, during the current capex phase, a large share of resource sector expenditure involves sourcing machinery and equipment. Moreover, consistent with the requirements of installing large-scale capital works, the capex phase commonly encompasses significant use of construction, manufacturing and professional services, supporting activity and employment in these industries.

ABS figures suggest combined employment in the manufacturing and construction industries has doubled from 4% in the decade from 1993 to 2003, to over 8% in the period between 2003 and 2012 — with much of this growth on the back of the oil and gas and broader resources boom. Commonwealth Treasury forecasts (2012) indicate the resource related sectors will grow over 5% a year. By contrast, non-resource related sectors are predicted to grow at an annual rate of 1%.

In addition, the oil and gas industry demands high quality inputs in order to export and compete in global markets. This has helped foster leading edge resource services firms to invest in oil and gas extraction and production R&D initiatives. The surge in oil and gas investment has also resulted in the greater use of contracted specialist engineering and consulting firms. The ability to efficiently project-manage, extract and produce more output will become crucial as lower cost international petroleum producers mobilise over the medium term. One example of such a company is Pressure Dynamics, based in Perth (see Case study 4).

#### Case study 4: Emergence of world class mining service companies

The opportunities in Australia's resources sector have enabled a range of innovative mining service companies to emerge and fill niche positions in global supply chains. An example of such a company is Pressure Dynamics, based in Perth.

Pressure Dynamics is a hydraulics company that offers services that it found lacking in the market — including design, manufacturing, supply, repair and installation of hydraulic, electrohydraulic, pneumatic components and complete turnkey control systems. It offers system design, electronic interfacing, engineering consultancy services, component supply, manufacturing, installation and repairs of fluid power equipment to the oil and gas industry, among others.

The company services both Australian and international companies, demonstrating the flow-on potential of the sector to support innovative industries along the supply chain through access to significant global markets.

##### *Contribution to the Shell Prelude FLNG project*

A major upcoming project for Pressure Dynamics will be the contract to design and manufacture the subsea control system Production Hydraulic Power Unit (PHPU) for Shell's new Prelude gas field, as part of the largest floating offshore facility in the world (see Case study 1).

Pressure Dynamics' role in this project will involve the installation of the PHPU in the turret of the FLNG facility, supplying the regulated hydraulic pressure necessary to maintain the flow of natural gas from the subsea production trees as well as ensuring an effective Emergency Shut Down (ESD) if required. The company will also be responsible for design and manufacture of three essential test and flushing systems required for commissioning the subsea control system. This equipment is to be delivered in August 2012.

It is likely that the use of construction and manufacturing in resource support services will decline as industry investment peaks. Based on current data, the capex phase is expected to peak in 2015. It is relevant to note that as new discoveries are made and future project developments are announced, the capex phase may be greater and extend beyond what is currently anticipated.

As the industry transitions to an operational (opex) intensive phase, the composition of supplying industries which benefit from production activities may change. Following project commissioning, smaller on-site workforces are typically required. This by no means implies that the flow-on contributions to regional and national employment will dissipate; rather the supply side industries supporting the project will change according to production, processing and distribution requirements. The differing functions of the opex phase rely on other segments of the resources support sector, including the maintenance, transport and wholesale trade industries. These sectors are utilised to manage the movement of upstream oil and gas to midstream and downstream sectors.

In addition, the industry is directly responsible for the supply of reliable energy supplies that underpin many other sectors of the economy, including electricity generation, as well as the consumption of gas for domestic purposes.

## Estimating industry tax payments

There are also a number of social and wider flow-on impacts that form a part of the ongoing contribution of this sector. For instance, the revenue created by the growing oil and gas sector is taxed and in some cases used to expand the supply potential of the economy. This is achieved by investing in the infrastructure around oil and gas sites and encouraging training in resources and support industries.

The taxation arrangements for oil and gas projects are complex, as is the interaction between taxation regimes. Oil and gas companies are subject to three main taxation regimes:

- corporate income tax which applies at a rate of 30%;
- royalties which apply at a rate of between 10% and 12.5% of the well head value depending on a project's location; and
- the PRRT which is imposed at a rate of 40% of the value of profits on a project.

The PRRT will be extended to onshore projects from July 1 2012. These three taxes formally interact (often in a complicated manner) as royalties fully offset PRRT liabilities from a project, while the payment of royalties and PRRT are deductible against corporate income tax.

Given the complexity of the petroleum taxation regime, the volatility of commodity prices (which can have large impact on a project's profitability) and the challenges associated with accurately forecasting project costs, it is difficult to project how much tax will be paid by the oil and gas industry in the future.

### *Two estimation scenarios*

To provide a broad indication of how much tax the oil and gas industry is likely to contribute over the period to 2025, two scenarios were developed:

- A low scenario which assumes that a base level of resource taxation is paid to the period 2025 at the rate of 2.5% of gross sales value for new oil and gas projects.
- A high scenario which assumes on average that a higher level of petroleum royalties are paid over the period, based on 5% of a project's gross sales value of petroleum sold. Deloitte Access Economics regards the second scenario as more likely, although this will depend on underlying cost structures for individual projects.

Currently, the oil and gas industry pays approximately \$7.9 billion in tax, consisting of \$4.4 billion on corporate taxes and \$3.5 billion in production taxes (which include royalties and excise, PRRT and other taxes). The output of existing projects, particularly those producing crude oil and condensate, is forecast to decline over the period to 2025. Based on projections of future output, these projects are nonetheless estimated to contribute around \$5.8 billion in tax in the 2025 financial year (in 2011-12 dollars), consisting of around \$3.2 billion in corporate income tax and \$2.6 billion in production taxes.

The 19 new oil and gas projects which have been modelled are also projected to contribute to taxation revenue at an increasing rate as production ramps up. By 2025 these projects are projected to contribute \$6.3 billion per annum in taxation revenue under the low scenario (\$5.3 billion in corporate income tax and \$1 billion in production taxes) and

\$7 billion per annum under the high scenario (\$5.0 billion in corporate income tax and \$2.1 billion in production taxes). Under the high scenario, corporate income tax payments fall slightly as a result of the higher production taxes being used as deductions.

These results suggest that by 2025 the oil and gas industry is projected to contribute over \$12 billion in taxation revenues a year (see Table 3.3). While these numbers should be seen as indicative given the volatility of commodity prices and cost structures for individual projects, they suggest that the pipeline of new projects is projected to provide substantial fiscal contributions over next decade and beyond.

**Table 3.3: Oil and gas tax payments, selected years and NPV**

<b>Contribution (\$b)</b>	<b>NPV* (2011-25)</b>	<b>2011</b>	<b>2020</b>	<b>2025</b>
Corporate	61.2	4.4	9.1	8.5
Production taxes	32.4	3.5	3.7	3.6
<b>Total</b>	<b>93.6</b>	<b>7.9</b>	<b>12.8</b>	<b>12.1</b>

Note: NPV uses a discount rate of 7%

Source: Deloitte Access Economics

### 3.3 New developments: the economy-wide impacts

As outlined above, the Australian oil and gas sector is undergoing high levels of actual and planned investment which will dramatically expand operational output over the short to medium term. The above discussion has provided an account of the economic contribution of the sector's operational activity. This section of the report examines the economy-wide impacts of both the capital expenditures and the additional output coming on stream.

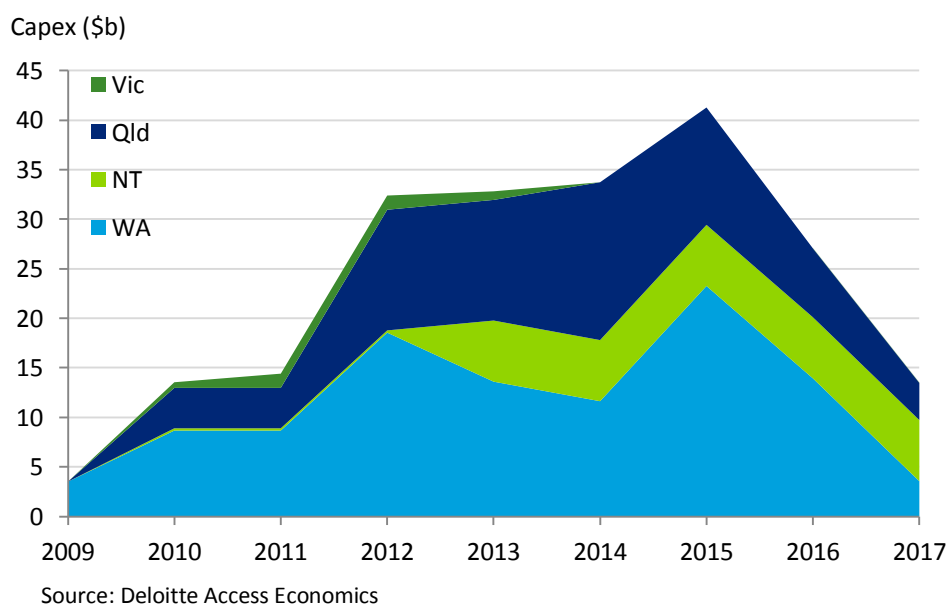
This aspect of the analysis has utilised the Deloitte Access Economics' in-house computable general equilibrium model.

#### Investment and output path

It is anticipated that the projects outlined in Table 2.1 will spend on average \$23 billion in capital outlay a year over the period 2009 to 2017, or about \$210 billion in total. During the opex phase these projects are modelled to increase oil and gas output by a peak of \$46 billion in 2020 and just over \$41 billion at the end of the modelling period 2025.

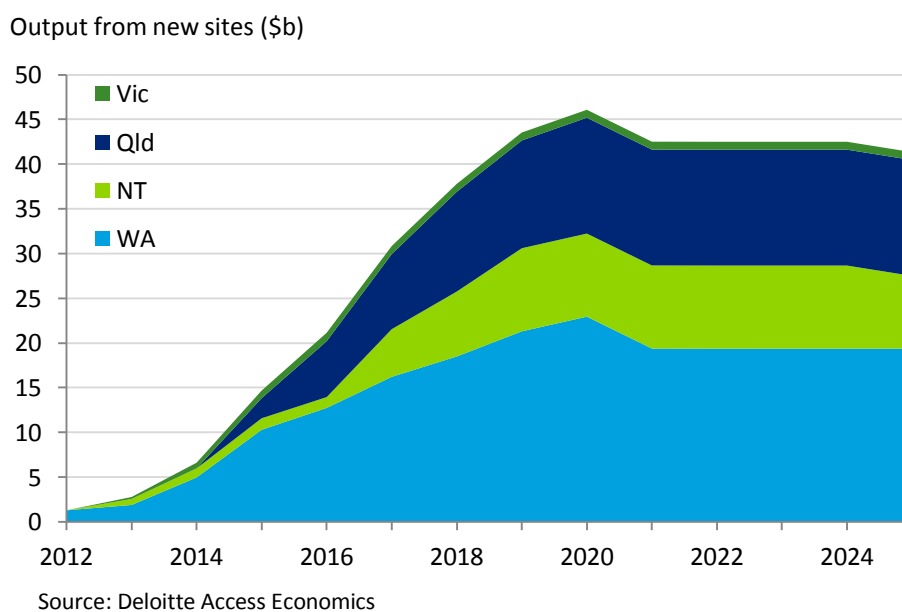
Chart 3.2 illustrates the pattern of capex investment, which peaks at around \$41.3 billion in 2015. Based on the scheduling of currently committed projects, most of the additional capital expenditures conclude by 2017. However, it is highly likely that additional projects will be committed over the intervening period, in which case the profile of capital expenditures will extend beyond 2017.

**Chart 3.2: Oil and gas industry capex profile**



As investment rises, the output capacity of the oil and gas industry expands considerably. Chart 3.3 shows the amount of output generated as new project investments come on stream. It can be seen that as capex begins to decline over time, the amount of new output in the oil and gas industry accelerates — peaking at \$46.1 billion in 2020, before stabilising to around \$42 billion over the period to 2025.

**Chart 3.3: Medium term oil and gas output growth, 2012-2025**



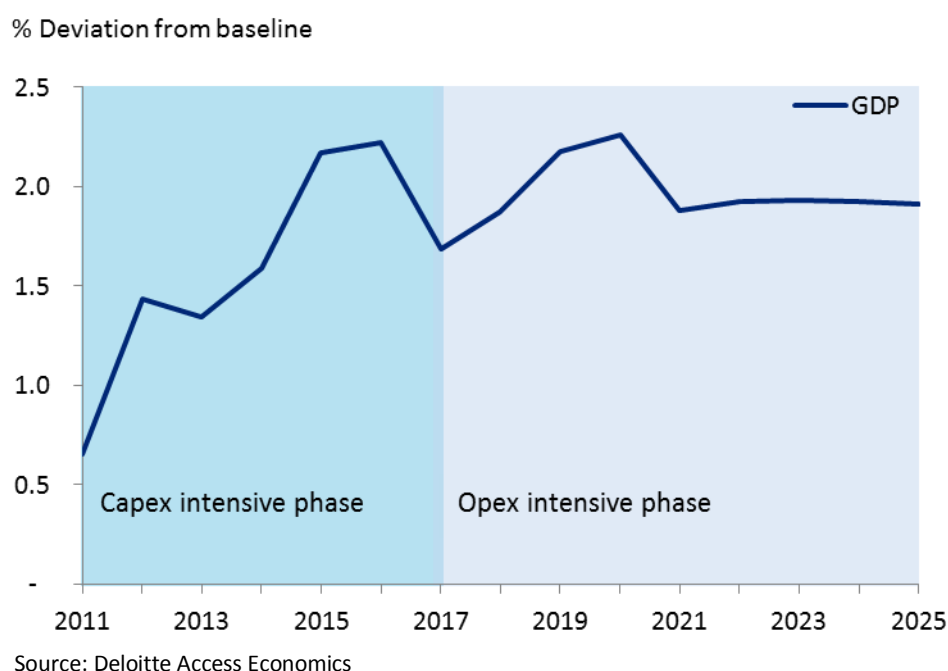
## Economy-wide impacts

The economy-wide impacts of the new oil and gas investment and production activity in the pipeline are modelled using the Deloitte Access Economics Regional General Equilibrium Model (DAE-RGEM). The model projects changes in macroeconomic aggregates such as GDP and employment. In practical terms these changes are reported as percentage deviations to a 'reference case' or baseline scenario. More information on the modelling framework can be found in Appendix A.

As a result of the capital expenditure and operational activity, as outlined above, GDP is projected to increase significantly above the reference case. Over the capex phase GDP is modelled to peak at around 2.2% in 2016 coinciding with the peak of the investment timeframe (see Chart 3.4).

From about 2017 the bulk of the additional economic activity in the sector effectively switches from capital-intensive activities to a ramp-up in oil and gas operational output.

**Chart 3.4: Investment and operational modelled impacts, GDP deviation from baseline**



Along with the increase in GDP, national employment also increases over the reference case. In 2012 oil and gas sector construction activity is modelled to increase national employment by 1.0%, over the opex phase this is modelled to decrease to 0.1% at 2025, see Table 3.4. As a result of the increase in employment and the modelled increase in wages, household consumption also rises.

**Table 3.4: Economic impacts, selected years**

<b>% deviation from baseline</b>	<b>2012</b>	<b>2015</b>	<b>2025</b>
GDP	1.4	2.2	1.9
Employment	1.0	0.7	0.1
Real wage	1.3	2.2	1.8
Consumption	1.7	2.2	1.7
Investment	14.6	14.3	1.9

Source: Deloitte Access Economics

Over the modelling period 2011 to 2025 national output, in NPV terms, is estimated to increase by just over \$260 billion above the reference case (see Table 3.5). This means that Australians can look forward to an increase in GDP equivalent to 20% of the economy's current output over the next decade-and-a-half solely as a result of the proposed oil and gas investments and their projected output over this period.

The substantial increase in economic output is largely concentrated in the resource-rich parts of the country — namely, Western Australia, Queensland and the Northern Territory. In fact, Western Australia on its own provides for just over half of the gains with an increase in economic output of \$135 billion in net present value terms.

**Table 3.5: Modelled GDP/GSP impacts, selected years and NPV**

<b>GDP/ GSP (\$m)</b>	<b>NPV (2012 – 25)</b>	<b>2012</b>	<b>2015</b>	<b>2025</b>
NSW	-6,711	637	-343	-1,690
Vic	7,976	534	493	1,382
Qld	91,891	6,111	9,732	14,834
SA	538	35	56	52
WA	135,419	11,639	20,489	19,144
Tas	-360	4	-22	-107
NT	32,666	2,039	3,909	4,311
<b>Australia</b>	<b>261,419</b>	<b>20,999</b>	<b>34,313</b>	<b>37,926</b>

Note: NPV uses a discount rate of 7%

Source: Deloitte Access Economics

Two states, namely New South Wales and Tasmania, report reductions in GDP from the baseline. This suggests resources and activity are being reallocated from those states to the resource intensive states. This occurs as part of the broader and national welfare-enhancing structural adjustments needed to capitalise on the resources boom.

Additional employment activity, as measured on a full-time equivalent (FTE) basis, is also heavily concentrated in the oil and gas intensive states. Over the investment phase, national employment peaks at about 103,000 FTEs in 2012, with these jobs mostly in Western Australia and Queensland. Over the subsequent less labour-intensive operational phase, employment is estimated to moderate substantially to 11,500 FTEs by 2025. This demonstrates the significant need for temporary workers during the period in which substantial industry capacity is being installed.

**Table 3.6: Employment impacts, selected years**

<b>Employment ('000 of FTE)</b>	<b>2012</b>	<b>2015</b>	<b>2025</b>
NSW	7.4	-1.0	-2.6
Vic	2.2	-1.2	0.0
Qld	38.7	16.8	5.5
SA	0.6	0.4	-0.4
WA	44.7	54.0	5.5
Tas	0.1	-0.2	-0.2
NT	9.4	8.8	3.7
Australia	103.1	77.8	11.5

Source: Deloitte Access Economics



## 4 Strategic policy issues: securing the industry's potential

The rapid growth of the oil and gas industry is generating some important challenges for industry and policymakers, especially in the context of trade exposed areas of the Australian economy such as manufacturing, tourism and education.

This section outlines some of the most pressing development and policy issues confronting the sector, particularly in relation to its rapid expansion in response to a favourable regional environment, and its role in driving long term national prosperity.

### 4.1 Australia's recent economic performance

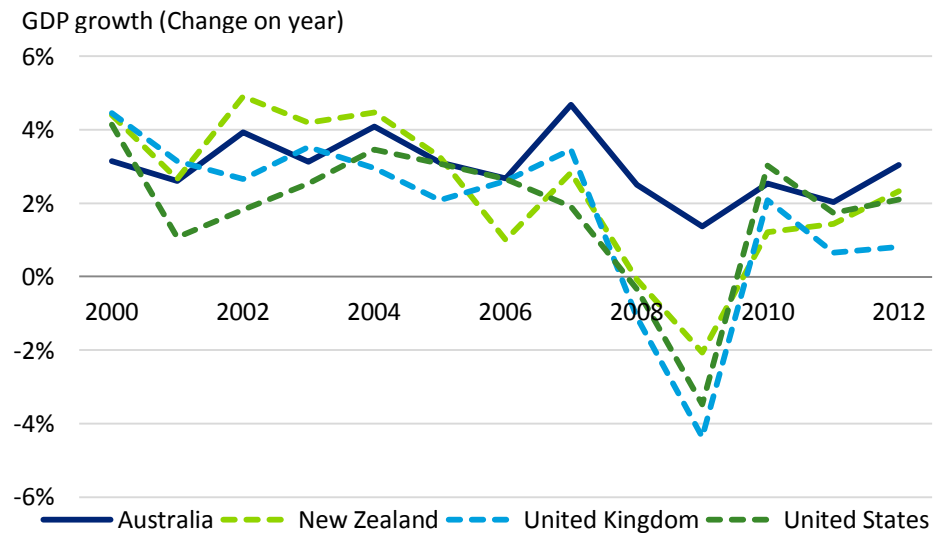
During the past two decades, the Australian economy has proved to be one of the strongest and most resilient in the world. Crucially, this enduring economic performance has been underpinned by the ongoing transformation of Australia into a modern, globally integrated and flexible economy — one which can effectively adapt to changing global and domestic circumstances and harness emerging opportunities.

#### Industry promoting macroeconomic resilience

Over the past two decades, there has been an appreciable increase in material living standards across Australia. Specifically, since 1990 GDP per capita has risen by approximately 50% in real terms — seeing the nation's GDP per capita climb the world rankings from 15th in 1990 to 7th in 2012 (IMF 2012).

Even through a deep global recession, in which the effects on world economic growth are still being felt, Australia has recorded 20 years of consecutive economic growth — at an average of 3.3% in real GDP annual growth, compared to 2.1% for other advanced economies (see Chart 4.1).

**Chart 4.1: A comparison of GDP growth, 2000-2012**



Source: IMF World Economic Outlook Database 2012

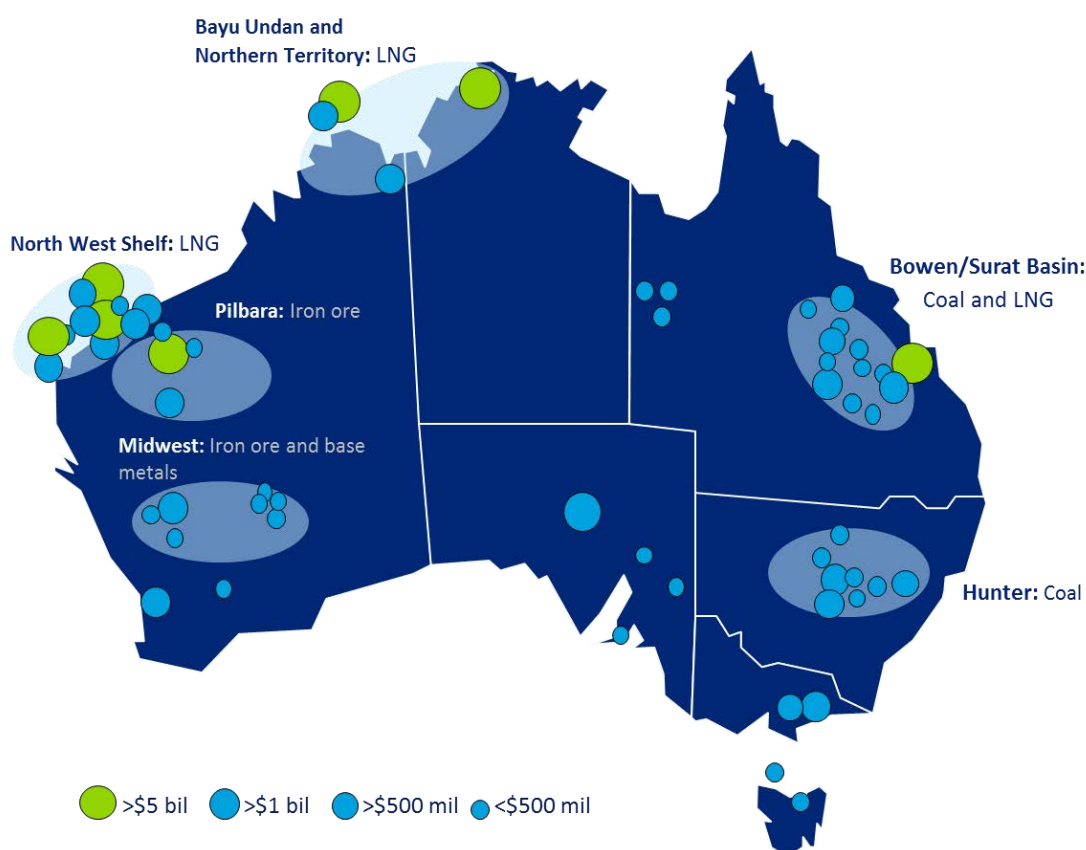
Australia's performance through the global economic downturn has been peerless across the developed world. Not only did the economy avoid a recession, but the subsequent recovery has been well above major OECD economies. While there is no single reason to explain why Australia's output growth has outpaced the rest of the developed during the economic downturn, the following factors are commonly cited:

- A large and early fiscal stimulus package.
- Sharp monetary policy response.
- The relative health of the domestic finance and banking sector.
- Robust emerging economy growth.

The last factor in particular has garnered much attention. The increase in demand for Australian resources from rapidly growing Asian economies has resulted in an extraordinary expansion in the resources sector — as well as other resource-related sectors such as construction and resource support services. It is widely believed that during the course of the global economic crisis, the robust export performance and substantial investments undertaken in the oil and gas industry (and other resource producers more broadly), provided critical income and employment support to the rest of the economy.

Data from the Deloitte Access Economics Investment Monitor indicates that since 2009, 37% of all investments in excess of \$20 million under construction in Australia have been in the upstream oil and gas sector. These investments, coupled with the sizable economic activity they entail, helped Australia withstand the more drastic economic declines experienced by other developed economies. A spatial depiction of the scale and location of resource sector projects currently under construction is shown in Figure 4.1 below.

**Figure 4.1: Size and location of current resource sector projects under construction**



Source: Deloitte Access Economics, BREE

With emerging and developing Asian economies expected to lead global growth over the medium term, there are significant opportunities for Australia to extend its run of uninterrupted economic growth. On the back of strong world demand for energy commodities, the forward pipeline of resource projects being developed or firmly committed is burgeoning, especially in the oil and gas sector. In total, 64% of major committed investments in Australia (which have not yet commenced construction) are in the oil and gas sector.

#### *Rising output and incomes across Australia*

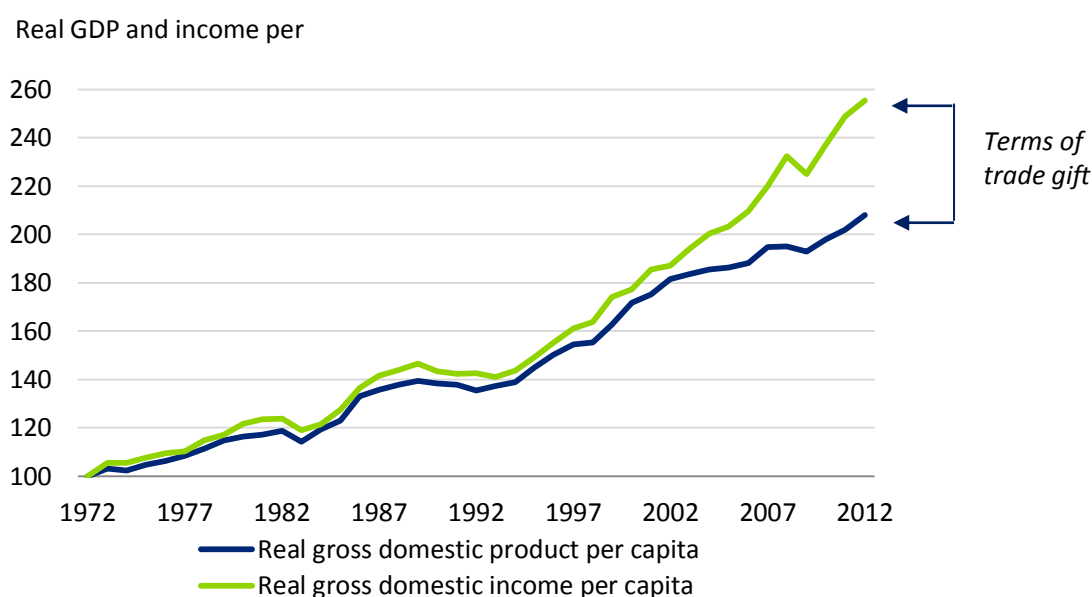
The net impact of the resources boom and the massive wave of oil and gas investment has been overwhelmingly positive. An important economic distinction between the current resources boom and other episodes has been its role in dramatically increasing Australia's terms of trade and the persistence at which this upswing has been sustained. In fact, over the period 2003-2012, the increase in the terms of trade has been more than three times greater than the last mining boom observed in the 1970s.

At the same time, oil and gas output as a share of national output has remained relatively stable. This suggests that the higher levels of national income experienced over the last decade have largely been achieved without a corresponding and equally significant increase in output. Essentially, Australia has been the recipient of a 'terms of trade gift', whereby the world economy is now willing to pay more for the goods we specialise in exporting.

Under present circumstances, conventional output volume measures such as real gross domestic product (RGDP) per capita no longer hold as an accurate measure of living standards in Australia. Instead, real gross domestic income (RGDI) per capita, which captures both changes in the volume of output and terms of trade price effects, is used as an indicator for living standards.

By comparing the two measures, Chart 4.2 illustrates that since around 2003, there has been a growing diversion between output and income per capita — the difference between each representing the gains from increases in the terms of trade.

**Chart 4.2: Comparison of output and income per capita**



Source: ABS Cat. No. 5206.0 and ABS Cat. No. 3101.0

## Countervailing productivity trends

It is generally accepted that productivity growth is the most important determinant of long run improvements in economic prosperity. In fact, over the past 30 years, it is estimated that around 80% of the increases in living standards in Australia have been due to increases in productivity levels (Commonwealth Treasury 2010).

A widely used measure of productivity in Australia is ‘multifactor productivity’. In its simplest form, multifactor productivity measures the efficiency with which inputs are transformed into outputs. In the short term, this reflects the impact of a variety of factors, such as the utilisation of available labour and capital, economies of scale and scope, and the process of resource reallocation. In the long term, however, multifactor productivity can be used to represent improvements in the way in which operations are conducted (technical progress), which is ultimately the source of economic wellbeing.

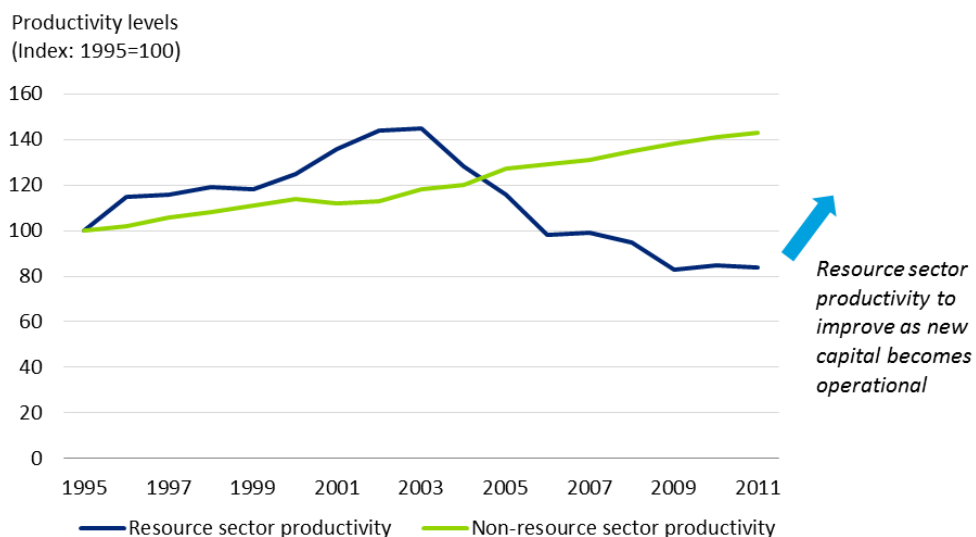
The Productivity Commission (2011) has estimated long run average productivity growth in Australia at around 1% per year. Since peaking at 2.3% in the 1990s, Australian productivity growth has been declining to almost stagnant levels (no growth).

The steady decline in productivity in Australia has led to many competing explanations. These include the mismeasurement of output and inputs, changes in the composition of the economy and lags between output and labour growth causing temporary productivity fluctuations. Given the complex and dynamic relationship between the myriad of economic variables, distilling productivity trends over the short term is a difficult and often inaccurate task. Rather the sources of productivity are commonly viewed in the context of longer term influences that manifest over time — that is, underlying productivity.

#### *Productivity trends in the resources sector*

A deeper analysis of productivity growth across industries reveals that increases in economy-wide productivity have been outweighed by declines in the quickly expanding resources industry. Chart 4.3 highlights that while non-resource sectors of the economy have seen steady increases in productivity, the broader resources sector has experienced declines in measured productivity, coinciding with the start of the resources boom in the early 2000s.

**Chart 4.3: Comparison of resource and non-resource sector productivity**



Source: ABS Cat. No. 6291.0

Despite the perceived decline in resource industry productivity, it should not be interpreted that the sector itself is unproductive, or that structural shifts are inefficiently redirecting inputs. Instead, this reflects the unprecedented levels of investment in the resources sector which has seen the use of inputs ramped up in response to the much higher prices being paid for its outputs. The unique features of oil and gas and other mining projects effectively distort productivity growth in two main ways:

- **Capital installation delays** — In the short to medium term, the capital expenditure phase of project expansion means that capital inputs grow ahead of project completion and the commencement of commercial production. Current measures of productivity classify these capital inputs as largely unproductive, instead of recognising their contribution to industry capacity enhancement.

- **Frontier exploration** — It is possible that output growth may never match the input growth in the resources sector. Much of the identified additional capacity is expended on extracting commodities from lower quality or harder to reach deposits that require more inputs. In such cases, investments are based on the increased value of production, not on the volume of output produced.

It is also important to recognise that any apparent productivity slump in the resources sector is temporary and has little bearing on its underlying productivity. Once projects become commercialised and start producing, the sector's productivity is expected to increase. This increase in productivity will be driven by a sizable acceleration in the operational capital to labour ratio (also referred to as capital deepening).

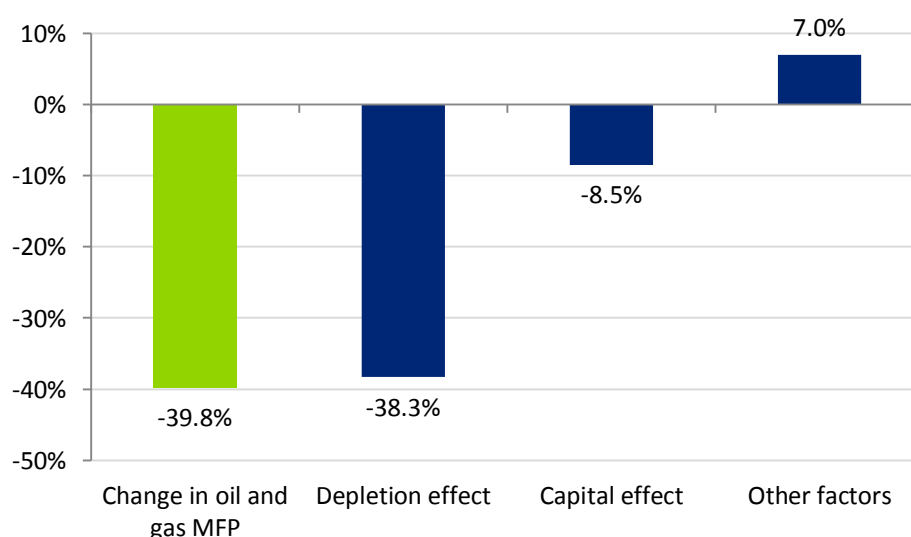
#### *Productivity trends within the oil and gas sector*

The oil and gas industry comprises the largest sub-component of the broader resources sector, accounting for over 30% of sector's total economic contribution. Naturally, it follows that productivity changes within the oil and gas industry have a noteworthy influence on the productivity trends observed in the resource sector and also in the Australian economy.

A key feature of the oil and gas industry is the greater use of capital inputs, which is high even when compared to other capital-intensive resource industries. As a consequence, oil and gas production has traditionally seen the highest level of labour productivity amongst the different resource sectors. For example, in 1999, value added per worker was \$1.7 million in oil and gas extraction, whereas it was below \$500,000 per employee across the coal, iron ore and gold mining industries.

However, since the early 2000s, there has been a 39.8% decline in MFP in the oil and gas sector. As indicated in Chart 4.4, long lead in times for new production capital are estimated to contribute only -8.5 percentage points, with the majority of the decline in industry MFP associated with deteriorating yields in maturing oil and gas fields. The cumulative effect has been a considerable negative impact on the MFP for the wider resource industry over the period 2001 to 2008.

**Chart 4.4: Contributions to MFP changes in oil and gas, 2001-2008**



Source: Productivity Commission 2008

As noted previously, the negative effects of a surge in capital investment are a temporary phenomenon and likely to be offset in the few years as new production comes on stream. Specifically, the current phase of capital deepening in the oil and gas industry raises the resources available for workers to produce more output in the future. As a result, labour productivity, measured by the amount of output produced per hour worked, also increases. Over the medium to long term, as more oil and gas projects become fully operational, it is anticipated that the industry will once again have one of the highest ratios of output per worker in the economy.

In the Productivity Commission working paper on productivity in the mining industry (2008), it is suggested that the significant depletion effect observed in the oil and gas industry since 2001 has been mostly due to the decreasing yields of crude oil and condensate. Should the demand for natural gas continue to increase (as is expected), the depletion effects on oil and gas industry MFP are expected to subside.

Similar to past developments, including steeply inclined and horizontal drilling techniques, continued technological improvements in the oil and gas sector are likely to increase both the levels of production (from deeper or new reserves) and the efficiency with which oil and gas is extracted. This is anticipated to make a positive contribution to resource sector MFP over the long term.

The considerable contribution and linkages between the resources sector and other parts of the economy mean that increases in the capital deepening ratio or efficiency of this sector will effectively raise aggregate multifactor productivity in the economy. Indeed, historically, periods of capital deepening and have been followed by periods of higher productivity. For example, this was evident during the 1990s, when capital deepening which occurred in the IT industry in the late 1980s to early 1990s significantly elevated national productivity.

From a public policy perspective, there should be greater attention on measures and settings which facilitate the effective reallocation of resources from lower performing capital-intensive industries — such as low value-added manufacturing segments, to the resource industry — as an avenue to raise productivity. Longer term economic gains are largely determined by the extent to which labour and capital inputs can produce more highly valued output — in essence, those which include harnessing Australia's comparative advantages like the extraction of energy resources.

## 4.2 Managing structural changes in the Australian economy

While the Australian economy has experienced impressive growth in the recent past, this growth has not been balanced across all sectors and states. To a large extent, Australia's economic growth has been accompanied by significant structural changes taking place between sectors and regions in order to efficiently reallocate the nation's scarce resources.

Structural change is central to the process of securing sustained prosperity in modern economies. Effectively, it underlies much of an economy's inherent 'dynamics'. The key feature of structural change is the transfer of resources from lower to higher productivity uses.

In the context of a resource boom, higher oil and gas activity attracts inputs from lower productivity uses, with market price signals (i.e. the exchange rate and returns to capital and labour) determining which sectors are most affected. The overall gain to the economy is determined by the extent to which labour and capital inputs can be redistributed to produce more highly valued output.

In the short term, the economy can partially adjust by drawing upon a combination of underemployed and unemployed resources or imported labour, finance and capital goods. Indeed, this was the pattern of expansion during Australia's gold rush in the 19<sup>th</sup> century. However, the long term nature of the fundamental factors driving the recent resources boom, namely the industrialisation of large Asian economies, means that the systemic importance of the oil and gas sector is likely to grow. Therefore, the associated reallocation of resources to the upstream oil and gas industry from other parts of the Australian economy is also expected to accelerate.

### The emergence of a multi-speed economy

The Australian economy is in the relatively early stages of the largest oil and gas investment boom on record. As discussed above, a central aspect of this boom is that global energy demand is expected to grow, stimulating the strong demand for Australia's oil and gas exports into the long term. However, present challenges to certain parts of the economy are facing considerable challenges due to the high terms of trade.

To understand the economic impact of the resources boom, it is useful to recognise the differences between the current boom (episode II) and the boom that started around 2003 (episode I). As a starting point, the economic landscape of the Australian economy is now quite different. Principally, since episode I, the terms of trade has increased three-fold. This combined with strong growth relative to other advanced economies and tightened macroeconomic policy settings has seen the Australian dollar appreciate to post-float highs. In addition, the economy is operating much closer to full capacity than was the case during episode I — with less scope to accommodate above trend growth without triggering price and wage pressures.

Though remote and regional resource areas in Australia are at the heart of commodity booms, they are also the first to face the pressures from capacity constraints and increases



in wages and in the cost of living. During the last commodity boom, international and interstate migration helped to alleviate these pressures to some extent. This time around migration targets have been wound back. This has placed greater difficulties on employers trying to fill vacancies, particularly in regional areas.

In spite of employment and income gains since the first boom, the recent economic slowdown and its lingering effects have subdued consumer and investor confidence. In particular, households are displaying more caution with regards to their discretionary spending. For businesses, the general sense of risk aversion and tighter access to credit is muting near term growth prospects.

Together, these forces have seen the emergence of a 'patchwork' or 'multi-speed' economy. In a broad sense, similar to its predecessor, episode II has stimulated pockets of high growth across Australian industries and regions. However, there are now other prevailing factors, unrelated to the resources boom, namely, weaker economic sentiment that are inhibiting growth in the areas where an exposure to the resources boom is already minimal.

### *Sectoral impacts*

From a macroeconomic perspective, Australia's high terms of trade is supporting strong growth in the broader economy. However, at a deeper level, challenging conditions remain in those sectors that are not benefitting — either directly or indirectly — from the resources boom.

Traditional trade theories outline how an economy is likely to evolve following an increase in the price of its major export. It is helpful to consider the Australian economy as divided into three broad sectors:

- resource and resource-related support sectors;
- non-resource tradable sectors which either export or compete with imports; and
- non-tradable sectors which neither export nor face competition from imports.

While the direction of the various economic impacts from a resources boom can be readily identified, determining their magnitude is much more difficult. In general, the economic costs associated with the transfer of factor inputs from non-resource sectors into the oil and gas industry will be smaller where:

- There is excess labour available in the economy — Skill shortages and lower labour mobility rates impact the ability of the resource sector to obtain adequate personnel.
- The amount of inputs used in the production of resource sector output is low — The oil and gas industry usually requires lower levels of intermediary inputs. This is related to their highly capital-intensive extraction operations.
- There is scope to import labour and capital — Australia is well placed to attract international workers and foreign capital investment. This can reduce pressure on domestic markets.

In the current and forward economic environment, characterised by limited supply capacity, the rapid expansion of the oil and gas sector must be facilitated by reduced growth in some other sectors. This has undeniably been the case, where the higher

exchange rate has reduced international demand for Australia's non-resource tradable sectors such as tourism and education.

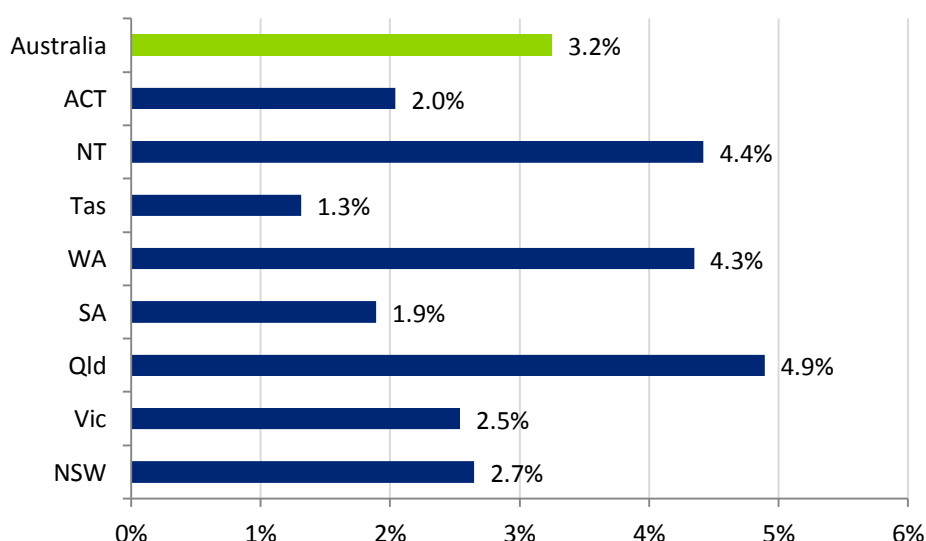
For mature non-resource tradable sectors like manufacturing, the appreciating currency and rising import penetration could well accelerate the longer term trend of their relative decline as a share of the economy, and lower levels of sectoral employment. This is likely to be further compounded as developing countries' own economic structures adjust to new comparative advantages and they move up the value-added chain. Indeed, China and other industrialising Asian economies are now increasingly producing higher value-added components (eg automobiles) which intensify competitive pressures faced by Australian and other advanced country (and higher cost) manufacturers.

On the other hand, rising revenues in the oil and gas sector have translated to rising incomes across Australia, in turn increasing the expenditure on high-value finance and professional services in non (or less) tradable industries. As a result, more labour and capital is being directed to the oil and gas sector and high-value service industries to take advantage of the current and anticipated growth in these areas.

#### *State impacts*

Australian growth prospects have been divergent across regions. Evidently, resource rich parts of the nation, mostly comprising Western Australia, Queensland and the Northern Territory have benefited significantly. This is supported by output figures which suggest that since 2006, the share of economic activity across these resource rich states has increased from 30% to 37%, while the share of activity in all other states has fallen by an equal amount from 70% to 63%.

**Chart 4.5: Projected average annual output growth, 2012-2017**



Source: Deloitte Access Economics

The outlook over the next five years suggests much the same in terms of economic development. Chart 4.5 demonstrates that over the period 2012-2017, Queensland is expected to experience the highest average GSP growth, at 4.9%, similar to the Northern

Territory and Western Australia, where output growth is estimated to average 4.4% and 4.3% respectively. This compares to average growth in Australian GDP of about 3.2% over the same period.

The relatively slower output growth in south-east states is a result of two reinforcing factors. South-east states have a greater exposure to the adverse effects of the higher exchange rates and capacity constraints and also see less of the direct gains of the resources boom (mainly due to their non-resource focused industrial structure). However, as outlined in Section 4.2, the wider contribution of the oil and gas industry extends beyond output growth and should not be underestimated. While the majority of indirect employment opportunities have been in the resource-support industries, including engineering, finance and professional services, states such as New South Wales and Victoria have also benefited from large oil and gas investments.

### **The risks of catching ‘Dutch Disease’**

The risk that a mining boom might lead to an appreciation of the real exchange rate and a consequent fall in the competitiveness of non-resource tradeable sectors was first identified in 1976 by Bob Gregory, an Australian economist. The effect was later coined the ‘Dutch Disease’ by the Economist Magazine in reference to the adverse impact of North Sea oil revenues on the size of the Dutch manufacturing sector in the 1970s.

The principal concern with Dutch Disease is that if a commodity boom turns out to be temporary, the structural adjustment associated with the boom and the increase in exchange rates may lead to non-resource tradeable sectors being unable to establish themselves again after the commodity boom ends. This is particularly problematic if there are large spillovers associated with the affected sectors.

If a commodity boom turns out to be permanent, structural adjustment will generally lead to improved economic growth as resources are transferred to sectors where these resources are most highly valued, assuming these new sectors have similar levels of spillover benefits in terms of skill development and research.

The main implications of a resource boom on other sectors of the Australian economy was summarised in a model by Corden (1984). These implications of this model are summarised in Box 2 below.

### Box 2: Implications of a resource boom on other sectors of the economy

Corden (1984) analyses the effect of Dutch Disease by dividing the economy into the three sectors noted in Section 4.2, the booming (resources) sector, the lagging sector (non-resource tradeable sector) and the non-tradeable sector.

A boom in the resources sector (either as a result of technical changes, the discovery of new resources or increased global commodity prices) affects the economy in two ways.

A *spending effect* arises due to the increase in income in the booming resources sector. This increased income leads to increased spending by either resources companies or their shareholders and also increases in tax revenue received by the government with a consequent increase in government spending. This increase in spending then flows through the economy leading to an increase in demand for non-tradeable goods and a rise in the price of those goods. This in turn leads to an appreciation of the real exchange rate. This appreciation will be even greater if there is an increase in international capital inflows into the mining sector.

The *resource movement effect* arises because the increase in income in the booming resources sector leads to an increase in demand for capital and labour and a consequent increase in the wage rate and rate of return on capital. This results in a shift in factors of production away from the lagging and non-tradeable sectors to the resources sector.

The net impact on the resource boom is an increase in output in the booming sector and a decrease in output in the non-resource tradeable sector due to the real exchange rate appreciation. The net impact on the non-tradeable sector is theoretically ambiguous because the impact of the spending effect will be to increase output of non-tradeables while the resource movement effect will have the opposite effect.

Where capital can be sourced from overseas and the employment share of the booming sector is relatively low, as is largely the case in Australia, the spending effect will predominate in which case the non-tradeable sector will also experience increased output.

This has largely been the Australian experience over the last five years with growth in the mining sector growing by 85% between 2005 and 2011 compared to 39% in rest of the economy (Corden 2012). This suggests that the resource boom has had a strong spending effect on the economy, although the resource movement effect is also evident from the decline in the share of total employment in trade exposed industries such as manufacturing.

While considerable concerns exist about the potential for non-resource tradeable sectors to bounce back once a commodity boom ends, international evidence suggests that developed economies are less vulnerable to 'Dutch Disease' effects (Australian Treasury 2011-12). This is not to suggest that structural adjustment or real exchange rate appreciations will not occur in developed economies (this has certainly not been the Australian experience) but rather that resource booms have not been found to reduce the overall economic growth rate in developed economies (Australian Treasury 2011-12).

The 2011-12 Commonwealth Budget (Budget Statement 4) notes that there has been little loss of spillovers from Norway's oil boom with Norwegian manufacturing actually benefiting from the boom. Moreover, while the mining sector only accounted for 9% of Australian GDP in 2008-09 it accounted for around 25% of business expenditure on research and development in 2010-11 (Australian Treasury 2011-12) which suggests that there are likely to be considerable spillovers for the rest of the economy from mining investment.

Perhaps the strongest evidence that Dutch Disease is unlikely to have a long term negative effect on growth in developed economies comes from the Netherlands itself. After the

boom subsided, Dutch manufacturing as a share of GDP did recover some of its earlier losses (although has since declined in line with other developed nations) and manufacturing exports as a share of GDP grew from around 20% of GDP in 1980 to almost 40% by 1997. Moreover, Dutch per capita growth rates since 1980 have typically matched or exceeded the OECD average (Australian Treasury 2011-12).

#### *Policy implications*

In Australia's case, the resources boom is likely to be long lasting rather than temporary, due to the increased demand for energy from the growing Asian middle class and Australia's significant resource endowment. This means that structural adjustment is likely to continue for some time as capital and labour move into sectors which offer a higher return.

It also means that policies which provide subsidies to particular trade exposed non resource industries (so that they are in a position to recover after the boom) are likely to be costly and potentially ineffective in the face of long term structural adjustment. Moreover, as assistance to specific industries would increase net exports such assistance is likely to lead to a further real appreciation in the exchange rate with a subsequent cost to other non-resource tradeable industries.

Thus targeted assistance to particular industries is unlikely to be an effective response to Dutch Disease effects. One potential response to Dutch Disease effects is to establish a sovereign wealth fund or run fiscal surpluses to encourage the Reserve Bank to lower interest rates and thus moderate the degree of real exchange rate appreciation (Corden 2012). This option is discussed in further detail in Section 4.6.

A finer point of note is the causes of structural changes extend beyond changes in the resource sector. Indeed structural change is part and parcel of economic advancement and rising living standards. This has been emphasised by the current RBA Governor, Glenn Stevens:

*The multi-speed economy is not just about the mining sector and squeezing other sectors by drawing away labour and capital and pushing up the exchange rate. It is doing that, but slower growth in sectors that had earlier done well from unusually strong gains in household spending would have been occurring anyway, even if the mining boom had never come along.*

*It is these changes in behaviour by households, in asset markets and in credit demand, that I think lie behind much of the disquiet — dissatisfaction even — that so many seem to have been expressing. But this, as I say, have occurred with or without the mining boom. In fact without the mining boom and its spillover, we would have been feeling the effects of those adjustments more acutely than we do now (RBA speeches 2012).*

In terms of economic and policy management, the adjustment pressures and disruptions caused by resources shifting from lower to higher productivity sectors should not be resisted but do need to be well-managed. Attempting to slow the structural changes emanating from the resources boom would be costly and ineffective, ultimately lowering the economic dividends for all Australians.

**Policy principle: Overall policy settings should have a supportive posture and facilitate the adjustments needed to maximise the economic gains from the resources boom.**

Any new policy rigidities or constraints, such as explicit industry protection measures, mandated local content requirements, onerous project approvals frameworks and additional fiscal imposts, will ultimately sacrifice economic welfare and intensify adjustment pressure on other sectors.

## 4.3 Fostering deeper engagement in the Asian century

The world economy is currently going through a transformative change, perhaps the largest shift in world economic order in the past century. Large Asian economies, principally China and India, which together represent almost 40% of the world's population, are rapidly industrialising and becoming richer. This irreversible economic advancement is currently having and will continue to exert a major influence on the Australian economy.

Given Australia's proximity to the region and capacity as a world class energy exporter, the shift in the global economy towards Asia will have an enduring effect on the oil and gas industry. Similar to how the North West Shelf was developed with a core regional focus, the massive investment pipeline of LNG facilities across northern half of Australia is being underpinned by robust energy demand from long term Chinese and Indian energy customers, along with more established Japanese and South Korean markets.

Australia's trade relationship with China, and to a lesser extent other emerging Asian economies, has provided enormous economic benefits over the last decade on the back of surging resource exports. Indeed, there is a natural complementarity between China's considerable requirements for a stable supply of commodities and Australia's abundance of high-quality resources and proven export performance. Because of this relationship, Australia will continue to have a deep stake in China's ongoing economic development.

Importantly, this has various economic and strategic dimensions, many of which are deeply interwoven.

In terms of the economic implications, Australia's international trade in goods, services and capital is crucial to long term economic development and our standard of living. The trade intensity of the Australian economy (exports and imports) has risen steadily over the past 50 years and now stands at around 46% of economic activity. Certainly, access to overseas markets has helped foster high rates of economic growth, develop new industries and infrastructure, and strengthen trade and economic linkages with the rest of the world.

It is important to recognise that much of the regional economic linkages which we now take as unremarkable were built on the back of Australia's substantial energy exports to Asia.

This energy gateway has and will continue to confer significant economic advantages to the nation:

- It raises national income and wealth, and diversifies our economic base.
- It allows Australia's natural resources to be exploited at scale and in a more efficient manner.
- It opens up business opportunities beyond the resources sector, for instance in tourism, education and business services, agriculture and advanced manufacturing.
- It promotes Australia's 'brand' and values overseas, facilitating deeper business and cultural understanding.

## Sensitivities regarding our relationship with China

While it is true that Australia has gained enormously from China's development trajectory, this exposure presents vulnerabilities especially should China's growth unexpectedly falter. In regard to these downside risks, a couple of points are important.

- Firstly, Australia's exports to China represent one, albeit large, serviced market in the region. Our geographic proximity to Asia and considerable resource prospectivity are profound economic advantages that should not be downplayed. China has selected Australia as a preferred but not exclusive provider, and many of the major LNG projects underway would not be commercially viable in the absence of Chinese demand.
- Secondly, the development pattern currently underway in China is intrinsically structural in nature. There is bound to be some cyclical turbulence along the way (some of which we are seeing unfold at present), but the nature of energy contracts is long term which provides surety for both buyer and seller.

Given China is now Australia's largest trading partner, its level of investment in Australia is quite small — especially compared with other large trading countries like the United States and Japan. This is changing, however, as China is effectively escalating its offshore investment push. In this regard, China's state-owned enterprises and investment funds have concentrated on purchasing assets to effectively diversify the country's enormous foreign reserves, secure reliable supplies of minerals and energy and provide a hedge against rising commodity prices (much as Japanese conglomerates did in the 1980s).

Some concerns regarding foreign investment — whatever their origin — in Australia's strategic energy resources are legitimate, especially where these involve foreign government interests. So far, these have been adequately managed within existing foreign direct investment policy frameworks.

However, Australia has always been reliant on foreign capital to develop its major energy export platforms and, accordingly, it is important that relevant policy frameworks and industry's broader engagement with the community focus on the merits of encouraging new sources of foreign capital which reflect changing global economic structures.

Another issue which has received some recent attention from commentators has been the perception of tension between Australia's clear economic interests in strong trade with China and our strategic military interests. These geopolitical dimensions are complex and well beyond the scope of this study, but a few aspects are noteworthy:

- A deep trade and economic relationship can be highly compatible with our strategic interests. It brings countries closer together by fostering a mutual interdependence and common interest — all of which constitute core aspects of ‘soft diplomacy’.
- Moreover, whatever the path of Australia’s strategic affairs over the longer term, our economic interests need not play a subordinate role. Australia’s ability to advance its interests globally, as well as maintain an effective defence posture, will be greatly supported by a robust economy and stronger public finances, areas where the efficient development of Australia’s resource endowments play a crucial role.

To reiterate, as China’s economic power grows, Australia stands to gain enormously. Arguably, no other country in Asia matters as much to Australia’s immediate future prosperity as China.

**Policy principle: To help support the phenomenal market opportunities from industrialising Asian economies, relevant policy frameworks should recognise and accommodate new sources of regional foreign capital, while protecting legitimate sovereignty interests.**

The oil and gas industry’s ‘economic dialogue’ with China and other industrialising Asian economies, along with that of other resource producers more generally, has set in place a strong and resilient foundation for pursuing a range of national interests in the region. From this position, Australia is fortuitously placed to continue building a long term energy partnership with the region.

## 4.4 Addressing workforce skills

Accessing skilled labour is a pivotal concern for the oil and gas industry. Given the rapid expansion trajectory and largely concurrent project scheduling, there are significant demands on industry to source and place workers to ensure that the pace of development can be sustained. These challenges are compounded by relatively low levels of unemployment and the labour demand deriving from buoyant activity across the wider resources sector.

Importantly, workforce pressures are extending beyond traditional trades and key regional centres heavily exposed to new mining and gas investment activity. While investment in the industry is strong, workforce issues require greater policy attention to address development needs.



### Case study 5: Indigenous skills development

One of the more positive aspects of the resources boom is the opportunity it can provide to Indigenous employment and welfare more generally. Almost all major developers are actively promoting various initiatives as part of their overall project development.

Acknowledging the Indigenous people in the region and ensuring the benefits from mining reach Indigenous communities, Inpex has contributed to Larrakia Trade Training Centre which assists all students to gain practical skills and meaningful employment opportunities in Darwin. Developed to support sustainable Indigenous economic development, it provides unique support to Indigenous students and teaches professional, practical skills such as electrical, automotive mechanics, metal fabrication, plumbing, civil and general construction, refrigeration and mining. Inpex also offers significant opportunities for Indigenous employment and environmental management in its programs.

Origin Energy has also implemented a range of initiatives to promote Indigenous skill development and employment. These include school-based Indigenous traineeships, pre-vocational training in process plant operations for Year 11 and 12 students and funded university placements.

As part of the Australia Pacific LNG project, Origin in joint venture with ConocoPhillips is also implementing an Indigenous engagement strategy. Origin has engaged in initiatives with Indigenous organisations to develop employment capacity and address skills gaps through targeted training to support Indigenous workforce development, as well as cultural awareness training for all program staff.

Development of local skills is considered to have positive effects for Indigenous communities as well as the oil and gas companies which invest in workforce development, through encouraging sustainable economic development and sharing the returns from mining in regional and remote areas.

### Utilising the local workforce

Local labour forces are generally unable to meet all the required demand of oil and gas projects.

Firstly, these projects have specific requirements. The different stages of capital-intensive oil and gas developments necessarily require workforces of varying sizes. During the project capex phase, there is a far greater labour requirement as large-scale civil works and facility development occurs. Conversely, project operations typically require fewer and often more specialised workers to manage the operation and maintenance of production facilities.

The discordance of labour requirements over the life of the project creates additional issues for the industry in matching workforce supply and demand. The nature of the development means that there are many short-term jobs available, but fewer long term opportunities after the capex phase. To some degree, this would impact on the relative attractiveness of the jobs on offer as they do not provide ongoing opportunities or much scope for career progression at the site. This may deter some potential employees who are looking for longer-term employment in the region.

This is further exacerbated by the regional nature of oil and gas production, where there are smaller localised labour pools, particularly in specialised trades and construction fields. Labour markets in regional and remote areas tend not to be in as great a state of flux as in metropolitan areas, with generally less job movement and people seeking alternate

employment, partly as a result of limited opportunities. As a result of this, a local labour market may be unable to contribute to the required oil and gas workforce.

Increasing the size of the local workforce through regional development has been tabled as a possibility in some cases; however, it does have drawbacks. Regional development is generally unfeasible for an existing project due to its slower and longer-term effects, compared with the immediate labour requirements often associated with project development schedules.

In addition, the large workforce is only required in the capex phase, meaning that many workers who permanently relocate to the region are likely to be under- or unemployed once facilities are commissioned. While regional development may provide alternate opportunities for these workers, this depends on the relative sustainability of the area in absence of resources development.

Costs of regional development would also generally need to be borne by the region, requiring significant up-front investment, while benefits may not be realised for many years. The sustainability of the region needs to be taken into account when development in a previously small locality is initiated, as the required services will need to increase alongside population.

It should be noted that there have been successes with utilising regional development to increase the local resources workforce, notably in Burra and Moonta in South Australia. The success of these regional towns is attributable to their diversification into other industries including tourism, agriculture and fishing (Business SA, 2011). This highlights the importance of regional sustainability on the success of such a measure.

#### **Case study 6: Addressing workforce issues**

The oil and gas industry is engaging innovative and proactive measures to train workers for large-scale projects. Skilling workers for required roles, rather than seeking to employ workers who already possess these skills, assists oil and gas companies in addressing the issues associated with securing skilled workers from local labour forces.

One example is the Gladstone LNG (GLNG) project. This is a US\$16 billion joint venture between Santos, PETRONAS, Total and KOGAS, based in Gladstone, Queensland. The project is committed to giving preference to local workers and small businesses. To train local people with the requisite skills to convert coal seam gas to LNG for export, the Santos GLNG and Skills Tech Australia Training Centre was opened in Brisbane in late 2011. The centre aims to bridge the skills gap for tradespeople from other industries to gain fast-tracked employment on the GLNG project.

Shell is also utilising a re-training program to allow workers to transition between projects. Shell is winding down operations at its Clyde (NSW) oil refining plant by September 2012 and is relocating some of its displaced workers to its \$8.9 billion Prelude Floating LNG project which is being developed in the Browse Basin, Western Australia. This 'sunset' to 'sunrise' industry example highlights how retraining can increase the flexibility of workers to adapt to new opportunities elsewhere in the organisation, and how companies can make the most of their existing and highly skilled labour resources in other areas of the business.

## The role of a FIFO workforce

The oil and gas industry's reliance on a large temporary workforce places greater onus on labour mobility and flexibility to enable workers to be deployed in their most productive capacity. FIFO workers have presented a broad-based solution to this workforce issue, allowing workers to operate in regional areas without the need to relocate or spend extended periods from their families.

Broadly, FIFO workers are based in regional or metropolitan areas and commute to work by plane, living in on-site villages when rostered for work. They are generally paid a commute allowance on top of a base salary and have their transport, meals and accommodation provided when at work. A typical example of a FIFO roster is two weeks at work and one week off, where an employee is rostered on shifts for a period of consecutive days and then has a period of leave, where they may return home as they wish.

While in many respects FIFO arrangements have showcased an effective and rapid response by producers (and the aviation industry) to substantial workforce challenges, they are by no means a perfect solution to the industry's needs. Skilled labour requirements must also be met at reasonable cost to be of benefit to the industry. Further, the need to transport workers to and from remote areas can drive up development costs and lead to other social pressures.

FIFO workers are generally considered to be well reimbursed for the displacement caused by their need to commute to remote areas without being able to return home for periods at a time. While the oil and gas industry, and resources industries in general, are able to meet these costs of labour, there are flow-on effects to the regions where the employees are based, which must compete with higher salaries to attract and retain skilled staff. Anecdotally, there are highly skilled professionals leaving metropolitan businesses to become FIFO workers or tradespeople in resources industries, due to the salaries offered in the industry.

## Social costs of a FIFO workforce

For the regions that host them, there can be social costs related to dependence on a FIFO workforce. For example, many regions experiencing rapid gas and mining development have faced an increase in rental prices as temporary workers compete for limited accommodation. Housing shortages may also be faced by locals as companies lock-up accommodation for their workers.

While those directly associated with the accommodation industry benefit from higher prices, other parts of the community can experience additional pressures as the cost of living is forced upwards. Existing businesses in the region may also face a higher cost of labour, and difficulties retaining labour, given the salaries paid to FIFO workers.

Additional demand for goods and services also drives up the prices of necessities as more highly-paid FIFO workers have the capacity to pay elevated prices. In particular, there has been some criticism of the pressure that FIFO places on regional health services, which are already thinly spread.

There are also criticisms that FIFO workers do not spend their money in regional areas. This can make their temporary presence appear ‘one-sided’ — in effect, driving up local prices for essential goods and services but not sufficiently contributing to regional development and the local economy. One particular (and perhaps unintended) consequence is that the availability of FIFO arrangements has, at times, effectively turned local workers into FIFO workers. Again anecdotally, some local residents have used the opportunity to relocate elsewhere (say the Gold Coast) and be rostered back to the region to work.

## Recent studies

There have also been a number of social costs identified which affect the people involved in FIFO employment. In 2009, research was conducted on the effects of FIFO arrangements and extended working hours on the stress, lifestyle, relationship and health characteristics of Western Australian resources sector employees and their partners (Clifford, 2009). Anecdotally, FIFO employment has been associated with negative impacts on employees, including elevated risks of high stress levels, depression, alcohol abuse, recreational drug use and relationship breakdowns.

The survey-based study confirmed the long-term negative impact of FIFO on employees’ work satisfaction and disruption to employees’ and partners’ lifestyle. However, on average it found no long-term impact on relationships, stress and health indicators. In the short-term, there were weak negative impacts on stress, and a small proportion of people who found the working arrangements particularly stressful. Overall, the results largely disputed the anecdotal evidence of negative health and relationship effects.

In August 2011, the Australian Parliament commenced an inquiry on the use of FIFO and drive-in, drive-out (DIDO) workforce practices in regional Australia. This Inquiry is currently at the stage of inviting submissions and holding public hearings, and will present a report when the Inquiry process is completed.

The submissions to the inquiry highlight the issues that stakeholders and the general public have identified in relation to FIFO employment.

Industry highlighted the necessity of FIFO to meet the needs for skilled labour, flexibility and global competitiveness in a difficult operating environment (Chamber of Minerals and Energy of Western Australia, 2011). It emphasised the choice and flexibility provided to employees, and the place of FIFO amid other workforce initiatives, including investing in skills and training, increasing workforce diversity and a flexible skilled migration program to support the economic prosperity of regional and state economies.

Skills Australia (2011) supported this view, and acknowledged FIFO as a complex issue, but a cost-effective method to address skills shortages and workforce needs, increase efficiency and avoid problems associated with establishing mining towns. While it accepted the potential negative impacts for regional areas, it countered this with the benefits to workers ‘home towns’ and the ability of families to locate near services, rather than completely relocating to the mine site.

From the perspective of regions hosting FIFO workers, the Regional Economic Development Corporation — Mackay, Isaac, Whitsunday (2011) identified that the FIFO workforce has detrimental impacts on a region through use of services and infrastructure without

monetary compensation. It also identified the safety and community issues related to transitory workers without commitment to the area. The submission addressed the “cannibalism of local industries” through the increased cost of living negatively impacting local residents. On the other hand, it stated that the Royalties for the Regions initiative being undertaken in Western Australia has been successful in encouraging private investment and provision of infrastructure in mining communities, and that such a measure should be extended to other states.

Community services are also impacted by FIFO workers. In its submission, the Australian Medical Association in Western Australia identified the pressures that FIFO workers are placing on health services in the state, particularly in remote towns and communities. A survey of medical professionals showed that more than 80% believed that governments and companies responsible for FIFO should provide support and improve health services.

Other than the regional impacts, personal and relationship impacts of FIFO employment were identified in the submissions. One submission by FIFO Families, an organisation supporting FIFO employees and their relatives, noted that research has shown that the most pressing issues for families are isolation, loneliness, trust and resentment. Issues with relationships, a lack of preparedness for isolation and stress were raised as well as the need for funding. These are similar to issues faced by families of Defence employees.

## Alternative solutions

Some of these criticisms of FIFO are somewhat exaggerated (as will be borne out in later analysis) but they do point to areas where industry and government need to work together more intently.

There is a need to consider alternative options to address ongoing workforce issues. For example, training for local workers in project-relevant skills could be instituted to meet specific demand. This option would have the benefit of utilising a local labour force with established accommodation and lifestyles.

On the other hand, targeted skilled migration programs could be utilised to increase the skilled workforce without the lead time associated with training. There may be some political issues associated with hiring overseas workers in regional areas in terms of language barriers and losses to the domestic economy.

Many producers are already taking active steps to address shortages in skilled workers. For example, direct company-sponsored training and fast-track programs and apprenticeships are being rolled out to meet the demands of various LNG producers in Queensland and Western Australia. These training programs are welcomed and will play a major role in improving the broader skills base of the economy, imparting a positive legacy impact especially given the massive pipeline of energy investments focused on surging demand from Asian customers.

### *Enterprise Migration Agreements*

On the other hand, targeted skilled migration programs could be utilised to increase the skilled workforce without the delay associated with training. Where genuine skill vacancies exist that cannot be filled by the Australian labour market, another option for mining companies is use of Enterprise Migration Agreements (EMA). Introduced in 2011, they

represent a temporary migration initiative to address the skill needs of the resource sector to ensure that skill shortages do not create constraints to major projects and jeopardise Australian jobs.

There has been some opposition from unions against the use of EMAs to bring overseas workers into the country for mining employment. However, these EMAs can only be used as a backup option where no Australian employees are willing and able to fill skill vacancies.

*Direct employers will need to comply with sponsorship obligations, including paying Australian market salary rates. This means overseas workers cannot be used to undercut Australian working conditions (DIAC 2012).*

This is particularly the case for operations in remote areas where workers may be unwilling to relocate or participate in FIFO schemes.

In the absence of EMAs, projects may be constrained from commencement and other Australian jobs could be jeopardised in downstream industries. They will ease capacity constraints and ensure economic and employment benefits can be realised. As such, there is a benefit both to Australian workers and companies of utilising EMAs to access overseas labour. EMAs are project specific and remain only one tool for meeting Australia's future skill needs.

Beyond these initiatives, there are other innovative approaches to addressing the skills shortage. These include employing or retaining older workers and therefore utilising a commonly overlooked potential source of labour. Further, alternative working arrangements could be implemented for people who require greater flexibility for family commitments, rather than a one-size-fits-all model of employment.

Improving the productivity of existing workers is another option available, whether this is through introducing a greater amount of capital into the process, reducing labour requirements, or improving efficiency through a restructure of the methods used in the organisation.

Many of these options have been canvassed in a recent Deloitte report *Where is your next worker?* (Deloitte 2011). Some of these approaches are likely to present viable alternatives for the industry as part of a multi-pronged strategy.

**Policy principle: Accessing skilled labour is a pivotal concern for the industry given its rapid expansion and as such this issue demands closer policy attention.**

For large capital-intensive projects, the up-front capex phase necessarily involves greater reliance on temporary workers. This emphasises the need to improve labour mobility and flexibility for workers to be deployed in their most productive capacity.

Various innovative solutions are available and a mix of strategies will be needed to manage sensitivities around FIFO workers and higher levels of skilled migration.

## 4.5 Domestic development issues

The development of Australia's resources does not in any way occur in isolation from the Australian community. Rather, resource companies operate with an implicit 'social licence' that reflects, among other things, the general public's acceptance of the project and the various economic benefits and impacts they involve. While these factors are typically well recognised by the broader community given Australia's successful and longstanding experience as a leading commodity exporter, there are areas where substantial reservations remain. Some of these key domestic development issues, along with relevant policy implications, are discussed below.

### Local content

The level of local content in major resource projects — whether this is labour or domestic goods and services — is an issue of particular community interest. In recent times there has been substantial media attention of these issues, especially in the context of Australia's patchwork economy.

Some sections of the business community and union groups have been critical of the use of overseas workers and firms to undertake significant elements of new project development. Many of these interests claim that local workers and businesses are being effectively overlooked by developers in their efforts to accelerate project investment.

In looking at local content issues, it is important to recognise the complexities and commercial realities of developing large capital-intensive projects.

#### *Capital-intensive and long lead time projects*

Even by the standards of most resource projects, oil and gas developments are capital-intensive, especially when projects involve liquefaction or refining facilities. As such, there are a number of important factors which affect the level of local content.

- Much of the key capital equipment is manufactured by a small number of major international suppliers, often using proprietary technologies. This includes gas platforms, modularised components and liquefaction facilities. For example, of the eight LNG facilities being constructed at present, four are using Bechtel LNG trains.
- Other components which may be manufactured in Australia in certain form and specification may not be made to the technical requirements of projects. For instance, many of the current gas projects underway are being configured with large diameter high grade 42 inch pipeline systems which are not made in Australia.
- Other equipment such as fabricated steel structures which can be made in Australia may not be available at the scale required by project developers.

These factors, both in isolation and conjunction, have a significant impact on the procurement strategies and development processes adopted by developers.

In terms of these development schedules, oil and gas projects, along with almost all resource developments involve long lead times. These projects tend to be larger, with development timeframes reflecting the size of the investment and the complexity of the attendant engineering, feasibility and procurement processes. In this environment, it is



highly challenging to manage international supply negotiations and arrangements. In particular, scheduling opportunities with key capital component suppliers (which often have tight order books) need to be locked in early to align with broader financing and project sanctioning processes.

#### *Major project development phases*

Many major projects split the development process into two phases:

- **Front-end engineering and design (FEED)** — FEED is a critical element of the assessment of a project prior to a financial investment decision, and has a core role in the need to assess the ability of resource project to be developed. This can involve basic engineering and design, project scheduling and cost estimates and can sometimes procurement of long lead equipment. The FEED process can also generate basic engineering packages, sometimes referred to as process design packages (PDPs), which are (ideally) sufficiently progressed to enable market tendering. FEED may be undertaken by specialist engineering firms but increasingly major EPC contractors have the in-house capability to do this.
- **Project implementation** — Detailed design and construction works occur (if at all) following FEED. These can be undertaken using an EPC or EPCM structure (see Box 3), which may or may not involve the FEED contractor. The decision on which contracting model to use is often deferred until the latter stages of the FEED process when the price of developed design packages can be market tested, and development risks assessed in detail.

The timing of these processes tends to be an important factor in the context of many procurement decisions. Before FEED, many developers will not have made a decision on their overall project development approaches such as whether an EPC or, increasingly, an EPCM arrangement is adopted. Most substantial procurement decisions and the determination of market-ready design packages have therefore not been firmed and are preliminary at best.



### Box 3: Typical development approaches for major projects

Major projects are commonly developed using two approaches: a turnkey engineering, procurement and construction contract (EPC contract); or an engineering, procurement and construction management contract (EPCM contract). These approaches are set out below, although it should be noted there can be variation around these structures and there is no definitive industry terminology.

EPC contracts provide developers with a considerable degree of certainty in the project development process. Typically, a single contractor will have responsibility (and accept the risks) for:

- the costs of construction (subject to limited adjustments);
- the time of completion (subject to extensions); and
- the quality of design and construction works and achievement of performance guarantees (subject to exclusions).

In contrast, an EPCM contract is a professional services contract with markedly different risk allocation and legal implications. The EPCM contract essentially splits responsibility for engineering and construction, with the contractor designing and managing the construction process for the owner but not doing any actual building or construction.

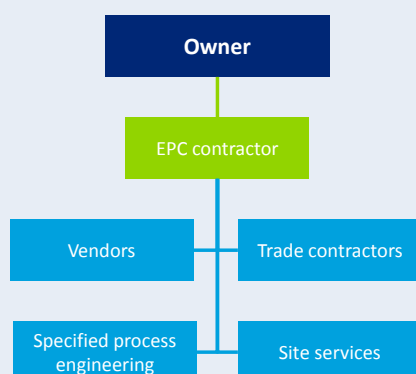
EPCM contractors can be responsible for:

- design including the basic engineering/FEED and detailed design;
- procurement of materials and equipment; and
- management and administration of the construction contracts.

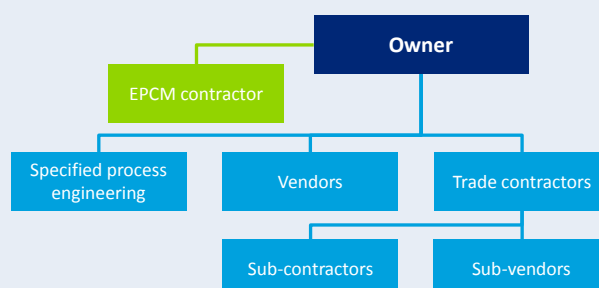
Under this structure, the contractor is not a principal — ie is not a party to a contract for the construction of the project. The contractor acts as the owner's agent and creates direct contractual relationships between the owner and suppliers and trade contractors. Any problems arising under trade contracts between trade contractors and the owner, such as delay and disruption and property and works damage claims, become the responsibility of the owner and not the EPCM contractor. Owners therefore take a more proactive role in overall project management when adopting an EPCM approach.

EPCM forms of project delivery have emerged largely in response to the increasing size and complexity of many large projects, particularly in oil and gas, mining, power and desalination sectors. It also reflects a limited pool of EPC contractors with the requisite capabilities and experience to undertake such projects, and therefore a reluctance to accept broad ranging development risks.

#### Typical EPC contract arrangements



#### Typical EPCM contract arrangements



### *Implications for procurement*

As part of these central procurement arrangements, it is common for developers to bundle a range of additional ancillary components (such as fittings and fabricated steel structures) where local suppliers may be available. Importantly, this enables them to secure the cost benefits of significant economies of scale, improve project scheduling and reduce interface risks.

Securing such cost savings and reducing third party risks is crucial to advancing world class resource projects in a competitive market, especially in the context of rising domestic cost factors elsewhere. Developers are typically weighing up the merits of competing projects, many of which are in other (lower cost) parts of the world, and it is therefore important that they can extract the maximum benefit from access to global supply chains.

That said, the local content in oil and gas project development is hardly insubstantial. Civil works and site preparation, installation of capital equipment, laying pipe networks and other major operations and maintenance activities are often undertaken by local businesses and contractors (some good examples have been highlighted in case studies). Further, oil and gas developers are actively involved in promoting deeper engagement of local businesses into their projects where possible. Many of these initiatives are formalised through Participation Plans with State and/or the Commonwealth Governments — often as a condition of development or to access relevant tariff concessions. Indeed, given their specialised and often large capital requirements, the ability of producers to secure tariff relief under different programs like the Enhanced Project By-law Scheme (EPBS) is important in reducing overall development costs.

Overall, local content appears to be around 60-70% for many current LNG projects, with differences mostly driven by the adopted technologies and the capital intensity of the project. A key feature of the empirical analysis was to factor these inherent local content differences between various forms of oil and gas projects.

### **Domestic gas reservation**

Another issue which has received considerable industry and policy attention concerns the effective management of Australia's gas resources for domestic use as opposed to export.

Since 2006, the Western Australian Government has applied a formal Domestic Gas Reservation Policy which aims to ensure that gas supplies are sufficient to underpin long term economic development and energy security. Under this state policy, project developers are required to reserve up to 15% of production for domestic supply to local energy markets. The reservation requirements are established between project developers and the Western Australian Government as a pre-condition to allowing onshore processing facilities on State land. Some flexibility on reservation limits is provided within the policy framework which allows for negotiations with project developers on a case-by-case basis.

While this policy is currently restricted to Western Australia, there have been calls to establish similar arrangements on the east coast, particularly with the present wave of large export focused LNG developments in Queensland.

In the context of the massive scale of investments and projects under consideration, the potential broadening of this policy by other jurisdictions presents a number of important issues for industry.

At a fundamental level, the policy reduces the financial returns to developers by requiring them to sell a portion of their production at (typically) lower domestic gas prices. In this way, the domestic reservation policy essentially acts as a subsidy to other industries and a tax on developing gas reserves. Certainly, if prices or other terms such as contractual duration were broadly equivalent between domestic and overseas customers, there would be little requirement for regulatory intervention in this manner.

There are some attendant economic welfare implications with the policy. Domestic gas reservation is effectively a quantitative restriction on gas exports (exports must be less than output minus the domestic gas reservation), combined with a subsidy to domestic consumption (which is the difference between the domestic and world price). Crucially, this gives rise to an economic welfare loss, largely borne by producers, which is potentially greater than simply providing a direct cash subsidy to domestic users.

#### *Risks and cost*

Importantly, the policy also imposes additional uncertainty, regulatory cost and risk on producers.

Many reserves are expensive to develop and securing sufficient commercial returns is likely to require developing large scale projects for export at world prices. Accordingly, placing additional risk and lower returns could place in doubt the viability of further large scale projects and discourage future investment in oil and gas development. An important implication is that this may actually reduce the certainty of domestic gas supply rather than increasing it.

This regulation (or quasi regulation) may not adversely impact on investment levels for the largest gas developments, which often have strong project fundamentals, but it will present a greater risk for more marginal developments. It is important to recognise that this policy sits alongside a raft of other regulations that developers are required to navigate. The marginal impact of market interventions of this type can be much higher than the absolute impact.

Domestic gas reservation could also result in projects, especially offshore gas projects, effectively shopping around for a better jurisdictional policy and regulatory regime. This could have two aspects:

- Companies may prefer to pursue a resource project in one jurisdiction rather than another on the basis of more favourable policy settings.
- Companies may look to circumvent the policy by shipping offshore gas (which is in Commonwealth waters) to a processing facility in another state or territory, or pursue offshore options.

While selecting a preferred location to develop a project is a standard business consideration, where policies target immobile resources (ie resource deposits) there can be greater risks of investments not proceeding at all, especially for more marginal projects.

### *Price issues*

The divergence between domestic (either east or west coast) and international prices has been cited as a factor in calls for wider domestic gas reservations. These price issues need to be put in perspective.

Markets have two sides — a buyer and seller — and a good price for one party means the other is receiving less favourable terms. Prices for energy and other resources have over the last decade or so moved well in producers' favour (following a considerable period of much lower energy prices). As a key energy exporter, this has generated significant wealth impacts (as illustrated in the empirical analysis) for the country as a whole. The greater the divergence between the prices received on world markets and those paid by domestic users (netting out differences in transport costs), the greater is the effective subsidy and the direct financial cost to producers.

Further, while cheaper local gas might look particularly attractive compared to overseas prices, this may not always be the case. Energy market developments in the United States and elsewhere involving unconventional forms of gas extraction could lead to a massive expansion in world supply and protracted periods of low gas prices. In such an environment, exposure to international prices would be a distinct advantage for local gas consumers.

### *Ongoing uncertainties*

Most formal domestic gas reservation schemes will involve ongoing adjustments to ensure an appropriate supply-demand balance is achieved. This 'dynamic' aspect of the policy gives rise to ongoing uncertainties for developers.

Markets are efficient mechanisms for bringing buyers and sellers together; and by intervening in this coordination process, a form of domestic gas reservation means the government has made a decision on behalf of local users to quarantine how much gas is needed domestically. It is unlikely that this amount will precisely match ongoing demand requirements. Indeed, Western Australia is likely to require only relatively small load increments which are unlikely to justify the appropriate investment. As a consequence, over time, changes will undoubtedly be required — especially in the context of mega LNG projects.

In a sense, reservation flexibility within the Western Australia Government's policy provides a protection against flooding the market with domestic gas. However, this project-by-project application can also contribute to policy uncertainty and risk, with the precise application of the policy being subject to commercial negotiation (before further negotiations between producers and users on price and other relevant terms).

### *Risks of entrenching industry assistance*

Many of the current industry calls for continuation and extension of the reservation scheme appear to have a legacy element. A form of domestic gas commitment was a feature of the State Agreements which cover the North West Shelf Project and the Gorgon Project. If subsidy arrangements are longstanding they can become deeply entrenched, making any policy change and accompanying price adjustments more difficult to effect.

This stands as a key risk associated with any broader application of domestic gas reservation scheme on the east coast. Like other forms of industry assistance, once such a policy is in place, it can be very difficult to unwind. Over time, any chilling effect on the hunt to discover and exploit the country's gas reserves, and the implications for Australia's sovereign risk profile, could be amplified.

### **A rising cost environment**

The core decision facing many existing developers is whether or not to commit to the large capital costs associated with constructing new (mainly LNG) production facilities.

The costs of establishing these major projects, including liquefaction trains and adjoining pipeline networks has been increasing due to rising construction costs (ie steel input costs) and skilled labour shortages. These pressures have already been evidenced in current Australian resource developments more broadly. Most recently, BG Group announced a budget overrun of \$5.2 billion for its QCLNG project at Gladstone, representing an increase of around 36% in overall development costs.

Cost over-runs and slippage of development schedules represent substantial risks to projects, especially given the considerable scale of investment. As was cited in the case of BG Group, these are being predominantly driven by a high Australian dollar, where projects are typically sanctioned on a UK or US dollar basis, coupled with a range of 'local market effects'. These include increased regulatory compliance requirements, rising labour costs and weather delays.

In the case of prevailing weather conditions and the value of the currency, both represent uncontrollable aspects of project development. The critical point is to ensure that government policy does not unduly contribute to the overall development risk profile.

### Case study 7: Environmental responsibility

Chevron's Gorgon Project is located at Barrow Island off Western Australia, a Class A Nature Reserve. Barrow Island is home to 13 species of land mammals, seven marine mammal species, 119 species of bird and over 43 reptile species, making it one of Australia's most important island populations. Many of these species are rare or extinct elsewhere. In addition, there are about 378 native species of plants on Barrow Island. There are no introduced plants or animals on the island making it a unique environment very different to mainland Australia.

Australia's largest onshore oil field has operated at Barrow Island for 45 years. The \$43 billion Gorgon Project commenced in 2009. Chevron has utilised Quarantine Management procedures to protect the conservation values of the region.

The Quarantine Management System (QMS) consists of more than 300 procedures, specifications, checklists and guidelines to protect the biodiversity of Barrow Island and its surrounding waters. The QMS was developed and refined in consultation with the broader scientific community, specialist environmental consultants and relevant government regulatory agencies. All goods, material, equipment and personnel movements to the island must adhere to comprehensive quarantine requirements prior to transport.



*The spectacled hare-wallaby, native to Barrow Island*

From the commencement of the Gorgon Project in September 2009, quarantine screening has been completed on more than 152,000 passengers and over 650,000 tonnes of freight. In addition, more than 19,000 personnel have received quarantine training specific to their role.

One hundred and eighteen audits have been completed to ensure contractors are meeting quarantine obligations and over 200 quarantine compliant vessels successfully mobilised.

The QMS was recognised by the Western Australian Environmental Protection Authority as 'likely to be world's best practice' and represent the world's largest non-government quarantine initiative. Chevron was also awarded the APPEA Environment Award for two consecutive years – for the Turtle Tagging Program and the QMS.

The company's commitment to the environment of Barrow Island reflects their corporate social responsibility. This has included particular consideration of plant and infrastructure locations to avoid areas of particular conservation significance and ensuring that there are no commercially viable development alternatives.

Two areas where the regulatory burden could be reduced include:

- Environmental approvals, especially regarding CSG production and integrating changes in project scope. While ensuring adequate environmental protection is clearly necessary, it appears that key aspects of the legislative framework could be improved to deliver greater certainty to industry and better integrate the requirements of the Commonwealth Government's new Independent Scientific Panel.

- State and Commonwealth Government policies facilitating local content for major project development. There are currently a range of different measures in place for oil and gas projects, which typically have both state and federal requirements. At the Commonwealth level, there have been recent changes to bolster Australian Industry Participation Plans, particularly those required to access relevant tariff concessions. It is important that these requirements appropriately recognise the long lead times of investments and the complexity of attendant engineering, feasibility and procurement processes.

Australian projects are not immune from price rises. Many producers (individually or through consortium partners) are diversified companies with a global portfolio of projects. These producers make investment decisions based on the relative returns available in different countries. Associated policy uncertainties and cost increases have the potential to increase the risks and costs of investing in Australia and make other countries more attractive.

#### *Stability of taxation regimes*

In relation to overall costs and risks, the stability or certainty of Australia's tax regime and how this pertains to long term resource projects is an important development factor. In many respects, it is the stability of a tax policy framework, as much as the policies themselves, which influence long term investment decisions. This is because investors in the oil and gas sector are exposed to particularly long project time horizons and thus ideally require a predictable set of rules to 'lock in' sizeable amounts of capital.

Importantly, continual changes in the taxation environment, whether these are incremental or fundamental in nature, can increase the sovereign risk profile for investors. At their worst, they can scuttle projects (especially marginal resource developments) and drive investors to pursue opportunities in other countries.

**Policy principle: Australia's reputation as a world class energy exporter should be protected and enhanced.**

Australia has many advantages as a developed country with proven resource prospectivity and supply performance. But rising development costs and risks of unwarranted regulatory interference could potentially undermine the economic payoffs from the boom and lead to long term supply contracts being lost to other energy exporting nations.

## 4.6 Sovereign wealth funds: the case for and against

A number of senior public figures such as Malcolm Turnbull, Ralph Norris and Bob Brown, as well as prominent economists, including Professor Warwick McKibbin (a former RBA board member) and the International Monetary Fund have called for the establishment of a sovereign wealth fund (SWF) in Australia.



A SWF can assist with:

- moderating exchange rate appreciations (such as occur during a resources boom);
- smoothing national spending — consumption — so that swings in national income have a more limited impact on the wellbeing of families and businesses and the volatility of the business environment they face;
- saving (quarantining funds) for future fiscal imbalances for example an ageing population or public sector pension funds;
- fiscal revenue stabilisation (smoothing volatile revenue flows), which can be important for countries such as Australia whose government revenues are influenced by swings in commodity prices.

In terms of the first objective, if a SWF is to moderate the effects of a resources boom on the exchange rate, it should be invested mostly abroad (Corden 2012). Using Australian currency to purchase assets abroad moderates the exchange rate appreciation effect associated with a resources boom, thus assisting the non-resource tradeable goods sector by lowering the relative cost of their goods internationally. Investing in a SWF abroad can also increase diversification of public sector asset holdings by introducing international asset exposure. This diversification reduces the impact of adverse shocks to domestic output on the value of funds in a SWF.

However, there are also some costs associated with requiring a SWF to invest its funds abroad. By requiring that funds be invested abroad a SWF may miss out on higher return domestic opportunities, which would also lead to reduced domestic investment and output.

The second broad justification for a SWF is that it can help address issues associated with Australia's ageing population by providing a way of offsetting future fiscal imbalances. The Future Fund is an example of a SWF created to meet future fiscal imbalances, in this case public sector pension liabilities. In this way, a SWF can potentially create a mechanism to provide for intergenerational equity from extraction of Australia's finite natural resources.

The third broad justification for a SWF is that it can help ensure that governments do not make permanent spending and tax promises off the back of temporary sources of revenue. Australia's national income — and hence the revenues underpinning the Federal Budget — have become more volatile since the global industrial revolution began to step up pace almost a decade ago. That is where sovereign wealth funds come in. These funds look to smooth the economic impacts of foreign demand for local goods and services — in this case, Chinese demand for Australian resources.

That is, in nations subject to large swings in national income, there is a risk that Budget policy itself destabilises the business cycle (raising spending during upturns, cutting it back again during downturns). Rather than this process being offset by opposite swings in interest rates, it makes sense for Budget policy to be smoothed rather than interest rates used to offset the lack of smoothing in Budget policy.

A SWF could be used to distribute government revenues from periods where commodity prices are above average to periods where commodity prices are weaker, thus allowing for households and businesses to smooth their consumption thereby increasing national welfare. In this way a SWF could act in a counter-cyclical manner so that funds set aside



during a resource boom would reduce inflationary pressures in the economy, while also helping to stimulate the economy during a downturn.

## Main advantages of a SWF

The objectives of a SWF discussed above could be achieved through running budget surpluses rather than creating a separate SWF (Henry 2010). The main advantages of a SWF over running a budget surplus are that:

- a SWF can be designed to quarantine funds for future needs in such a way that governments are unable to or less likely to raid surplus funds prior to the future need arising — a SWF can provide a mechanism which is at ‘arms-length’ from government to protect the rights of current and future citizens;
- a SWF can be managed independently; and
- a SWF can be used to focus public opinion on making efficient investments from the proceeds of a resources boom.

Essentially, if a SWF is properly designed it can ensure that sufficient funds are provided to meet future policy objectives. However, it should be noted that the way a SWF is designed is critical to preventing it being used by governments to fund short-term political priorities, either by directly using funds in a SWF or by indirectly borrowing against the security of the fund.

## Some disadvantages of a SWF

One of the main disadvantages of a SWF relative to a budget surplus is that it reduces the flexibility of current governments to respond to present-day policy priorities or to invest in infrastructure, human capital or superannuation which can also be used to improve the welfare of future generations. In fact, such investments could potentially do more to improve the long term prospects of the country than quarantining capital in a SWF which will only become available at some future date. The advantages and disadvantages of other alternatives to a SWF are outlined in Table 4.1.

**Table 4.1: Alternatives to a SWF**

	<b>Advantages</b>	<b>Disadvantages</b>
Budget surpluses	Can achieve all the objectives of a SWF and funds are immediately available to respond to policy priorities.	Short-term political objectives can reduce the incentive for large budget surpluses and increase the risk of funds being used prematurely.
Tax cuts	Allows decisions on future needs to be made privately by consumers and businesses.	Consumers and businesses may not take a long term perspective on their future savings needs.
Funding physical infrastructure	Would address current infrastructure deficits and improve long run growth.	Would be pro-cyclical in increasing economic activity during a commodity boom and use similar resources to oil and gas and mining construction.

	Advantages	Disadvantages
Assist in pursuing difficult economic reforms	Could improve long run growth and productivity.	Additional reforms are politically difficult and would also be pro-cyclical in nature.
Investing in human capital	Would improve long run growth and productivity.	Pro-cyclical in nature, particularly if large funding increases are required.
Providing tax incentives for superannuation	Would help smooth future consumption and fiscal outcomes.	Can only be used to smooth consumption for older individuals and benefits may not be spread evenly.

Source: Deloitte Access Economics

Another potential disadvantage of a SWF is that in the case of the Future Fund returns have not been particularly strong in recent years. The real return on the Future Fund between 2005-06 and 2010-11 has averaged 2.2% (Carling and Kirchner 2011), which has been relatively similar to the cost of current government debt incurred in recent years. Thus the existence of the Future Fund has not led to an appreciable improvement in Australia's net debt position relative to placing such funds in a budget surplus.

Finally, if not properly designed, a SWF can suffer from a lack of accountability and transparency while its investments can be subject to political interference. These considerations suggest the need for strict rules on how funds in a SWF can be spent. However, it should be noted that Australia's governance arrangements are considered world leading in terms of their reporting transparency, accountability provisions and clear commercial mandate.

## The potential application of a SWF to Australia

Given current fiscal consolidation concerns, establishing a SWF does not appear to be an immediate policy priority. The Secretary of the Commonwealth Treasury (2011) has noted:

*The act of paying down net debt out of future surpluses is identical to accumulating financial assets in a sovereign wealth fund. It has the same effect on the government's balance sheet and the level of public saving.*

*Efforts to reduce government net debt should be the immediate focus — whether this is done by reducing gross debt on issue, or maintaining gross debt but building up financial assets, in a sovereign wealth fund, is an important but second order issue ...*

*I am not suggesting that a sovereign wealth fund is not without merit, just that we should be clear about the role that it can and should play.*

Thus while Treasury appears open to the possibility of establishing a SWF, reducing government debt appears to be the major priority. The recent decision to progressively increase compulsory superannuation contributions to 12% financed by the minerals resource rent tax and the large current concessions for superannuation, also suggests that the Government sees superannuation as playing an important supporting role in smoothing future consumption and addressing issues associated with an ageing population.

A critical issue in establishing a SWF is how it will be funded. It should be noted that a SWF need not necessarily be funded by an additional impost on the resources industry — indeed Australia's Future Fund has been financed through general government surpluses and proceeds from the sale of public assets. A SWF could also be funded through direct contributions from taxpayers, although this option is likely to be politically difficult to implement.

That is an important point — there are two different questions here: whether Australia should have a SWF and, if so, how it should be financed.

Hence the debate around a SWF goes to the timing of when the nation spends the proceeds of the tax system, rather than how those taxes are raised in the first place.

However, there is a risk that, in practice, these two issues could be conflated and that a SWF explicitly linked to the current resources boom may be financed, at least in part, from additional imposts on the petroleum and wider resources sector (especially given the current state of Commonwealth finances).

Depending on how the tax is designed, it could create distortions in the allocation of inputs between the oil and gas sector and other sectors in the economy and may restrict the level of growth resulting from the boom. The difficulties of properly defining a 'normal' profit for the industry was also highlighted in the recent debate over the minerals resource rent tax.

Given that the benefits of resource projects flow-on to other sectors of the economy as well as into government budgets by virtue of existing taxation arrangements (as highlighted in this analysis), sustained increases in commodity prices are likely to significantly increase government revenues.

A SWF financed from general budget surpluses could avoid some of the distortions associated with taxation of particular sectors of the economy. However, it would require appropriate fiscal discipline from the Government. Given that Australia is currently running a slender surplus position and large surpluses are not projected for the medium term (Federal Budget 2012), a SWF is unlikely to be viable in the medium term unless greater fiscal restraint is used or there is a further rise in commodity prices which would increase government revenues.

If a SWF were to be established it is important for its objective to be clearly defined to prevent the SWF being used for short-term political objectives. In Australia's case the two most compelling justifications for a SWF would be fiscal revenue stabilisation given the inherent volatility of commodity prices, and the need to fund future structural deficits associated with an ageing population.

The strength of these two justifications in Australia's case is perhaps not as strong as in Norway which is often cited as a successful example of the use of a SWF. Norway's resources have a relatively shorter economic life than Australia's overall energy and mineral resources endowment. In addition, Norway's resource sector accounts for a relatively larger share of the overall economy compared to Australia, while the Norwegian Government is expected to experience a fiscal gap of 5.5% by 2050 compared to 2.5% by 2050 in Australia.

The differences between Australia and Norway do not mean that the issues of fiscal stabilisation and an ageing population are not important for Australia or that a SWF would not be an appropriate long term mechanism to address them. Indeed, there are many advantages to using a SWF over other policy instruments to achieve these objectives. However, the case for implementing a SWF in the short term appears less pressing than for countries like Norway.

**Policy principle: Policymakers should guard against backsliding on broader policy and institutional settings.**

Australia's fiscal and broader institutional settings have led to this resource boom being (largely) well managed, especially compared to previous booms. The petroleum resource rent tax has provided a stable and relatively predictable fiscal regime.

There have been calls for Australia to reframe aspects of its fiscal settings through establishing a (new) sovereign wealth fund to capture the benefits from high resource prices. A SWF can be used to meet particular policy objectives but needs to be carefully designed to minimise distortions between sectors and to ensure that funds are appropriately quarantined. Given the current budget position, it is difficult to see the establishment of a SWF as an immediate policy priority.

## 5 Conclusions

Over many decades Australia's oil and gas industry has played a substantial role in unlocking Australia's abundant energy resources and reinforcing our international reputation as a world class energy exporter.

Looking forward, the industry is well-placed to take advantage of the considerable opportunities presented by strong demand for energy resources within our region. This is being underpinned by a remarkable level of investment in new production facilities across the country, predominantly in Western Australia, Queensland and the Northern Territory. The scale of these investments is quite unprecedented and it showcases the industry's enterprise and capabilities to concurrently execute complex and long term projects.

The level of industry investment and the substantial boost in production slated to come on line over the next decade will provide enormous economic benefits to the country. However, in order to fully harness these gains, there will need to be further adjustment in the allocation of resources within the economy. This has already presented various sectoral and workforce pressures, such that the 'multi-speed' or 'patchwork' economy is now a common thread in the national conversation.

A number of policy principles have been presented in this paper regarding an effective way to manage these structural and development pressures, reflecting our proud track record of responding to new opportunities, modernising the economy and engaging with the rest of the world.

# Appendix A: General equilibrium model

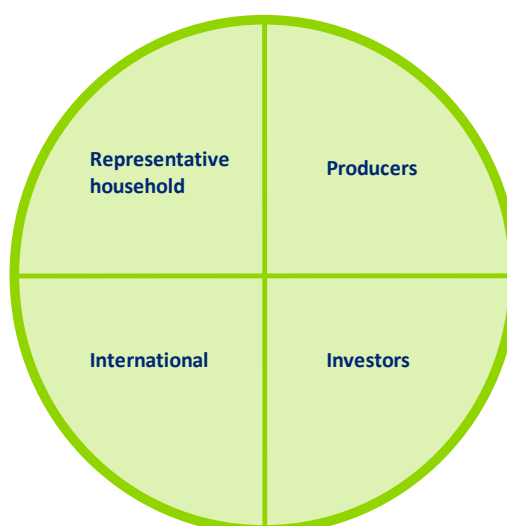
DAE-RGEM is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium model of the world economy. The model allows policy analysis in a single, robust, integrated economic framework. It projects changes in macroeconomic aggregates such as for GDP, employment, export volumes, investment and private consumption. At a sectoral or industry level, detailed results such as output, trade flows and employment are also produced.

The model is based on a set of key underlying relationships between different groups of agents in the economy: households, producers, investors and international agents. Each of these groups is represented as a discrete *component* in the model. The relationships between components are solved simultaneously and, as such, there is no logical start or end point to conceptualise the model's operation.

Figure A.1 shows the key components of the model for an individual region. Regions can be specified for particular analyses and can be entire countries (or multi-country regions like the Euro Zone or East Asia) or specific areas of a country like Australian States and Territories.

The model's database and broad economic foundations are outlined below.

**Figure A.1: Key components of DAE-RGEM**



## The database

DAE-RGEM is underpinned by a detailed global database. This is derived from the Global Trade Analysis Project (GTAP), which produces a global database for general equilibrium

modelling that covers 113 regions or countries and 57 industry sectors (the base year is 2004).

The Australian component of the database is provided by the Productivity Commission and is based on Australian input-output tables developed by the Australian Bureau of Statistics. As noted, the model also splits Australian economic activity into States and Territories, thus allowing regional analysis to be undertaken.

The base data quantifies the economic flows between sectors, including bilateral trade, and also accounts for greenhouse gas emissions from fossil fuel combustion. The database is 'benchmarked' or calibrated so that an initial equilibrium solution exists that replicates actual sectoral production, consumption, trade and factor usage in the base year (2004).

## Economic foundations of the model

### *Income, consumption and savings*

- Each region contains a 'representative household' that receives all income from factor payments (labour, capital, land and natural resources), taxes and net foreign income from borrowing (lending).
- Under standard economic setting (otherwise known as the model's closure), savings are a function of the rate of return on capital which reflects the return on savings. Government consumption moves in line with national income. Household consumption, therefore, is determined as the residual of national income, savings and government consumption.
- At the detailed level, 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.
- 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 (constant elasticity of substitution) 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 influenced by movements in the real wage rate and is governed by an elasticity of supply parameter. This implies that changes in the demand for labour, positively or negatively, will impact both the level of employment and the wage rate.

### ***Investment***

- Investment takes place in a global market and allows for regions to have different rates of return that reflect their individual risk profiles and policy impediments to investment. A global investor ranks countries as investment destinations based on two factors: the current level of global economic growth and comparative regional 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.

### ***Market clearing***

- Prices are determined via competitive 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).
- Internationally traded goods (imports and exports) are differentiated by the country of origin and treated as imperfect substitutes (according to the so-called Armington assumption). 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.

### ***International***

- Each of the components outlined above operate, simultaneously, in each region of the model. That is, for any simulation the model forecasts changes to trade and investment flows within, and between, regions subject to optimising behaviour by producers, consumers and investors. This implies some global conditions must be met such as balancing of global exports and imports and for global debt repayments and debt receipts to equalise each year.



### Some stylised dynamics in the model

- **The representative household**

Moving clockwise around Figure A.1 from the top left quadrant, the representative household interacts with producers in two ways. First, in allocating expenditure across household and government consumption, demand for production is sustained. Second, the representative household owns and receives all 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 interacts with investors through the supply of investable funds (that is, savings). Linkages with the international sector occur via trade in goods and capital. Importers compete with domestic producers in consumption markets, and regions lend or borrow money from each other.

- **Producers**

Apart from selling goods and services to households and government, producers sell products to each other (intermediate usage) and to investors.

Capital is an input into production. Investors respond to the conditions facing producers in a region to determine the amount of investment. Generally, increases in production are accompanied by increased investment. For example, making machinery, constructing buildings and other similar activities — which form the basis of a region's capital stock — are undertaken by producers. In this way, investment demand adds to household and government expenditure from the representative household, to determine the demand for goods and services in a region.

Producers also 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.

- **Investors**

Investment takes place in a global market, with regions having different rates of return based largely on their risk profile. Investors seek to optimise their investments by directing capital to countries according to prevailing levels of economic growth and the comparative attractiveness of countries as global investment destinations.

- **International**

Each of the components outlined above operate, simultaneously, in each region of the model. That is, for any simulation the model forecasts changes to trade and investment flows within, and between, regions subject to optimising behaviour by producers, consumers and investors. This implies some global conditions must be met such as balancing of global exports and imports and for global debt repayments and debt receipts to equalise each year.

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