



2018-2028

Western Australian Resources Sector Outlook

**The Chamber of Minerals and
Energy of Western Australia**

April 2018



1/3

The Resources Sector accounts for nearly one-third of **the \$248 billion** Western Australian Gross State Product (GSP).



The Western Australian economy has continued to grow, with a **47% increase in GSP** over the past 10 years



WA currently produces **98% of Australia's iron ore** & **37% of global iron ore**, making it the largest iron ore producer in the world.

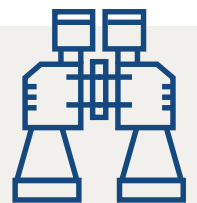


Mineral and Petroleum exports account for **90% of Western Australia's total exports.**



For 10 years, **WA** (on average) **has produced twice the amount of gold** relative to the rest of Australia.

Outlook



Modest growth in resources sector production is expected, supported by increased domestic capacity and growth in global industrial activity.

Increased domestic capacity and competition from foreign producers will limit the upside for commodity prices over the next couple of years. For LNG prices, the upside is also limited by the emergence of the US as a major player with the potential to increase global supply significantly.

With strong growth in global industrial production, and increasing uptake of battery technologies, the outlook for base metals is relatively positive.

Key Enablers

People

118,423 people in resources-related employment

106,502 mining employees and contractors on-site

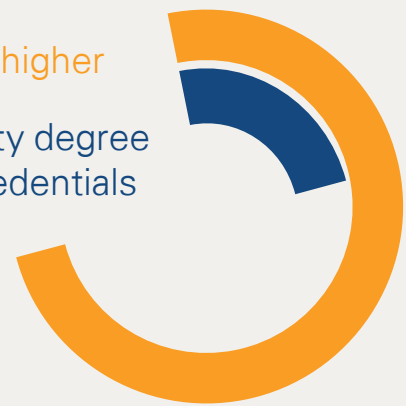
9,653 employed in oil & gas

2,268 employees in exploration

Resources sector employees are highly skilled

70% have Cert III or higher

24% have a university degree or post-grad credentials



Over the outlook period, demand and competition for skilled labour is expected to increase within the sector and also across the broader economy.

Water



The **Pilbara region** abstracts the majority of water at **450 GL** (68%)



Followed by **Goldfields-Esperance** with **105 GL** abstracted (16%)



It is estimated water abstraction by the resources sector could increase from **654 GL in 2016 to 773 GL by 2024**, an 18% increase.



Over 40% (256 GL) was dewatering that was **returned to the environment** or used in other activities (offsite).

Infrastructure

Well-coordinated planning and delivery of infrastructure such as ports, rail and road is often a catalyst for growth and is key to the success of the resources sector.

Ports

- With **projected increases in export volumes**, port infrastructure and efficiency will need to be a key focus, including better availability of slots at multi-user berth ports.

Rail

- The Perth/Peel region is expected to see an increase of outbound freight of around **11% a year, on average, between 2016 and 2020**.
- Over the outlook, inbound freight volumes, particularly for the Goldfields/Esperance region, are likely to fluctuate over the period **2019-20 to 2021-22**.

Roads

- Federal and State governments have allocated **\$2.3 billion across 17 new road and rail projects**. Part of the package includes **\$44.2 million** for **regional road projects** to improve regional road safety.
- The South West/Great Southern region is likely to see a **sharp increase in use of road infrastructure** as a number of projects look to increase production.

Aviation

- The WA Department of Transport recently allocated **\$3.88 million until 2019** for regional airports.
- Over the outlook period, increasing demand for aviation infrastructure will require investment in new (and existing) aviation infrastructure by government and industry to ensure aviation capacity meets on-going demand.

Social Infrastructure

- An increase in digital technology to improve access to “virtual” educational services.

Energy



Total energy consumption in WA's resources sector is expected to grow at a rate of **2.4% p.a.** over the outlook period* (more than double the total estimated increase across all sectors) with the **upward trend in natural gas consumption** likely to continue.

Self-generated and purchased electricity for the resources sector is anticipated to increase by around 1,743 GWh (13.4%) and 824 GWh (20.7%), respectively.

*Australian Energy Projections to 2049-50 (BREE 2014).

Technology & Innovation

20% of resources sector jobs have been partially or fully automated and this is likely to continue.

Over the outlook period, emerging technologies will change the landscape in which the resources sector operates, and advances in technology and innovation are likely to accelerate.

Opportunities and Challenges



People

One of the major constraints on the growth of the sector remains the ability to attract and retain appropriately-skilled personnel such as geoscientists and engineers. There is also likely to be significant demand for (and limited supply of) people with autonomy experience and an understanding of data science as it applies to mining.

The potential shortage of such human resources is, in part, a structural problem that is best addressed by government, educational institutions and industry continuing to work together.



Energy

Increased energy consumption is expected to be met, in part, by increased supply from alternative (renewable) sources and by continued development and adoption of energy-saving technologies. Reliance on coal and diesel for energy generation is expected to decline over time as policies designed to encourage the use of clean and low-emission energies are put in place and act as substitutes for fossil fuels. Advancing the use of renewables, however, requires appropriate investment for the expansion of Western Australia's energy infrastructure. To meet the energy needs of the resources sector, a combination of policy initiatives, new infrastructure and industry and academic engagement will be required to drive innovation and technological transformation in the generation and use of energy.



Infrastructure

Pressure is expected to be placed on Western Australia's physical infrastructure (bridges, rails, ports, and aviation) in the longer term driven by population growth and economic activity. Housing affordability/availability and access to higher education remain points of contention in the regions. A key challenge for Western Australia is that the regions tend to be large, remote and sparsely populated. This means that economies of scale are difficult to achieve in the provision of public services.



Water

Various challenges exist for Western Australia's resources sector in relation to water. Almost half of the 2017-18 RSO survey respondents indicated they expect an issue with water access or use to impact their project or hub over the next decade. In the North West, increasing agricultural developments are likely to lead to increased competition for water. In the South West, a drier climate will likely put pressure on existing water sources. Mining operations are taking steps to conserve, re-use and recycle water and there is potential for expanding this activity. Stakeholders have indicated their desire to recycle surplus water by distributing it to further productive uses. A concerted effort is required from government and industry to unlock the environmental benefits of additional water recycling initiatives. Other incentives such as pricing and rebate schemes can encourage more efficient use of water.



Technology & Innovation

Innovation is a key driver of economic growth and improved living standards. Australia's resources sector will continue to drive innovation and technological change as it seeks to maintain and enhance its competitiveness. Continued advances in drone technology, automation and artificial intelligence will present new opportunities but also create new challenges for the sector. Access to digital technologies will present opportunities to overcome some of the challenges posed by the remoteness of communities and work opportunities in Western Australia. This, however, will require reliable communication infrastructure.

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Contents

Executive Summary	1
1. Introduction	6
1.1. <i>Scope</i>	6
1.2. <i>Report Structure</i>	6
2. Economic Overview	8
2.1. <i>Global economic snapshot</i>	8
2.2. <i>Western Australian economy</i>	9
2.3. <i>Economic Outlook</i>	16
3. Western Australia Resources Sector.....	18
3.1. <i>Overview</i>	18
3.2. <i>Regional Activity</i>	22
3.3. <i>Exploration and Investment</i>	31
3.4. <i>Commodity Prices</i>	33
3.5. <i>Resources Sector Outlook</i>	35
4. Key Growth Enablers	41
4.1. <i>People</i>	42
4.2. <i>Energy</i>	51
4.3. <i>Water</i>	63
4.4. <i>Infrastructure</i>	74
4.5. <i>Technology and Innovation</i>	89
Appendix A: New Major Projects	92
Appendix B: Methodology.....	96

Executive Summary

The Chamber of Minerals and Energy of Western Australia (CME), in conjunction with KPMG, is pleased to present the 2018-2028 Resources Sector Outlook (RSO). The RSO is intended to inform decision making by providing an integrated outlook for the resources sector across the enabler areas of people, energy, water, infrastructure, and technology and innovation.

The Western Australian economy is dominated by the resources and services sectors. Exports of minerals and energy (mainly iron ore, LNG and gold being the main contributors) are important drivers of the state's economic prospects, supported by exports of agricultural commodities such as wheat. Prospects for the Western Australian resources sector depend heavily on global economic conditions.

Global demand and world industrial production have provided sustained support to the resources sector and Western Australian economy over the past two decades. Over the next decade world GDP growth is expected to average 3.3% per annum. While global growth is expected to be below the average rate recorded over the past two decades it is also projected to be less volatile.

Commodity prices are important to the prospects of the Western Australian resources sector and broader economy. The prices of key commodities have declined sharply since the period 2010-2013. In the last year, prices of high-grade iron ore and LNG have rebounded reflecting increased confidence of broad-based and sustained global growth.

Although the central case is for a relatively benign economic outlook key economic, geopolitical and technology risks remain. A degree of volatility in commodity markets is inevitable as information and perceptions of these risks change over time.

The overall production outlook for the Western Australian resources sector is positive. Modest growth in production is expected, supported by the increase in capacity and growth in global industrial activity. Over the ten year outlook period, increased supply and moderating demand will keep commodity price growth contained.

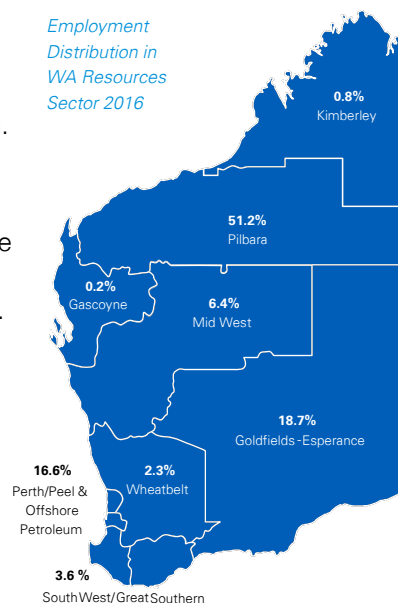
In an environment of moderate global growth and limited scope for upside on commodity prices opportunities for the Western Australian resources sector to grow and maximise its contribution to the economy will be dependent on maintaining and enhancing competitiveness through productivity improvements driven by people, infrastructure and technology and innovation and through access to reliable and efficient supplies of key inputs, including people, energy and water.

Key Enablers

People - the workforce is an integral part and a key enabler in sustaining and developing the potential of the resources sector in Western Australia.

The resources sector and supporting workforce has been declining since its peak of around 120,000 in 2013 down to around 115,000 employed people in 2015-16, before rising again to 118,423 in 2016-17. To put these figures into context, prior to the investment boom (2003-04 to 2011-12), employment in the resources sector averaged around 73,800 employees. RSO survey and other data sources suggests this is likely to flatten out with modest growth over the longer-term to 2028.

Over 50% of Western Australian resources sector jobs are located in the Pilbara. The Perth/Peel and Pilbara regions of Western Australia are comprised of a large commuter workforce. More than half of the Pilbara resources sector workforce reside outside of the region.



Conversely, about 30% of the resources sector employees that live in Perth/Peel commute outside of the region to work.

The resources sector workforce has higher levels of educational attainment compared to the average across all industries. In 2016, 70% of employees in the resources sector had at least Certificate III and IV or higher qualifications, with 24% having a university degree or post-graduate credentials.

The composition of resources sector workforce remains unbalanced with females accounting for less than one-fifth of the Western Australian resources sector workforce.

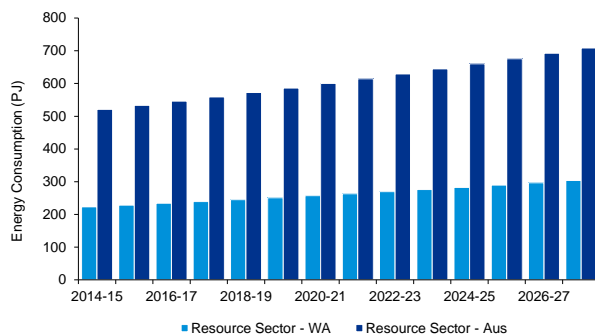
The share of Indigenous employees in the current resources sector workforce is 4%, with over half of these employed as machine operators and drivers. This level of Indigenous employment is not expected to change significantly over the outlook period.

The size of the resources sector workforce is not expected to change significantly over the next decade. Due to the regional and remote locations of operations, the sector will continue to rely on Fly-in fly-out/Drive-in drive-out (FIFO/DIDO) employees.

One of the major constraints on the growth of the resources sector remains the ability to attract and retain appropriately-skilled personnel such as geoscientists and engineers. In addition, as the use of automation and technology increases, there will be increased demand for data scientists, programmers and other specialists from both the resources sector and other industries. The potential shortage of such human resources is, in part, a structural problem best addressed by government, educational institutions and industry continuing to work together. The resources sector is currently working with government and education providers to tackle workforce needs. Over the outlook period, demand and competition for skilled-labour is expected to increase within the resources sector and also across sectors.

Energy - total energy consumption in Western Australia’s resources sector is expected to grow at a compounded annual rate of 2.4% over the outlook period. In the ten years to 2027-28, self-generated and purchased electricity by the resources sector is anticipated to increase by around 1,743 (13.4%) and 824 Gigawatt hours (GWh) (20.7%), respectively.

Energy Consumption – Resources Sector



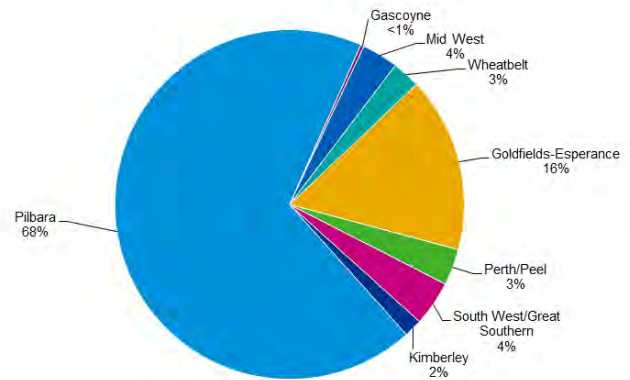
Source: KPMG; DIIS; RSO Survey

Increased energy consumption is expected to be met, in part, by increased supply from gas and alternative sources such as renewables and by continued development and adoption of energy-saving technologies. Renewable sources of energy are likely to play an increasingly important role over the medium-to-longer term. Consumption of diesel - as a primary source of energy generation - is expected to decline over time as policies designed to encourage the use of clean and low-emission energies such as LNG are put in place and act as substitutes for fossil fuels. Advancing the use of renewables, however, requires appropriate investment for the expansion of Western Australia’s energy infrastructure and transmission network.

Electricity productivity is expected to increase and is consistent with the Federal Government’s strong commitment to improving Australia’s energy productivity by 40% by 2030. Energy security and reliability is a key factor for the resources sector. To facilitate greater use by the resources sector for renewable energy, efficient and effective storage technologies will be important. The ability to meet the energy needs of the resources sector will involve a combination of policy initiatives, infrastructure, and industry and academic participation to drive innovation and technological transformation in the generation and use of energy.

Water - estimated total water abstraction by Western Australia’s resources sector in 2016 was 654 gegalitres (GL). Of this, over 40% (256 GL) was dewatering water that was either discharged or consumed offsite. The Pilbara region abstracted the overwhelming majority of water, at 450 GL (68%); followed by Goldfields-Esperance with 105 GL (16%) abstracted.

Resources Sector Water Abstraction by WA Region 2016



It is estimated water abstraction by the resources sector could increase from 654 GL in 2016 to 773 GL by 2024, an 18% increase. For the resources sector, the Pilbara region will be the largest water abstractor at 450 GL.

Surplus water from dewatering is either returned to the environment via discharge or re-injection otherwise it is on-sold through distribution. Surplus water from dewatering is expected to remain in steady proportion to total water abstracted. Through proportional growth, returned water is expected to increase from 185 GL to 219 GL.

Various challenges exist for Western Australia’s resources sector in relation to water. Almost half of the RSO survey respondents indicated they expect an issue with water access or use to impact their project or hub over the next decade.

Increasing demand from both the resources and agricultural sector will potentially place strain on water availability. In the Pilbara and Kimberley regions, increasing agricultural developments are likely to access excess dewatering water. In the South West/Great Southern region, a drier climate will likely put pressure on existing water sources.

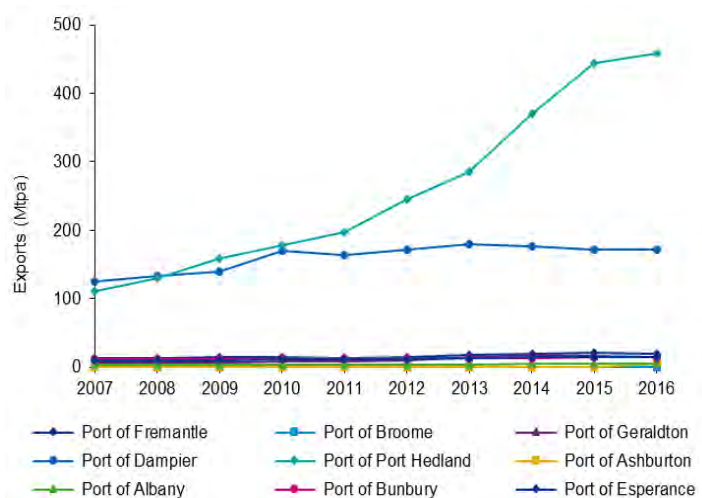
Mining operations take steps to conserve, re-use and recycle water, and further consideration is being given to new opportunities. Stakeholders have indicated their desire for use of surplus dewatering water by distributing it to further productive uses. There is potential for environmental benefits to arise out of such water use initiatives, but achieving such benefits will require a concerted effort from both government and industry.

Infrastructure - substantial pressure is expected to be placed on Western Australia’s physical infrastructure (bridges, rails, ports and aviation) in the longer term driven by population changes and economic activity.

Port infrastructure

The majority of exports (by volume) are transported by sea through the Port Hedland and Dampier ports, which are both located in the Pilbara region of Western Australia. Iron ore dominates the cargo out of both of these ports, making up over 80% of the exports transported out of the Dampier port and 98.8% of the exports transported out of the Port Hedland port.

WA Export Volumes by Port, Mtpa, 2007 to 2016

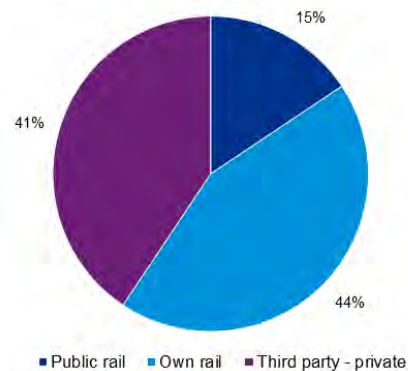


Rail infrastructure

With a projected increase in freight on state-owned rail lines a larger amount of capital will need to be invested in state rail infrastructure to bring the rail lines up to capacity.

Results from the RSO survey indicated that resources sector operators are primarily using either their own rail lines or privately operated third party rail lines to conduct their operations.

Proportion of Rail Usage



Roads infrastructure

The Great Northern Highway has been, and will continue, to act as a major supply corridor for the Western Australian resources sector. With increasing development and road freight needs in areas along the northern coast, the North West Coastal Highway - and the roads which link it to the Great Northern Highway - may require infrastructure improvements as freight loads increase along these road ways.

Airport infrastructure

Over the outlook period, investment in new (and existing) aviation infrastructure will be required by government and industry to ensure aviation capacity meets on-going demand, and aviation services remain a key enabler for economic activity within the resources sector and Western Australia.

Social infrastructure

Housing affordability/availability and access to higher education remain points of contention in the regions. Western Australia faces a significant challenge when providing health services across the state, as it is servicing a relatively small and widely dispersed population.

Although availability of technical colleges and higher education institutions are limited due to a lack of adequate demand, there are other avenues through which these services can be accessed for example, virtual schools, eLearning, and the digital classroom.

A key challenge for Western Australia is the regions tend to be large, remote and sparsely populated. This means economies of scale are difficult to achieve in the provision of public services.

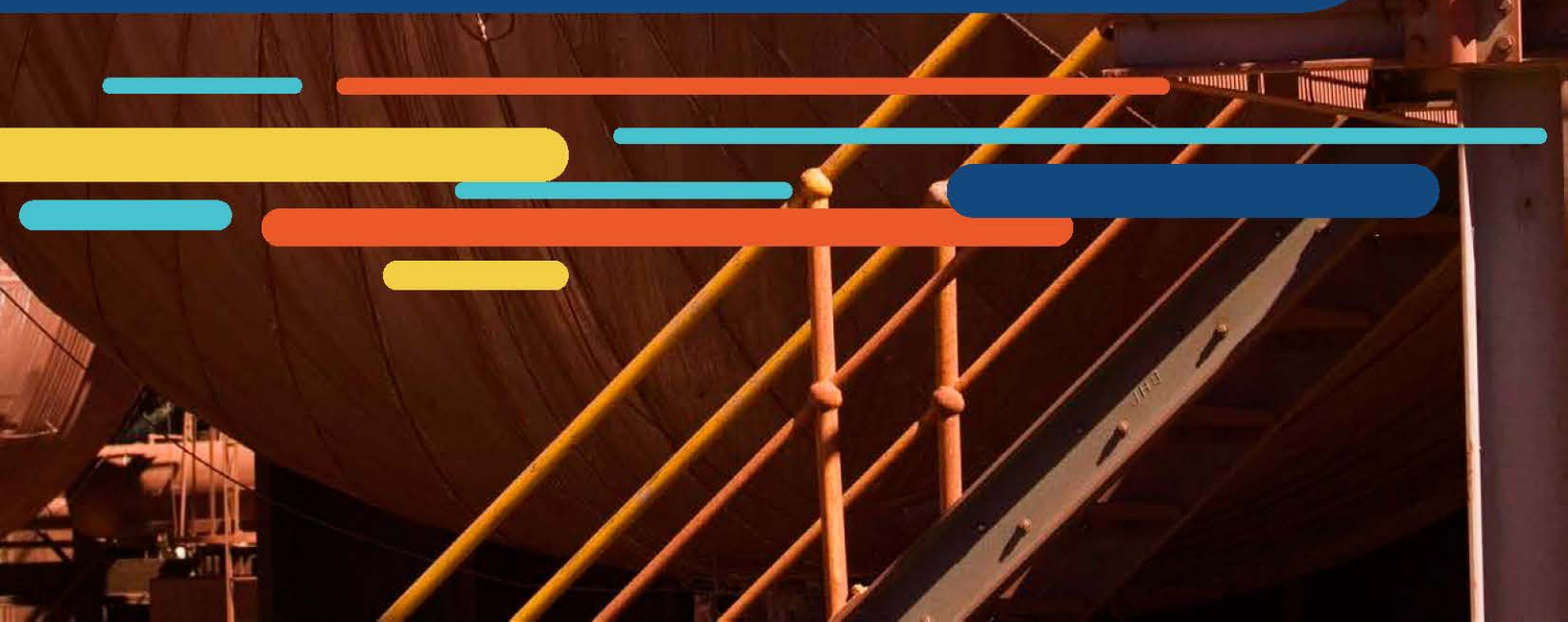
Technology and Innovation - innovation is a key driver of economic growth and improved living standards. Australia's resources sector will continue to drive innovation and technological change as it seeks to maintain and enhance its competitiveness.

Over the next decade, a new generation of emerging and disruptive technologies will most certainly change the landscape in which the resources sector operates. For example, continued advances in drone technology, automation and Artificial Intelligence (AI) will present new opportunities but also create new challenges for the sector. The working environment will also likely change - just over 20% of jobs have been partially (or fully) automated in the last five years and this is likely to continue into the future

Access to digital technologies will present opportunities to overcome some of the challenges posed by the remoteness of communities and work opportunities in Western Australia. This, however, will require reliable communication infrastructure.



Introduction



1. Introduction

CME commissioned KPMG to assist in developing an integrated supply and demand outlook for 2018-2028 for the resources sector and its key enabler areas of people, energy (electricity, natural gas and renewable energy), water, infrastructure (ports, road, rail, aviation and social), and technology and innovation.

The analysis is presented at both the broad Western Australia level, and also at the regional level. This report has been designed to both inform government policy settings and assist corporate planning.

1.1. Scope

The scope of this engagement encompassed:

1. Developing a resources sector outlook (considering supply and demand factors, including surveying existing resources sector producers and those with expansion plans and new sites). This included reviewing the forecasts from the 2013 and 2015 reports; reviewing the existing survey tools; and using this review to produce a new and refined survey (henceforth referred to as the “RSO survey”) to collect the resources sector current demand projections.
2. Identifying trends and themes in the key enablers: People; Energy; Water; Infrastructure Capacity; and Technology & Innovation.
3. Analysing the implications of the resources sector and key enablers outlook, including the opportunities and challenges faced across the regions of Western Australia.

1.2. Report Structure

The remainder of this report is organised as follows:

- Section 2 provides an economic overview of the Global, Australian and Western Australian economies. Included in this section is an understanding of the economic outlook for these economies;
- Section 3 provides a detailed understanding of the resources sector and its outlook, informed by survey responses, stakeholder consultation and desktop research;
- Section 4 describes the industries that support the resources sector and provides an understanding of factors affecting their outlook; and
- The Appendices list new major projects and describes the survey methodology and the analytical approach applied in this report.



Economic overview

2. Economic Overview

2.1. Global economic snapshot

Global economic conditions have continued to improve over the course of 2017 and the outlook for the global economy remains relatively strong. Global economic activity is estimated to have grown by 3.7% in 2017 – 0.5% higher than in 2016.¹ Global economic indicators including production, manufacturing and trade are at their highest levels in recent years, while business and consumer confidence remain healthy. Global growth has also continued to be broad-based across the major advanced economies with the U.S., Japan and the Euro Area seeing further improvement in economic activity over the second half of 2017. Amongst the emerging economies, China, India, ASEAN-5², and emerging Europe have seen a strengthening in economic activity. This is the result of stronger demand and world trade growth along with supportive financial conditions. As a result of relatively stronger growth amongst key trading partners, prospects for the Australian and Western Australian economy are positive.

In terms of Australia's major trading partners, Chinese GDP has been strong over 2017 and is estimated to grow by 6.8% in 2017-18, a small uptick from the previous year. While growth in China has been falling gradually in recent years it is important to recognise these growth rates apply to a significantly bigger economy – in real terms the Chinese economy is now about 2.3 times bigger than it was 10 years ago. Recent data indicates the composition of Chinese growth is also changing to reflect its transition from a developing economy dependent on exports and investment to one that is more balanced, with household consumption becoming a more important driver of growth.

The U.S. economy grew at an annualised rate of 2.6% in the last quarter of 2017. Over the past decade, U.S. growth has been relatively modest as the economy emerged from the global credit crisis. Even though growth has been relatively modest, current economic indicators suggests economic activity is strengthening and gaining momentum moving forward. The unemployment rate, at 4.1% in November 2017, has also fallen to its lowest rate since 2001. Inflation (at 1.6%) remains below the Federal Reserve's target rate. While the Federal Reserve has flagged an end to expansionary monetary policy, further fiscal stimulus could be on the cards heading into 2018 with an overhaul of the federal tax system.

Japan's economy is estimated to have grown around 1.8% in 2017 driven by strong net exports and expansionary fiscal and monetary policy. Labour market conditions continue to tighten with the unemployment rate at 2.8% for 2017. Inflation, at 0.4% for 2017, still remains below the Bank of Japan's target of 2%. An end to accommodative monetary policy and Japan's shrinking labour force could detract from growth over the medium-term.

The European Union (EU28) and the Euro Area (EA19) have both enjoyed an extended period of healthy economic growth. Annual GDP growth for 2017 was estimated at around 2.6% for the EU28 and 2.5% for the EA19. Labour markets continue to strengthen and unemployment rates have declined (8.8% in EA19 and 7.4% in EU28). Further, growth across Europe has been generally broad-based across the member countries.

Economic growth in the U.K. has remained modest over the year at 1.7% in 2017. The relative slowdown in the U.K. economy has been driven by softer private consumption as well as the uncertainties surrounding the negotiations of Brexit. Higher inflation as well as a depreciation of the sterling is expected to weigh on consumer and household spending going forward. Business

¹ IMF World Economic Outlook January 2018.

² The ASEAN-5 countries are Indonesia, Malaysia, Philippines, Vietnam and Thailand.

investment growth remains subdued in the wake of uncertainty on the Brexit outcomes and is unlikely to pick-up till negotiations are resolved.

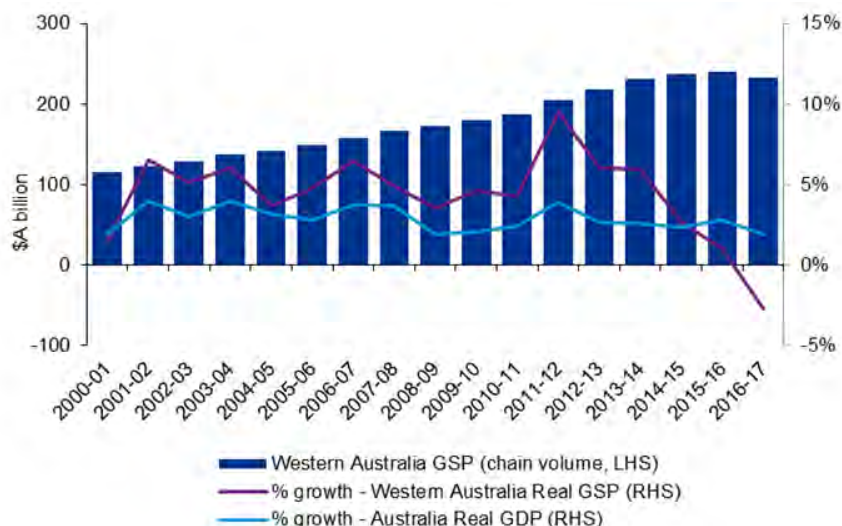
India's GDP is estimated to have grown by 6.4% in 2017, down from around 7% the year prior. Growth in 2017 was primarily driven by strong growth in gross fixed capital expenditure but was partially offset by a slowdown in household consumption and government spending. Economic activity is still strong and there are early signs that the Indian economy has not been adversely affected by effects of demonetisation (in 2016) and the GST implementation in the middle of 2017. Inflation has increased over the year (currently at 3.6%) but remains below the Reserve Bank of India's target of 4.0%. The Indian government's recapitalisation plan for state-owned banks over the next couple of years is expected to lift investment through further access to credit, and hence Indian economic growth.

2.2. Western Australian economy

Western Australia accounts for around 14% of Australia's Gross Domestic Product (GDP)³ and 11% of Australian employment.⁴ In 2016-17 the Western Australian economy provided 1.3 million jobs and generated Gross State Product (GSP)⁵ of almost \$248 billion.

2.2.1. GSP and its components

Figure 2-1: Gross Domestic and State Product (Western Australia and Australia), 2000-01 to 2016-17



Source: ABS

After many years of strong performance, growth in the Western Australian economy has slowed. The pull-back from the commodities and resources sector investment boom has weighed heavily on the Western Australian economy. In 2015-16, real GSP growth in Western Australia was 1.0%, which was 1.8 percentage points lower than the 2.8% growth recorded at the national level. In 2016-17, real GSP in Western Australia fell by 2.7%, significantly underperforming the national economy which grew by 2.0%. This decline was primarily driven by a sharp contraction in business investment which fell 28.6% from the previous year.

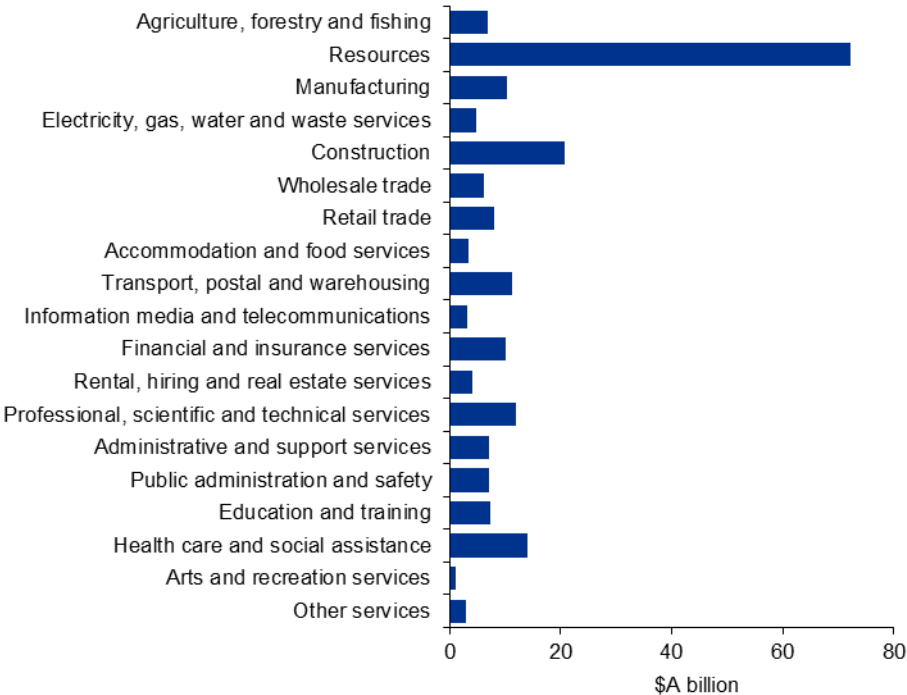
³ Australian Bureau of Statistics, *Australian National Accounts: State Accounts* (cat. no. 5220), 17 November 2017.

⁴ Australian Bureau of Statistics, *Labour Force, Australia, Detailed*, Nov 2017 (cat. no. 56291), 21 December 2017.

⁵ Gross State Product (GSP) is a measure of a State's output or economic value. It is the sum of all the State's industries value-added (production less inputs from other industries).

The resources sector is a significant contributor to the State’s GSP. In 2016-17 the resources sector accounted for almost one-third of Western Australian GSP (as measured by industry factor income). Another 9% is provided by the construction sector, which has strong links to the resources sector.

Figure 2-2: Industry contribution to Western Australian GSP - factor income, current dollars, 2016-17

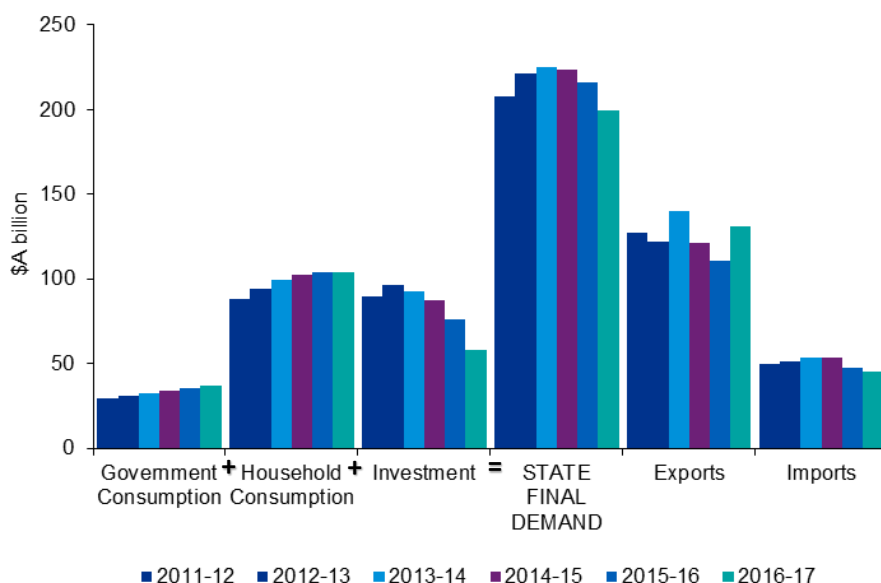


Source: ABS

Domestic demand in the Western Australian economy, as measured by State Final Demand (SFD, comprising government and household consumption plus investment), has been contracting as business investment declines from its peak in 2012-13. The contraction in Western Australian real SFD over the past three years is expected to continue for a fourth consecutive year in 2017-18 (albeit more modestly).⁶ The contraction in recent years in SFD has been significantly greater than that in GSP with net international exports making strong positive contributions. This change in the composition of the Western Australian economy reflects the transition of the economy away from growth driven by a resources sector investment boom to growth driven by net exports. This transition has been, and will continue to be, challenging for the Western Australian economy.

⁶ Western Australia State Budget 2016-17 – Budget Paper 3

Figure 2-3: Components of Western Australia Gross State Product, chain volume, 2011-12 to 2016-17



Source: ABS

Expenditure on investment has been the main drag on SFD and GSP over the last few years. In particular, real business investment fell 19% in 2015-16 and 29% in 2016-17, and is expected to fall further over the next two to three years.⁷ New capital expenditure in Western Australia is largely investment by the resources sector and has been declining since peaking in 2012-13.⁸

Figure 2-4: New Capital Expenditure (Western Australia and Australia), current dollars, 2000-01 to 2016-17



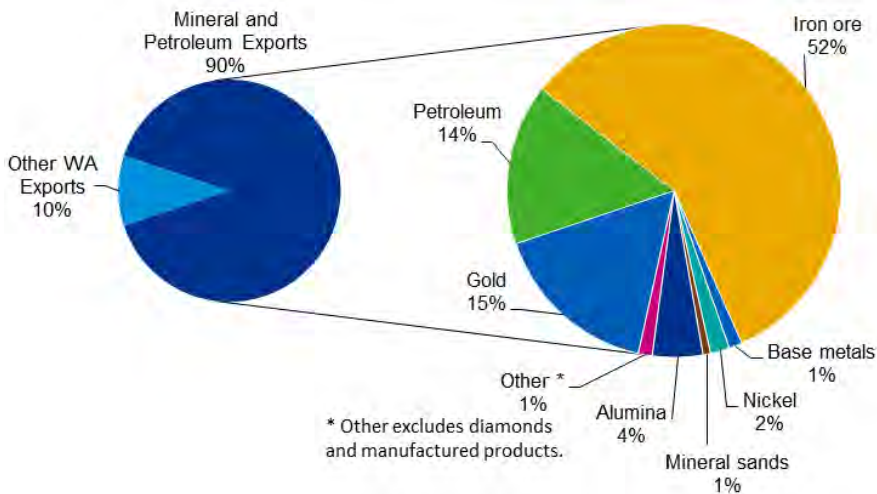
Source: ABS; DMIRS

⁷ For example, the Western Australian Treasury is projecting business investment to contract by 12% in 2017-18 and 8.5% in 2018-19 (2017-18 Government Mid-year Financial Projection Statement). The Western Australian Treasury is projecting Western Australia's share of national capital investment to fall from a peak of around 36% in 2011-12 to 2014-15 to around 12% by the end of 2020 (Western Australia State Budget 2016-17 – Budget Paper 3).

⁸ The ABS measure of New Capital Expenditure reported in figure 2-4 differs in several respects from the measure of investment reported in figure 2-3, which is the ABS estimate of gross fixed capital formation by all sectors reported in the State Accounts. The former measure is expressed in terms of current prices whilst the latter is a chain volume measure. In addition, New Capital Expenditure does not include public sector investment, dwelling investment or investment by certain sectors (see <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/5625.0Explanatory%20Notes1Dec%202017?OpenDocument> for further details).

Exports account for almost half of Western Australia’s GDP. Over 2016-17, mineral and petroleum exports provided a boost to the Western Australian economy courtesy of higher commodity prices and steady demand from abroad.

Figure 2-5: Western Australia Merchandise Exports, current dollars, 2016-17



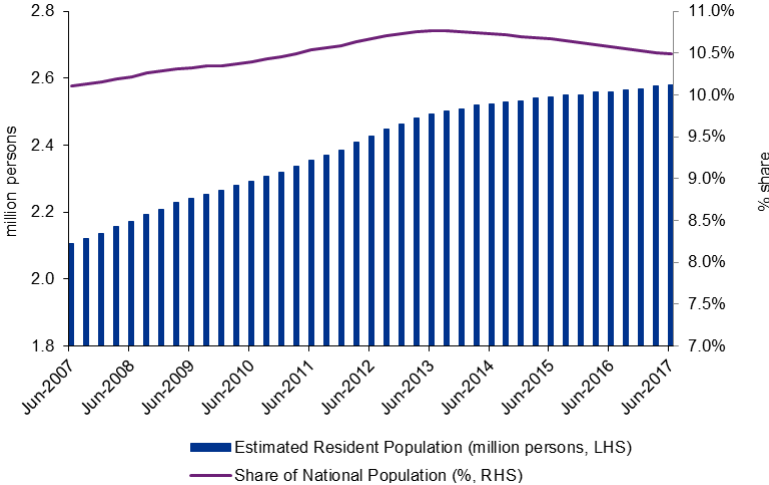
Source: ABS; DMIRS

Merchandise exports, and mineral and petroleum exports in particular (which account for 90% of the total value of Merchandise exports), are expected to continue to drive the state’s growth in the next few years. This reflects the increased productive capacity of the mineral and petroleum sector put in place during the resources sector investment boom. The transitory boost to the economy provided by resource investment boom is gradually being replaced by a secular increase in production by the resources sector as recently completed projects enter their operational phases and ramp up production.

2.2.2. Population and Employment

As at June 2017, Western Australia’s resident population was estimated at 2.6 million people⁹, reflecting an increase of 21,400 people (0.8%) from the previous year. This was below the national average resident population growth rate of 1.6% over the same period. Western Australia’s share of the nation’s population has remained relatively stable at around 10.5% over the past 10 years, peaking at 10.8% between 2010-13.

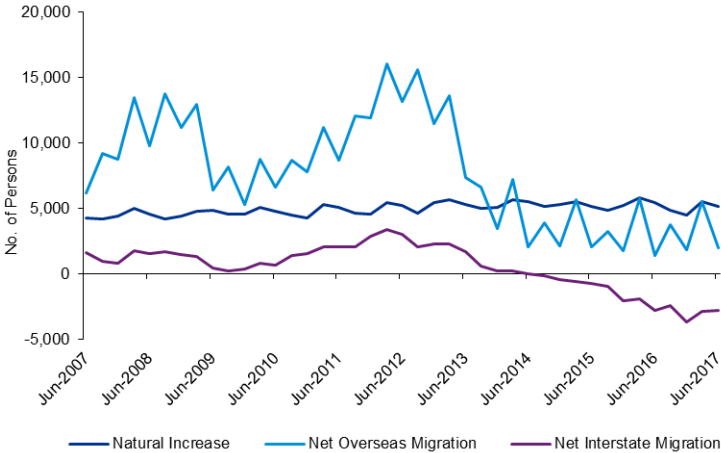
Figure 2-6: Estimated Resident Population, persons, 2007 to 2017



Source: ABS

While Western Australia’s natural population increases have been relatively stable (at between 20,000 and 21,000 in each year since 2007), significant movements have been observed in both overseas and interstate migration. Net interstate (and overseas) migration peaked during the ‘investment boom’ years of 2010-13, driven by demand for labour in the resources sector. At its peak, Western Australia saw net interstate migration reach a high of over 2,000 people moving to the state each quarter. Similarly, net overseas migration peaked over the same time frame. Net interstate migration has been trending downward since 2013-14, reflecting an outflow of people from Western Australia to other states and territories.

Figure 2-7: Migration and Natural Population, change (persons), 2007 to 2017

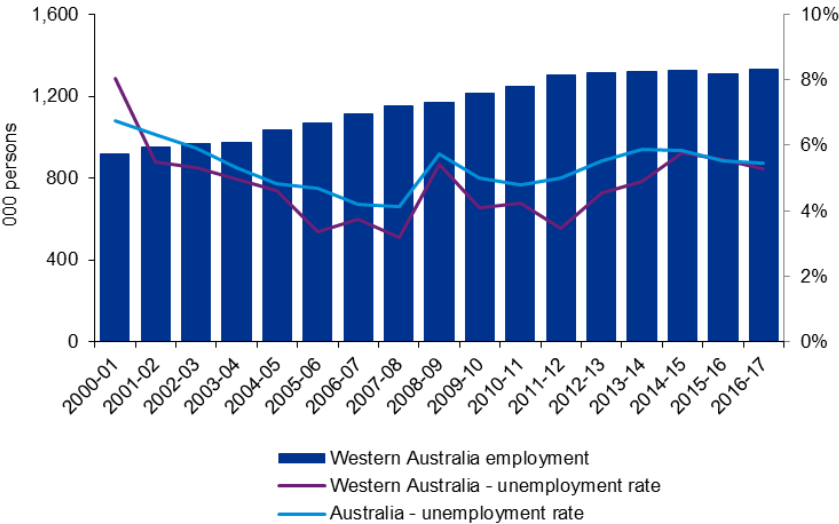


Source: ABS

⁹ As at June 2017, (ABS, Australian Demographic Statistics, Cat No. 3101.0, Jun 2017).

As at June 2017, there were approximately 1.3 million people employed and 74,700 unemployed persons in the state. Relative weakness in Western Australia’s economy, as measured by the state’s GSP, has flowed through to its labour market. Labour conditions are relatively soft in comparison to the state’s labour market performance over the past 10 years. This slowing in employment growth has brought the state’s unemployment rate, at 5.3%, back to being more aligned to the national unemployment rate (5.5% in December 2017).

Figure 2-8: Employment and Unemployment Rate (Western Australia and Australia), 2000-01 to 2016-17

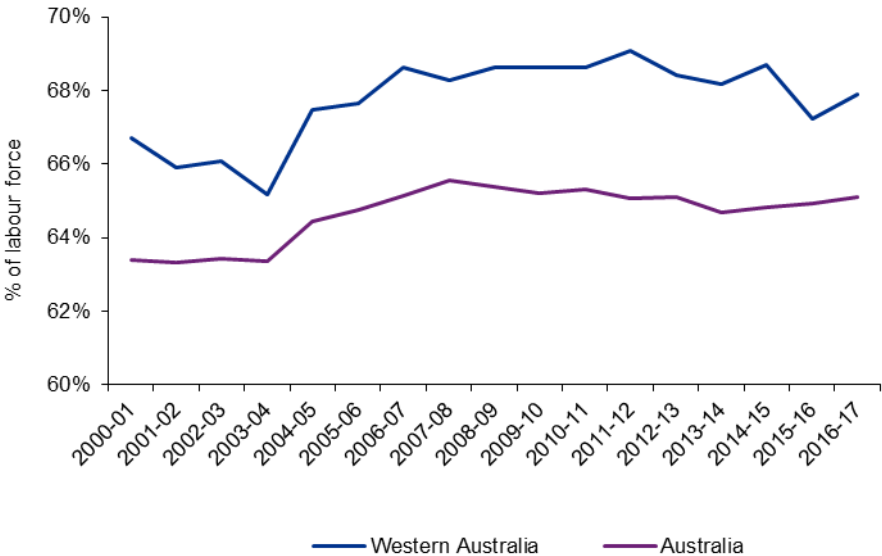


Source: ABS

Western Australian youth unemployment at 15.1% is significantly higher than the national youth unemployment rate, which is 12.8%. Wage growth remains sluggish due to spare capacity in the labour market with wage inflation up 1.2% year-on-year in March 2017.

Labour force participation rates in Western Australia remain comparatively strong (68%) and above the national average participation rate (65%). The participation rate is higher in the rest of Western Australia (71%) than in the greater Perth area (68%).

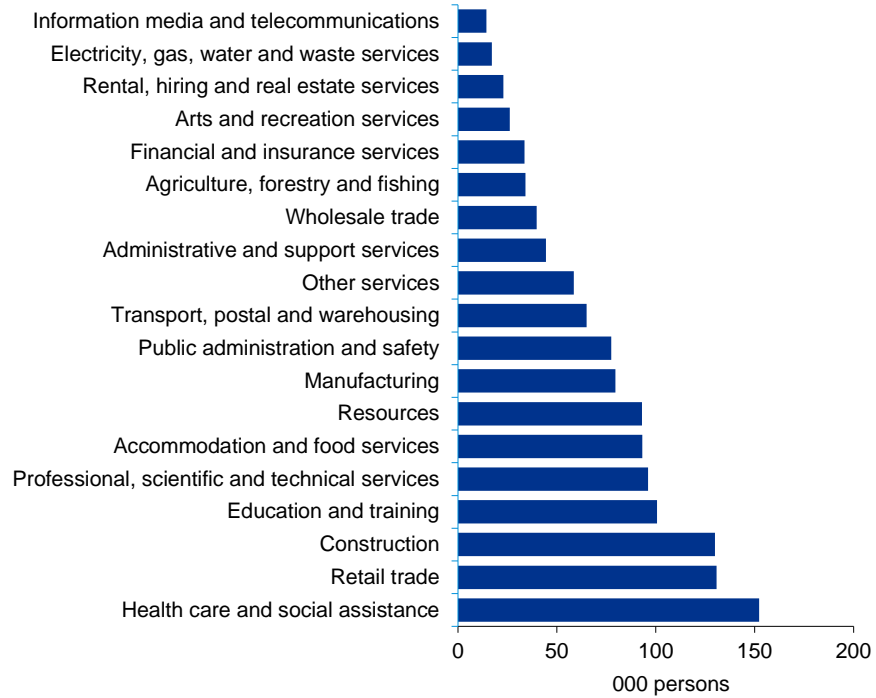
Figure 2-9: Labour Force Participation Rate (Western Australia and Australia):



Source: ABS

Employment in Western Australia is spread across a number of industries. The *Construction, Retail trade* and *Health care and Social assistance* sectors each account for 10% or more of total employees. Another 7-8% of employees have jobs in each of the *Resources, Accommodation and food services, Professional, scientific and technical services* and *Education and training* sectors.

Figure 2-10: Industry contribution to Western Australian Employment, 2016-17



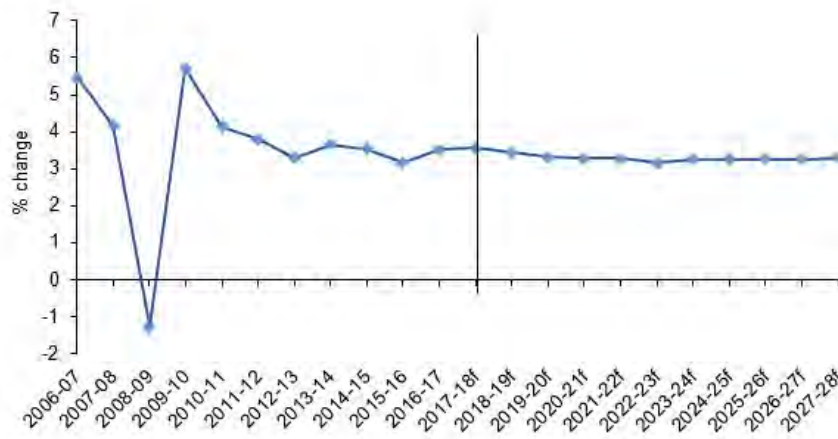
Source: ABS

More detail on employment across the regions, with particular focus on the resources sector, is provided in section 4.

2.3. Economic Outlook

Over the next decade world GDP growth is expected to average 3.3% per annum. This is below the average global growth rate recorded over the past two decades, largely as a result of more moderate Chinese growth, the Chinese economy is transitioning to a developed economy which traditionally correlates to lower rates of growth. The outlook for the Australian economy remains positive, with real GDP projected to grow at an average annual rate of around 2.6% over the next decade. Reflecting the projection for the global economy, growth in the Australian economy over the next decade is projected to be below the average rate recorded over the two previous decades but it continues the relatively stable economic expansion that the economy has enjoyed since 1991.

Figure 2-11: World GDP Growth

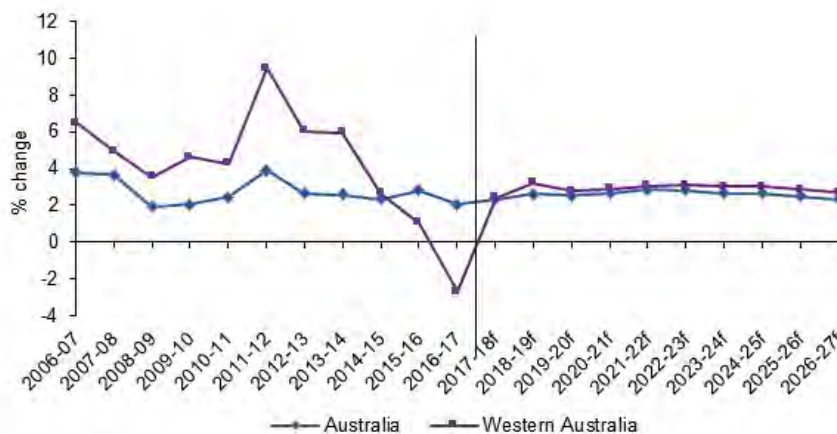


Source: KPMG; IMF.

Strong global demand and world industrial production has provided support to the resources sector and Western Australian economy over the past two decades. Solid export growth and investment driven by the resources sector has allowed the Western Australian economy to grow at over 4.0% per annum over the past two decades. The slowdown in resources sector investment since 2013, has been a drag on Western Australian growth but this investment cycle is coming to an end.

The continued expansion in global growth and increased capacity of the Western Australian resources sector will continue to support growth in Western Australian exports. Over the next decade, economic growth in Western Australia is expected to continue to be higher than the national average. The difference between the two is expected to be less marked over the forecast horizon than it was during the past decade. Importantly, growth in the Western Australian economy is also expected to be less volatile than it has been in the recent past.

Figure 2-12: GDP/GSP Growth – Australia and WA



Source: ABS, KPMG



Western Australia Resource Sector

3. Western Australia Resources Sector

This section outlines the key features of the Western Australian resources sector – its size and geographic reach. There are a number of key drivers for the resources sector’s future outlook, including exploration activity and investment and commodity prices. The key findings from the RSO survey and stakeholder consultations also provide context for the resources sector outlook.

3.1. Overview

The Western Australian economy is dominated by the resources and services sectors. Exports of minerals and energy (mainly iron ore, LNG and gold are the major contributors) are important drivers of the state’s economic prospects, supported by exports of agricultural commodities such as wheat.

Figure 3-1: Western Australia Resources Sector Production Summary

Resource	Unit	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Iron Ore	kt	397,604	454,385	511,760	623,507	718,807	748,100	789,821
Petroleum								
- LNG	kt	17,290	15,611	19,805	20,050	20,448	20,956	28,685
- Crude Oil	Ml	13,925	11,122	8,609	7,304	7,844	7,686	5,404
- Condensate	Ml	6,882	5,889	6,117	5,559	6,753	6,775	6,038
- Natural Gas	'000 m ³	8,981,495	9,080,655	8,713,949	9,368,839	9,875,339	10,223,641	9,708,934
- LPG -But. & Prop.	kt	924	835	753	631	553	532	527
Gold	t	184	181	180	196	193	196	205
Alumina	kt	12,281	12,425	13,531	13,718	13,771	13,941	14,038
Nickel	kt	194	209	227	210	183	176	157
Base Metals	kt							
- Copper		150	159	209	211	184	190	170
- Lead		41	7	17	79	59	6	3
- Zinc		71	64	56	54	78	83	83
Mineral Sands	kt							
- Zircon		299	180	216	212	183	175	137
- Ilmenite		394	332	271	79	100	175	169
- Rutile		50	39	47	65	30	41	20
- Leucoxene		26	22	29	29	17	18	5
- Other								

Note: that not all mineral and petroleum commodities produced in Western Australia are listed in the figure. It was not practical to aggregate remaining commodities into an “Other” category because of incompatible volume metrics. An “Other” category is included in the following figure relating to production values.

Source: DMIRS

Commodity supply continues to grow as a number of large projects have completed their construction phases and are commencing their operating and production phase. Global demand for commodities remains healthy but has started to 'flatten' out. With supply catching up to demand there has been downward pressure on commodity prices in recent years translating into lower profits and a decline in investment in new projects. Despite this, in 2016-17, Western Australia's mineral and petroleum industry reported sales of \$105 billion¹⁰ – a 19% increase from 2015-16.

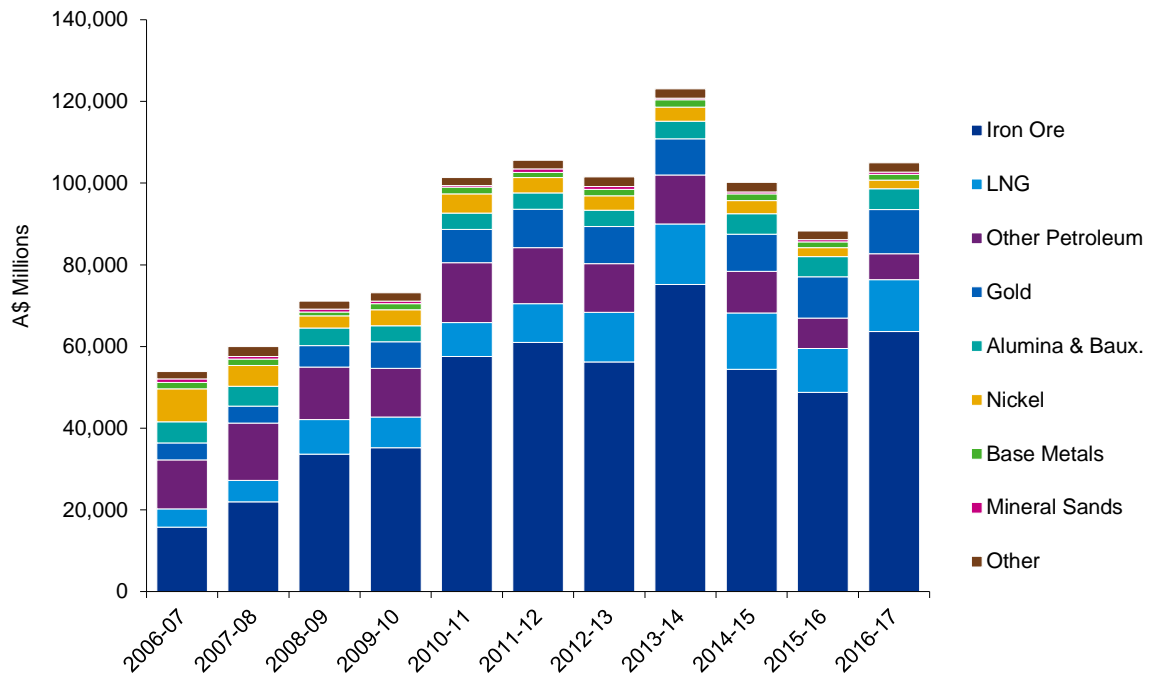
Figure 3-2: Western Australia Resources Sector Value of Production Summary (\$ millions)

Resource	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Iron Ore	57,533	60,973	56,204	75,166	54,376	48,767	63,653
Petroleum							
- LNG	8,329	9,496	12,147	14,804	13,817	10,765	12,681
- Crude Oil	8,529	7,677	5,972	5,725	4,494	3,043	2,064
- Condensate	3,989	3,842	3,922	4,033	3,488	2,214	2,229
- Natural Gas	1,365	1,450	1,435	1,656	1,827	1,913	1,830
- LPG - But. & Prop.	774	734	634	586	406	249	273
Gold	8,184	9,421	9,023	8,891	9,111	10,117	10,830
Alumina	3,990	4,010	4,028	4,295	5,023	4,939	5,088
Nickel	4,686	3,722	3,512	3,419	3,170	2,203	2,081
Base Metals							
- Copper	1,332	1,181	1,423	1,560	1,283	1,181	1,179
- Lead	100	14	35	179	137	15	10
- Zinc	162	122	104	118	197	195	194
Mineral Sands							
- Zircon	198	219	190	114	136	136	76
- Ilmenite	53	58	73	20	21	40	41
- Rutile	35	52	80	66	30	41	20
- Leucoxene	12	17	31	26	15	16	5
- Other	136	458	372	176	291	320	411
Other resources	1,953	2,149	2,304	2,227	2,364	2,103	2,293
Total	101,360	105,595	101,488	123,061	100,184	88,256	104,959

Source: DMIRS

¹⁰ Department of Mines, Industry Regulation and Safety (DMIRS).

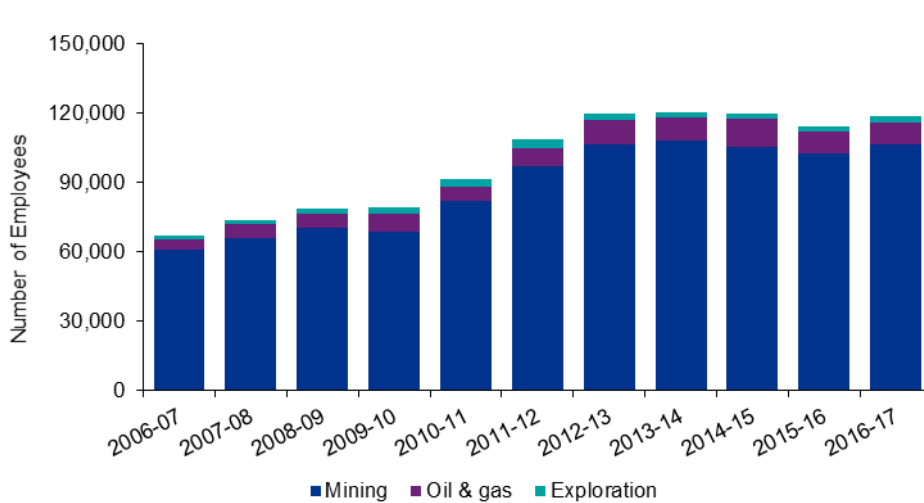
Figure 3-3: Western Australia Resources Sector Value of Production (\$ millions)



Source: DMIRS, KPMG

Employment¹¹ in the Western Australian resources sector has grown by approximately 75% over the decade (2006-07 to 2016-17). As at 2016-17, resources sector employment (including contractors) was 118,423 people.

Figure 3-4: Western Australia Resources Sector Employment



Sources: DMIRS data for Mining and Exploration employment; and ABS Labour Force Survey data for Oil & Gas employment.

¹¹ Employment in the Mining sector includes direct employees plus contractors on-site.

On a commodity basis, the iron ore industry accounts for half of all direct employment in the Western Australian resources sector. This was followed by gold (27,124), oil and gas (9,653), bauxite/alumina (6,645) and nickel (5,900) reflecting the relative sizes (by commodity production value) of the industries. Over a five-year period, significant increases in employment (in levels) can be observed in the gold, oil and gas, and construction materials industries. The largest fall in employment (in levels) over the same time period is observed in the iron ore, nickel and diamond industries.

Figure 3-5: Western Australia Resources Sector Employment by Commodity (last 5 years)

Commodity	2012-13	2013-14	2014-15	2015-16	2016-17
Mining					
Base metals	2,920	2,649	2,531	2,358	2,239
Bauxite/Alumina	7,392	7,408	7,481	7,234	6,645
Coal	418	638	958	1,128	1,098
Construction Materials	925	1,030	1,454	1,591	2,481
Diamonds	2,391	1,573	1,413	988	821
Gold	22,242	18,593	19,577	23,562	27,124
Mineral sands	2,408	2,302	2,241	2,336	2,396
Iron ore	54,868	62,244	58,988	53,099	52,869
Nickel	7,638	6,477	6,099	5,645	5,900
Salt	1,137	1,072	974	869	845
Tin - Tantalum - Lithium	435	389	564	758	1,084
Other	3,542	3,495	3,234	2,818	3,001
Total mining	106,315	107,871	105,514	102,386	106,502
Oil & gas	10,582	10,190	11,841	9,462	9,653
Exploration	2,646	2,320	2,178	2,167	2,268
Total Number of Resources Sector Employees	119,543	120,380	119,533	114,015	118,423

Sources: DMIRS data for Mining and Exploration employment; and ABS Labour Force Survey data for Oil and gas employment.

3.2. Regional Activity

The Western Australian resources sector has a footprint in all regions with the value of production ranging from about \$55 million in the Gascoyne region to just over \$63 billion in the Pilbara.

- Iron ore dominates the resources sector in terms of production values and employment (onsite including contractors). This activity is concentrated in the Pilbara region.
- Gold is the most significant resources commodity in the Goldfields-Esperance, Mid West and Wheatbelt regions.
- Bauxite/alumina is important in the Perth/Peel and South West/Great Southern regions, with the world's largest bauxite mine located in the Perth/Peel region.
- The Kimberley region is renowned for its diamond production, with this region producing approximately 90% of the world's pink diamonds, and all of the diamonds in Western Australia.
- Salt is the main mining activity in the Gascoyne region.
- Offshore petroleum production values are shown separately from the regions. Note that offshore oil & gas production values are not allocated to particular regions.

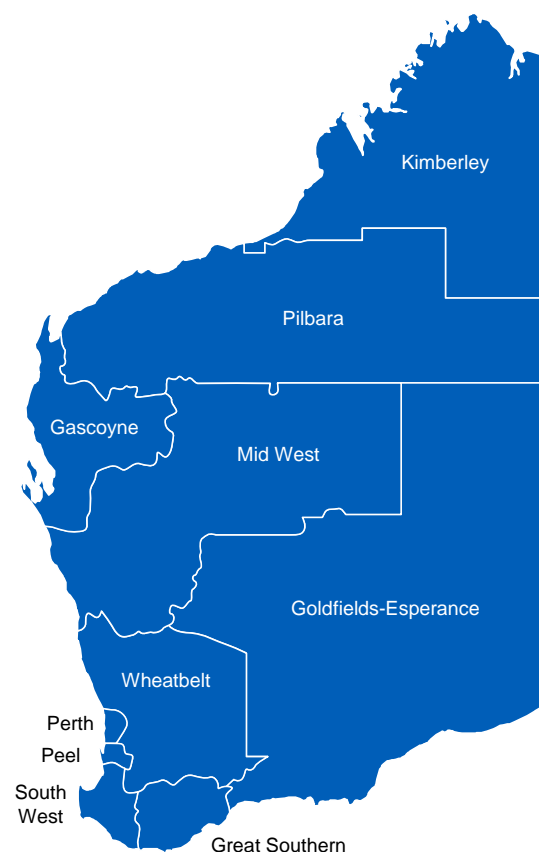
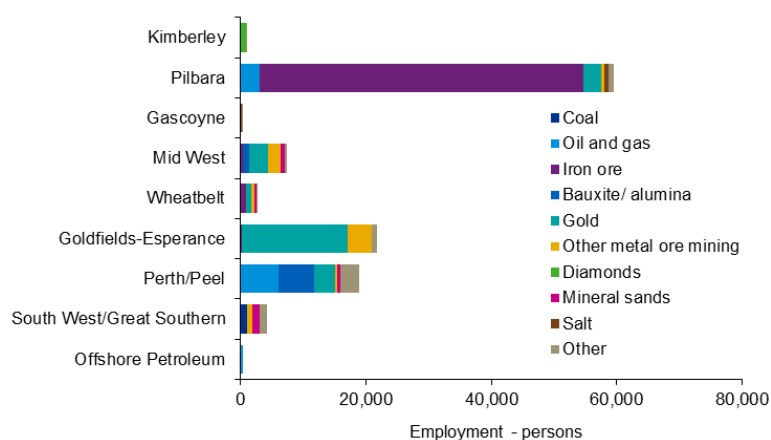
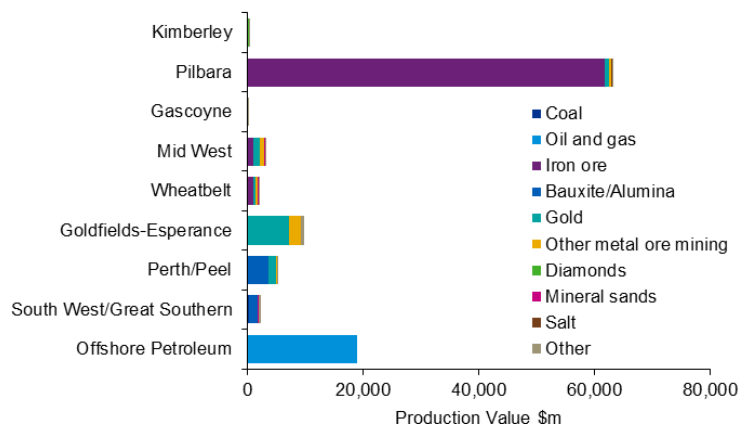


Figure 3-6: Resources Sector Employment in Western Australia regions, 2016-17



Sources: KPMG estimates based on data from DMIRS (mining) and ABS (oil & gas). Employment is defined by the DMIRS as the average number of individuals on-site, and includes both employees and contractors.

Figure 3-7: Resources Sector Activity in Western Australia regions, 2016-17



Sources: KPMG estimates based on data from DMIRS.

3.2.1. Kimberley

The Kimberley region has a diverse economy in Western Australia that boasts a mix of industry activities including mining, construction, tourism, retail and agriculture.

In 2016, Gross Regional Product (GRP) in the Kimberley was an estimated \$2.6 billion, down from around \$4 billion in 2011.¹²

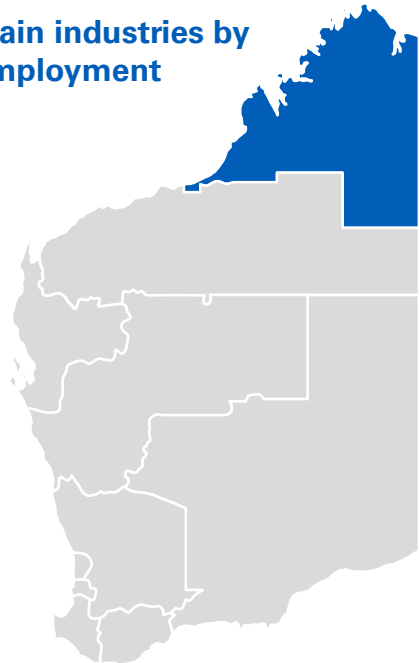
The estimated resident population in the Kimberley was around 36,400 in 2016, dropping back from around 38,000 between 2012-14.¹³

In 2016, there were 13,650 Kimberley residents in employment.¹⁴ Almost 14,600 people working in the region,¹⁵ indicating a number of people commute to the region for work.

The region's unemployment rate has been relatively volatile over the past decade, hitting 8.6% in 2016,¹⁶ up from a low of 5.4% in 2011.¹⁷

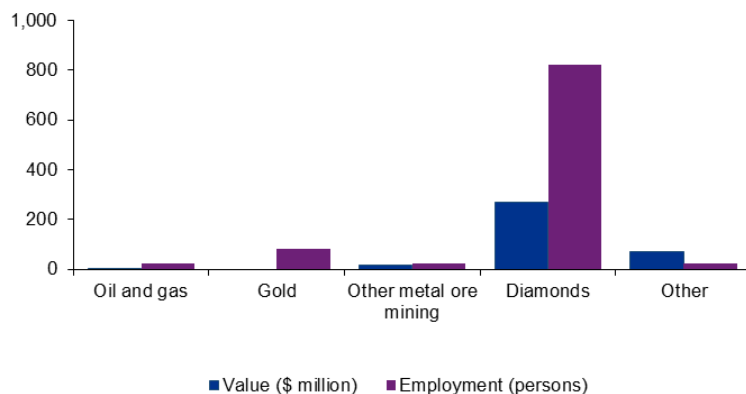
In 2016-17, the resources sector in the Kimberley employed 974 people and had \$356 million worth of production.¹⁸ This activity was dominated by diamonds, as the Kimberley region produces approximately 90% of the world's pink diamonds, and all of the diamonds in Western Australia.

Main industries by employment



- 16%** Health Care & Social Assistance
- 13.7%** Education & Training
- 9.7%** Accommodation & Food Services
- 9.4%** Public Administration & Safety

Figure 3-8: Resources Sector Activity in the Kimberley Region, 2016-17



Source: KPMG estimates based on data from DMIRS (mining) and ABS (oil & gas). Employment is defined by the DMIRS as the average number of individuals on-site, and includes both employees and contractors.

¹² Department of Primary Industries and Regional Development, February 2018.

¹³ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.

¹⁴ ABS, Employment by Place of Usual Residence, Census, 2016.

¹⁵ ABS, Employment by Place of Work, Census, 2016.

¹⁶ Estimated from ABS, Employment by Place of Work, Census 2016.

¹⁷ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018

¹⁸ KPMG estimates based on data from DMIRS.

3.2.2. Pilbara

The Pilbara economy is resource intensive, heavily dependent on the mining, energy and construction sectors.

In 2016, GRP in the Pilbara was an estimated \$29.8 billion, representing around 12.5% of Western Australia’s GSP for that year.¹⁹

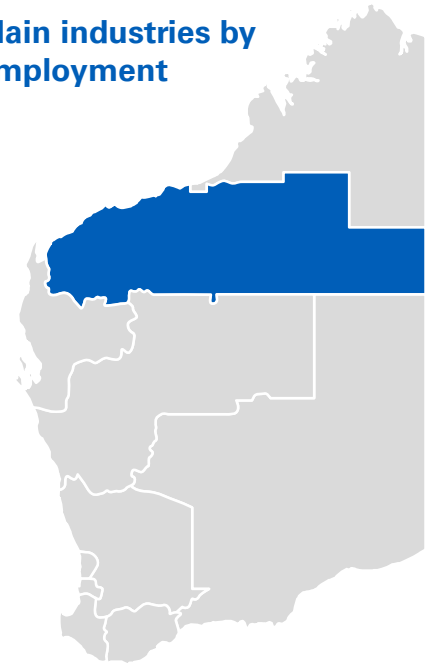
The estimated resident population in the Pilbara was around 61,400 in 2016, dropping back from around 64,000 between 2012-14.²⁰

In 2016, there were 31,915 Pilbara residents in employment²¹ and over 60,000 people working in the region,²² indicating a significant number of people commute to the region for work.

The region boasts a relatively low unemployment rate of 4.5% in 2016²³, although this rate has increased from a low of around 2% in 2011.²⁴

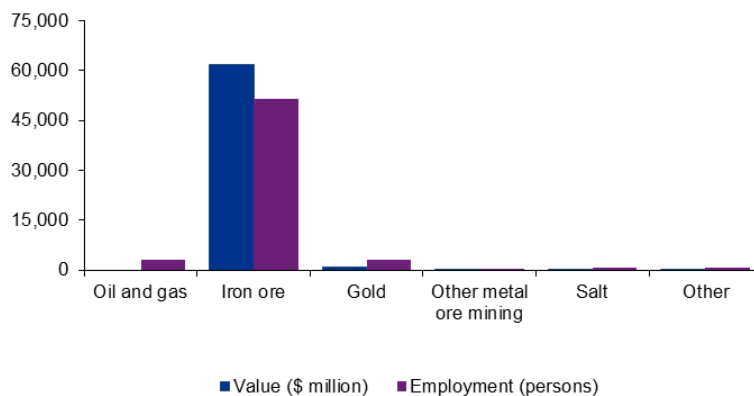
In 2016-17, the resources sector in the Pilbara employed 59,593 people and had \$63.3 billion worth of production. The iron ore industry dominates the Pilbara’s resources sector.

Main industries by employment



- 45.5%** Resources sector
- 16.9%** Construction
- 4.9%** Transport, Postal & Warehousing
- 4.5%** Professional, Scientific & Technical Services

Figure 3-9: Resources Sector Activity in the Pilbara Region, 2016-17



Source: KPMG estimates based on data from DMIRS (mining) and ABS (oil & gas). Employment is defined by the DMIRS as the average number of individuals on-site, and includes both employees and contractors.

¹⁹ Department of Primary Industries and Regional Development, February 2018.
²⁰ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.
²¹ ABS, Employment by Place of Usual Residence, Census, 2016.
²² ABS, Employment by Place of Work, Census, 2016.
²³ Estimated from ABS, Employment by Place of Work, Census2016.
²⁴ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.

3.2.3. Gascoyne

The Gascoyne region economy is diverse, with industry activity ranging across a number of sectors including tourism, resources, agriculture and fishing.

In 2016, real GRP in the Gascoyne region was an estimated \$1.1 billion, growing by 5.8% on average (compound annual growth rate (CAGR)) over the past five years.²⁵

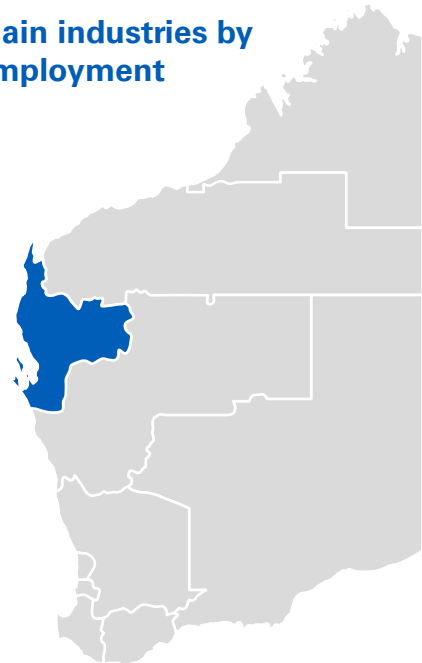
The estimated resident population in the Gascoyne region has been relatively stable over the past five years, sitting at 9,800 persons in 2016.²⁶

In 2016, there were 4,238 Gascoyne region residents in employment,²⁷ similar to the number of people working in the region.²⁸

The Gascoyne region's unemployment rate is around 5.7%,²⁹ and (similar to other regions across the state) this unemployment rate has grown over the past five years.³⁰

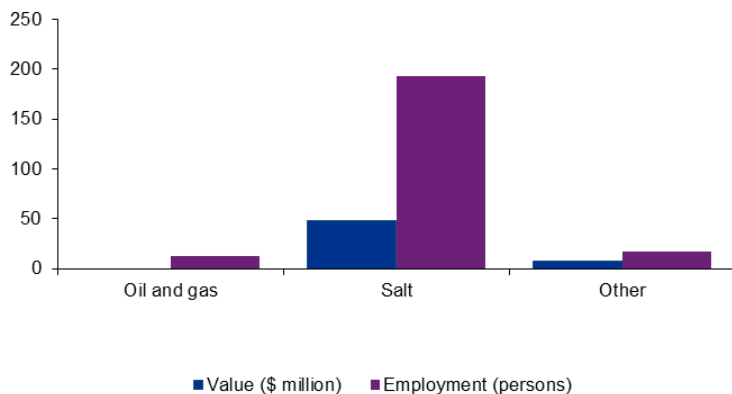
In 2016-17, the resources sector in the Gascoyne region employed 222 people and had \$55 million worth of production.³¹ This activity was predominately salt production.

Main industries by employment



- 11.5% Resources sector
- 11.5% Accommodation & food services
- 10.8% Agriculture, forestry & fishing
- 10% Retail trade

Figure 3-10: Resources Sector Activity in the Gascoyne Region, 2016-17



Source: KPMG estimates based on data from DMIRS (mining) and ABS (oil & gas). Employment is defined by the DMIRS as the average number of individuals on-site, and includes both employees and contractors.

²⁵ Department of Primary Industries and Regional Development, February 2018.

²⁶ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.

²⁷ ABS, Employment by Place of Usual Residence, Census, 2016.

²⁸ ABS, Employment by Place of Work, Census, 2016.

²⁹ Estimated from ABS, Employment by Place of Work, Census 2016.

³⁰ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.

³¹ KPMG estimates based on data from DMIRS.

3.2.4. Mid West

Industry activity in the Mid West region ranges across a number of key sectors including mining, agriculture, tourism and fishing.

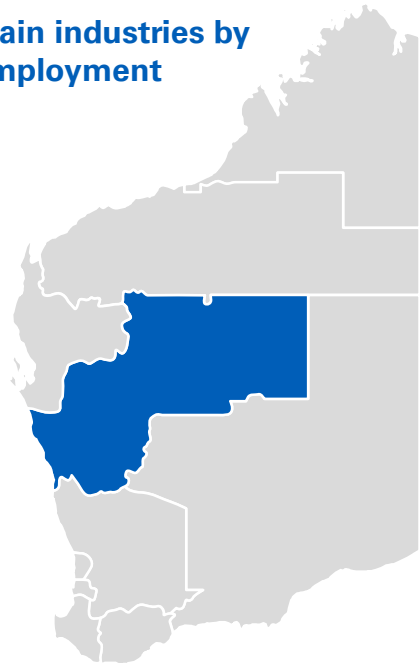
In 2016, the Mid West region's GRP was estimated to be \$6.1 billion, down from an annual average of around \$6.6 billion over the two years to 2013.³²

The Mid West's resident population was estimated to be 55,100 persons in 2016 down from around 57,000 between 2012-14.³³

In 2016, there were 23,316 Mid West residents in employment.³⁴ With 24,211 people working in the region,³⁵ this indicates a number of people commute to the region for work.

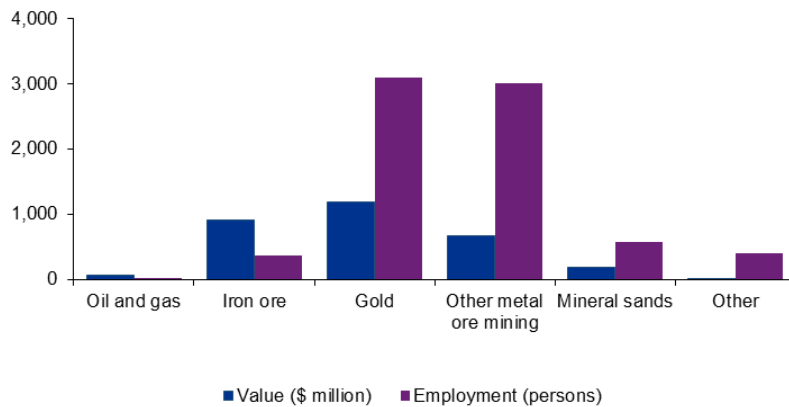
The Mid West region's unemployment rate is relatively high at 8.2%,³⁶ up from a low of 5.2% in 2011.³⁷ In 2016-17, the resources sector in the Mid West region employed 7,442 people and generated \$3 billion worth of production.³⁸ This activity was dominated by gold, silver and other metal ore mining.

Main industries by employment



- 13.4% Resources sector
- 11% Health care & social assistance
- 9.8% Education and training
- 9.5% Retail trade

Figure 3-11: Resources Sector Activity in the Mid West Region, 2016-17



Source: KPMG estimates based on data from DMIRS (mining) and ABS (oil & gas). Employment is defined by the DMIRS as the average number of individuals on-site, and includes both employees and contractors.

³² Department of Primary Industries and Regional Development, February 2018.

³³ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.

³⁴ ABS, Employment by Place of Usual Residence, Census, 2016.

³⁵ ABS, Employment by Place of Work, Census, 2016.

³⁶ Estimated from ABS, Employment by Place of Work, Census 2016.

³⁷ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.

³⁸ KPMG estimates based on data from DMIRS.

3.2.5. Wheatbelt

The Wheatbelt economy largely depends on the agriculture sector, and is the state’s main producer of cereal crops. Tourism, mining, retail, manufacturing and fishing also contribute to the Wheatbelt economy

In 2016, GRP in the Wheatbelt region was estimated to be \$6.1 billion, and is one of the few regions in the state that has seen steady annual growth in GRP over the past five years with a CAGR of 3.8%.³⁹

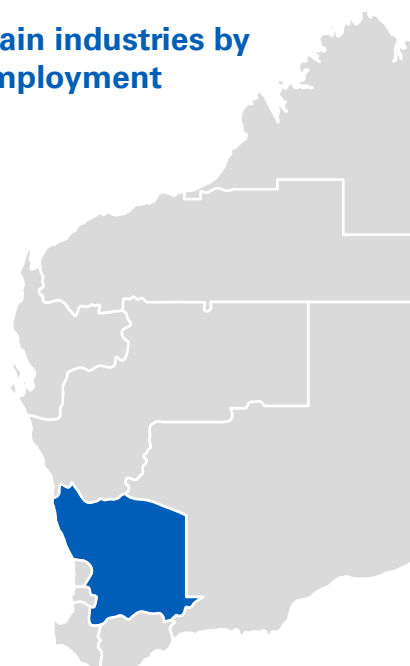
The Wheatbelt’s resident population was estimated to be 77,100 persons in 2016. Also in contrast to many of the other Western Australian regions, the resident population in the Wheatbelt has continued to grow over the past five years.⁴⁰

In 2016, there were almost 32,000 Wheatbelt residents in employment.⁴¹ With just under 30,000 people working in the region,⁴² this indicates some of the Wheatbelt residents commute to other regions for work.

The unemployment rate in the Wheatbelt region is estimated to be 5.7%,⁴³ up from around 4.4% in 2011.⁴⁴

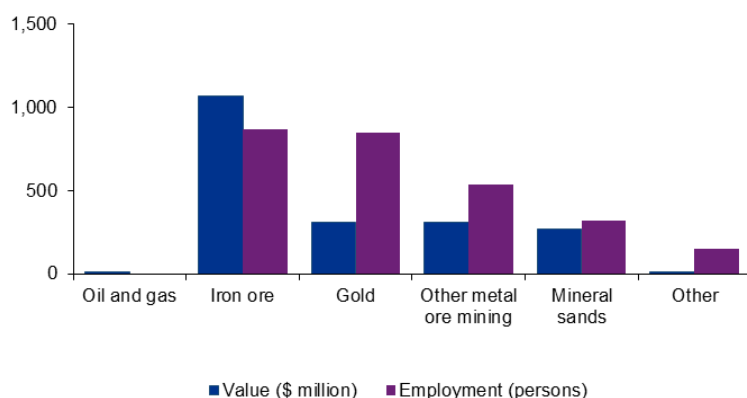
In 2016-17, the resources sector in the Wheatbelt region employed 2,716 people and generated almost \$2 billion worth of production.⁴⁵ This activity was dominated by gold production, with iron ore and other metal ore mining also making a contribution.

Main industries by employment



- 28.7%** Agriculture
- 8.7%** Health care & social assistance
- 8.7%** Education and training
- 7.3%** Retail trade

Figure 3-12: Resources sector Activity in the Wheatbelt Region, 2016-17



Source: KPMG estimates based on data from DMIRS (mining) and ABS (oil & gas). Employment is defined by the DMIRS as the average number of individuals on-site, and includes both employees and contractors.

³⁹ Department of Primary Industries and Regional Development, February 2018.

⁴⁰ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.

⁴¹ ABS, Employment by Place of Usual Residence, Census, 2016.

⁴² ABS, Employment by Place of Work, Census, 2016.

⁴³ Estimated from ABS, Employment by Place of Work, Census 2016.

⁴⁴ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.

⁴⁵ KPMG estimates based on data from DMIRS.

3.2.6. Goldfields-Esperance

Goldfields-Esperance is the largest region in Western Australia. The regional economy is varied, encompassing mining, agriculture, gold-related tourism, and fishing and aquaculture.

In 2016, GRP in the Goldfields-Esperance region was an estimated \$11.6 billion. GRP has been falling over the past five years, down from around \$14.5 billion in 2011.⁴⁶

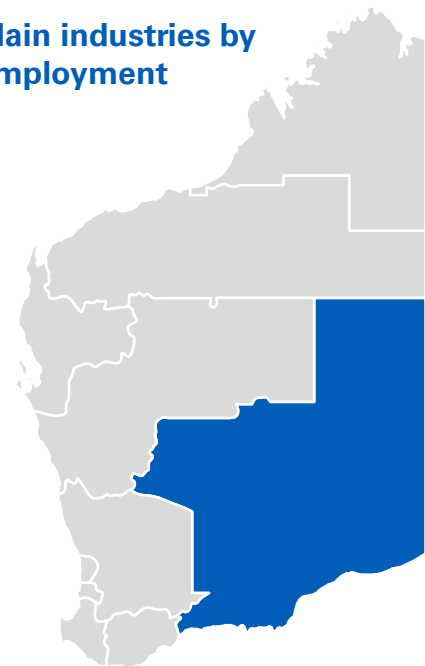
The resident population in Goldfields-Esperance was estimated to be around 56,500 persons in 2016. The population in this region has remained relatively steady over the past four years.⁴⁷

In 2016, there were 25,600 Goldfields-Esperance residents in employment.⁴⁸ With significantly more (30,211) people working in the region,⁴⁹ this indicates a large number of people commute to the region for work.

The unemployment rate in the Goldfields-Esperance region in 2016 is estimated to be 6.0%,⁵⁰ up from around 4.3% in 2011.⁵¹

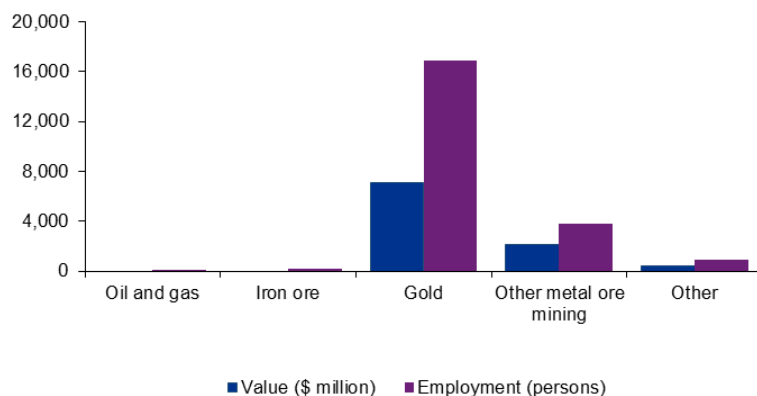
In 2016-17, the resources sector in the Goldfields-Esperance region employed 21,799 people and generated \$9.7 billion worth of production.⁵² This activity was dominated by gold, with smaller contributions from other metal ore production.

Main industries by employment



- 13.4% Resources Sector
- 11% Health care & social assistance
- 9.8% Education and training
- 9.5% Retail trade

Figure 3-13: Resources sector Activity in the Goldfields-Esperance Region, 2016-17



Source: KPMG estimates based on data from DMIRS (mining) and ABS (oil & gas). Employment is defined by the DMIRS as the average number of individuals on-site, and includes both employees and contractors.

⁴⁶ Department of Primary Industries and Regional Development, February 2018.

⁴⁷ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.

⁴⁸ ABS, Employment by Place of Usual Residence, Census, 2016.

⁴⁹ ABS, Employment by Place of Work, Census, 2016.

⁵⁰ Estimated from ABS, Employment by Place of Work, Census, 2016.

⁵¹ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.

⁵² KPMG estimates based on data from DMIRS.

3.2.7. Perth/Peel

The Perth/Peel region is Western Australia’s smallest in area but largest by population. The Perth/Peel regional economy is the state’s most diverse with activity in resources, manufacturing, construction, retail trade, tourism, professional services, health, education and public administration.

In 2016, GRP in the Perth/Peel region was estimated to be \$165 billion. Perth/Peel GRP has grown over the past five years, up from around \$144 billion in 2011.⁵³

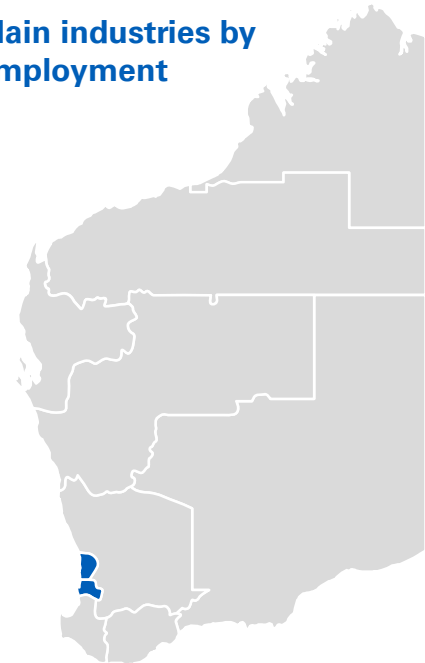
The resident population in Perth/Peel was estimated to be around 2 million persons in 2016.⁵⁴

In 2016, there were 923,000 Perth/Peel residents in employment.⁵⁵ In contrast, there were 855,000 people working in the region,⁵⁶ indicating that this region is likely a considerable source of employees commuting (FIFO/DIDO) to other regions.

The unemployment rate in Perth/Peel is estimated to be around 8.0% in 2016,⁵⁷ up from around 4.8% in 2011.⁵⁸

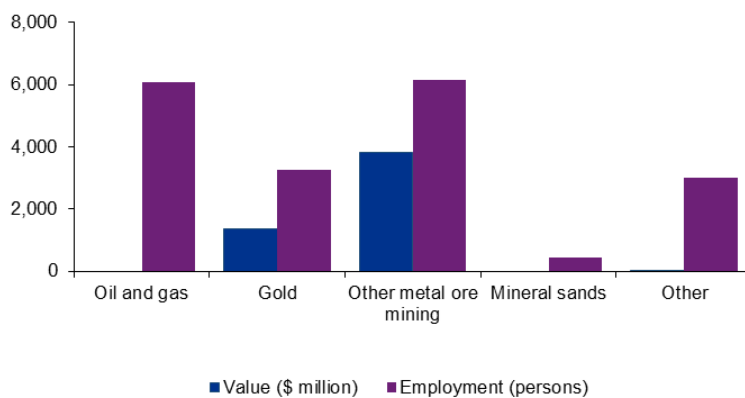
In 2016-17, the resources sector in the Perth/Peel region employed 18,885 people and generated \$5.2 billion worth of production.⁵⁹ The Perth/Peel region boasts the world’s largest bauxite mine and one of Australia’s largest producing gold mines, with alumina and bauxite accounting for around 70% of the value of total resource production in the region.

Main industries by employment



- 13.5%** Health care & social assistance
- 10.9%** Retail trade
- 9.8%** Education and training
- 8.7%** Construction

Figure 3-14: Resources Sector Activity in the Perth/Peel Region, 2016-17



Source: KPMG estimates based on data from DMIRS (mining) and ABS (oil & gas). Employment is defined by the DMIRS as the average number of individuals on-site, and includes both employees and contractors. Note that offshore oil & gas production values are not allocated to particular regions.

⁵³ Department of Primary Industries & Regional Development, February 18.

⁵⁴ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.

⁵⁵ ABS, Employment by Place of Usual Residence, Census, 2016.

⁵⁶ ABS, Employment by Place of Work, Census, 2016.

⁵⁷ Estimated from ABS, Employment by Place of Work, Census, 2016.

⁵⁸ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018;

⁵⁹ KPMG estimates based on data from DMIRS.

3.2.8. South West/Great Southern

The South West/Great Southern regional economy has strong tourism, resources, agriculture and manufacturing sectors.

GRP in the South West/Great Southern region has grown strongly over the past five years, reaching just under \$17 billion in 2016, up from \$13.5 billion in 2011.⁶⁰

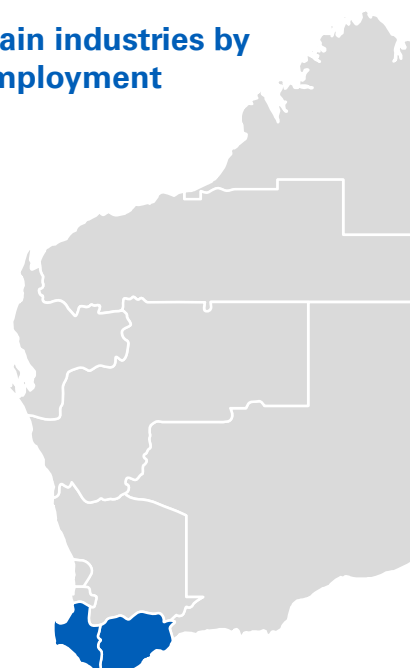
The resident population in South West/Great Southern was estimated to be around 240,500 persons in 2016.⁶¹

In 2016, there were 102,000 South West/Great Southern residents in employment.⁶² In contrast, there were 92,300 people working in the region,⁶³ this indicates some of the South West/Great Southern residents commute to other regions for work.

The unemployment rate in South West/Great Southern region in 2016 is estimated to be around 6.0%,⁶⁴ up from around 4.7% in 2011.⁶⁵

In 2016-17, the resources sector in the South West/Great Southern region is estimated to have employed 4,214 people and generated \$2.3 billion worth of production.⁶⁶ This activity is dominated by alumina and bauxite production.

Main industries by employment



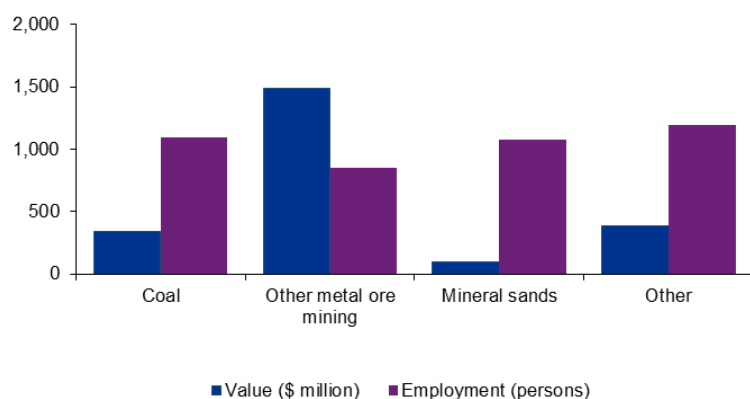
12.3% Health care & social assistance

12.2% Retail trade

9.7% Education and training

9.2% Agriculture, forestry & fishing

Figure 3-15: Resources Sector Activity in the South West / Great Southern Region, 2016-17



Source: KPMG estimates based on data from DMIRS (mining) and ABS (oil & gas). Employment is defined by the DMIRS as the average number of individuals on-site, and includes both employees and contractors.

⁶⁰ Department of Primary Industries and Regional Development, February 2018.

⁶¹ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018.

⁶² ABS, Employment by Place of Usual Residence, Census, 2016.

⁶³ ABS, Employment by Place of Work, Census, 2016.

⁶⁴ Estimated from ABS, Employment by Place of Work, Census, 2016.

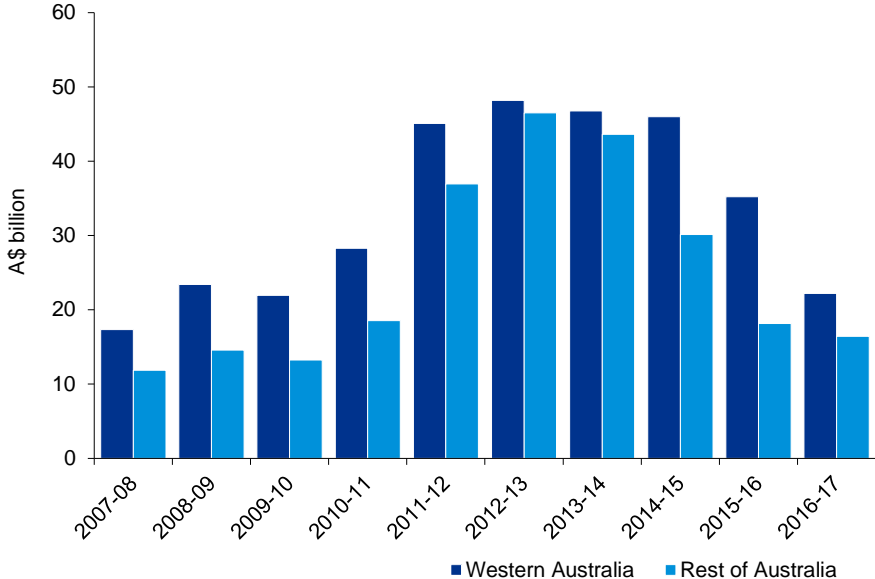
⁶⁵ ABS Data by Region, Annual (2011 to 2016), <http://stat.abs.gov.au/itt/r.jsp?databyregion>, accessed January 2018;

⁶⁶ KPMG estimates based on data from DMIRS.

3.3. Exploration and Investment

The longer-term outlook for the resources sector is impacted by ‘supply-side’ factors, with investment in capital projects playing a pivotal role. In 2016-17, investment in Western Australia’s resources sector totalled \$22.2 billion.⁶⁷ This represented a 37% decline in investment from the previous financial year when investment was \$35.2 billion. Over the decade, investment in the resources sector in Western Australia has seen total growth of 28%. The peak of this growth was in 2012-13, which saw investment reach a total of \$48.2 billion. The fluctuation in resources sector investment is a common theme across the rest of Australia.

Figure 3-16: Resources Sector Investment:



Source: DMIRS; ABS

After consecutive declines in 2014-15 and 2015-16, mineral exploration expenditure in Western Australia has picked up. In 2016-17, Western Australian mineral exploration expenditure was around \$1.03 billion, up from the previous years’ spend of \$871 million.⁶⁸ This was led by expenditure on exploration for gold (\$510 million), iron ore (\$282 million) and nickel cobalt (\$67.4 million). As a share of total Australian mineral expenditure, Western Australia’s share was approximately 65.7%. Western Australian petroleum exploration expenditure, on the other hand, has declined since its recent peak of \$3.3 billion in 2012-13. Latest data shows that in 2016-17, petroleum exploration expenditure has fallen to \$652 million.

⁶⁷ Based on the ABS estimate of new capital expenditure by the ANZSIC Industry Division Mining. This includes Coal Mining, Oil and Gas Extraction, Metal Ore Mining, Non-Metallic Mineral Mining and Quarrying and Exploration and Other Mining Support Services.
⁶⁸ Exploration expenditure includes operating and capital expenses associated with the exploration activities, such as wages and salaries, operation and maintenance of equipment, purchase of equipment and machinery and other capital and non-capital items.

Figure 3-17: Mineral Exploration Expenditure (Western Australia and Rest of Australia)

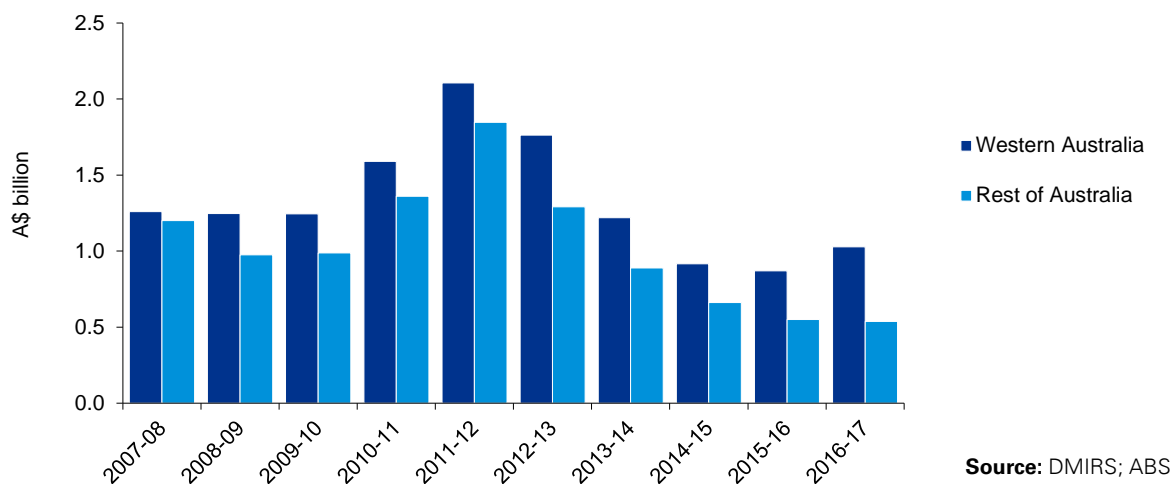
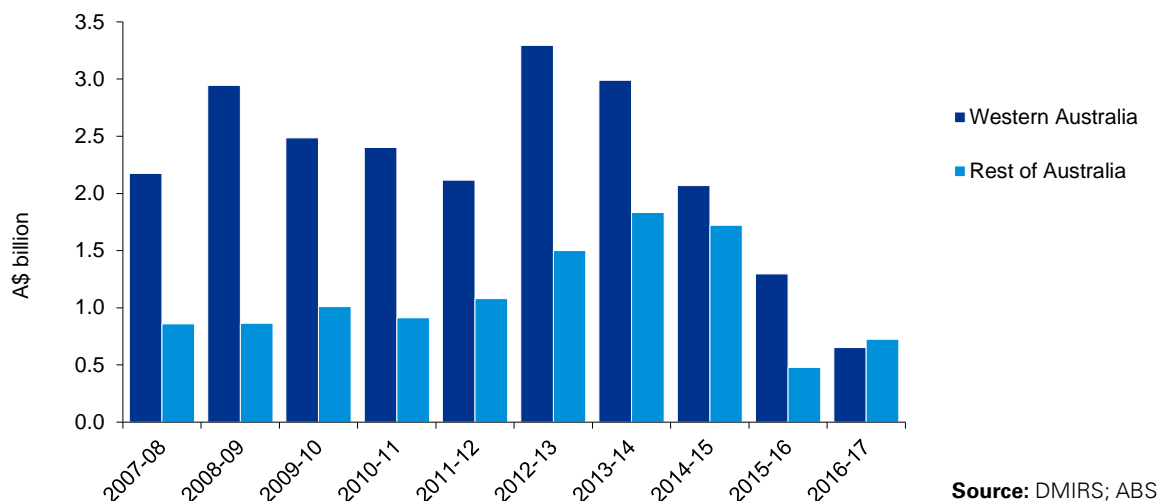


Figure 3-18: Petroleum Exploration Expenditure (Western Australia and Rest of Australia)



Expansion in the capacity of the Western Australian resources sector is heavily dependent on the development of new projects. An indication of potential expansion in capacity can be deduced from the pipeline of projects that are currently planned but not yet under construction. The DMIRS reports⁶⁹ that as of September 2017, there was an estimated \$99 billion worth of resource projects in Western Australia ‘under construction’ or at the ‘committed’ stage of development.⁷⁰ The development pipeline includes a further \$49 billion of capital investment for resources projects in Western Australia and are designated as ‘planned’ or ‘possible’.⁷¹ What proportion of these ‘planned’ or ‘possible’ projects is ultimately developed, and the timing of such developments, is subject to considerable uncertainty. Among other things, these uncertainties include assessments of future price and cost conditions and government policy settings.

⁶⁹Department of Mines, Industry Regulation and Safety (DMIRS) – Review of resources industry activity.

⁷⁰ Note that \$57.3 billion of this pipeline is for the Wheatstone and Prelude Floating LNG projects. The former commenced operations in late 2017 and the bulk of its capex program is finished while construction of the latter is well advanced with commissioning expected in the later part of 2018.

⁷¹ Mineral and petroleum projects are categorised as follows by DMIRS:

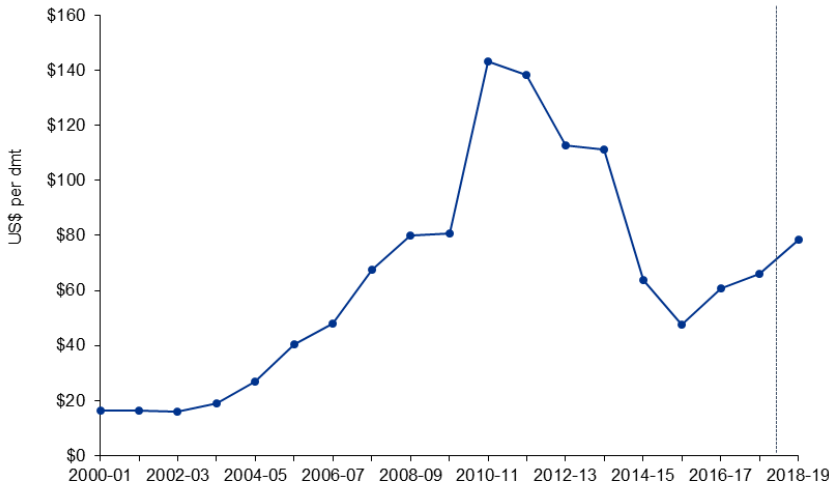
- “Projects under construction – those actually under construction.
- Committed projects – company has reached a final investment decision (FID).
- Planned projects – those undergoing advanced feasibility studies including definitive and bankable feasibility studies and Front End Engineering Design (FEED).
- Possible projects – comprise those raising capital but not yet conducting definitive and bankable feasibility studies.”

3.4. Commodity Prices

Iron ore is Australia’s largest export (by value), accounting for almost 22% of Australia’s merchandise exports and about 17% of total exports. Western Australia currently produces about 98% of Australia’s iron ore and 37% of global iron ore production, making it the largest iron ore producer in the world. Iron ore is Western Australia’s most significant resource (both by value and employment). In 2016-17 the value of Western Australian iron ore production was just over \$63.6 billion, accounting for almost 61% of the total value of Western Australian minerals and petroleum production. Approximately half of all employees in the Western Australian resources sector are employed in the iron ore industry.

Iron ore prices can become volatile in the short term due to market uncertainties with risks that have the potential to impact demand and supply conditions. Over the longer term, the trend in high grade iron ore prices reflects underlying demand and supply conditions. Sizeable movements in high grade iron ore prices can have potentially large impacts on the Western Australian resources sector, supporting industries and the broader economy. China’s strong demand for steel (production) drove the strong increase in iron ore prices between 2005 and 2011, punctuated by the negative impact of the global financial crisis in 2009. Moderating demand and increased uncertainty about future global economic conditions combined with expansion in supply has seen prices fall sharply from their peak in 2011. Increased confidence in global growth prospects has supported a rebound in iron ore prices over the last year. In the first two months of 2018 iron ore prices have averaged just over US\$75 per dry metric tonne.

Figure 3-19: Average USD Price of Western Australian Iron Ore



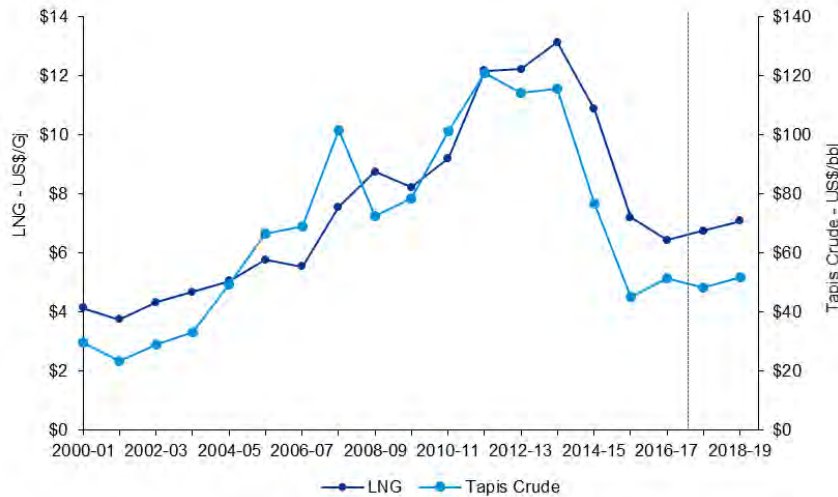
Source: KPMG, DIIS, DMIRS

Global trade in iron ore is forecast to reach 1.6 billion tonnes in 2019 with an annual growth rate of 1.6% in 2019. The most recent Department of Industry, Innovation and Science (DIIS) projections have iron ore prices falling over in 2018-19 by 7.2% (giving an average of just over US\$61 a tonne in 2018-19).⁷² Price movements since this forecast was made suggest the DIIS projections for iron ore are on the pessimistic side. Moderating demand and additional supply will limit the upside for iron ore prices over the next few years. However, increased market confidence in moderate but sustained global growth will continue to support the gradual recovery in prices from the lows in 2015-16.

⁷² Resource and Energy Quarterly December 2017. Iron ore prices are based on 62% iron content delivered prices to China, including cost and freight.

In 2016-17, LNG accounted for just over 12% of the value of Western Australia’s production of minerals and petroleum. Global oil prices have recently strengthened and are expected to remain within range for 2018, in part driven by the extension of the OPEC-Russia deal to extend oil output cuts till the end of 2018. This will likely place upward pressure on global oil prices which will flow through to Australian LNG export prices – the majority of which are tied to the price of oil.

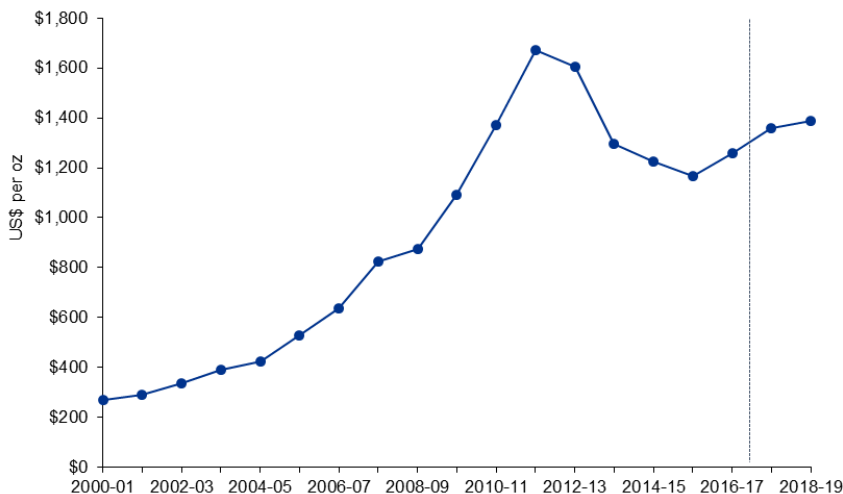
Figure 3-20: LNG and Tapis Crude Oil



Source: KPMG, DIIS, DMIRS.

Gold accounted for around 10% of the value of Western Australia’s production of minerals and petroleum in 2016-17. The value of Australia’s gold exports in 2016-17, was approximately \$18 billion with production from Western Australia making up over \$10 billion. Western Australia is Australia’s largest gold producer and, over the last 10 years, Western Australian gold production has on average been twice that of the rest of Australia.⁷³

Figure 3-21: Gold Prices



Source: KPMG, DIIS, DMIRS.

Global gold prices have risen recently due to the weakness of the U.S. dollar, concerns about Bitcoin and trade frictions.⁷⁴ Scope for significant increases in gold prices over the medium term are limited

⁷³ Resource and Energy Quarterly December 2017.

⁷⁴ National Australia Bank, Minerals & Energy Outlook February 2018.

with real US Treasury yields expected to rise to more normal levels and inflation remaining contained. There are upside risks to this outlook if geopolitical and economic risks escalate.

3.5. Resources Sector Outlook

The prospects for Western Australia's resources sector over the short-to-medium-term remain broadly positive although there is a divergence across commodities. As discussed previously, commodity prices have started the year strongly and the global economy is expected to continue its healthy momentum through the remainder of 2018 and into the medium term.

The resources sector in Western Australia is currently transitioning from a period dominated by construction on new capacity to a period where this new capacity comes on stream and production is ramped up. Real investment activity in the sector has declined with further falls expected through 2018.⁷⁵ As a consequence, near-term construction activity in the resources sector is expected to decline further but production is anticipated to grow moderately. Of the major projects, the Gorgon LNG project progressed to the completed stage while the Wheatstone and Prelude projects are scheduled for completion by the end of 2018.⁷⁶ Improving market conditions are likely to continue into the year and the underlying fundamentals are likely to remain healthy over the outlook period.

The overall production outlook is positive. Modest growth in production is expected, supported by the increase in domestic capacity and growth in global industrial activity. The increased domestic capacity, together with competition from foreign producers, particularly iron ore from Brazil and LNG from Qatar, will limit the upside for commodity prices over the next couple of years. In the case of LNG prices the upside is also limited by the emergence of the U.S. as a major player with the potential to increase global supply significantly. With strong growth in global industrial production, the outlook for base metals is also relatively positive.

The remainder of this section looks at the outlook for key commodities in the Western Australian resources sector. In compiling these projections, information obtained from the RSO survey was supplemented with Department of Mines, Industry Regulation and Safety (DMIRS) data and with information from government, industry and other stakeholders. It should be noted that, owing to the uncertainty companies had regarding their new projects over the long-term, most RSO survey respondents were unable to provide estimates of the projected production beyond 2021-22.

Specifically, the RSO survey indicated production (of various commodities) is expected to increase moderately in the short-term (2018-19) and be little changed over the medium-to-longer-term (2020-28).

Key drivers of this outlook include:

- Global demand for resource commodities expected to remain stable over the next few years.
- Steel demand is expected to slow as the construction boom in China moderates placing downward pressure on prices.
- Demand for higher quality iron ore in China will affect lower-grade producers.

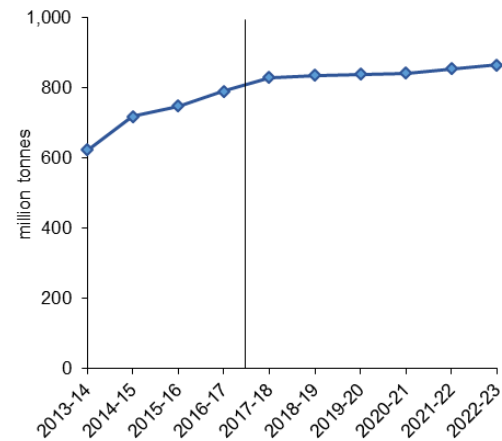
⁷⁵ Department of Industry, Innovation and Science (DIIS) – Resources and Energy Quarterly December 2017 report has resources sector investment falling by 31% in 2017-18.

⁷⁶ DIIS Resources and Energy Quarterly – December 2017.

Figure 3-22: WA Iron Ore Production

About 61% of the value of Western Australia’s resources sector production is iron ore. Thus activity in the iron ore sector is a significant driver of overall resources sector performance in Western Australia. Western Australia’s iron ore production is expected to grow moderately over the short-term.

This growth will be supported by steady import demand from China, Japan and South Korea – Australia’s key export destinations. Growth in production is also expected to be driven by new additions to capacity and ongoing improvements in productivity. Over the longer-run, growth in iron ore production is projected to be relatively flat.

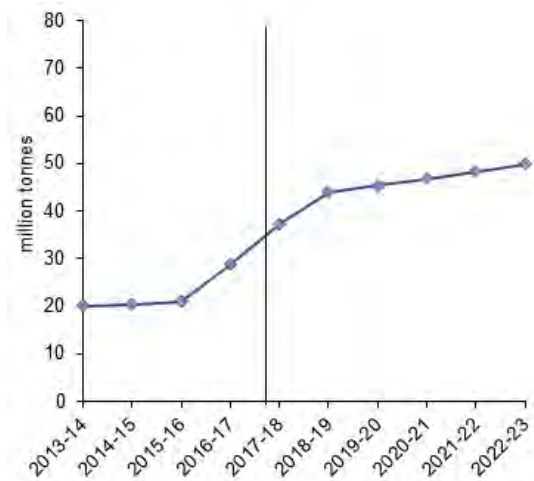


Source: KPMG estimates based on data from RSO Survey; DMIRS; ABS, Office of the Chief Economist, and IBIS World.

The petroleum sector⁷⁷ is the second largest component of the resources sector, accounting for 18% of the total value of mineral and petroleum sales in Western Australia. Within the petroleum sector, LNG remains Western Australia’s most valuable petroleum product by far, with a production value of \$12.7 billion in 2016-17.

Figure 3-23: WA LNG Production

The volume of LNG production in Western Australia increased by approximately 37% from 2015-16 to 2016-17. In 2018-19, LNG is projected to displace metallurgical coal as Australia’s second largest export, with total Australian LNG export volumes forecast to reach 76.5 million tonnes (up from 52 million tonnes in 2016-17).⁷⁸ The projected increase in LNG production capacity in 2018-19 will be, in part, driven by projects coming online in the coming two years (Wheatstone LNG project, Prelude FLNG, and Inpex’s Ichthys LNG project).



Source: KPMG estimates based on data from RSO Survey; DMIRS; ABS, Office of the Chief Economist, and IBIS World.

Australia, being the second largest exporter of LNG (behind Qatar) is likely to benefit from this increase in trade volume.⁷⁹ LNG imports by Australia’s trading partners China and South Korea are expected to drive this demand over the short-term (2016-19). Japan’s imports of LNG, however, are expected to decline with the reactivation of nuclear power generation reactors. Over a longer time horizon, global LNG supply is projected to rise with major expansions in the U.S. expected to account for over half of new capacity. This potential increase in supply will keep price growth contained and increase competition for market share.

⁷⁷ Western Australia’s petroleum sector comprises crude oil, condensate, LNG, natural gas and LPG (butane and propane).

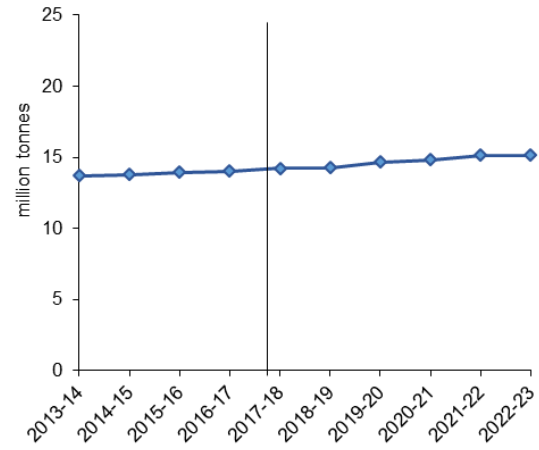
⁷⁸ Resources and Energy Quarterly – September 2017.

⁷⁹ Qatar currently exports approximately 73.8 million tonnes of LNG while Australia exports around 45.0 million tonnes.

The Federal Government’s Australian Domestic Gas Security Mechanism⁸⁰ which is aimed at ensuring gas supply in Australia meets the forecast needs of the domestic market, applies only to east coast exporters and is unlikely to have a material impact on the Western Australian resources sector.

Alumina and bauxite production is forecast to remain steady over the short-term, with no expected major additions to capacity or closures within Western Australia over the forecast period. Recently announced tariffs on aluminium imports by the US may impact Western Australian producers as global producers adjust to the new policy environment.

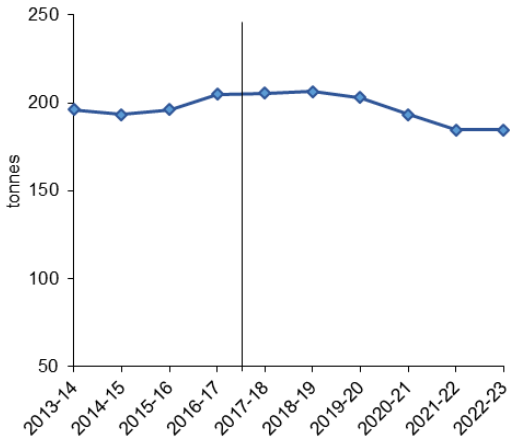
Figure 3-24: WA Alumina and Bauxite Production



Source: KPMG estimates based on data from RSO Survey; DMIRS; ABS, Office of the Chief Economist, and IBIS World.

Gold production has grown modestly over the past three years, with relatively strong gold prices and demand. Production is expected to increase modestly in the near term then gradually fall in the medium to long term. Production from existing mines is close to a peak and as their resource base is depleted production costs will tend to rise. New projects are expected to partially offset the reduction in production from existing mines.

Figure 3-25: Gold Production

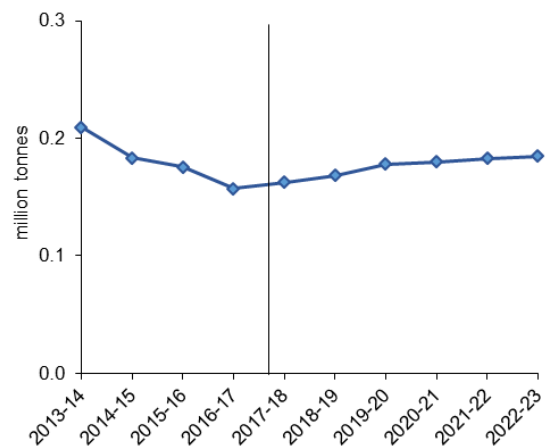


Source: KPMG estimates based on data from RSO Survey; DMIRS; ABS, Office of the Chief Economist, and IBIS World.

⁸⁰ Department of Prime Minister and Cabinet – Australian Domestic Gas Security Mechanism: Regulation Impact Statement Updates.

With lower nickel prices, nickel production volumes and values have fallen over the past four years. With global demand for steel expected to grow over the medium term, demand for nickel is also expected to rise. Nickel production is expected to grow modestly over the projection period with the increase in demand for lithium-ion batteries for powering electric vehicles.

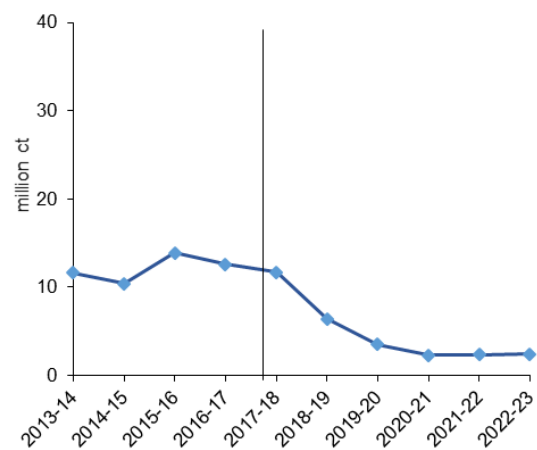
Figure 3-26: Nickel Production



Source: KPMG estimates based on data from RSO Survey; DMIRS; ABS, Office of the Chief Economist, and IBIS World.

With the depletion of existing diamond reserves and the likely closure of the remaining significant diamond mine in Western Australia, diamond production is expected to dramatically decrease over the medium term. The diamond industry is thus returning to an exploration phase, and the extent and length of the decline will be impacted by any new discoveries.

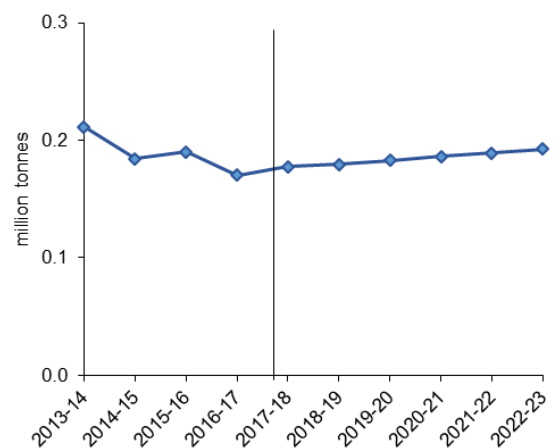
Figure 3-27: Diamond Production



Source: KPMG estimates based on data from RSO Survey; DMIRS; ABS, Office of the Chief Economist, and IBIS World.

Copper production has also seen a contraction recently, with lower prices and weaker growth in global demand. However, production is expected to grow modestly over the projection period. A key factor in this is an expected improvement in global demand and prices as copper is sourced for high end manufacturing.

Figure 3-28: Copper Production



Source: KPMG estimates based on data from RSO Survey; DMIRS; ABS, Office of the Chief Economist, and IBIS World.

Other resources include salt, mineral sands, lithium and construction materials. Salt and, lithium are two key performers in this group. With growing demand for lithium-ion batteries, global demand for lithium is expected to increase strongly over the coming years. Salt is also expected to experience continued modest growth in demand, which should support growth in production.

Figure 3-29: Tin – Titanium - Lithium Production

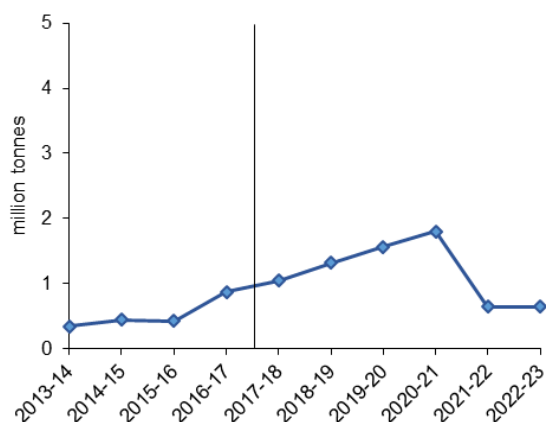
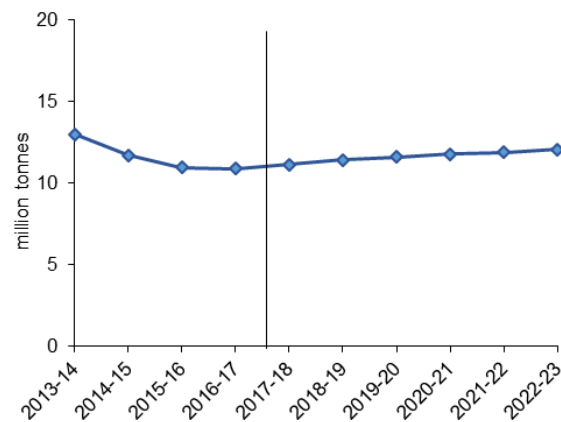


Figure 3-30: Salt Production



Source: KPMG estimates based on data from RSO Survey; DMIRS; ABS, Office of the Chief Economist, and IBIS World.

In summary, the outlook for Western Australia’s resources sector is generally positive in the short to medium term. Some further downward pressure on commodity prices is likely to accommodate increased global supply and moderating demand.

Considerations

The main considerations when interpreting the projected prospects for the Western Australian resources sector relate to global growth and conditions.

While there is a possibility that global growth over the next decade may be stronger than projected, geopolitical, environmental, societal and technological risks have the potential to derail the broad-based and balanced growth environment that characterises our central case. Geopolitical issues, including tensions on the Korean peninsula, uncertain Brexit negotiations and tensions in the Middle East, have the capacity to significantly disrupt the global economy. In 2017, the World Economic Forum’s Global Risks Report⁸¹ highlighted societal risks (such as rising wealth disparity) in polarised societies that could amplify the costs associated with economic growth and technological advancement.

Global efforts to reduce growth in carbon emissions has the potential to provide upside to the Western Australian resources sector. With the increasing reliance on renewable energy, there is potential upside for the Western Australian economy around lithium, nickel sulphate and other battery minerals, albeit from a relatively small current base. There is also potential upside for the Western Australian gas industry if carbon policies encourage further development of gas-fired electricity generation as economies transition away from reliance on coal-fired electricity generation towards cleaner energy sources such as gas and renewable energy.

Other policy changes, for example in the areas of tax, climate change policy and industrial relations, have the potential to introduce up and downside risks to the central case projection for the Western Australian resources sector. Similarly, emerging technologies and innovation, including various forms of automation, can act as potential disruptors to the sector, in both a positive and negative manner in the longer-term.

⁸¹ The Global Risks Report 2017 – World Economic Forum.

Key Growth Enablers



4. Key Growth Enablers

This section focuses on the factors that will enable the Western Australian resources sector to grow and maximise its contribution to the broader economy. Economic growth is expected to be moderate but relatively stable over the next decade.

In such an environment, scope for upside on commodity prices is limited and opportunities for growth will be dependent on maintaining and enhancing competitiveness through productivity improvements driven by *people, infrastructure and technology and innovation* and through access to reliable and efficient supplies of key inputs, including *people, energy and water*.

As foreshadowed, the central case is for a relatively benign economic outlook but key economic, geopolitical and technology risks remain. A degree of volatility in commodity markets is inevitable as information and perceptions of these risks change over time. A competitive resources sector will be equipped to cushion the impacts of downside risks and to benefit from upside risks.

4.1. People

People are an integral part of the resources sector and a key enabler in sustaining and developing the potential of the sector in Western Australia. In 2016-17, there were 118,423 employees in the resources sector in Western Australia.⁸² These included both part-time and full-time employees and also contractors.

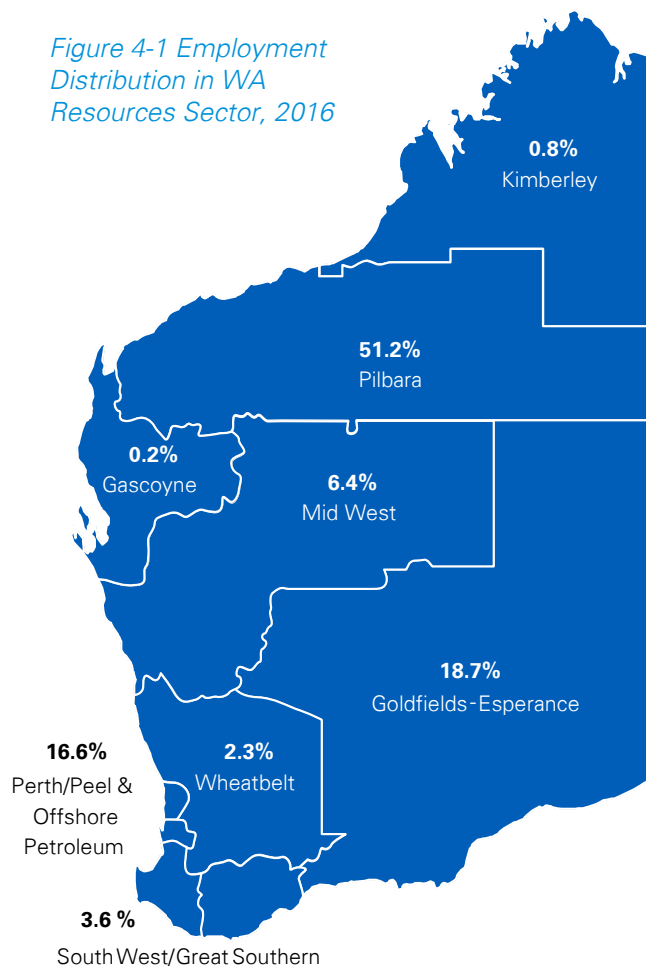
4.1.1. Regional Distribution

Western Australia's resources sector is spread across the various regions and, likewise, its workforce. Figure 4-1 presents the employment distribution of Western Australia's resources sector set across the various regions.⁸³

In 2016-17, the largest share of on-site employment in Western Australia's resources sector was in the Pilbara. Approximately 59,600 persons or 51% of total on-site employment in the resources sector worked in the Pilbara region. The vast majority of the Pilbara's resources employees worked in metal ore mining.

The Goldfields-Esperance region ranked second with around 21,800 employed persons or 18.7% of the total. Perth/Peel recorded the third highest number of employed persons at around 18,900 persons or around 16% of total employed persons in Western Australia's resources sector. The majority of individuals employed in the resources sector in these two regions worked in metal ore mining, with a significant proportion of Perth/Peel employees also in the oil and gas sector. There are another estimated 461 employees in offshore petroleum.

The Gascoyne and Kimberley regions were among those with the lowest share of employment in Western Australia's resources sector – at around 220 and 970 persons respectively, each making up less than 1% of total employment.



Source: KPMG; DMIRS; ABS

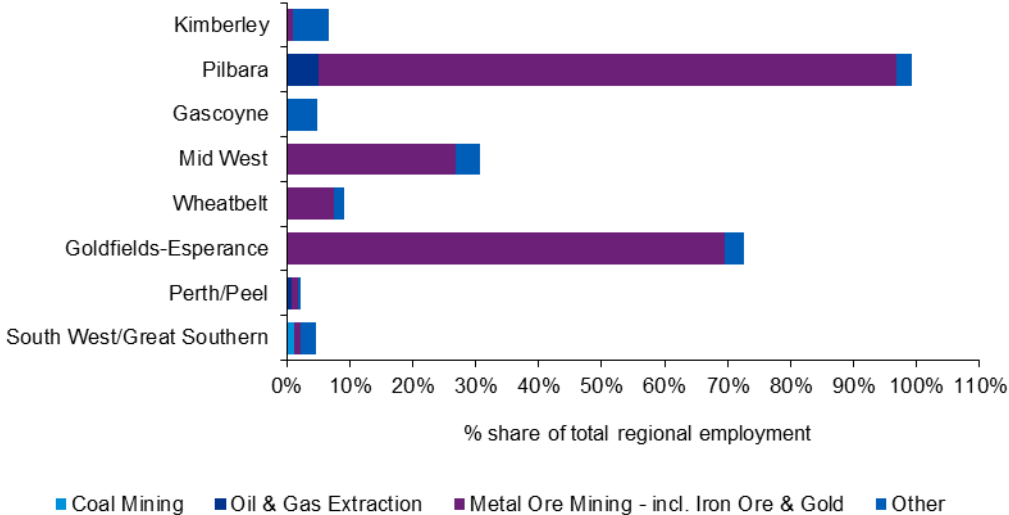
⁸² Department of Mines, Industry Regulation and Safety (DMIRS). Oil & Gas estimates from ABS.

⁸³ The data was derived from the Department of Mines, Industry Regulation and Safety (DMIRS) 'Employment by Site' series (this series excludes personnel in administrative locations located outside operating sites). There will be some discrepancies between this dataset and the employment data published by the ABS since the ABS's employment data are classified in reference to the Australian and New Zealand Standard Industrial Classification (ANZSIC). Under ANZSIC guidelines, not all mining employment is reflected in ABS's Mining industry classification. This analysis uses the 'Number of Individuals (Average on-site)' to measure employment in the sector.

Regional Reliance

To assess the reliance on the resources sector of each region, the proportion of those employed in the resources sector in each region (discussed above) was compared with total regional employment across all sectors in that region (identified in the 2016 Australian Census).

Figure 4-2: Resources Sector share of total regional employment by place of work, 2016



Source: KPMG; DMIRS; ABS

In 2016, resources sector on-site employees (including contractors) made up a significant proportion of each regions total workforce, accounting for:

- over 90% of all people who work in the Pilbara;
- around three-quarters of people who work in the Goldfields-Esperance region;
- almost one-third of all people working in the Mid West; and
- 20% of people who work in the Wheatbelt.

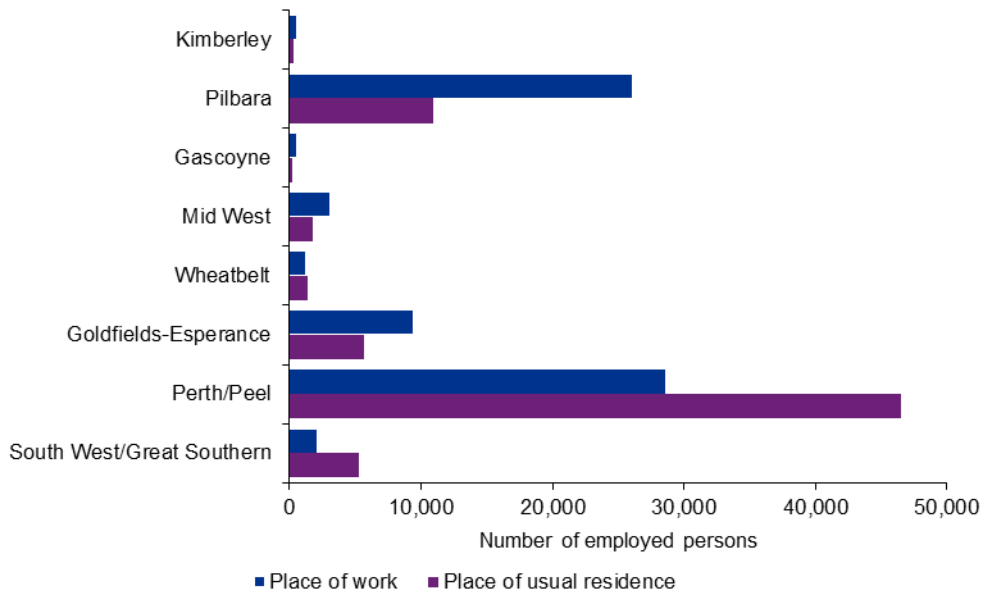
In contrast, the resources sector constituted smaller shares of total employment (resources and non-resources) in the regions of Kimberley (6.6%), South West/Great Southern (4.6%), Gascoyne (4.6%), and Perth/Peel (1.2%), reflective of the economic diversity of those regions.

Commuter workforce

Many employees in the resources sector reside in regions outside of their project location. The composition of employees in the resources sector in each region has been derived from ABS 2016 Census information, which classifies individuals who worked in the resources sector by their place of work and place of usual residence.⁸⁴ It is worth noting, in contrast to the DMIRS data, corporate personnel (who did not work on-site) were included in the Census, while contractors from other industries who work on-site are not included in the Census defined resources sector workforce.

While the Census data differs in terms of coverage, it provides a good understanding of the regional distribution of employees who commute to or from a region for work in the resources sector. The data indicates many employees living in the Perth/Peel region in 2016 commute to other regions for work. In contrast, many employees in the Pilbara region live in other regions and travel to the Pilbara for work.

Figure 4-3: Employment Distribution in WA Resources Sector by Place of Work and Place of Usual Residence, 2016



Source: KPMG; ABS 2016 Census; Australian National Accounts: Input-Output Tables, 2014-15 (ABS Cat. No. 5209.0.55.001)

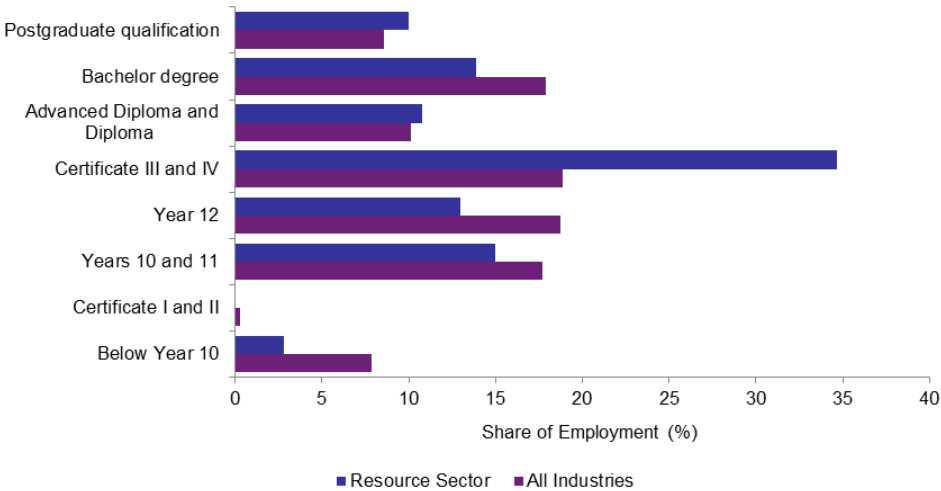
⁸⁴ Place of Work data provide information on where employed persons over 15 years of age worked in the week prior to Census Night. Place of Usual Residence records the geographic area in which a person usually lives.

4.1.2. Workforce characteristics

Skill Levels

At the national level, the resources sector workforce has higher levels of educational attainment compared to the average across all industries. As illustrated in Figure 4-4 in 2016, 70% of employees in the resources sector have at least Certificate III and IV or higher qualifications, with 24% having a university degree or post-graduate credentials. The RSO survey respondents identified a similar pattern - a considerable proportion (almost 50%) of respondents' employees have completed university or other tertiary equivalent qualifications. This is indicative of a relatively technically-skilled workforce within the resources sector.

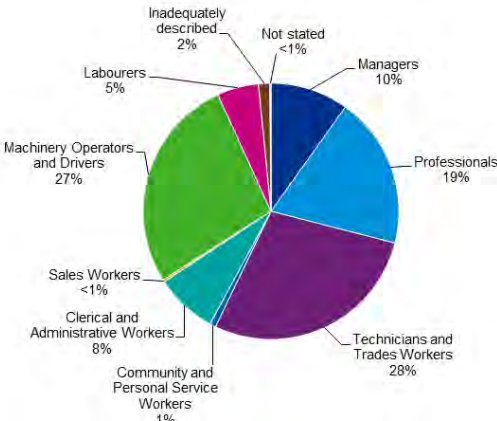
Figure 4-4: Australian Resources Sector Workforce Educational Attainment



Source: ABS Survey of Education and Work 2016, LMIP

Technicians and trade employees comprise the largest share of the resources sector workforce in Western Australia (see Figure 4-5). Companies surveyed gave no indication of significant changes in the workforce composition going forward. Stakeholder consultation, however, identified the increase in automation as a key potential disruptor to the future workforce structure. Industry believes there is strong possibility of increased automation within the sector over the next 10 years. The future workforce composition will depend on new project developments and/or other factors such as innovation and increased automation. This is likely to include greater demand for higher trained technology employees.

Figure 4-5: WA Resources Sector Workforce Occupations



Source: KPMG; RSO Survey; 2016 Census

Education and Training Programs

Around 48% of RSO survey respondents expect the availability of appropriately-skilled employees to be a potential constraint on the growth of their operations over the outlook period. Companies aim to tackle future skills shortages by increasing apprentice and trainee intakes, attracting specialist employees through high remuneration, and partnering with vocational institutions to develop a smart mining curriculum.

Current levels of education and training support vary across companies. In general, companies allocate between 2-3 weeks of training time per employee per year. Education and training support for employees is expected to increase over the next five years, as companies allocate a larger budget to training and up-skilling their workforce.

Diversity and Inclusion

The composition of resources sector workforce remains unbalanced with females accounting for less than one-fifth of the Western Australian resources sector workforce. Of these, over one-third are in professional roles, and one-fifth are machine operators and drivers.⁸⁵

Most companies reported a commitment to promoting inclusion and diversity with policies in place to encourage female participation over the next decade. However, a number of companies have indicated that changing the level of female participation in this sector will take time.⁸⁶

In addition to gender, other diversity issues were also identified.

- The share of Indigenous employees in the current resources sector workforce is 4%, with over half of these employed as machine operators and drivers⁸⁷. The level of Indigenous employment is not expected to change significantly over the outlook period.⁸⁸
- With regard to international diversity, surveyed companies indicated only a small number of employees are on a 457 working visa. Employees on the 457 visa are usually in management positions or technical roles companies cannot fill locally. There are no planned changes to the number of international hires, with future employment decisions heavily dependent on the availability of local skills in Australia. Recent reforms to the migration visa system may have an impact on the ease of access to international employees, despite the aim of these reforms being to increase the quality and economic contribution of skilled migrants and address public concerns about displacing Australian employees.⁸⁹

“Collectively, the sector can act as a catalyst for change by focusing on programs to attract and retain diverse talent, and focusing on creating an inclusive environment where women, Indigenous people and other diverse candidates can succeed.”

CME, Diversity in the Western Australian Resources Sector, p23

⁸⁵ CME, Diversity in the Western Australian Resources Sector, 2017.

⁸⁶ RSO survey, 2017.

⁸⁷ CME, Diversity in the Western Australian Resources Sector, 2017.

⁸⁸ RSO survey, 2017.

⁸⁹ The Government has recently reformed employer sponsored skilled migration visas. The Temporary Work (Skilled) visa (subclass 457 visa) will be abolished and replaced with the Temporary Skill Shortage (TSS) visa in March 2018.

See: <https://www.homeaffairs.gov.au/WorkinginAustralia/Documents/abolition-replacement-457.pdf>

4.1.3. Employment Outlook

WA Resources Sector

The resources sector and supporting workforce has been declining since its peak of around 120,000 in 2013, declining to around 115,000 employed people in 2015-16, before rising again to 118,423 in 2016-17.⁹⁰ The RSO survey and other data sources suggests this is likely to flatten out with modest growth over the longer-term to 2028.

Figure 4-6: Resources Sector Workforce – WA, '000 persons, 2016-17 to 2027-28



Source: KPMG estimates based on data from DMIRS, RSO Survey; ABS, Office of the Chief Economist, IBIS.

The number of construction/development employees is expected to decline marginally in the short-term, and remain stable over the medium-to-longer term. There may be upside risks to this projection if more new major projects get underway. Owing to the uncertainty resources sector companies had regarding their new projects over the long-term, most respondents were unable to provide estimates of the projected construction/development workforce beyond 2021.

Operational employees make up most of the resources sector workforce. Over the next five years, the number of operational employees is estimated to fall. This is largely driven by a short-term contraction in iron ore employees – as a result of lower ore prices, higher production costs and greater use of automated systems. Iron ore production and employment should stabilise over the longer term, as expansions to iron ore projects come on line after the next five years, and this is reflected in a relatively flat employment outlook going forward.

In a cost-sensitive environment, technological innovation becomes critical for maintaining and enhancing competitiveness. The adoption of new technologies to improve productivity and competitiveness will continue to change the structure of job roles across the industry. Hybrid job roles in this operational environment will become more common, such as automation technicians bringing together skills from a number of currently discrete roles. This process will require changes to the industry skilling regime.

The availability of the FIFO/DIDO option in the resources sector provides employees with some flexibility to choose where they reside. Mobility is an important aspect of the industry and this flexibility has enabled the sector to be more competitive in attracting and retaining a skilled workforce. Skill shortages, however, still exist particularly in a number of trade areas (mechanical fitting, diesel fitting) and also across the drilling sector. Anecdotal evidence suggests many skilled employees who were attracted to Western Australia by relatively high wages on resources and energy construction projects have now returned to other states (notably New South Wales, Victoria and Queensland) which are currently experiencing a surge in infrastructure related project activity.

⁹⁰ KPMG estimates based on DMIRS and ABS Cat no. 6291.0.55.003 data.

Outlook by Region

The workforce in the **Pilbara** is expected to decline over the next five years, as the iron ore industry faces lower prices and high levels of competition; and as technology allows for more remote working. Thereafter, a number of project expansions are expected to come online, boosting activity and increasing employment.

The region remains the major contributor of construction and operational employment in Western Australia’s resources sector.

The **South West/Great Southern** region is projected to have its resources sector workforce rise over the outlook period, supported by growth across the mineral sand, lithium and nickel sectors.

With growing demand for lithium-ion batteries, global demand for lithium is expected to increase strongly over the coming years.

The resources sector workforce in the **Goldfields-Esperance** region is anticipated to rise over the next few years, before coming back a little. The change in the resources workforce in this region is predominately due to changes in employment in the gold sector, with some positive influence from the nickel sector. Exploration investment to discover new deposits will play a significant role in maintaining production levels and averting a softening demand for employees in the gold sector.

Resources sector employment in the **Wheatbelt** region is also heavily influenced by the gold and iron ore sectors. With the closure of the Cleveland-Cliffs Koolyanobbing iron ore operations expected around June 2018, a sharp decline is expected in resources sector employment in the Wheatbelt region in 2018-19. Resources sector employment is then expected to remain relatively flat over the coming years.

Figure 4-7: Pilbara resources sector workforce (persons)

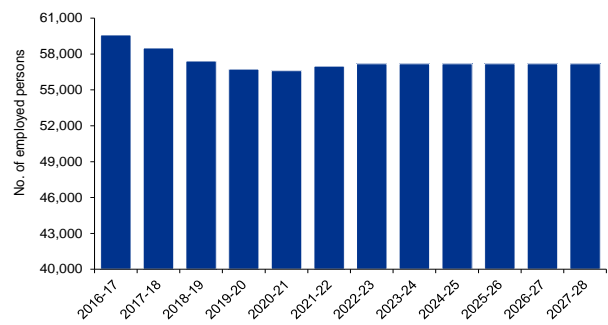


Figure 4-8: South West/Great Southern resources sector workforce (persons)

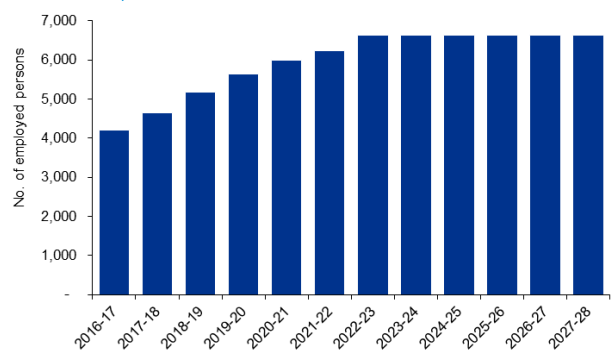


Figure 4-9: Goldfields-Esperance resources sector workforce (persons)

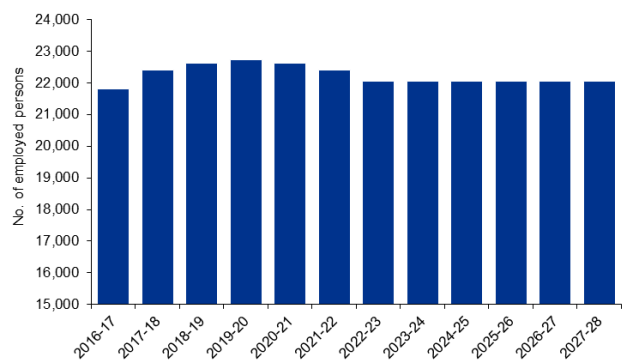
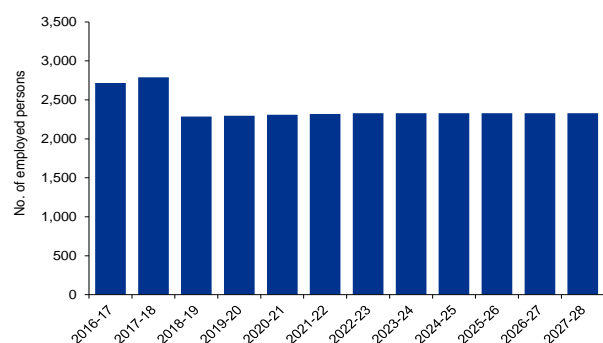
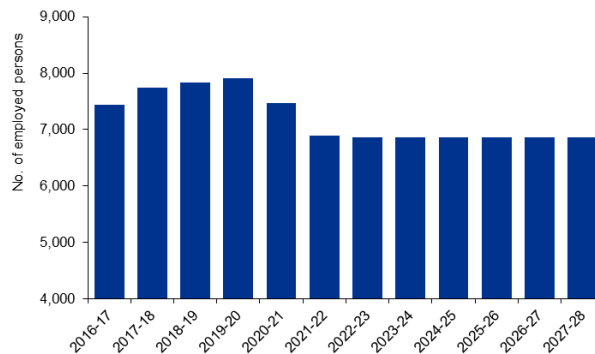


Figure 4-10: Wheatbelt resources sector workforce (persons)



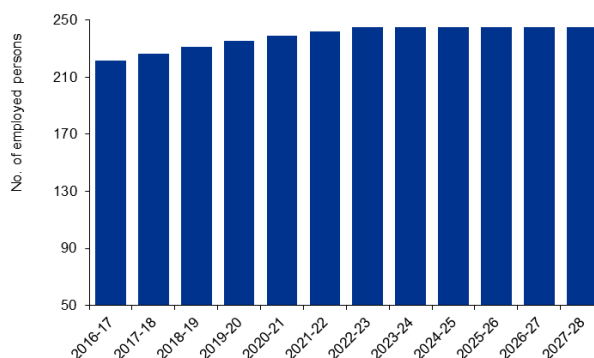
Resources sector employment in the **Mid West** region is projected to grow in the short-term to support iron ore and gold production. Resources sector employment in this region, and in particular in the gold and other metal ore mining sectors, is expected to then experience a modest contraction as lower prices combine with higher costs to impact demand for employees.

Figure 4-11: Mid West resources sector workforce (persons)



The **Gascoyne** region is projected to have its resources sector workforce steadily increase over the outlook period. Salt production is currently the main resources sector employer in this region. With increased demand (and corresponding increased production) of salt expected, employment growth should also continue.

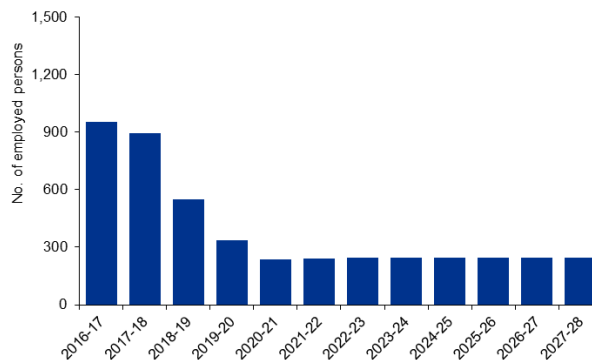
Figure 4-12: Gascoyne resources sector workforce (persons)



Future projects/hubs are likely to be LNG-related. Recently, the Gascoyne region authorities signed a long-term LNG supply agreement with LNG provider EVOL LNG.⁹¹

The **Kimberley** region has long been one of the world’s largest suppliers of diamonds. With the likely closure of a key diamond mine in the region around 2021-22, resources sector employment in the Kimberley is expected to fall significantly.

Figure 4-13: Kimberley resources sector workforce (persons)



Modest ongoing employment in the Kimberley is expected to be supported by new or ongoing graphite and dysprosium dioxide projects. There is also the potential presented by mineral sands (Thunderbird project) and rare earth (Brown’s Range) projects that are scheduled for production in 2018-19.

Source: KPMG estimates based on data from DMIRS, RSO Survey, ABS, Office of the Chief Economist, IBIS.

The resources sector workforce in the Perth/Peel region is expected to show modest growth over the short term, with employment levels then remaining relatively stable over the outlook period.

⁹¹ <https://www.gascoyneresources.com.au/wp-content/uploads/2018/01/180131-Gascoyne-Executes-Long-Term-LNG-Supply-Agreement.pdf>

4.1.4. Opportunities and Challenges

The resources sector workforce remains a primary enabler for the development and growth of the sector. The fact the sector requires a skilled and technically proficient workforce to remain competitive brings challenges but also opportunities going forward.

From extensive consultation and independent research, it is clear one of the major constraints on the growth of the sector remains the ability to attract and retain appropriately-skilled personnel such as geoscientists and engineers. In addition, as the use of automation and technology increases, there will be increased demand for roles such as data scientists from both the resources sector and other industries.

Skills shortages that have been reported are, in part, a structural problem which needs to be resolved through a collaborative approach. Whilst this is not an immediate concern, a national survey of employers of Mining Engineers in April 2017⁹² found that 100% of vacancies were filled within six weeks of advertising, receiving 28 applicants per vacancy with an average of 3.4 of these applicants considered to be suitable for the role. This is likely to be an issue when the economic cycle and activity in the resources sector picks-up going forward.

The Western Australian economy will recover over the next three years. Although longer term growth is projected to be modest relative to the previous two decades there may be pressures in the labour markets, particularly if the strength in the construction activities in the eastern seaboard states continues. Lead indicators of labour demand such as advertised job vacancies and business conditions are improving, suggesting that surplus capacity in the labour market is being absorbed.

The resources sector is currently working with government(s) and education providers to address its workforce needs. This includes up-skilling and increased training of employees, along with improved pathways between study and employment. The Department of Training and Workforce Development has devised a revitalised approach to determining skill shortages on a regional basis, with a study of the Goldfields-Esperance region having recently been conducted using this new approach.⁹³ In addition to improving the performance of the workforce through training, there are opportunities to expand the pool of employees by focusing on improving the diversity of the workforce.

⁹² Survey of Employers Recently Advertised (SERA), Australian Government Department of Jobs and Small Business, April 2017.

⁹³ The Department of Training and Workforce Development provides a list of the regional workforce development plans currently available for download.

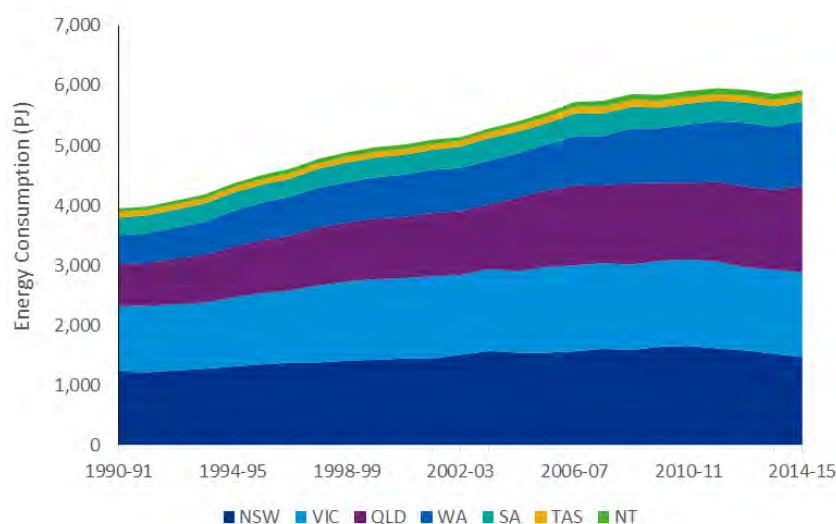
4.2. Energy

Total net energy consumption⁹⁴ in Western Australia increased from 1,061 Petajoules (PJ) in 2013-14 to 1,072 PJ in 2014-15. This represented an annual growth rate of 1.1%. Over the 25 years to 2015, total net energy consumption in Western Australia grew at a CAGR of 3.5%. This was almost double the national compounded annual growth rate of 1.8%, reflecting the increase in energy demand from Western Australia's industries, particularly the resources sector. The total net energy consumption of 1,072 PJ accounts for 18.1% of net energy consumption over the whole of Australia.

4.2.1. State Comparisons

Of the states and territories, Western Australia ranks fourth in energy consumption behind New South Wales, Queensland and Victoria. Growth in energy consumption has, on average, been below the rate of economic growth over the past few decades. The relationship between energy use and economic output is referred to as energy intensity (or inversely, energy productivity) of the Australian economy. Western Australia's decline in energy intensity can be attributed to improvements in energy efficiency and a shift towards less energy-intensive sectors such as services.

Figure 4-14: Net Energy Consumption by state and territory

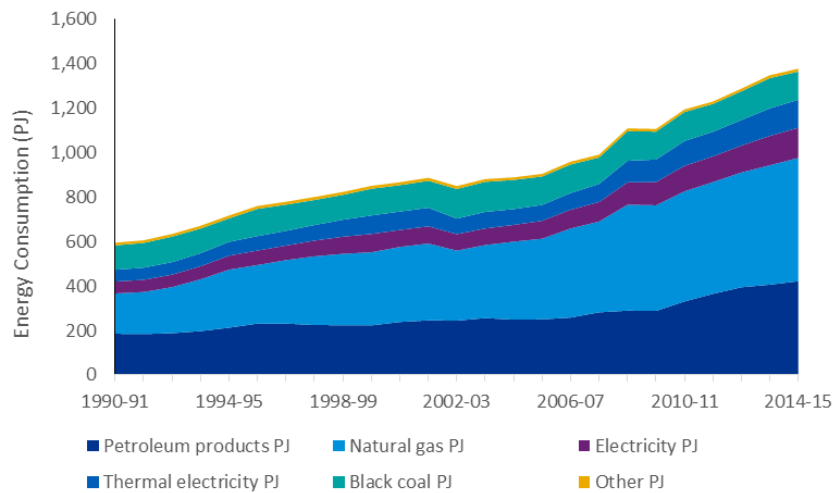


Source: DMIRS

By fuel type, natural gas accounted for the largest share, at over 50% (approximately 554 PJ), of Western Australia's energy consumption in 2014-15. Approximately 422 PJ of petroleum product was consumed making it the second largest share of energy consumption by fuel type within Western Australia at 39%. Over the 25 years to 2015, consumption of natural gas grew at a CAGR of 5%, higher than the growth rate of any other fuel and total energy consumption. This upward trend in natural gas consumption will likely continue over the outlook period.

⁹⁴ Total net energy consumption is total quantity (in energy units) of primary and derived fuels consumed less the quantity of derived fuels produced.

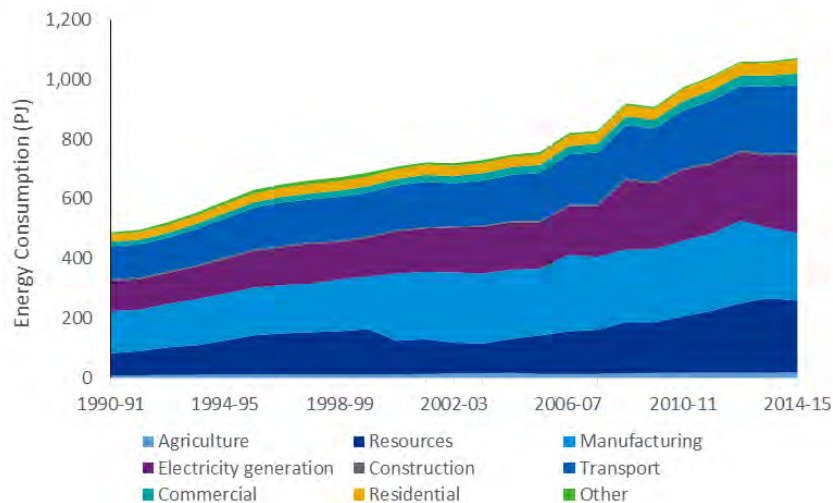
Figure 4-15: Energy Consumption by Fuel Type (Western Australia):



Source: DMIRS

By industry, energy consumption by the resources sector increased from 74.5 PJ in 1990-91 to 239.7 PJ in 2014-15. Over the 25 years to 2015, energy consumption in the resources sector grew at 5.2% CAGR. This was the largest growth rate observed across the various sectors. As a proportion of total energy consumption in Western Australia, this accounts for 22% of total energy consumption.

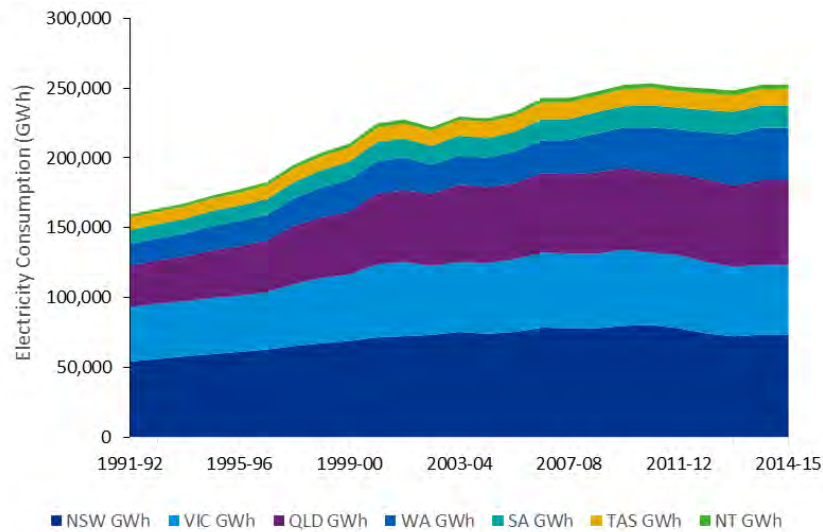
Figure 4-16: Energy Consumption by Various Sectors (Western Australia):



Source: DMIRS

Electricity consumption in Western Australia has grown in tandem with energy consumption which, in 2014-15, was 37,553 GWh.

Figure 4-17: Electricity Consumption by State and Territory:

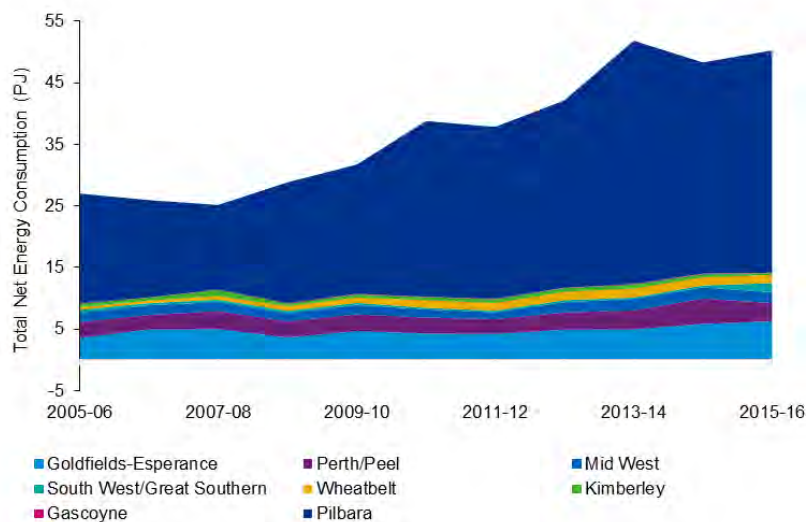


Source: DMIRS

4.2.2. Regional Electricity Consumption

Due to data limitations, estimating energy consumption in the resources sector by regional distribution is challenging. In this instance, regional energy consumption was estimated by proportioning total net energy consumed by the resources sector in Western Australia with the sales value of the resources sector for each region.⁹⁵

Figure 4-18: Regional Distribution of Total Net Electricity Consumption in the WA Resources Sector, 2005-06 to 2014-15



Source: KPMG; BREE, DMIRS

⁹⁵ Regional electricity consumption by the resources sector was estimated in 2015-16 by combining data on total resources sector electricity use in Western Australia with data on electricity production intensities of key commodities and sales data for different commodities in each region. This was then checked against a simple split of total resources sector electricity use split by region using commodity sales value shares. The two estimates were similar – indicating that using values is likely a reasonable proxy for historical shares.

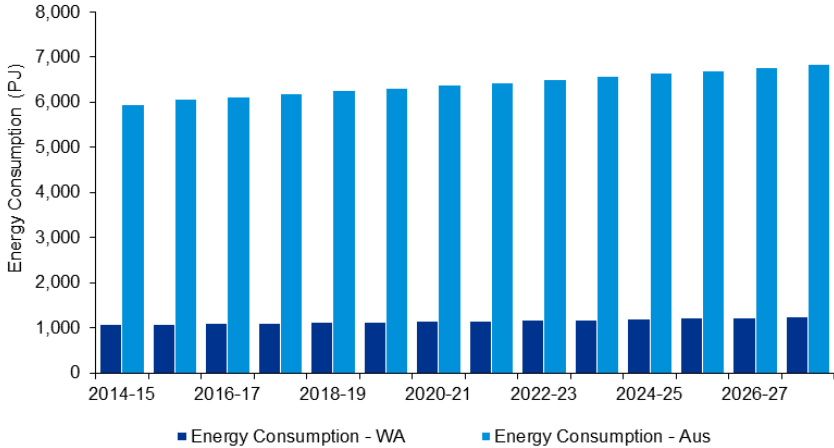
In 2015-16, the Pilbara’s resources sector consumed the highest amount of total electricity, at almost 30 PJ, while the resources sectors of Goldfields-Esperance and Perth/Peel ranked second and third at 5.1 PJ and 2.4 PJ, respectively. In contrast, the resources sectors in the Kimberley and Gascoyne regions consumed the least electricity at only 0.2 PJ and 0.04 PJ. Total net energy consumption of the other regions was roughly similar – within the range of 1.1 PJ – 1.4 PJ.

4.2.3. Energy Outlook

WA Resources Sector

After more than a decade of strong growth in energy consumption in the resources sector (the average annual growth rate, Australia-wide, from 2006-15 was 10%⁹⁶, energy consumption has started to decline. A key driver contributing to the decline has been the uptake of more efficient technologies in the sector and the shift towards more sustainable and renewable sources. The International Energy Agency’s projection⁹⁷ is for global energy consumption to slow from an average annual rate of 1.9% a year between 1990 and 2014 to 1.1% a year between 2014 and 2020 and 1.0% between 2020 and 2025.

Figure 4-19: Final Energy Consumption – Australia and WA

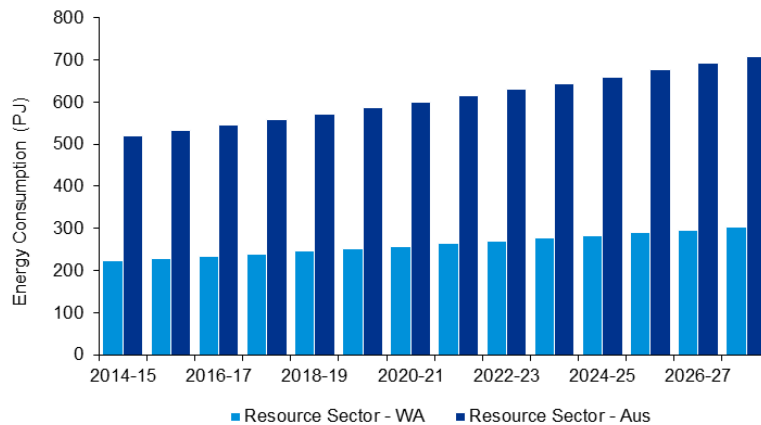


Source: KPMG; DIIS; RSO Survey

Energy productivity⁹⁸ has grown by an annual average rate of approximately 2% over the last decade to 2015. This is expected to partially offset the projected increase in energy consumption over the outlook period. Energy consumption in the Western Australian resources sector is expected to remain relatively flat over the next couple of years before increasing moderately in the longer-term with a CAGR of 2.4%.

⁹⁶ DIIS – Resources and Energy Quarterly December 2017.
⁹⁷ International Energy Agency – World Energy Outlook (2016).
⁹⁸ Energy Productivity is defined as Gross Domestic Product divided by total energy consumption.

Figure 4-20: Energy Consumption – Resources Sector

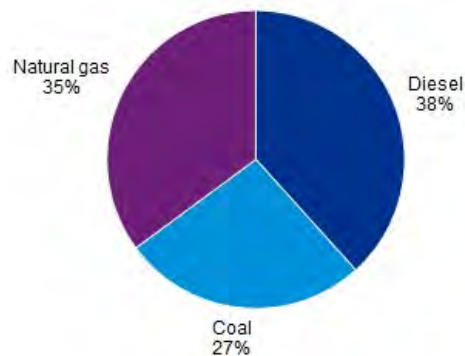


Source: KPMG; DIIS; RSO Survey

Energy consumption for electricity is, in part, a function of economic growth, incomes and commercial and industrial activity. As a result, despite improvements in energy efficiency, electricity consumption is projected to rise over the outlook period in line with increasing incomes, economic growth and industrial activity.

The proximity of power stations to resource projects is a key factor in determining the energy sources used for electricity generation. Regional communities not connected to either the North West Interconnected System or South West Interconnected System (SWIS) depend on other sources for electricity generation such as diesel, renewable and gas-based sources. The RSO survey indicated the energy sources used for electricity generation by the resources sector are fairly evenly spread across natural gas, diesel and coal.

Figure 4-21: Energy Sources used by Resource Projects for Electricity Generation Energy Source



Source: RSO Survey

Diesel is the main source for self-generated energy, accounting for 38% of self-generated electricity. This is followed closely by natural gas at 35%, while the remaining 27% comes from coal. A number of companies have indicated their intention towards utilising renewable sources of energy which will decrease their reliance on traditional sources over time.

Proposed changes to energy and climate change policies can potentially advance the use of renewables for electricity generation. For instance, the proposed National Energy Guarantee (NEG)⁹⁹, whose purpose is to promote the provision of reliable, secure and affordable electricity, will require retailers and large loads that purchase electricity from the wholesale market to meet a defined

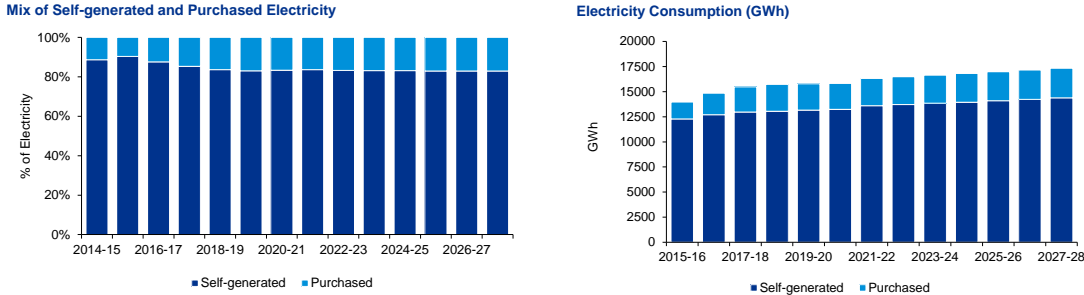
⁹⁹ The NEG is designed to operate through the National Energy Market of which Western Australia is not a part of. The Western Australian government will have to mimic or set up its own scheme if it seeks similar obligations.

emissions level. Generally, while allowing the electricity system to continue its operations reliably, the NEG acts as a driver of new investment in clean and low emissions technologies¹⁰⁰.

With regard to self-generated electricity in the resources sector, more than half of the RSO survey respondents (58%) reported the capacity to generate more electricity if required. Over 80% of companies use self-generated electricity to fulfil their own increased demand rather than for distribution to other parties. For electricity distributed to others, most respondents reported supplying to the SWIS or to specific towns. In addition, respondents who purchased electricity mainly sourced it from the SWIS.

In the 10 years to 2027-28, self-generated and purchased electricity by the resources sector is anticipated to increase by around 1,743 GWh (13.4%) and 824 GWh (20.7%), respectively. Although a large proportion of electricity consumed is currently self-generated (in the past three years, RSO survey respondents indicated that self-generated electricity accounted for almost 90% of resources sector electricity use). It is projected companies in the resources sector will see a modest increase in their share of purchased electricity. In 2027-28, the ratio of self-generated to purchased electricity is expected to be approximately 8:2.

Figure 4-22: Self-generated and Purchased Electricity

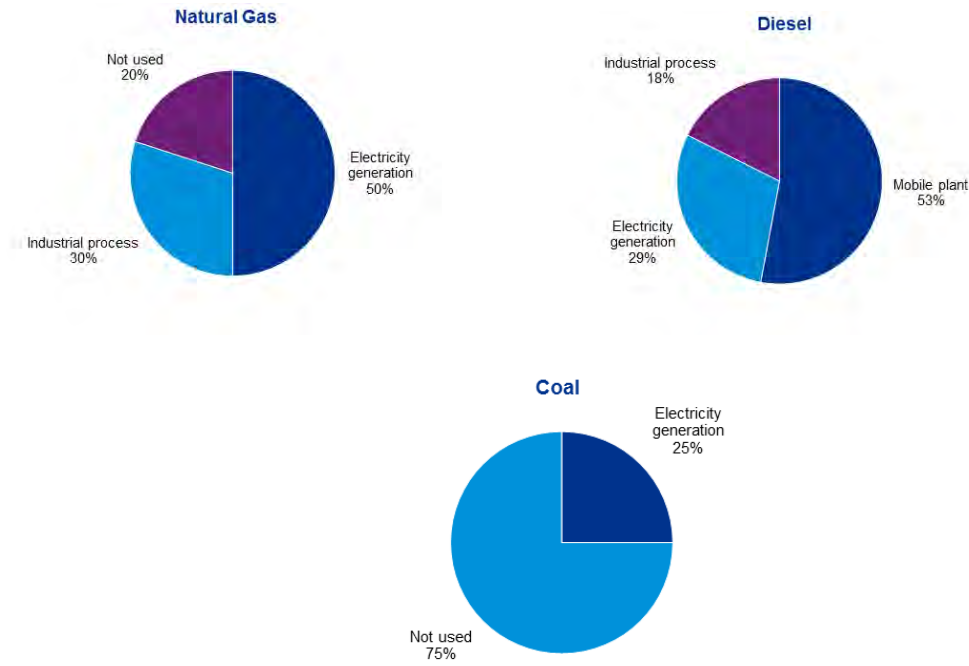


Source: KPMG; RSO Survey; Department of Environment and Energy

In addition to electricity generation, two other prevalent energy sources in the sector – natural gas and diesel – are also utilised for other purposes. Natural gas is utilised in the industrial process while diesel is used primarily in mobile plants. In contrast, coal is used solely for electricity generation.

¹⁰⁰ <http://www.coagenergycouncil.gov.au/publications/energy-security-board-update>

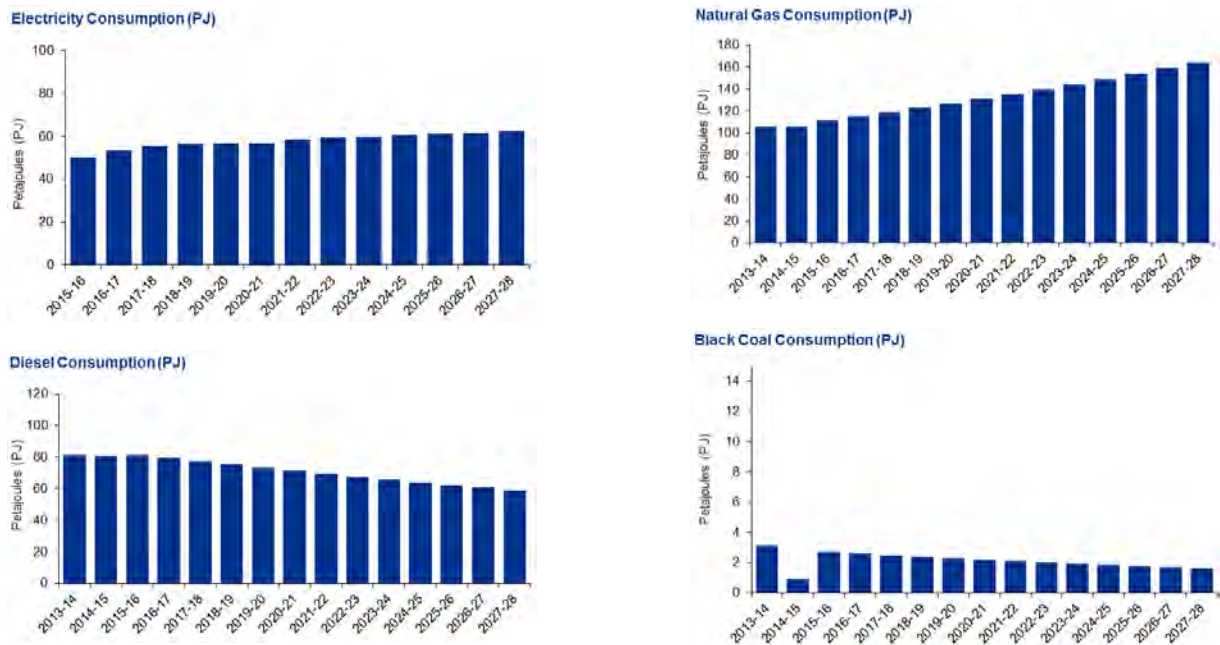
Figure 4-23: Purposes of use for energy sources by RSO survey respondents



Source: RSO Survey

Electricity consumption is expected to rise at a CAGR of 2.2% over the outlook period. Between 2015-16 and 2027-28, it is projected natural gas consumption will grow at a CAGR of 3.3%, while the use of diesel and coal as a source of electricity generation will decline at a compounded annual rate of 2.6% and 4.2% respectively.

Figure 4-24: WA Resources Sector - Electricity, Natural Gas, Diesel and Coal Consumption, PJ



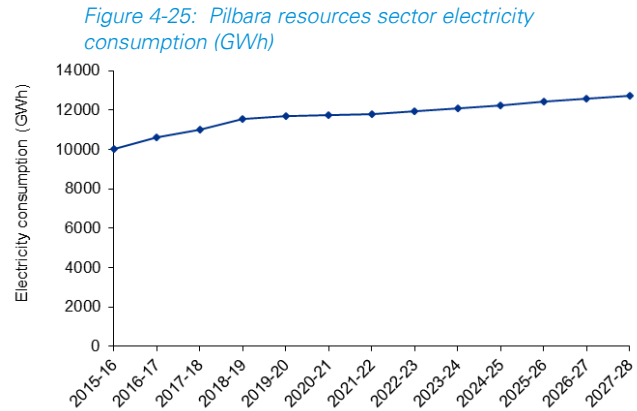
Source: KPMG; RSO Survey; Department of the Environment and Energy

Energy security (defined by the International Energy Agency as uninterrupted availability of energy sources at an affordable price) will be a key consideration going forward. This will involve a concerted effort by governments, industry and consumers. Possible measures to enhance energy security will be reducing reliance on any single source of energy by having a diverse energy supply mix and expanding off-grid electricity generation.

Outlook by Region

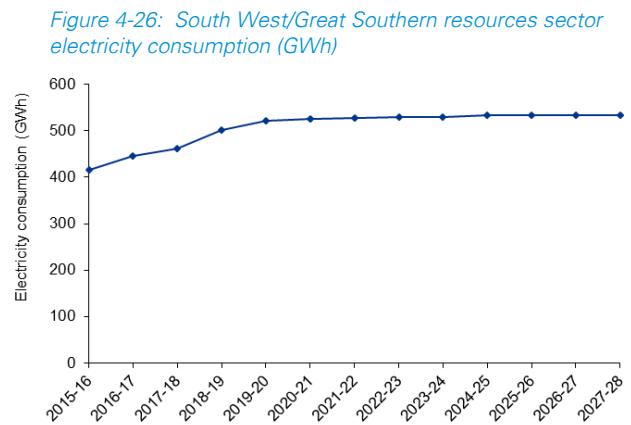
The resources sector in the **Pilbara** is expected to increase its electricity consumption at a compound annual rate of 2.4% over the outlook period. This is in line with RSO survey respondents indicating growth in electricity rising in line with growth in iron ore production.

2015-16: 10,032 GWh
 2027-28: 12,751 GWh
 Change: 27.1% ▲



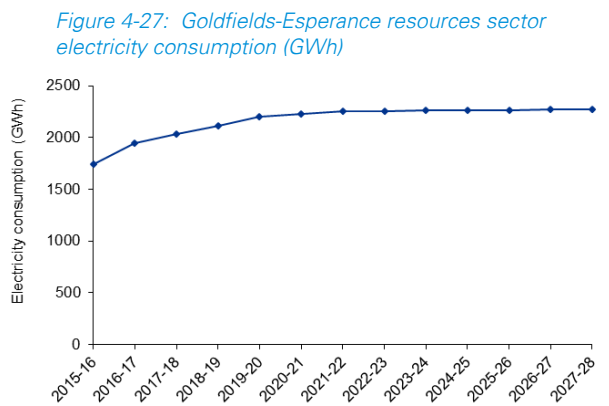
The **South West/Great Southern** region is projected to see an increase in electricity consumption in the resources sector, growing at a compound annual rate of 2.5%. Growth in electricity consumption will be driven by increased production in copper, nickel, tin and lithium.

2015-16: 416 GWh
 2027-28: 533 GWh
 Change: 28.1% ▲



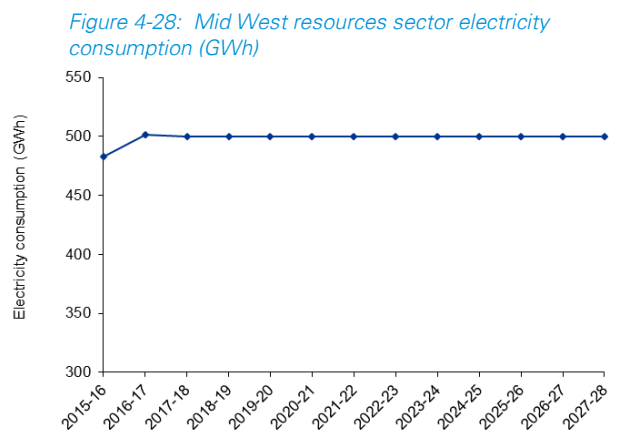
From 2017-18, electricity consumed in the **Goldfields-Esperance**'s resources sector is expected to rise by around 26% (driven by gold and silver production) over the next four years, and then remain relatively steady thereafter. Over the outlook period, the CAGR is projected to be around 2.7%.

2015-16: 1,746 GWh
 2027-28: 2,270 GWh
 Change: 30% ▲



Following an increase of 3.9% over 2016-17, electricity consumption by the resources sector in the **Mid West** region is projected to decline slightly by 0.4% and remain flat, at just around 500 GWh, thereafter. This is in line with RSO survey respondents indicating little change in production.

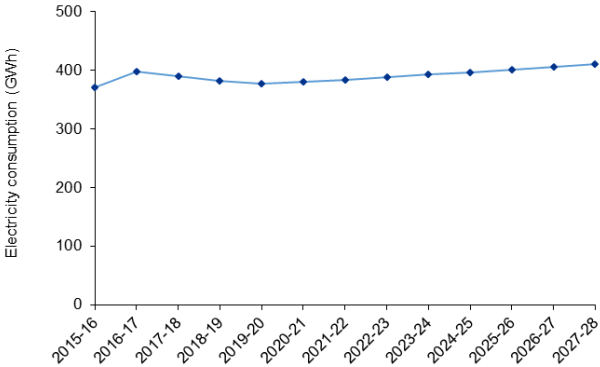
2015-16: 483 GWh
 2027-28: 500 GWh
 Change: 3.4% ▲



The resources sector in the **Wheatbelt** region is expected to see a slight decline in electricity consumption over 2018-19 with the closure of the Cleveland-Cliffs Koolyanobbing iron ore operations expected around June 2018. Over the outlook period, consumption is expected to grow at a CAGR of 0.6%.

2015-16: 370 GWh
 2027-28: 394 GWh
 Change: 6.3% ▲

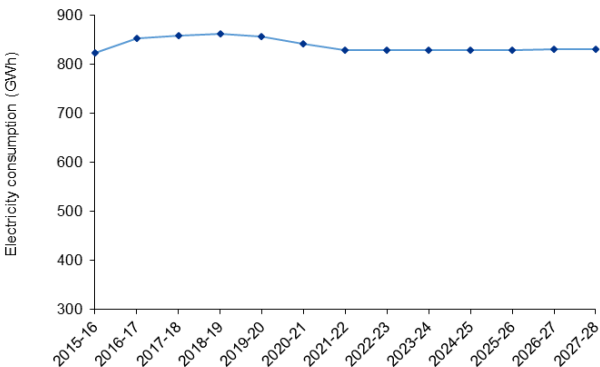
Figure 4-29: Wheatbelt resources sector electricity consumption (GWh)



Electricity use by the resources sector in the **Perth/Peel** region is projected to continue to grow over the short term, dropping slightly in the medium term before picking back up over the longer term.

2015-16: 824 GWh
 2027-28: 830 GWh
 Change: 0.7% ▲

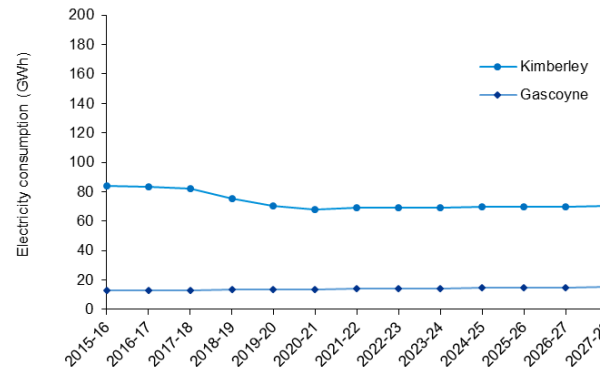
Figure 4-30: Perth/Peel resources sector electricity consumption (GWh)



Resources sector electricity demand in the **Kimberley** region is expected to reduce over the medium term with diamond production slowing. There is, however, the possibility of an increase in demand if mineral sands and rare earth projects move to full-scale development. Over the outlook period, the CAGR is projected to be around -1.8%.

2015-16: 68 GWh
 2027-28: 70 GWh
 Change: -16.6% ▼

Figure 4-31: Kimberley and Gascoyne resources sector electricity consumption (GWh)



The **Gascoyne** region is expected to see growth in its resources sector electricity consumption, albeit from a low base, in line with expected increases in production.

2015-16: 13 GWh
 2027-28: 15 GWh
 Change: 18.8% ▲

Sources: KPMG; DMIRS; Department of the Environment and Energy – table F5; RSO Survey

4.2.4. Renewable Energy

The declining cost of renewable energy generation (for example, by wind or solar power), is expected to drive the increase in electricity production from renewables over the outlook period.¹⁰¹ In addition, the share of renewables as a proportion of total energy source is projected to increase.

Opportunities for renewables

Economic, environmental, political and social factors have placed increased pressure to reduce electricity generated through fossil fuels. Fossil fuel prices and logistics substantially influence resources viability and is usually determined by global factors and beyond the control of most companies.

High quality renewable energy resources are abundantly available in Western Australia, typically in parts of the state where resources sector projects are located.¹⁰² In terms of costs, the levelised cost of electricity (LCOE)¹⁰³ of renewables has shifted in comparison with fossil fuels – renewables have already achieved parity in several cases while soon approaching parity in others.

Further, renewable energy can enhance the diversity of supply in remote locations as well as hedge against fuel price volatility and carbon pricing mechanisms.¹⁰⁴ In addition, operational risks can be lowered by the diversifying energy supply sources, reducing the running time of traditional generators and improving scheduled downtime servicing.¹⁰⁵ From an environmental perspective, renewables are well-positioned to play an important role in reducing emissions.

Challenges faced by renewables

Perceptions play a crucial role in the transition to renewables since companies still prefer energy generation sources that have been tried and tested. Concerns over technological efficacy and intermittency have been raised. Developments, however, have been made to allow the integration of renewable energy, such as solar or wind power, with fossil fuels to address technical reliability issues – a hybrid solution. Moreover, intermittency can be managed by the feasibility of battery storage, of which significant progress has been made over the last few years.

It is also challenging to achieve higher renewable energy penetration¹⁰⁶ levels given load profiles for mine sites typically maintain twenty-four hour operations – without storage, renewable energy supply profiles are intermittent. Most mining operations are not near a grid and therefore access to renewable energy has to be near the mine site or through the use of micro-grids.

In terms of financing, renewables require a long payback period which can conflict with some projects that have a relatively short or uncertain mine life – therefore making the use of renewables for these projects unattractive. This barrier can be overcome if investors, developers and governments (State and Federal) offer customised financing solutions and short-term power purchase agreements.

¹⁰¹ The Bureau of Resources and Energy Economics (BREE), for instance, expects electricity generation from renewables to grow at 1.5% per annum from 2014-15 to 2049-50.

¹⁰² <https://www.CME.com/policy-and-publications/policy-areas/economic-competitiveness/preview?path=Renewable%2BEnergy%2Bin%2Bthe%2BResources%2BSector.pdf>

¹⁰³ LCOE is the net cost to install, operate and maintain an electricity system spread over its expected life-time electricity output – commonly measured in \$/Megawatt hour (MWh).

¹⁰⁴ *ibid*

¹⁰⁵ *ibid*

¹⁰⁶ 'Penetration' refers to the proportion of electricity generated by a particular resource. This proportion can be relative to the total amount of electricity generated (or consumed).

Hydrogen as a long-term solution

The long-term potential deployment of hydrogen as a key source of energy generation over the next 30-40 years is envisioned. Hydrogen can contribute substantially to delivering decarbonisation by allowing renewable energy integration and power generation on a large scale. Diversification (of energy sources) benefits will also increase the resilience of energy system. Other potential benefits include decarbonising transport, and providing clean feedstock for industry.¹⁰⁷

4.2.5. Opportunities and Challenges

Total energy consumption in Western Australia's resources sector is expected to grow at a compounded annual rate of 2.4% over the outlook period. This is higher than estimates of the Western Australia's total energy consumption which is projected to grow at 1.1% per annum.¹⁰⁸

Rising demand for energy is likely to be driven by stronger global demand for energy and mineral commodities, economic growth, and increased commercial and industrial activity. Increased energy consumption, however, is expected to be met, in part, by increased supply from alternative (renewable) sources and technological advancements in the energy space.

Regional consumption of electricity and natural gas in the resources sector is also projected to increase at a relatively stable rate over the outlook period. On the other hand, consumption of coal and diesel - as a primary source of energy generation - is expected to decline over time as policies designed to encourage the use of clean and low-emission energies are put in place and act as substitutes for fossil fuels.

In 2016, the insufficiency of capacity in Western Power's regional grid inhibited existing operations in the Goldfields region from ramping up production and delayed the start of new mines when the gold price improved. Looking forward, as the Goldfields region expands to potential demand levels of 70-120 MWh, Western Power will likely face constraints in ability to supply. This again emphasises the need for a more diverse portfolio of power supply to avoid sole dependence on grid power.

Renewable sources of energy are likely to play a substantive role in increasing the supply of energy (especially in electricity generation) over the medium-to-longer term. Improvements in efficiency are also projected to ease the strain on energy consumption in the resources sector. Advancing the use of renewables, however, requires appropriate investment for the expansion of Western Australia's energy infrastructure and transmission grid. Heavy dependence on traditional fossil-fuel sources such as coal, one of the major sources of energy over the past few decades, will gradually decline over the next couple of decades.

Electricity productivity is expected to increase given the Federal Government has a strong commitment to improving Australia's energy productivity by 40% by 2030.¹⁰⁹ Should the target be reached, energy consumers will be one of the major winners and greenhouse emissions in Australia will also be reduced. The approach to achieving the target has been outlined in National Energy Productivity Plan.¹¹⁰

In the longer-term, future energy demand and consumption will be dependent on domestic and global policies such as those related to climate change and carbon emissions (Renewable Energy Target). Energy security will be a key factor and more importance will be attached to energy storage in the resources sector. The ability to meet the energy needs of the resources sector will involve a

¹⁰⁷ http://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-Scaling-up_Hydrogen-Council_2017.compressed.pdf

¹⁰⁸ Australian Energy Projections to 2049-50 (BREE 2014).

¹⁰⁹ http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/National%20Energy%20Productivity%20Plan%20release%20version%20FINAL_0.pdf

¹¹⁰ *ibid*

combination of policy initiatives, infrastructure, and industry and academic participation to drive innovation and technological transformation in the energy space.

There is an opportunity in the Pilbara to transition from the use of diesel as a fuel source for power generation and transport to the use of LNG as an alternative fuel source. The Pilbara is well placed to transition to LNG fuelling with mine sites operating close to gas producers. Successful transition from diesel to LNG would require a joint effort by industry and governments.

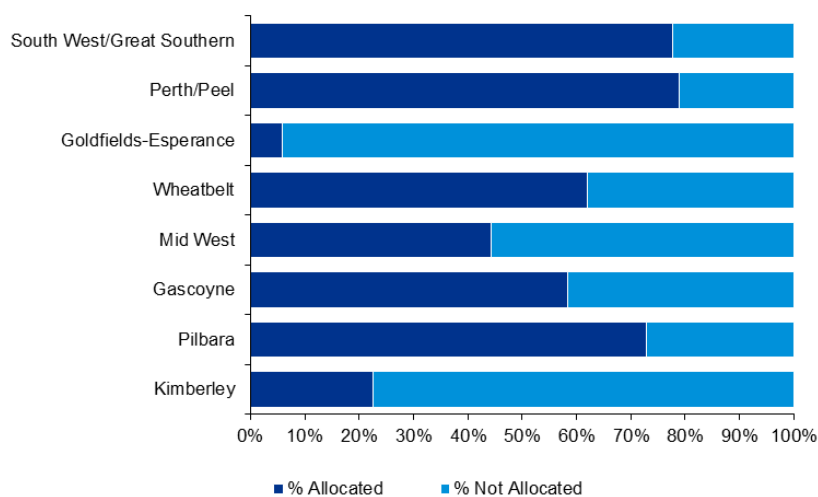
4.3. Water

Water resources are a key input into many industries, and the resources sector is no exception. As with many areas of the country, Western Australia is facing challenges in meeting the needs of water users in an environment of climate change, competing interests and evolving technology and needs.

4.3.1. Water Availability

The Department of Water and Environmental Regulation (DWER) sets abstraction limits¹¹¹ to manage the volume of water that can be abstracted from a resource annually to protect against depletion in the longer-term. Groundwater from sedimentary basins (such as the Perth Basin and Canning Basins) form a reliable water source for Western Australia and is important for public water supply. The majority of groundwater abstraction by the resources sector in Western Australia is sourced from fractured rock groundwater resources rather than from sedimentary basins.

Figure 4-32: Groundwater Allocation by Region (Western Australia), 2014



Source: DMIRS

Water resources in Western Australia are not evenly distributed across regions.

- While the Kimberley accesses groundwater, much of this is used in hydro generation.
- The Pilbara region accesses groundwater from bore fields and intends to make extensive use of mine dewatering to supply water to other industry (agriculture) and public use into the future.
- The Gascoyne region has a good supply of water, of variable quality.
- In the Mid West, mining and agricultural industries both need more water to continue to develop and are necessitating investigations into new water sources in some areas.
- The coastal areas of the Wheatbelt region have access to groundwater and surface water, while the northern Perth Basin's groundwater is in sedimentary aquifers.
- The Perth/Peel region accesses water from a combination of scheme water, groundwater, stormwater recovery and recycled wastewater. Wastewater recycling provides the best opportunity for future water supply and is being further investigated.

¹¹¹ The abstraction limit includes water that can be taken or abstracted from a water resource for household, urban, irrigation, stock, resource extraction and industrial water use. It does not include water that is left in the resource for social, cultural or ecological purposes.

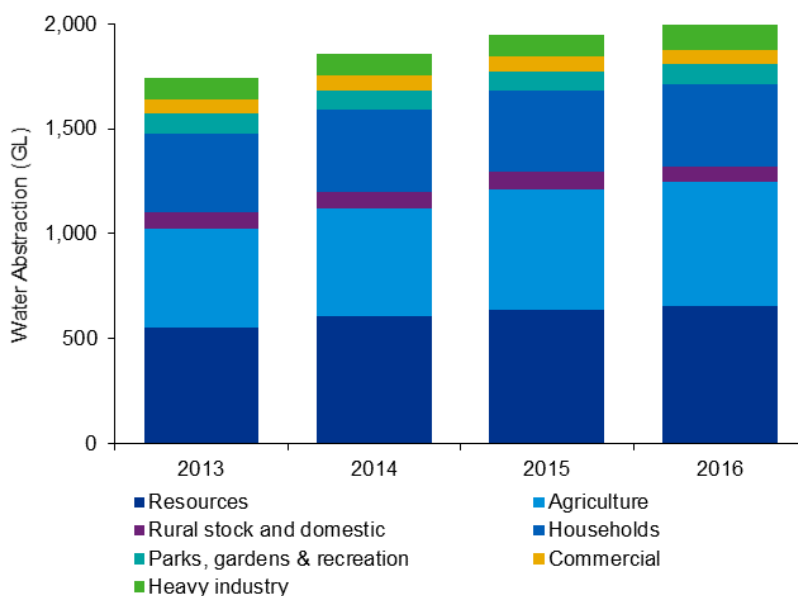
- The South West region’s water needs are currently supplied through groundwater, mine dewatering and surface water from the Wellington reservoir. Water availability in this and the Great Southern region is of concern as the region’s climate becomes drier, with groundwater currently supplemented by wastewater recycling, stormwater harvesting and managed aquifer recharge.

Modern methods in science and technology are currently being used to explore new possibilities using water as an enabler of growth and development in the decades ahead.

4.3.2. State Water Abstraction and Use

Western Australia abstracted 2,000 GL of water in 2016. Besides a small dip during the wet years of 2012-13 to 2013-14, total state water abstraction has been relatively stable since 2009-10.¹¹²

Figure 4-33: State Water Abstraction by Activity (WA)

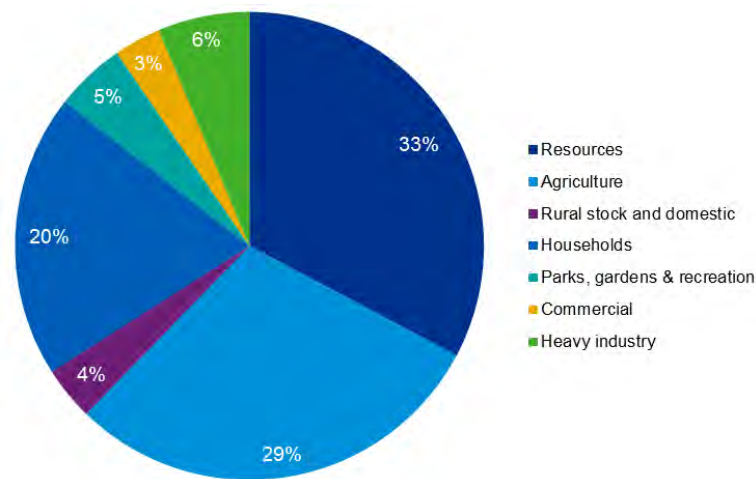


Source: DWER

The resources sector and irrigated agriculture sector continue to abstract the largest share of Western Australia’s water, followed by households. Of total water abstracted in Western Australia in 2016, the resources sector accounted for 654 GL (33%), agriculture extracted 590 GL (30%), and households accounted for 392 GL (20%).

¹¹² BOM Annual climate statements.

Figure 4-34: Share of State Water Abstraction by Activity 2016 (WA)



Source: DWER

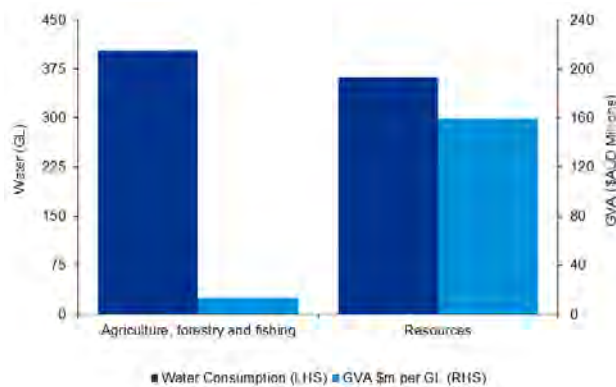
As the two largest abstractors of water, the agriculture and resources sectors can sometimes be in competing positions. The vast majority of Western Australia’s mining operations are remote from other land uses, and as such there is currently limited competition for water in mining. However, there are some instances where there is competition for groundwater. These are generally confined to the South West/Great Southern region and relate to access to sedimentary aquifers along the coast.

With a drying climate, several companies in the South West/Great Southern region that traditionally self-sourced their water are starting to discuss longer term supply options. The agricultural sector can use excess dewatering water from the resources sector as is the case on Hamersley and other pastoral stations in the Pilbara.

The agriculture sector also abstracts a significant portion of water used in Western Australia. Irrigated agriculture is carried out widely across the State and particularly within the Perth/Peel, South West/Great Southern, and the Kimberley and Gascoyne regions.

From a value-add perspective, one GL of water used by the resources sector adds almost \$160 million to Western Australia’s GSP – twelve-times that of the agricultural sector. Whilst this analysis only considers one input it is clear that, in times of scarcity, water delivered to the resources sector will deliver greater financial benefits to the state. Water is an important enabler for the resources sector, thus efforts to increase access and availability should be encouraged.

Figure 4-35: Water Usage vs GVA¹¹³ per GL (WA)



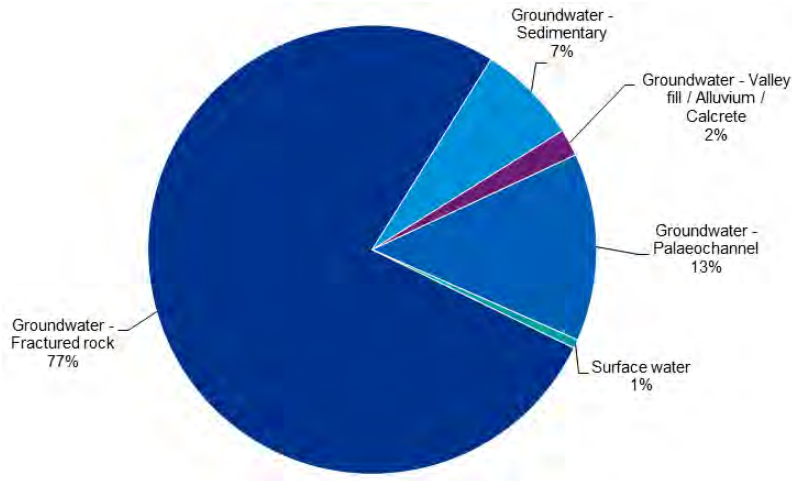
Source: KPMG, ABS, DWER

¹¹³ Gross Value Added (GVA) is the value of output at basic prices minus the value of intermediate consumption at purchasers’ prices.

4.3.3. Resources Sector Water Abstraction and Use

The RSO survey indicated the resources sector predominantly extracts water from groundwater sources. This is also supported by data from the DWER which shows that in 2015, almost all water was sourced from groundwater, with less than 1% sourced from surface water.

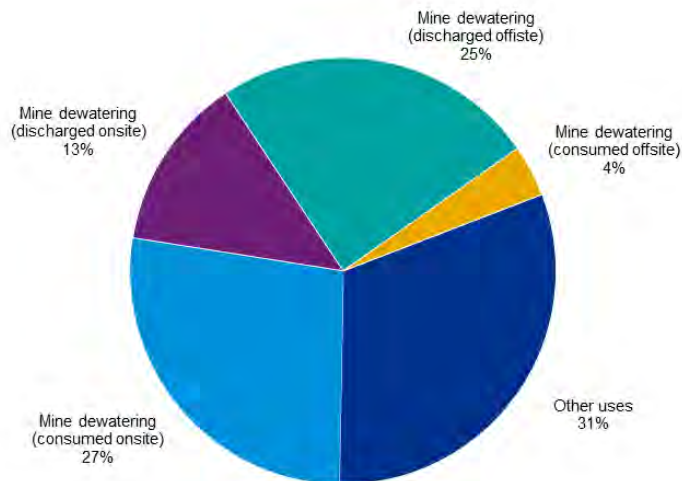
Figure 4-36: Water Abstraction by Source, WA Resources Sector



Source: DWER

A significant proportion of resources sector water abstraction is through mine dewatering. Mine dewatering is a process to remove water from mines and is necessary to allow safe mining below the water table. This dewatering water is then used to meet operational needs (predominantly dust suppression) with the excess dewatering water discharged offsite, reinjected into the aquifer or disposed on site (e.g. via evaporation ponds). Excess dewatering water surplus to operational needs accounts for more than half of the dewatering water abstracted.

Figure 4-37: Uses for Abstracted Water, WA Resources Sector



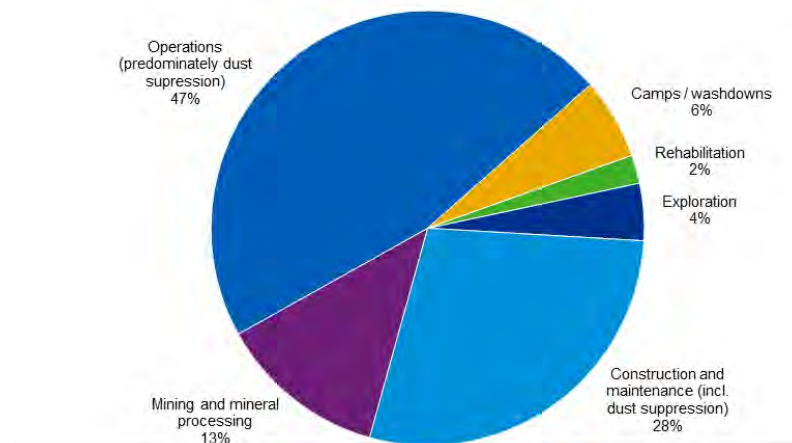
Source: DWER

Water used by the resources sector for operational activities include:¹¹⁴

- transport of ore and waste in slurries and suspension;
- separation of minerals through chemical processes;
- physical separation of material such as in centrifugal separation;
- cooling systems around power generation;
- suppression of dust, both during mineral processing and around conveyors and roads; and
- washing equipment.

Data from DWER shows the majority of water used by the resources sector is sourced from mine dewatering and is used onsite mainly for dust suppression (47%). The remainder is largely used in mining and mineral processing, and construction and maintenance activities.

Figure 4-38: Water Use in Operational Activity, WA Resources Sector



Source: DWER

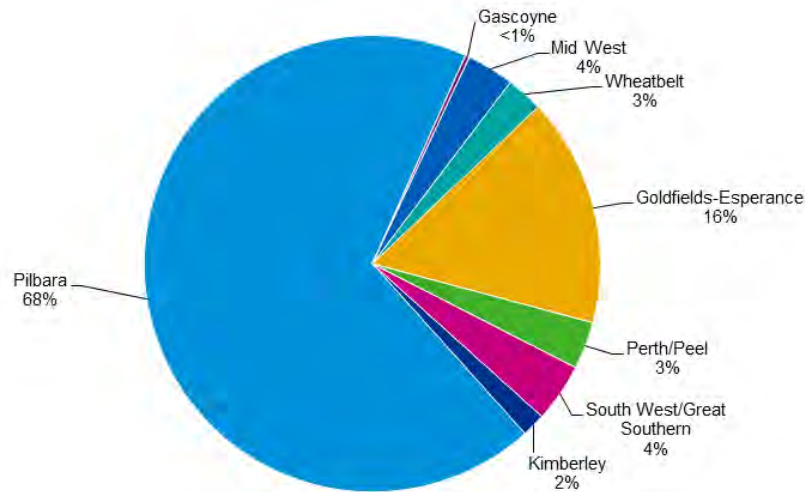
¹¹⁴ Western Australian Water Corporation.

Abstraction by Region

Estimated total water abstraction by Western Australia’s resources sector in 2016 was 654 GL. Of this, over 40% (256 GL) was dewatering water that was either discharged or consumed offsite.

The Pilbara region abstracts the majority of water, at 450 GL (68%); followed by the Goldfields-Esperance region with 105 GL abstracted (16%).

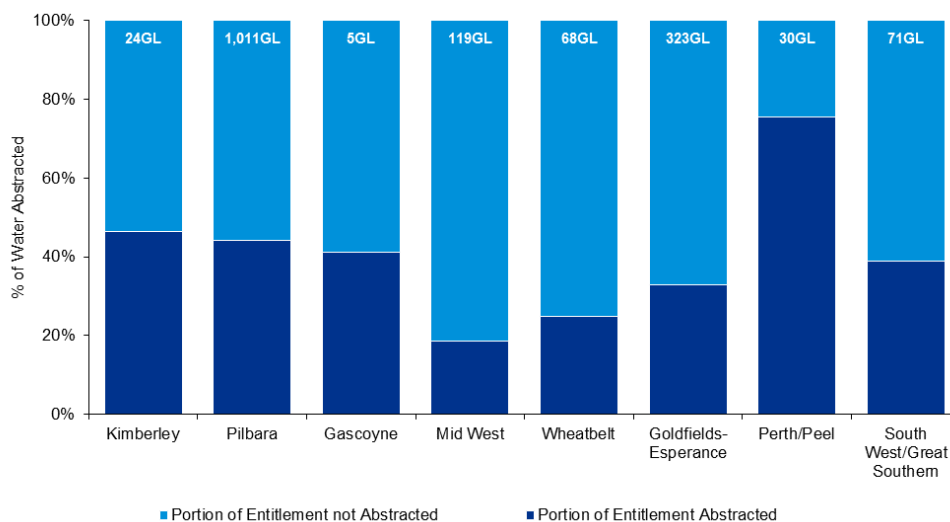
Figure 4-39: Resources Sector Water Abstraction by WA Region 2016



Source: DWER

For the resources sector, all regions besides Perth/Peel abstracted significantly less water than they were entitled to in water accounting year 2016.¹¹⁵ Entitlement figures are based on the maximum predicted abstraction required to meet peak dewatering requirements or operational water needs. The amount of water drawn on entitlements across regions varies due to the type of resource-related activity, phase of production, reliability of local water source and local climate conditions.

Figure 4-40: Percentage of water entitlement abstracted by region - Resources Sector 2016



Source: DWER

¹¹⁵ Water accounting year 2016 covers meter reading start dates between 1 July 2015 to 30 June 2016 (and therefore meter reading end dates between 1 July 2016 and 30 June 2017).

4.3.4. Water Outlook

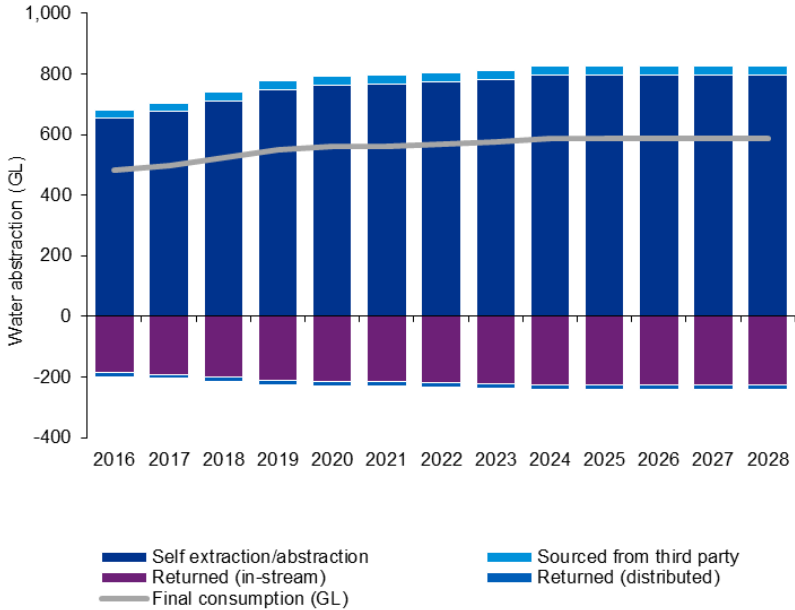
WA Resources Sector

Water abstraction by Western Australia’s resources sector is expected to continue to rise over the immediate term, partially driven by the onset of major projects currently in the pipeline. Respondents to the RSO survey indicated no change in aggregate water use after 2024, which is illustrated in the figure below. This is likely a reflection of the difficulty in estimating water use into the longer term.

Forecasting expected water use over the long-term is challenging, with a strong relationship between availability of water, demand for water and climate conditions. In addition, regulatory frameworks surrounding water licencing in Western Australia can, and have been, subject to change. Further, changes in technology can also significantly affect water use – both savings and additional demand – through technology advances in water efficiency and in the ability to mine deeper below the water table.

In the absence of major drought or flood events, RSO survey respondents have indicated an expected increase in abstraction volumes. It is estimated water abstraction by the resources sector could increase from 654 GL in 2016 to 773 GL by 2024, an 18% increase. This is largely driven by an expected increase in water abstraction in the Pilbara over the next few years, likely the result of increased dewatering requirements as below water table mining for iron ore increases. After accounting for water returned to the environment, final water use by Western Australia’s resources sector in 2024 could be around 569 GL up from 482 GL in 2016.

Figure 4-41: Water Use Projections: WA Resources Sector, GL



Source: KPMG estimates based on data from ABS, DWER, and the RSO Survey

Western Australia’s resources sector is expected to continue to be heavily reliant on self-sourcing water, with RSO survey respondents indicating no discernible change in trend between self-abstraction and third-party water sourcing. The majority of respondents (75%) indicated current water sourcing arrangements were their preferred water sourcing mix. Through proportional growth, water sourced from a third party is expected to increase from 26 GL to 30 GL.

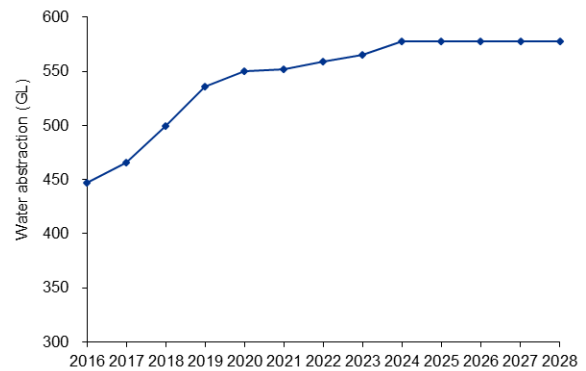
Surplus water returned to the environment (returned in-stream) or on-sold (returned distributed) is also expected to remain in steady proportion to total water acquired. Through proportional growth, returned water is expected to increase from 185 GL to 219 GL.

Resources Sector Abstraction by Region

The **Pilbara** region will continue to have the highest volume of water abstraction. 2017-18 RSO survey respondents indicate a steady increase up to 2020, likely the result of additional dewatering as iron ores are mined further below the water table.

2016: 450 GL
 2024: 578 GL
 Change: ▲ 128 GL (29.2%)

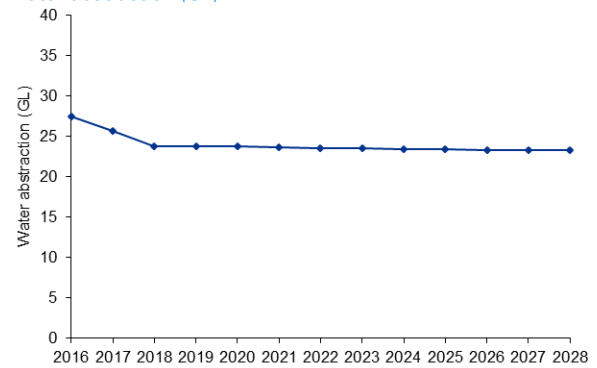
Figure 4-42: Pilbara resources sector water abstraction (GL)



Following a rise in abstraction in the **South West/Great Southern** region in 2016, the region is expected to experience a modest decline in water abstraction volumes. This is potentially due to competition within, and external to, the resources sector for access to water and forecast decline in the average rainfall for the region over the outlook period.

2016: 27.5 GL
 2024: 23.5 GL
 Change: ▼ 4.0 GL (-15.2%)

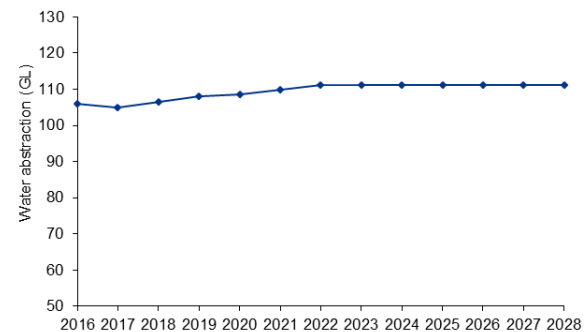
Figure 4-43: South West/Great Southern resources sector water abstraction (GL)



The **Goldfields-Esperance** region is expected to increase abstraction levels over the outlook period. RSO survey respondents indicated a decline in abstraction volumes in 2017, after which abstraction is set to rise above 2016 levels, and then growing modestly over the medium term.

2016: 106 GL
 2024: 118 GL
 Change: ▲ 12 GL (8.8%)

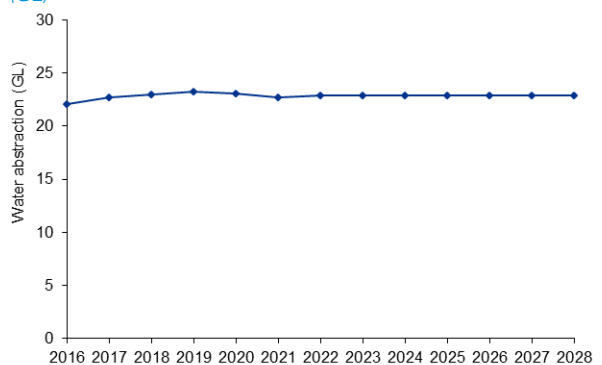
Figure 4-44: Goldfields-Esperance resources sector water abstraction (GL)



The **Mid West** region is expected to increase abstraction levels over the outlook period. RSO survey respondents indicate continued modest growth between 2016 and 2020, after which abstraction is expected to remain relatively constant.

2016: 22.0 GL
 2024: 22.8 GL
 Change: ▲ 0.8 GL (11.1%)

Figure 4-45: Mid West resources sector water abstraction (GL)

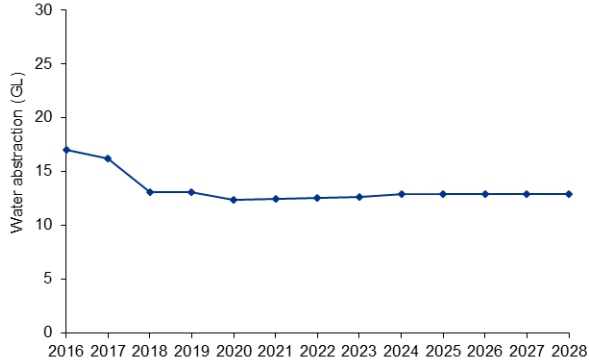


Sources: KPMG; 2017-18 RSO Survey

The **Wheatbelt** region abstraction levels can be quite volatile (in terms of % change), growing by 25% and 40% in 2014 and 2015 respectively, before dropping by 19% in 2016. RSO survey respondents indicate that abstraction is expected to decline further over the coming years, before recovering slightly and then remaining relatively constant over the medium term.

2016: 17.0 GL
 2024: 12.9 GL
 Change: ▼ 4.1 GL (-24.4%)

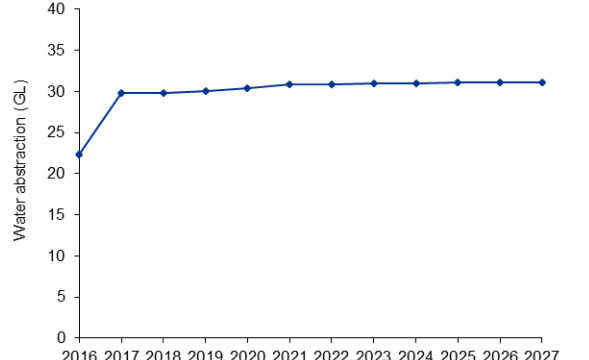
Figure 4-46: Wheatbelt resources sector water abstraction (GL)



After strong growth in 2016 (41.2%), the **Perth/Peel** region is expected to have increased abstraction levels in 2017. Following this, RSO survey respondents indicate continued steady, yet relatively small, growth over the rest of the outlook period.

2016: 22.3 GL
 2024: 31.0 GL
 Change: ▲ 8.7 GL (39.5%)

Figure 4-47: Perth/Peel resources sector water abstraction (GL)



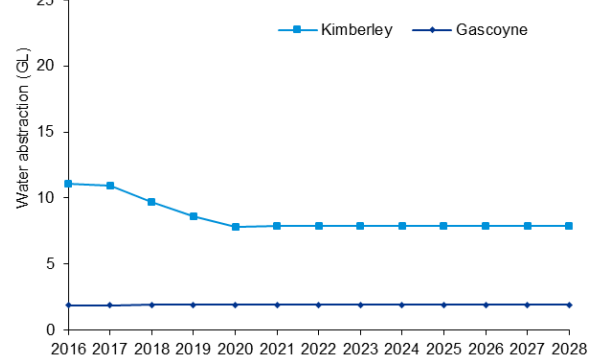
The **Kimberley** region is expected to experience a modest decrease in abstraction as water use by the diamond industry tapers off.

Water abstraction in the **Gascoyne** region is modest, and is expected to remain relatively constant over the outlook period.

Kimberley 2016: 11.1 GL
 2024: 7.9 GL
 Change: ▼ 3.2 GL (-28.8%)

Gascoyne 2016 to 2024: ▲ 1.9 GL

Figure 4-48: Kimberley and Gascoyne resources sector water abstraction (GL)



Sources: KPMG; 2017-18 RSO Survey

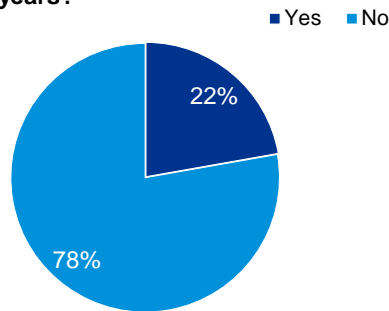
It should be noted that RSO survey respondents only provided guidance on expected water abstraction over the short to medium term. Growth in water abstractions in the regions could continue to grow into the longer term if new mines are established.

4.3.5. Opportunities and Challenges

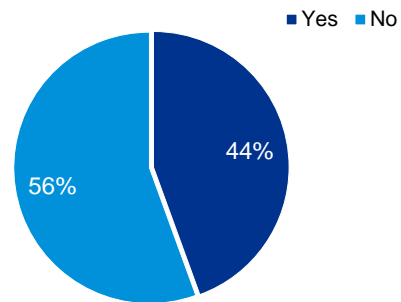
Extensive consultation with stakeholders, in addition to information provided in the RSO survey, has revealed various challenges for Western Australia’s resources sector in relation to water. Almost half of RSO survey respondents indicated they expect an issue with water access or use to impact their project or hub over the next decade.

Figure 4-49: Issues regarding water access/use

Have there been any significant issues relating to water access/use that have impacted this project or hub **over the past 2 years?**



Are there any significant issues relating to water access/use that are expected to impact this project or hub **over the next 10 years?**



Source: RSO survey

Increasing demand

Increasing demand from both the resources and agricultural sectors will potentially place strain on water availability. In the South West, increasing agricultural developments, combined with potential growth in the resources sector are likely to lead to increased competition for water. However, in the Pilbara region, this also presents opportunities and synergies if harnessed by both sectors.

Climate

An increase in the frequency and duration of dry years as a result of climate change would place increasing strain on the availability of water in Western Australia.

These impacts are likely to be most pronounced in the South West. The Bureau of Meteorology indicates rainfall in this region has reduced significantly since 1950, with the Bunbury to Walpole region the most affected – experiencing a reduction of up to 50 millimetres in rainfall every 10 years.¹¹⁶

In northern Western Australia, climate change may have less of an impact on average rainfalls, but more of an impact on the frequency and intensity of cyclones, which would also influence water availability in these regions.

Senate Inquiry into water use by extractive industries

The Federal Government Senate is conducting an Inquiry into water use by the extractive industries. The report, focusing predominantly on social, economic and environmental impacts of extractive projects’ take and use of water is due on 27 June 2018.¹¹⁷ There is uncertainty around the potential findings and recommendations contained within this report and issues for the resources sector’s

¹¹⁶ <http://www.bom.gov.au/cgi-bin/climate/change/trendmaps.cgi?map=rain&area=wa&season=0112&period=1950>

¹¹⁷ Parliament of Australia (2017). Available at: https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/WaterUseGovernance

longer term water use. Changes to regulatory frameworks and impacts on the resources sector's social licence to operate may arise as a result of the inquiry's outcomes.

Recycled water and surplus water use

A number of regions have investigated the options around water recycling. The South West/Great Southern region currently has the highest level of wastewater recycling in the state. In the Perth/Peel region, wastewater recycling is seen as a viable way to meet ongoing growth in the demand for water.

Mining operations take steps to conserve, re-use and recycle water, and further consideration is being given to new opportunities. Stakeholders have indicated their desire for use of surplus dewatering water by distributing it to further productive uses.

For example, the agricultural sector indicated an interest in receiving flows of water abstracted by mining operations for dewatering purposes that is surplus to the mine's operational needs. While the state has worked to reduce regulatory burdens, there is still some concern any transactions that involve the on-sale of water sourced from dewatering may incur significant 'red tape' or regulatory difficulties.

There is potential for environmental benefits to arise out of such water use initiatives, but achieving such benefits will require a concerted effort from both State government and involved sectors.

Rising prices

Despite the resources sector not being overly reliant on third-party water sourcing, rising water costs are expected to burden future project viability. Price volatility in the water market translates to risk and uncertainty; which is unwelcome in any commercial operation.

This is particularly pertinent for the Perth/Peel region, where RSO survey respondents indicated 25% of water required for operations will need to be sourced from third-parties year on year over the ten year outlook period. This is highly disproportionate to the rest of Western Australia, which has an average third-party source requirement of 4%.

Government

The private sector is encouraged to be innovative in the water space, yet it is perceived governments provide no incentive for action. **Pricing and rebate schemes can encourage more efficient use of water. Funding for research in water conservation is likely to have longer-term impacts.**

In 2012, the then Western Australian Department of Environment and Conservation identified a number of approaches to address water issues across the state through their "Adapting to our changing climate" report.¹¹⁸ These included:

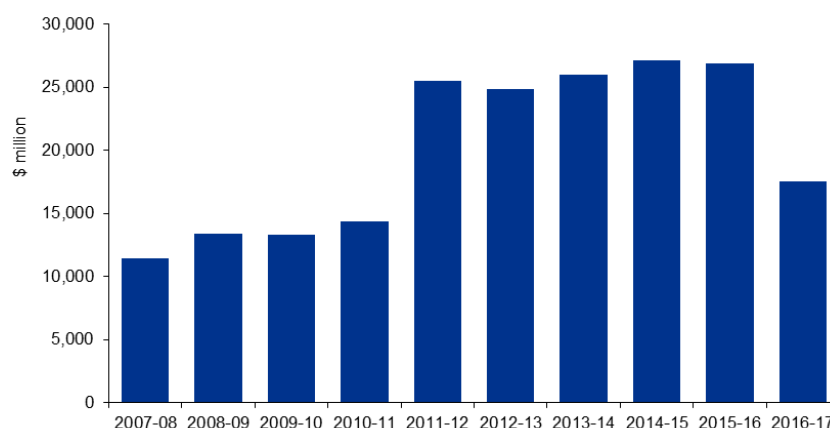
- a move toward water pricing that reflects the true cost of water;
- actions to strengthen water efficiency and water recycling targets for Perth;
- strategies to increase the adoption of water-sensitive urban design;
- the development of new opportunities for water recycling, particularly for industrial, agricultural and recreational use; and
- trial and implementation of managed aquifer recharge initiatives.

¹¹⁸ WA Department of Environment and Conservation – Adapting to our changing climate (2012).

4.4. Infrastructure

Well-coordinated planning and delivery of infrastructure is often a catalyst for growth, and is a key enabler for the resources sector. In Western Australia, infrastructure investment has been heavily influenced by the resources sector. For example, the preference for use of private railway lines was a contributor to the large amount of infrastructure investment by the private sector. In 2015-16, the value of construction work within 'heavy industry'¹¹⁹ reached over \$25 billion before declining to around \$17.5 billion in 2016-17.

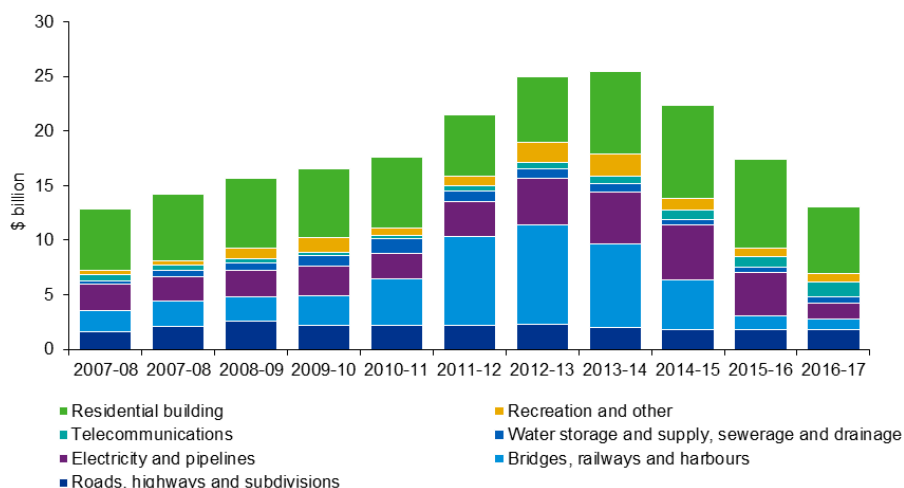
Figure 4-50: Value of Construction Work within the Heavy Industry Infrastructure, \$ billion, 2007-08 to 2016-17



Source: ABS

This activity has contributed to between 56% and 75% of total engineering construction activity in Western Australia over the past decade. Over the period 2011-12 to 2013-14, construction was concentrated mainly on bridges, railways and ports in support of increased activity in the resources sector. In tandem, the value of construction on electricity networks and gas pipelines also saw a spike over the same period.

Figure 4-51: Other Engineering Infrastructure and Residential Building Construction, \$ billion, 2007-08 to 2016-17



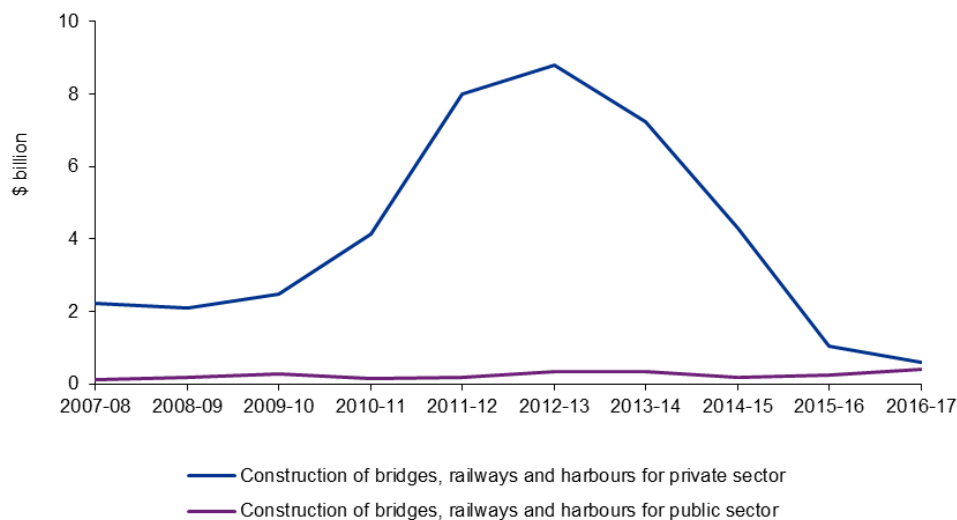
Source: ABS

¹¹⁹ Heavy industry is defined as the total value of oil, gas, coal, bauxite, alumina and other minerals and other heavy industry. More specifically, construction relating to heavy industry includes the construction of production, storage and distribution facilities; refineries; pumping stations; mines; chemical plants; blast furnaces; steel mills; and other industrial processing plants and ovens.

4.4.1. Bridges, Railways and Ports

Investment in bridges, railway and port infrastructure throughout Western Australia has experienced a significant decline from the highs of 2012-13. This decline was centred within the private sector and correlated with the cycle of the resources sector, which peaked in 2012-13, before declining relatively sharply thereafter. In comparison, public sector expenditure on bridges, railways, and ports, has been relatively steady with only modest increases over the past few years.

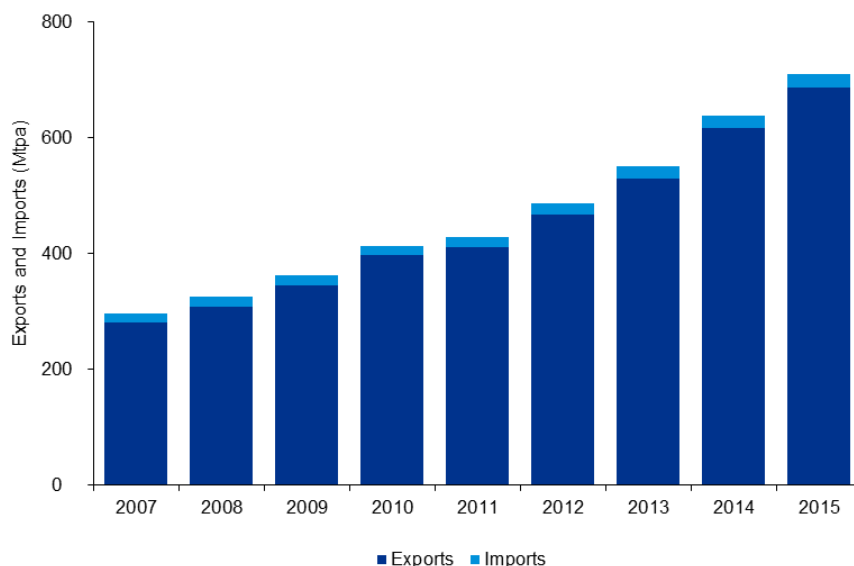
Figure 4-52: Value of Work done on Bridges, Railways and Ports, \$ billion, 2007-08 to 2016-17



Source: ABS

Despite the recent slowing in private construction activity for bridges, railways and ports, the initial high levels of investment into critical infrastructure over the past decade continues to support increasing trade volumes through Western Australian ports.

Figure 4-53: Western Australia Trade Volumes, Mtpa, 2007 to 2016

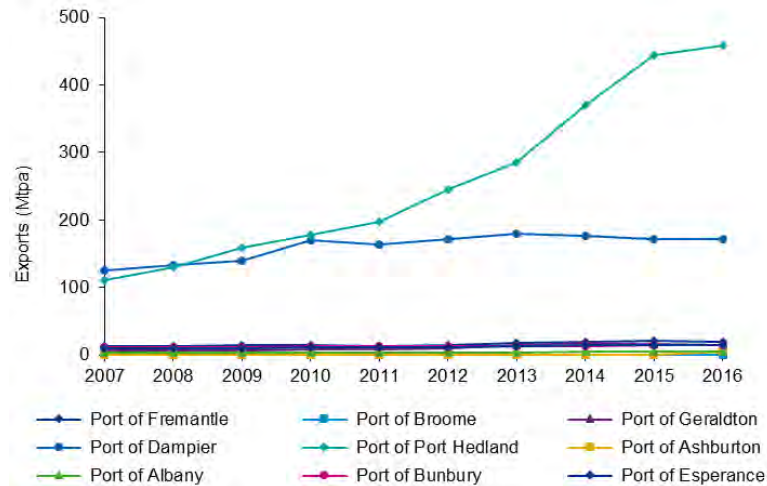


Source: WA Ports Handbook 2016

Ports

The majority of exports (by volume) are transported by sea through the Port Hedland and Dampier ports, which are both located in the Pilbara region of Western Australia. Iron ore dominates the cargo out of both of these ports, making up over 80% of the exports transported out of the Port of Dampier and 98.8% of the exports transported out of the Port of Port Hedland.

Figure 4-54: WA Export Volumes by Port, Mtpa, 2007 to 2016



Source: WA Ports Handbook 2016

The current infrastructure configuration at the Port of Geraldton (in particular, harbour depth and channel design) has significantly restricted draught, vessel size and fill-factor outcomes. For all ports in Western Australia generally, the availability of slots at multi-user berths has been flagged as an issue for the resources sector. For container yards, having 24-hour access to empty container release or extended hours up to midnight could assist transport activities. Streamlining the Australian Quarantine and Inspection Service (AQIS) for container imports would also be of benefit.

With projected increases in export volumes, port infrastructure and efficiency will be a key focus over the outlook period. RSO survey results highlighted North Quay and Rouse Head to Fremantle Port terminals get congested.

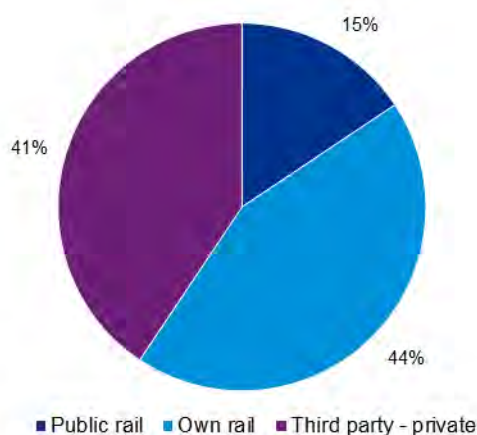
The opportunity to be able to deliver increased export containers out of, and receive import containers through, the Inner and Outer Harbours (Fremantle, Kwinana or Bunbury) due to the possible development of the Outer Harbour Westport project, would be advantageous.

Rail

Based on RSO survey results, the volume of outbound freight transported by rail is expected to increase moderately over the short-term across all the regions. The Perth/Peel region is envisaged to see an increase of outbound freight of around 11% a year, on average, between 2016-17 and 2019-20. For inbound freight, the Goldfields-Esperance region is reported to see fluctuations in volume over the period 2019-20 to 2021-22.

One of the major commodities within the resources sector, iron ore, is largely transported via rail - with privately owned or third-party operated rail lines transporting the majority of the freight volumes from project/hub sites to the ports. Results from the RSO survey indicated resources companies were primarily using either their own rail lines or privately operated third party rail lines to conduct their operations.

Figure 4-55: Proportion of Rail Usage



Source: RSO Survey

The *Western Australia Regional Freight Transport Network Plan*, however, suggests state-owned rail line will grow increasingly important in freight movement within Western Australia. With a projected increase of over 126% in freight on these state-owned lines, the plan has also determined that a larger amount of capital will need to be invested in state rail infrastructure to bring the line up to capacity.¹²⁰

Opportunities and Challenges

A number of opportunities and challenges facing the resources sector relating to rail and port infrastructure have been highlighted through consultation with stakeholders and information obtained through the RSO survey. In particular, as most bulk quantities are transported via rail to and from project sites, respondents anticipate issues with the ability of current rail infrastructure to handle future freight loads.

Port infrastructure will be a key focus during resources sector growth periods, infrastructure redevelopment within ports will require careful (and advanced) planning as increasing traffic from road and rail into ports has the potential to reduce the efficiency of freight movements. Any port upgrade or redevelopment should be done in close consultation with key stakeholders including current port users and potential port users to determine capacity requirements through the berths, stevedoring, and any energy usage.

The development of the Inner and Outer Harbours at Fremantle, Kwinana and Bunbury are key initiatives that have the ability to facilitate increased capacity in trade and infrastructure to support the growth of the resources sector. Additionally, the development of the Inner and Outer Harbours will need to take into consideration the planning for the rail and road networks, supporting industrial land and intermodal terminals, as well as the environmental and social issues impacts in its planning.

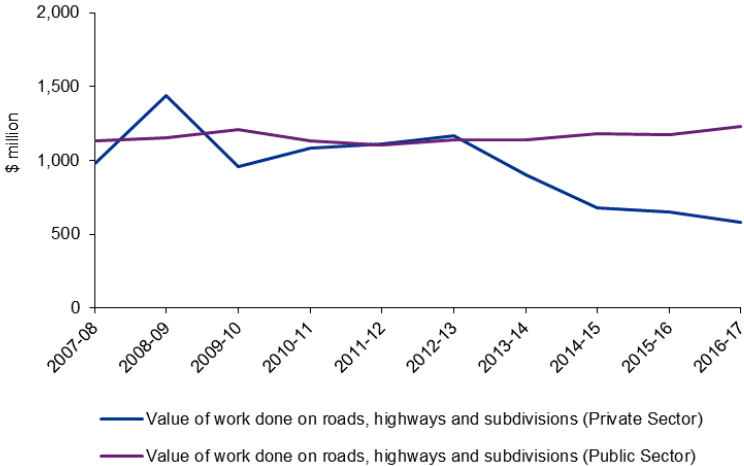
In the longer-term, it is likely that there will be substantial pressure placed on Western Australia's physical infrastructure (bridges, rails, and ports). This will be a consequence of population changes and economic activity. While current pressures are not severe, a surge in economic and industrial activity could lead to potential constraints towards the end of the outlook period.

¹²⁰ https://www.transport.wa.gov.au/mediaFiles/about-us/ABOUT_P_RegionalFreightPlan_FullA3.pdf

4.4.2. Roads

Efficiency of road freight within Western Australia is essential to the resources sector. Figure 4-56 outlines the private and public spend on roads, highways and subdivisions within Western Australia. What this illustrates is that private sector expenditure on roads, highways and subdivisions has been declining since 2012-13, and appears to be on a downward trend. On the other hand, public sector expenditure has been steady throughout this time and has seen a slight uptick over the year.

Figure 4-56: Value of work undertaken on roads, highways and subdivisions by sector, \$ million, 2007-08 to 2016-17



Source: ABS

Public expenditure on road infrastructure is likely to see a moderate increase as roads throughout the state will require upgrades to improve their safety, reliability and provide additional capacity where needed. The Federal and State governments have already allocated \$2.3 billion across 17 new road and rail projects. As part of the package, \$44.2 million is for regional road projects in Western Australia to improve regional road safety.¹²¹

Some of the major projects include the freeway network consisting of the Kwinana-Mitchell Freeways and Tonkin Highway running along the north-south corridor of Perth, Whiteman-Yanchep Highway connecting the northern suburbs and the Fremantle-Rockingham Highway connecting to the Kwinana and Mitchell Freeways through the new Stock Road Tunnel.

There’s also a freight corridor from Muchea to the Fremantle Port’s inner and outer harbours giving better access to regional areas via national and suburban highways. This is likely to benefit the resources sector with RSO survey respondents indicating the use of major State and Federal roads for transporting freight.

Based on the RSO survey results¹²² and consultation with key stakeholders, the volume of inbound and outbound freight transported via road is expected to be little changed over the outlook period. Therefore, we do not foresee any significant issues relating to road infrastructure that might substantially impact resources sector operations over the outlook period. However, a notable exception is the South West/Great Southern region where inbound and outbound freight is expected to see an increase due to the doubling of production from a number of resource projects from 2018-19 onwards.

¹²¹ <https://www.mediastatements.wa.gov.au/Pages/McGowan/2017/05/Joint-media-statement-2-point-3-billion-dollars-jobs-and-infrastructure-boost-for-Western-Australia.aspx>

Opportunities and Challenges

Within the next two decades, Western Australia's population is projected to reach 3.97 million, a 69% increase from 2011.¹²³ Over the same period, the state's economy is estimated to grow significantly faster than its population. With population and economic growth being the key drivers of infrastructure demand, the current estimates point towards a capacity constraint with respect to existing road infrastructure.

The Great Northern Highway has been, and will continue, to act as a major supply corridor for the Western Australian resources sector. With increasing development and road freight needs in areas along the northern coast, the North West Coastal Highway - and the roads which link it to the Great Northern Highway - may require infrastructure improvements as freight loads increase along these road ways.

As with bridges, railways and ports, it is likely there will be pressure placed on Western Australia's roads going forward. This will be a consequence of population changes and economic activity. While current pressures are not severe, a peak in the economic cycle could lead to potential constraints towards the end of the outlook period.

Infrastructure is vital to the ongoing success and growth of the resources sector. A discussion paper by the Western Australian Department of Transport has identified that corridor encroachment along freight routes in Western Australia is becoming more common, leading to pressure to impose operational restrictions on transport which reduces the efficiency of the freight network.¹²⁴ This is in accordance with a recent report by Infrastructure Australia whose findings suggests that failure to appropriately protect corridors could hold substantial risks for governments and, in turn, taxpayers.¹²⁵

¹²³ ABS Catalogue 3222.0

¹²⁴ https://infrastructure.gov.au/transport/freight/freight-supply-chain-submissions/WA_Transport.pdf.

¹²⁵ Infrastructure Australia – Corridor Protection: Estimating the savings from effective corridor protection (2017).

4.4.3. Aviation

Aviation within Western Australia is essential to the resources sector, which is heavily dependent on effective transport and air service is often the most efficient form of transportation for the dispersed regional and remote communities within Western Australia. Given the volume of FIFO employees commuting from Perth Airport to the regional airports using either regular public transport (RPT) or charter flights, it is important to be cognisant of the changes to infrastructure in aviation within Western Australia.

Perth Airport has determined its passenger service will be under serious strain by 2020¹²⁶ and has put in place infrastructure development plans to meet the projected demand over the next seven to 10 years. These plans include expansions to the existing terminals within the airport, construction of a new terminal for the airport, passenger parking near the airport, transport to and from Perth Airport as well as transport between the terminals and an additional runway for the Perth Airport. Passenger numbers are forecast to reach 18.9 million a year by 2028-29 from 13.7 million a year in 2012-13.¹²⁷

The new runway is a key part of the expansion and will allow Perth Airport to keep up with the increasing passenger demands. The planning phase for this runway is scheduled to be completed by 2019, with construction completion by 2028. This will allow additional air services to operate from Perth Airport (which is the main aviation hub in Western Australia), allowing the airport to increase airline services and capacity to meet increasing passenger demand.

Regional airports within Western Australia are also pivotal to the progress of the resources sector and are used for the transportation of employees and freight. Following the strong growth of the resources sector, it became increasingly apparent that the capacity of regional airports throughout Western Australia, particularly in the Pilbara, was critical to the resources sector for employee transport.

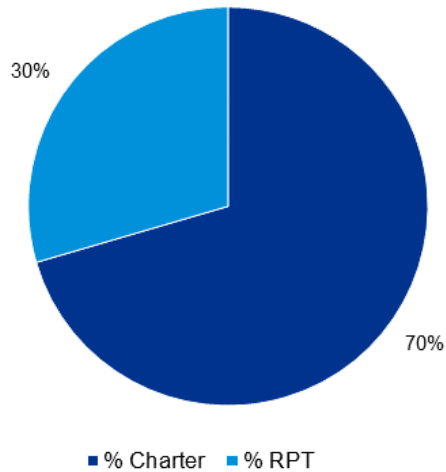
A number of issues have been flagged by stakeholders as potential constraints on the resources sector going forward. For instance, limited seats (and at relatively high cost) available for commercial flights coupled with increasing demand can potentially act as a substantial impediment on the sector. Ageing infrastructure and an ageing aircraft fleet is another.

The majority of the employees (70%) utilise chartered flights as opposed to RPT flights to get to and from airstrips – particularly from place of residence to the airstrip nearest to their project site or hub (and vice versa). Transportation from these airstrips to the project or hub itself is normally via bus, coach or light vehicle although helicopters (particularly for offshore projects) are used on occasion. Based on the RSO survey results and consultation with key stakeholders, the proportion of employees on charter flights (as opposed to RPT) is expected to be little changed over the outlook period.

¹²⁶ <https://www.perthnow.com.au/news/wa/perth-airport-unveils-25b-expansion-plan-ng-8c3fa86d793f1f5a8e6c5c9927d65e80>

¹²⁷ Western Australian State Aviation Strategy (Department of Transport 2015).

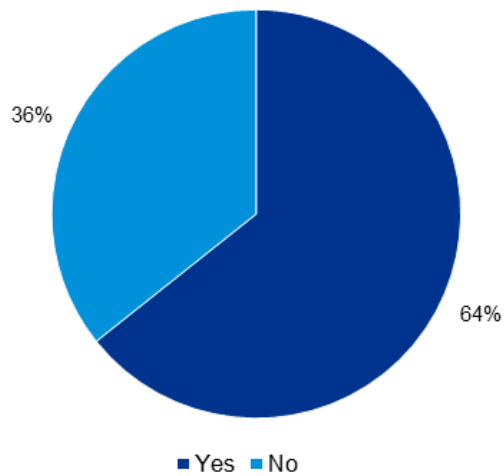
Figure 4-57: Proportion of Employee Movements on Charter and RPT Flights



Source: RSO Survey

Apart from passenger transport, air services are used primarily in urgent freight delivery or repairs, and emergency situations. In relation to freight transportation, the majority of respondents (64%) have indicated air freight services are not usually utilised and, when used, are for transportation of perishable food items in emergency situations, urgent maintenance supplies, and critical repairs. Demand for air freight services tends to fluctuate in accordance with these 'emergency or critical' situations and are therefore not foreseeable.

Figure 4-58: Utilisation of Air Freight



Source: RSO Survey

Opportunities and Challenges

Airport planning within Western Australia faces unique challenges in comparison with other areas of transport infrastructure in the state. Airport planning in Western Australia is not coordinated on a state-wide basis and, as such, remains subject to under-investment and neglect. Planning challenges arise with the different requirements faced by the metropolitan and regional airports.

Regional airports face unique infrastructure challenges. There is aging aeronautical infrastructure, inadequate or non-existent boundary fencing and less financial assistance as local governments cannot generally afford large capital works infrastructure. As such, regional airports fund these infrastructure investments through airport reserves where available, State and Federal Government grants, and debt instruments.

The Western Australian Department of Transport allocated \$3.88 million in funding to the Regional Airports Development Scheme (RADS) over the two years to 2019, providing a source of funding in the short-term. This scheme received over 30 applications requesting more than \$3.3 million in grants to improve regional airports in Western Australia. Of these, 13 regional airports were successful in obtaining funding for 16 projects totalling almost \$1.25 million. The RADS funding provides significant support to regional airport projects. Between 2008 and 2017, 256 regional airport projects have received funds from RADS totalling more than \$56 million.¹²⁸

Safety and security is a top priority in aviation. Concern, however, was raised as to the potential implications of the Federal Government's Aviation Security Review.¹²⁹ In particular, there is apprehension the review may recommend changes to security that either directly or inadvertently impact charter flights from a cost perspective. For the regions, as it stands, the cost charged to passengers for the provision of security is considerably higher for passengers travelling from smaller regional airports and pending the outcome of the Aviation Security Review this could increase those costs even further.

Over the outlook period, investment in new (and existing) infrastructure will be required by government and industry to ensure aviation capacity meets on-going demand. Aviation services will remain a key enabler for economic activity within the resources sector and Western Australia.

¹²⁸ Western Australia Department of Transport.

¹²⁹ Department of Infrastructure, Regional Development and Cities - Review into security at Australian security regulated airports (2017).

4.4.4. Social Infrastructure

Social infrastructure is a key enabler for the development and progression of the resources sector within Western Australia. Social infrastructure is the interdependent mix of facilities, services, programs, and networks (amongst others) that binds communities in regional areas. In the last decade, owing to the remoteness of many project sites and hubs, the emphasis on the development of regional areas, which support the resources sector, has been given considerable attention.

Housing

The number of new houses approved within Western Australia peaked between 2012-13 and 2015-16. Since then, the annual number of dwelling approvals has returned to pre-resources boom levels.

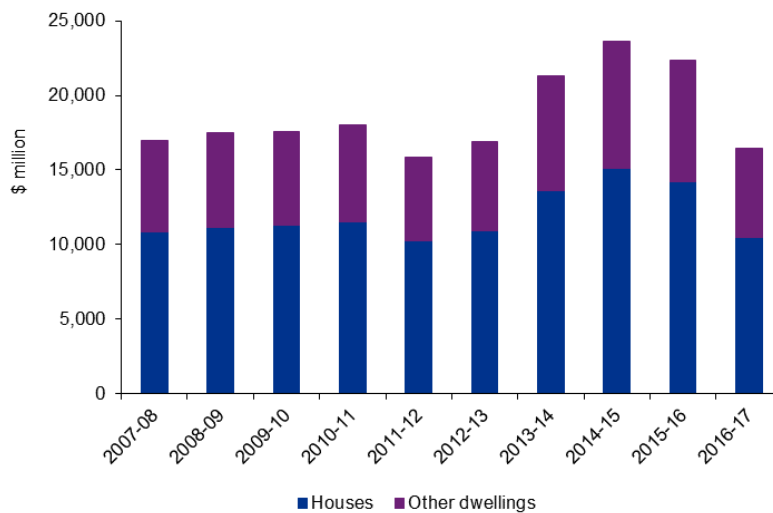
Figure 4-59: Number of dwelling unit approvals, 2007-08 to 2016-17



Source: ABS

A similar pattern is observed in the value of residential work done, peaking between 2013-14 and 2015-16 and then returning to 2007-08 levels.

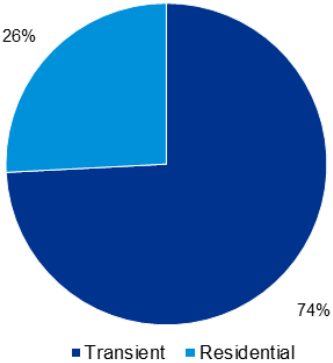
Figure 4-60: Value of residential work done in the Residential sector, \$ million, 2007-08 to 2016-17



Source: ABS

With the abundance of natural resources located in regional and remote areas of the state, it is becoming more common for employees in the sector to live in Perth and other regional locations where they have existing homes and social networks, their children have schools and their partners have jobs, while they travel between the two.

Figure 4-61: Proportion of Workforce in Transient or Residential Accommodation



Source: RSO Survey

Providing choice to employees is critical to the resources sector and the economy, and reflects the need to attract and retain a skilled workforce. FIFO/DIDO and residential employment are complimentary, not supplementary approaches in a total workforce management package, with a mixture of employment type governed by the project circumstances.

Achieving the right balance between residential and FIFO/DIDO workforces, is no simple matter. For companies, providing employees with the option of FIFO/DIDO employment does have an economic driver. Companies face a range of challenges in relation to residential employment including lack of housing affordability, deficiencies in housing quality, relative lack of services and the changing expectations of communities in the development of FIFO/DIDO practices.

Resources sector companies have always invested significantly in the provision of permanent residential accommodation, community services and infrastructure, and will continue to do so, further demonstrating their commitment to providing choice for their employees and to investing in regional and remote communities in which they operate.

Providing maximum flexibility and choice to employees in the resources sector is recognition of the importance of properly addressing the needs of employees who have a preference for relocation and residence to the regions. The resources sector is supportive of a residential workforce and investment that improves the sustainability and liveability of regional communities.

Health

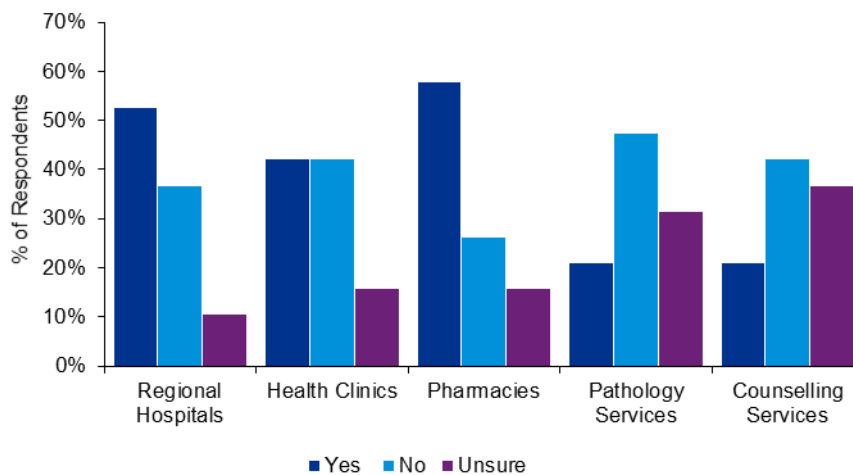
Western Australian Department of Health has invested more than \$7 billion in building and improving new and existing health facilities. These have included two new hospitals in the Perth metropolitan area, improvements to children’s health facilities, health campuses in Albany and Busselton and the foundations for more in Karratha, upgrades to 30 regional sites, a state cancer centre and more accommodation for staff and visiting specialists in regional areas.¹³⁰

Although there has been large investments in Western Australia’s health care system, there are still a number of challenges that remain. A report from the Western Australian Department of Health “A fair share for WA health care”¹³¹ outlined a number of issues that Western Australia is facing in the health services area. In particular, the current funding model is seen as inadequate as it does not take into account hospital locations, scale and scope. It is based on patient profiles and not on input costs – which can vary significantly from location to location.

These considerations affect the ability of Western Australian hospitals to operate at or near the National Efficient Price (NEP). This is an important consideration, as the NEP is used in determining the amount of national healthcare funding available to each state and territory. This places a large burden on the Western Australia health system due to the large area which needs to be covered.

RSO survey results indicated provision of hospitals, health clinics and pharmacies are generally available within proximity (20km) of project sites or hubs. Pathology services, however, are reported to be limited. By and large, RSO survey respondents were mostly satisfied with the availability of, and access to, fundamental health services and facilities. Concerns are more specific and relate to specialist health care (mental health services and counselling, in particular) and physical infrastructure. For example, upgrades to the Tom Price Hospital and Paraburdoo Hospital in the Pilbara region were highlighted. In addition to the direct health benefits, having up-to-date services and facilities also help attract and retain the residential workforce in the regions.

Figure 4-62: Health Services within 20km of Project/Hub



Source: RSO Survey

Looking ahead, in addition to the more traditional health services, respondents would like to see a determined focus on mental health services and facilities as well as counselling services in regional Western Australia.

¹³⁰ <http://ww2.health.wa.gov.au/Improving-WA-Health/Infrastructure>

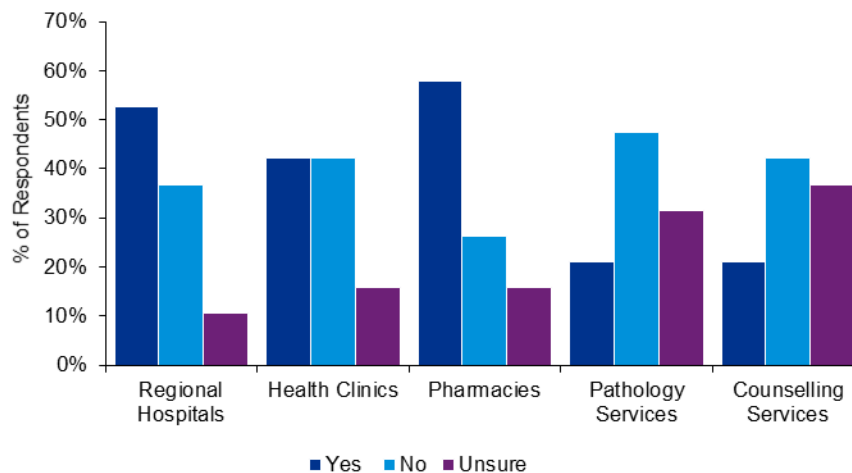
¹³¹ WA Department of Health – A fair share for WA health care (2017).

<http://ww2.health.wa.gov.au/~media/Files/Corporate/Reports%20and%20publications/Fair%20share%20for%20health%20care/Fair-Share-For-WA-Health-Care.pdf>

Education and Child Care

Stakeholder consultation has identified access to education as an issue that affects the resources sector from a social standpoint. Limited access to tertiary, technical colleges, and high schools, for instance, reduces the incentive for families to live and reside in regional and remote locations. There is a view that an increase in quality social infrastructure, such as access to quality schools, will help attract/retain employees and not provide a disincentive preventing employees and their families from living and residing in the regions.

Figure 4-63: Educational and Childcare Services within 20km of Project/Hub



Source: RSO Survey

The resources sector has an important role to play in the education system, and the ongoing scale of investment in education and training (particularly in regional areas) is significant. This investment can help support better student outcomes and incentives for families to live and reside in regional areas. The resources sector has been collaborating with the education sector and government to build the knowledge and skills of all students from primary to tertiary level. This investment and collaboration is important to support future access to an adaptable, flexible, innovative and productive workforce, to maintain a strong and growing economy.

Access to flexible and affordable child care remains a barrier to many families relocating to regional and remote areas. Resources sector families are often located away from traditional support networks, with both parents working, subject to FIFO rosters or other forms of shift work. Limited access to flexible and affordable child care can reduce incentives for employees to work in regional areas, particularly for women who are often the primary carers. To help address this, resources sector companies have developed and implemented a range of child care policies, strategies and initiatives to attract and retain women in their workforce. To further reduce these barriers, the resource sector has also implemented flexible work options such as re-designing roles to fit flexible work arrangements, supporting part-time work and job sharing roles and allowing work from home arrangements. The resources sector's child care and flexible working arrangements continue to evolve to support its workforce. However, the resources sector, government and other stakeholders will need to collaborate to increase workforce participation, particularly in regional and remote areas.

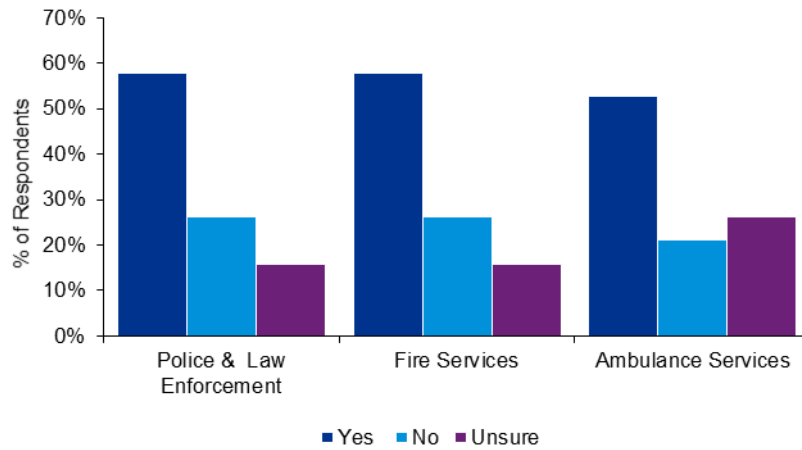
The 2017-18 State Budget of Western Australia allocated increased funding for education infrastructure in Perth and the regions. A total of \$465 million of new investment will lead to 11 new schools being built and 28 schools upgraded or extended across Western Australia.¹³²

¹³² WA State Budget 2017-18 Fact Sheet. <https://www.ourstatebudget.wa.gov.au/2017-18/fact-sheets/2017-18-fact-sheet-set.pdf?>

Emergency and Other Services

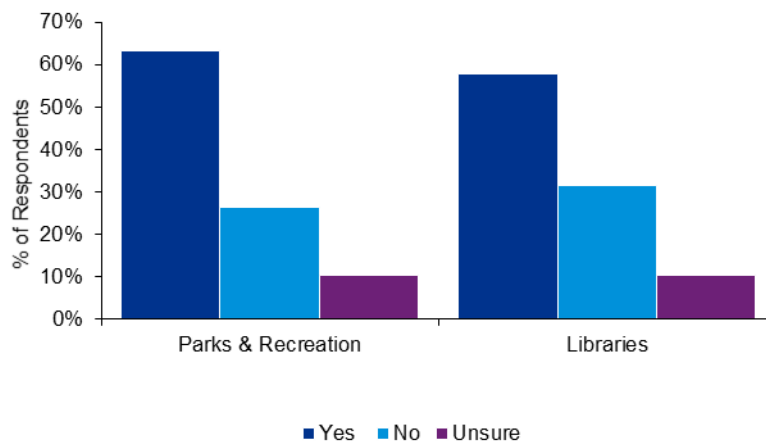
The availability of emergency and security services in close proximity (within 20km) to project site or hub was deemed adequate within regional project site and hubs. The majority of respondents were also either 'strongly' or 'mostly' satisfied with the availability of these services with little change expected over the outlook period.

Figure 4-64: Emergency Services within 20km of Project/Hub



Source: RSO Survey

Figure 4-65: Other Services within 20km of Project/Hub



Source: RSO Survey

For other services, the majority of RSO survey respondents have indicated availability to recreational facilities or services such as parks and libraries. Around 60% of RSO survey respondents have indicated that these services are provided in close proximity (within 20km of the project or hub). Other recreational facilities such as hotels and entertainment centres, however, are limited in the regional areas.

Opportunities and Challenges

Through the consultations and RSO survey results, a number of observations were brought to the fore regarding social infrastructure and its interaction with the resources sector. During the period of strong resources sector growth, there were areas where a large amount of social infrastructure was built. At present, with growth slowing in these areas there is excess supply and a lack of critical mass to support these facilities.

Western Australia faces a significant challenge when providing health services across the state, as it is servicing a population that is relatively small and widely dispersed. This is illustrated through the need to provide hospitals to the Pilbara and Kimberley regions where there is a small population and the input costs are significantly high.¹³³

Family members of resources sector employees also face challenges, and a shortage of opportunity in the respective regions is often the reason why regional residential uptake is low. While there has been new investment in schools, some areas still lack the infrastructure required to deliver appropriate educational services. Access to digital technology, is one avenue that can improve the standard of living in regional communities through 'virtual' access to educational services.

Finally, the regions within Western Australia tend to lack economies of scale due to their size and remoteness which presents multiple challenges from an economic perspective. Lack of scale adds costs to businesses along the value chain. Attracting and retaining people in the regions will help create scale but is almost seemingly a catch-22.

¹³³<http://ww2.health.wa.gov.au/~media/Files/Corporate/Reports%20and%20publications/Fair%20share%20for%20health%20care/Fair-Share-For-WA-Health-Care.pdf>

4.5. Technology and Innovation

Innovation is a key driver of economic growth and improved living standards. Australia's resource sector companies are well-placed to drive innovation and technological advances within the sector, having been at the forefront of research and development for many years. Advances in drones, automation and Artificial Intelligence (AI), to mention a few, will present new opportunities but also create new challenges for the sector. A new generation of disruptive technology will also likely lead to a shift in the way the resources sector operates in the commercial environment (e.g. changes to business models). Over the outlook period, increasing advances in technology and innovation within Western Australia's resources sector is likely to accelerate.

In terms of its workforce (which is relatively specialised and, hence, dependent on technological development), just over 20% of jobs have been partially (or fully) automated in the last five years.¹³⁴ Automation is likely to continue into the future at similar rates of change.¹³⁵ While some roles may face contractions due to the increasing use of automation, other roles, particularly, technologically-related roles, will be faced with increasing demand. The RSO survey highlighted an increasing demand for specialist skills within the resources sector which are not being met at present.

While automation is largely responsible for this uptick in demand for specialist tech skills, there are a number of other technological innovations which are seeing increased use in the resources sector. Drones, for instance, used for collection of spatial information, both surface and underground, are being utilised more often and will continue to increase in use as their software becomes more robust, and application more widespread. Machine learning AI and 3D mapping to fully automate and assess ore fragmentation are other examples of standout innovation. Overall, these innovations are expected to improve the efficiency of operations within the sector.

Improved safety outcomes have also been associated with automation. For example, the use of autonomous drills have seen improved safety outcomes and a reduction in health risks associated with dust, noise and vibration.¹³⁶

Regulation often comes hot on the heels of innovation. With the increasing introduction of autonomous trucks and drills to the resources sector, the then Western Australia Department of Mines and Petroleum (now DMIRS) developed and released the world's first code of practice for safe autonomous mining.¹³⁷ The code of practice was developed over 18 months with the help of a working group of Western Australian industry experts. Future policy initiatives around the regulation of emerging and disruptive technologies need to be designed such that innovation is not stifled but also such that safety and security is not compromised.

To remain competitive and continue to grow, the role of the Mining Equipment, Technology and Services (METS) sector in the innovation process will also be of paramount importance. METS companies provide services in specialist areas such as geotechnical engineering, hydrogeology, and mine waste management which are directly linked to innovation and technology. One example in development is the provision of baseload renewable energy generated from council waste. Other examples include working with manufacturers to develop fit-for-purpose mining equipment ranging from excavation to ground support installation and the development of communications systems that will be the foundation for advanced data analytics in the resources sector.

¹³⁴ RSO Survey.

¹³⁵ Ibid.

¹³⁶ Productivity and Innovation in the Mining Industry – BAEconomics (2016).

¹³⁷ http://www.dmp.wa.gov.au/Documents/Safety/MSH_COP_SafeMobileAutonomousMiningWA.pdf

Opportunities and Challenges

Technological advancement and innovation is a continuous process which has already had implications for the resources sector and will continue to affect how it operates moving forward. Staying at the forefront of emerging technologies will enable the resources sector to capitalise on the opportunities of the future. Definite challenges also lie ahead and locating individuals with the right skill-set will be important. However, a lack of a clear and coordinated strategy between government and industry relating to the regulation of emerging technologies will be a barrier.

Remote operation centres have been created in Perth, allowing for automated vehicles and mine equipment to be monitored remotely requiring less people on the ground at the site. As a result, improvements in productivity are possible as scarce resources can be re-directed and used more efficiently. The challenge this poses, however, is that the reduction of on-site roles is likely to lead to the diminishing of regional communities surrounding these project sites and hubs.

Advancements in mining exploration technology are important to the Western Australian resources sector. As exploration technology improves, it allows for more cost effective exploration and discovery of new mineral deposits within Western Australia.¹³⁸

These advancements in innovation and technology further requires the resources sector to 'up-skill' its workforce in order to stay competitive and meet future demands. Access to digital technology will allow businesses to more efficiently allocate scarce resources and system automation will allow companies to collect and analyse large amounts of data.

Access to digital technologies will present huge opportunities and can alleviate 'remoteness' and inaccessibility. For instance, 'virtual' access to health and educational services (digital classrooms), when these facilities are not physically located within the regions, can improve the standard of living in regional communities. This, however, will require reliable communication infrastructure.

Over the next decade, emerging technologies will most certainly change the landscape in which the resources sector operates. The digital age will permeate all aspects of the resources sector. Regional development will also be tied to the effective use of emerging information communication technologies. The resources sector has been working with government and education providers, and will need to continue working together, to shape educational courses to ensure the skill requirements for these new and emerging technology and innovation roles can be met now and into the future. To stay competitive and continue to grow, the resources sector has to be at the frontier of technological change and be ready to adapt and meet this challenge.

¹³⁸ <https://www.csiro.au/en/Research/Mining-manufacturing/Mineral-discovery-and-exploration>

Appendix A



Appendix A: New Major Projects

Project	Company	Estimated Start Up	Resource	Estimated New Capacity	Capacity Unit
Aphrodite Gold Project	Aphrodite Gold	2023+	Gold	1,261,000	oz
Balla Balla project (phase I)	Todd Capital	2020+	Magnetite	45,000	kt
Barrambie Titanium Project	Neometals	n/a	Titanium, Ferro-Vanadium	13,3	kt
Browns Range	Northern Minerals	2018	Dysprosium dioxide	282	t
Browse	Woodside/BP/PetroChina/Shell/Japan Australia LNG	2021+	Gas/LNG	n/a	n/a
Buckland Project	BC Iron	2021+	Hematite	8,000	kt
Buckland road and port infrastructure project (mine-to-port project)	BC Iron	2020+	Iron Ore	20	mtpa
Bullabulling	Norton Gold Fields	2023	Gold	175,000	oz
Calingiri	Caravel Minerals	2022	Copper	35.5	kt
Cash Maple Development	PTTEP Australasia	2023+	LNG	2	Mt
Cataby Mineral Sands	Iluka Resources	n/a	Ilmenite, zircon, rutile	330,55,30	kt
Coburn	Strandline Resources	n/a	Ilmenite, zircon, HiTi	109/49.5/23.5	kt
Corunna downs	Atlas Iron	2020+	Hematite	4000	kt
Crux LNG	Shell/Nexus Energy/Osaka gas	2023+	LNG	3	Mt
Cyclone Zircon Project	Diatreme Resources	n/a	Zircon, Hiti87, Hiti68	65/10/47	kt
Dalgaranga Project	Gascoyne Resources	2018	Gold	100,000	oz
Dinner Hill (Stage 1 and 2)	Potash West	n/a	SOP	390	kt
Durkin	Mincor Resources NL	2023+	Nickel	-	kt
Equus	Hess	2023+	Gas/LNG	n/a	n/a
Gabanintha Project	Australian Vanadium Ltd	n/a	Vanadium	10	kt
Glenburgh	Gascoyne Resources	2020	Gold	100,000	oz
Great Northern Pipeline	Buru Energy/Mitsubishi		Gas	n/a	PJ pa
Gruyere Project	Gold Road Resources	2019	Gold	270,000	oz

Project	Company	Estimated Start Up	Resource	Estimated New Capacity	Capacity Unit
Gum Creek Gold	Horizon Gold (previously Panoramic Resources)	2023	Gold	90,000	oz
Honeymoon Well	Norilsk Nickel	2021+	Nickel	45	kt
Iron Bridge	Fortescue Metals Group/Baosteel/Formosa		Magnetite	1,500	kt
Julimar Phase 2 Development	Woodside/KUFPEC	2019+	Gas/LNG	n/a	n/a
Kalgoorlie Nickel project	Heron Resources/Ardea	n/a	Nickel, cobalt	19.5, 0.9	kt
Kalgoorlie North	Excelsior Gold	2022	Gold	52,600	oz
Karlawinda	Capricorn Metals	2019	Gold	100,000	oz
Kintyre	Cameco/Mitsubishi	2023	U3O8	3,600	t
Koodaideri	Rio Tinto	2021+	Hematite	70,000	kt
Marillana	Brockman Resources	2018	Hematite	18,500	kt
McIntosh	Hexagon Resources Limited	n/a	Graphite concentrate	88,000	t
Moonshine Magnetite	Macarthur Minerals	n/a	Magnetite	10,000	kt
Mt Forrest	Mindax	2020	Hematite	2,000	kt
Mulga Rock	Vimy Resources	2020	U3O8	1,300	t
Nebo-Babel/West Musgrave	Cassini Resources Limited/OZ Minerals	2021+	Nickel, Copper	12.3, 14	kt
New Morning/Daybreak	Western Areas	n/a	Nickel	4	kt
NiWest Nickel Laterite project	GME Resources	n/a	Nickel, Cobalt	14, 0.54	kt
North Perth Basin Project (Boonanaring, Atlas)	Image Resources NL	2018	Ilmenite, zircon, rutile, leucosene	89/32.4/9/5.4	kt
Nyidinghu	Fortescue Metals Group	2020	Hematite		
Nyidinghu Rail Spur	Fortescue Metals group	2020+	Iron Ore	n/a	
Pannawonica Iron Ore Project (Mesa J)	Red Hill Iron	n/a	Hematite	4,000	kt
Panton PGM	Panoramic Resources	n/a	Platinum group metals	83,000	oz
Parker Range iron ore project	Cazaly Resources	2021+	Hematite	6,000	kt
Pilbara Iron Ore Project	Todd Corporation/Flinders Mines	n/a	Hematite	15,000	kt
Pilgangoora	Pilbra minerals	2018	Lithium Carbonate Equivalent	48	kt
Prelude Floating LNG	Shell/INPEX/KOGAS	2018	LNG	3.6	Mt
Scarborough	Exxon Mobil/Woodside	2021+	Gas/LNG	6	Mt

Project	Company	Estimated Start Up	Resource	Estimated New Capacity	Capacity Unit
Sherlock Bay	Australasian Resources/Metals Australia	n/a	Nickel	9	kt
Sulphur Springs Copper-Zinc Project	Venturex Resources	2020	Copper, Zinc, Silver	12.5, 32.2, 200,000	kt, kt, oz
Thaduna/Green Dragon Copper Project	Ventnor Resources/Sandfire Resources	n/a	Copper	340	kt
Thunderbird	Sheffield Resources	n/a	Zircon, ilmenite, leucosene	114/, 439/30	kt
West Pilbara Iron Ore Project	API Joint Venture	2022	Hematite	30,000	kt
Whim Creek Zinc-Copper Project	Venturex Resources	n/a	Zinc, Copper	20, 10	kt
Wiluna Uranium Project	Toro Energy	2023	U3O8	900	t
Wiluna West	GWR Group	2023+	Hematite	10,000	kt
Wingellina	Metals X	2018	Nickel-Cobalt	40, 3	kt
Yakabindie	BHP (100%)	2023+	Nickel		kt
Yangibana	Hastings Technology Metals Limited	n/a	Rare earths	20	Mt
Yeelirrie	Cameco	2023	U3O8	3,850	t
Yogi Mine Project	Ferrowest	2021+	Magnetite	4,500	kt

Source: Department of Industry, Innovation and Science (DIIS).

Appendix B



Appendix B: Methodology

To provide appropriate industry forecasts for the Western Australia resources sector KPMG employed the use of a survey. The aim of the survey was to provide KPMG with relevant stakeholder knowledge in which to assist in developing a resources sector outlook for Western Australia.

Information was also collected during workshop sessions run with CMEWA working group members and relevant government bodies which brought context to the survey data and provided additional information.

The responses to the survey generally captured a good representation of the resource sector with projects within the Outlook representing around 77% of the total value of production in the Western Australian resources sector in 2016-17. It should be noted that, owing to the uncertainty companies had regarding their new projects over the long-term, most RSO survey respondents were unable to provide estimates of the projected production or enabler use beyond 2021-22. Where there were gaps in responses, information obtained from the RSO survey was supplemented with DMIRS data and with information from government, industry and other stakeholders.

Survey

The survey was developed in an internet based survey tool called QuestionPro, the movement from a file based survey to an online survey aimed to provide easy access and navigation to the respondents to maximise data quality.

Information sought from surveys included:

- Resources sector historical and forecast figures;
- Interaction between the stakeholder and the key enablers; and
- Qualitative information relating to the resources sector within Western Australia.

Preliminary discussions with CME identified the importance of working with members of the CME working group to provide a survey which would be an improvement over the previous, gathering the appropriate industry data, identifying gaps from the previous and way in which the survey could be adjusted to capture those gaps.

The survey questions were finalised with approval from CME prior to implementation. The surveys were sent out to CME members by KPMG via email, the email to the survey contain a URL link to the KPMG survey as well as PDF versions of the survey to allow for offline completion.

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