

report

# THE FUTURE OF MANUFACTURING JOBS IN QUEENSLAND

PREPARED FOR:

THE AUSTRALIAN MANUFACTURING WORKERS' UNION (AMWU)



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Note: the opinions, comments and/or analysis expressed in this document are those of the author or authors and do not necessarily represent the views of the Union.

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## ACRONYMS

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AME	Aircraft Maintenance Engineer
ANZSIC	Australian and New Zealand Standard Industrial Classification
ANZSCO	Australian and New Zealand Standard Classification of Occupations
AQF	Australian Qualifications Framework
ASCED	Australian Standard Classification of Education
DETE	Queensland Department of Education, Training and Employment
EU	European Union
GDP	Gross Domestic Product
GVA	Gross Value Added
IMAG	Industry and Manufacturing Advisory Group (for Queensland Government)
IP	Intellectual Property
NSRC	National Survey of Research Commercialisation
n.e.c	Not elsewhere classified
OECD	Organisation for Economic Co-operation and Development
QNLMRM	Queensland Non-Linear Multi regional Model
R&D	Research and Development
SME	Small and Medium-sized Enterprise
UK	United Kingdom
USA	United States of America
3D	Three dimensional

Note:

When reference is made to Manufacturing, reference is being made to Traditional Manufacturing unless specified otherwise.

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# EXECUTIVE SUMMARY

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## Introduction

Australian Manufacturing has broad coverage of workers from Boilermakers, Fitters & Turners, Mechanics, Printers, Graphic Designers, Laboratory Technicians and general manufacturing workers. New emerging technologies, globalisation and the attractive Australian dollar are contributing to a major shift in traditional manufacturing and traditional manufacturing jobs. The composition of Queensland manufacturing is different to the rest of Australia, and has in the past been heavily associated with the mining industry. With the decline in mining, the rise of emerging technologies and this shift towards globalisation it is important to examine the past current trends, in order to predict future trends in the Queensland manufacturing labour force.

This project examines this for Queensland's manufacturing jobs and industries, using administrative, survey and qualitative data which contain information on manufacturing jobs and industry structure to assess past, current and future trends. This seeks to provide strong evidence-based research to support policy decisions about where to place resources and training to ensure the Queensland manufacturing labour force find and maintain secure jobs in the future.

## Summary of Findings

The key findings are summarised below. Further details are included in the main body of the report.

- Manufacturing's share of employment has dropped 23 percentage points in the last four decades.
- By 2019 the Australian Manufacturing industry is expected to decrease by another 5 percentage points.
- In the last decade, there has been a 2 percentage point decrease in the Manufacturing industry's contribution to Australia's GDP.
- Currently 7 percent of employees are employed in the Manufacturing industry in Australia and Queensland.
- Technological advancement, which requires workers to adapt their skillset and develop specialised knowledge and expertise has contributed to the decline.
- The decline in the Mining industry has impacted the industries that provide support to mining operations (of which Manufacturing has a significant portion).
- Outsourcing manufacturing to countries with lower production costs, reduces both low and high skilled jobs and Intellectual Property (IP) is lost through this outsourcing.
- The Manufacturing industry is a net supplier of skills that are critical to other industries, particularly in the resources sector.
- The Manufacturing industry is a net supplier of skills that are critical to other industries, particularly in the resources sector.
- Australia could model some of the success of the Fraunhofer Society in Germany, which has boosted its manufacturing contribution to Germany's GDP (which is currently 23 percent compared to 7 percent for Australia).

- Queensland has invested \$180 million in the Advance Queensland program, which incorporates Advanced Manufacturing.
- Some identified barriers to innovation by manufacturing businesses are a lack of funds and shortage of skilled personnel.
- In Queensland, there has been steady growth in the Professional, Scientific and Technical Services. There has been steady but slower growth in Computer Systems Design and related services, and a decline in Printing and Construction.
- A higher proportion of Construction jobs are in the Gold Coast and Sunshine Coast, although the Gold Coast has the highest proportion of jobs in Repair and Maintenance.
- A higher proportion of Professional, Scientific and Technical Services jobs are located in Brisbane and the Gold Coast, as compared to other regions in Queensland.
- The contemporary Australian labour market can be divided into three groups that reflect the degree of globalisation experienced by each type of employment:
  - Group 1: Positive/Opportunistic – these workers are able to change employment and job roles depending on market factors and conditions (e.g. Fitters & Turners);
  - Group 2: Vulnerable – these workers have insecure employment opportunities, with skills that are job-specific and non-transferrable (e.g. Boilermakers);
  - Group 3: Insulated – these workers have locally specific skills, training and professional qualification (e.g. Printers and Laboratory Technicians).
- It is estimated that one fifth of Australian workers (Group 1) will be able to take advantage of globalisation, while a third will be directly threatened (Group 2). The remaining (around half) possess specific protective skills and expertise that allow them to find different roles (Group 3).
- The three industries that will show the largest growth over a five year period (to 2020) are: Health Care and Social Assistance; Professional, Scientific and Technical; and Education and Training.
- Three of the selected professions have predicted growth (up to 2020) and these are:
  - Professional, Scientific and Technical Services (i.e. Laboratory Technicians, and Graphic and Web Designers); and
  - Metal Fitters and Machinists (i.e. Fitters & Turners).
- Employment is expected to decline from 2020 onwards for Metal Fitters and Machinists and Structural Steel and Welding Trades Workers (Boilermakers).
  - Employment for Diesel Mechanics and Auto Technicians is expected to remain relatively steady from 2020 onwards.
  - Employment of Aircraft Maintenance Engineer Mechanics is expected to decline over the next five years, and continue to decline past 2020.
- Employment for Diesel Mechanics and Auto Technicians is expected to remain relatively steady from 2020 onwards.

- Employment of Aircraft Maintenance Engineer Mechanics is expected to decline over the next five years, and continue to decline past 2020.
- Three major challenges face vocational education and training providers in Australia and globally, these are: a changing and broadening learner base, increased competition from other providers, and weaker signals of demand from industry.
- Based on the assumption that Queensland has a growth rate of 3 percent over the next 5 years, the results showed the following occupation job growth predictions:
  - Laboratory and Scientific Assistants (3.8 percent);
  - Graphic and Web Designers (3.5 percent);
  - Fitters & Turners (3.2 percent);
  - Diesel and Motor Mechanics (2.4 percent);
  - Boilermakers (2.1 percent).

## Recommendations

A number of recommendations have emerged as a result of this exercise, and these are summarised below. Full details of these recommendations are included in the final chapter of the report.

- The future success of Queensland's Manufacturing industry depends on strategic investment and coordination by government, commercial organisations and research institutes to promote global opportunities for emerging knowledge-based enterprises, particularly in regards to Advanced Manufacturing.
- Without a policy for Advanced Manufacturing (driven by innovation and technological change), there is a real prospect of losing science and engineering expertise in research and production.
- There needs to be private and public collaborative investment (similar to the German model) that seeks to nurture the development of innovative capability, knowledge transfer and inter-firm linkages and networks, through partnerships with academic institutions. This can have related social benefits of increased employability, community cohesion and wellbeing.
- The 10-year Advanced Manufacturing Roadmap announced by the Queensland State Government, under the guidance of the Industry and Manufacturing Advisory Group (IMAG), will provide strategic direction for how this will work in practice. However, the long-term success of this initiative will depend on it being fully embedded into the policy process.
- Policy must ensure, where possible, that public procurement fully supports Manufacturing, particularly the section of the industry engaged in innovation and new-value added activities, since this provides significant returns on capital investment and jobs growth.

# INTRODUCTION

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Traditional Manufacturing in Australia is declining and has been doing so for many years, both as a contributor to GDP and as a contributor to employment. So what does this mean for the Queensland Manufacturing industry and Queensland jobs, both now and in the future? These questions are important in understanding how to plan for the future when it comes to the Manufacturing industry and manufacturing employment. In order to address these questions we have undertaken an investigation; firstly, to identify the current jobs within the Queensland Manufacturing industry; secondly, to identify where these jobs are; and finally, to identify the types of workplaces these jobs fit into. We have profiled current and future trends in Manufacturing, and projected what we propose Manufacturing will look like in the future: the types of jobs, the skill sets workers are likely to need, and in what industries these jobs will exist. This is important to prepare workers to remain employable in the Manufacturing environment, which is especially important in this climate of unpredictable employment.

To achieve this we have:

- assessed the current jobs and industry mix that exists in Queensland on a regional and demographic (e.g. age and gender) basis. This looks at the specific types of jobs that currently exist in the Manufacturing industry as well as the types of workplaces in which jobs exist (see Chapter 2).
- projected future trends for industry and jobs in Queensland over a 5 and 10 year period. This highlights trends for the Manufacturing industry jobs specifically, as well as trends for manufacturing jobs in other industries (see Chapter 3).
- recommended policy based strategies that will maximise the number of secure Queensland-based jobs that fall within the Manufacturing industry. This includes strategies to ensure workers are adequately skilled for future jobs and new industries (see Chapter 4).

In addition to projecting future trends in Queensland, Chapter 3 looks at the Australian labour market with a focus on Manufacturing jobs, with an exploration of eight key occupations and five case studies. These case studies provide real life examples of the impact of changes in Manufacturing from five of the eight key occupations.

For ease of reading, there is a 'Facts up Front' Section at the start of each chapter, this section contains highlights/key findings from that chapter. Explanations or definitions for words or ideas are included in a box within the text (as we have done below for 'Manufacturing'); a technical description used is included in Appendix I; and data sources are included in Appendix II. Also, additional detailed tables, figures and lists are available in Appendices III, IV, and V.

**Manufacturing**

1: something made from raw materials by hand or by machinery

2 a: the process of making wares by hand or by machinery especially when carried on systematically with division of labour

b: a productive industry using mechanical power and machinery

3: the act or process of producing something

*Source: Merriam-Webster Dictionary*

# 1 AN EXPLORATION OF THE MANUFACTURING INDUSTRY AND WORKFORCE IN AUSTRALIA

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## **FACTS UP FRONT:**

- Manufacturing's share of employment has dropped 23 percentage points in the last four decades.
- By 2019 the Australian Manufacturing Industry is expected to decrease by another 5 percentage points.
- In the last decade, there has been a 2 percentage point decrease in the manufacturing industry's contribution to Australia's GDP.
- Currently 7% of employees are employed in the Manufacturing Industry in Australia and Queensland.
- Technological advancement, which requires workers to adapt their skillset and develop specialised knowledge and expertise, has contributed to the decline.
- The decline in the Mining Industry has impacted the industries that provide support to mining operations.
- Outsourcing manufacturing to countries with lower production costs reduces both low and high skilled jobs, and IP is lost through this outsourcing.
- The Manufacturing Industry is a net supplier of skills that are critical to other industries, particularly in the resources sector.
- Australia could model some of the success of the Fraunhofer Society in Germany, which has boosted its manufacturing contribution to Germany's GDP (currently 22.6% compared to 6.9% for Australia).
- Queensland has invested \$180 million in the Advance Queensland program, which incorporates advanced manufacturing.
- A lack of both funds and skilled persons are barriers to innovation identified by manufacturing businesses.
- In Queensland, there has been steady growth in the Professional, Scientific and Technical Services. There has been steady but slower growth in Computer Systems Design and related services, and a decline in Printing and Construction.

**FACTS UP FRONT:**

- A higher proportion of Queensland Construction jobs are in the Gold Coast and Sunshine Coast.
- The Gold Coast has the highest proportion of Queensland jobs in Repair and Maintenance.
- A higher proportion of Professional, Scientific and Technical Services jobs are located in Brisbane and the Gold Coast, as compared to other regions in Queensland.

## **1.1 A SNAPSHOT OF AUSTRALIAN MANUFACTURING**

Trends over the last decade show that Manufacturing is undergoing a dramatic shift, with working and employment patterns changing rapidly. Manufacturing's share of employment dropped from 30.5% in 1965 to 7.8% in 2015, a pattern consistent with that of other major economies. The decline in employment has been associated with a substantial decrease in blue collar, routine jobs that are classified as 'low skilled'. The once-dominant manufacturing sectors of the OECD economies have been transformed over the past five decades into a much more diverse and complex service economy which now accounts for approximately 77% of employment in Australia. Since the 1980s, the broader macroeconomic stance of government has placed a continuing emphasis on programs designed to create a competitive environment, along with an aspiration to phase out industry-specific protection packages.

These patterns of growth and decline in employment are broadly attributable to various kinds of structural changes including: the internationalisation of production and distribution; the development of new technologies; government regulatory policy; and the institution of improved labour management relations. These changes have allowed new technologies to be widely used, by removing regulations that previously had stood in the way of them being rolled out. Common examples of these practices include the extension of work hours to enable continuous production processes, and the availability of flexible working practices through new, non-permanent employment arrangements including casual work, outsourcing, and subcontracting<sup>i</sup>.

A major driver of this change is technology, which has led to a phenomenon referred to as 'the hollowing out of work'<sup>ii</sup>. This is the situation where routine jobs are replaced by technology. Such technological advancement has meant that there are non-routine jobs at both ends of the spectrum: low end skills, such as food preparation or care work; and high end skills such as professional and specialist services.

## **1.2 THE CHANGING STRUCTURE OF MANUFACTURING IN AUSTRALIA**

For Traditional Manufacturing workers to remain employable in this changing environment, they have to constantly adapt their skillsets, and evolve to have specialist knowledge and expertise. This is considered here in detail, reflecting on the particular circumstances that differentiate Queensland from the rest of Australia.

### **1.2.1 The decline in Manufacturing in Australia**

Data from the Australian Bureau of Statistics Labour Force Survey indicates that Manufacturing overall is declining in Australia, with a decrease of 122,400 jobs between August 2005 and August 2015<sup>iii</sup>. Moreover,

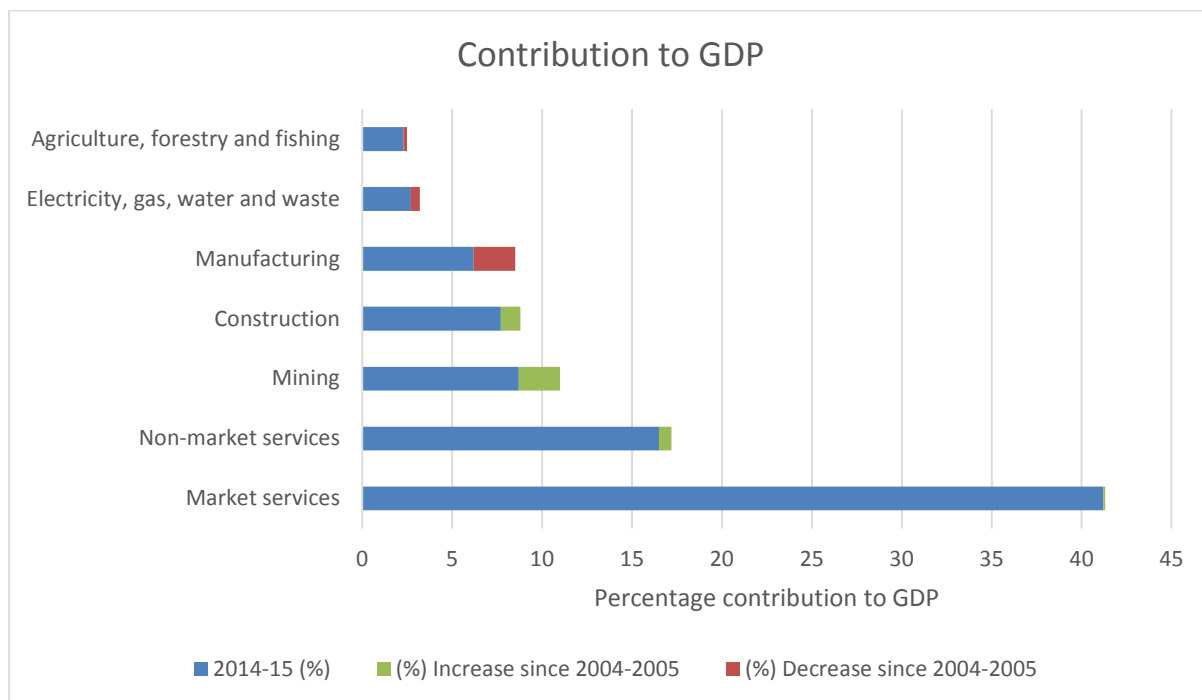


Manufacturing's contribution to Gross Domestic Product (GDP) has decreased from 8.5% to 6.2% during the same period<sup>iv</sup> (see Figure 1 below).

Despite this decline, the Manufacturing industry is still one of the top eight Australian employers, and accounts for 7.4% of Australia's total employment and 7.1% of Queensland's total employment<sup>iii</sup> (see Table 1). Furthermore, Manufacturing accounted for 37.8% of Merchandise Exports and 89.9% of Merchandise Imports during 2014-2015<sup>v</sup>. Primary Metal and Metal Products; and Food Manufacturing are some of the biggest exporting industries in Australia, with close to \$3 billion and \$2 billion of export revenue respectively (see Figure 2).

Figure 3 presents the percentage of Queensland's workers employed in each industry, with the corresponding percentage for Australia. They show that primary metal and metal product manufacturing, food product manufacturing, and Machinery and Equipment Manufacturing are the three top contributors in terms manufacturing exports from Australia. When focusing on Manufacturing in Queensland, Table 1 shows that roughly 7% of employed people in Queensland are working in the Manufacturing industry. In comparison, the figure is close to 8% nationally. It is important to note that due to the role of the Mining industry in Queensland, the profile of manufacturing in Queensland is different to the rest of Australia.

Figure 4 shows the projected increase or decrease in industry size. It shows that although there is an expected increase in the majority of industries (due to general population growth and the related demand for services), there are three industries that are projected to have a decline. These are: Mining (projected decline of 14.1%), Manufacturing (projected decline, 5.3%), and Agriculture, Forestry and Fishing (projected decline of 3.1%). When Mining is removed, Manufacturing is shown to be the industry that experiences the most decline.



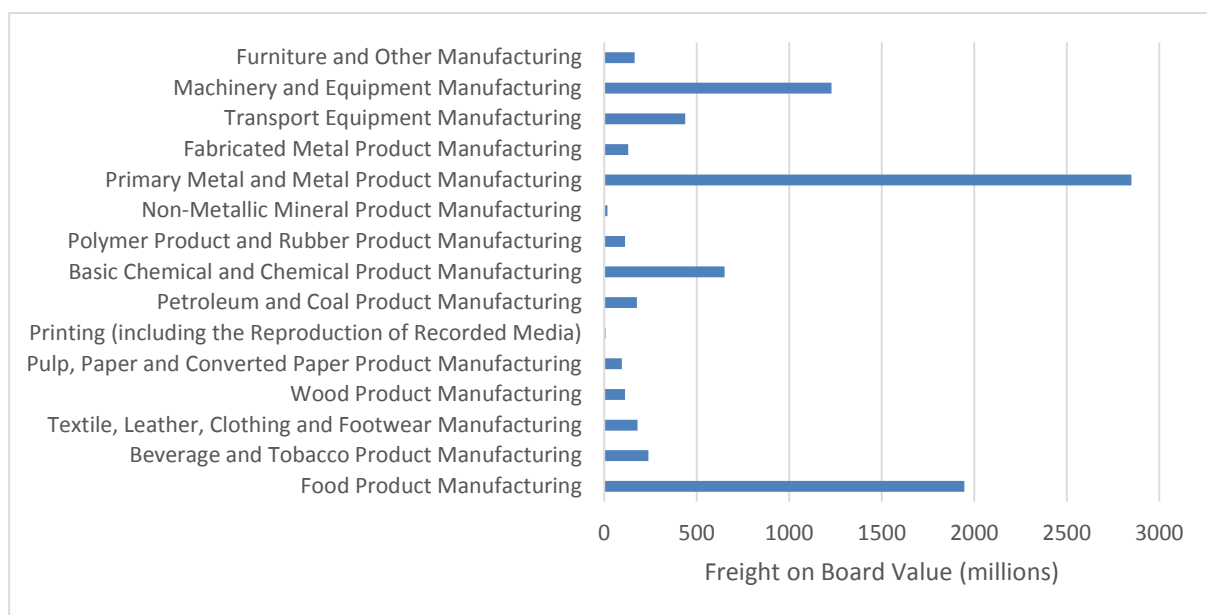
**Figure 1. Australian industries' contribution to Gross Domestic Product, percentage of exports 2004-05, 2014-15**

Source: Manufacturing Data Card<sup>vi</sup>

**Table 1. Top eight employing industries in Queensland**

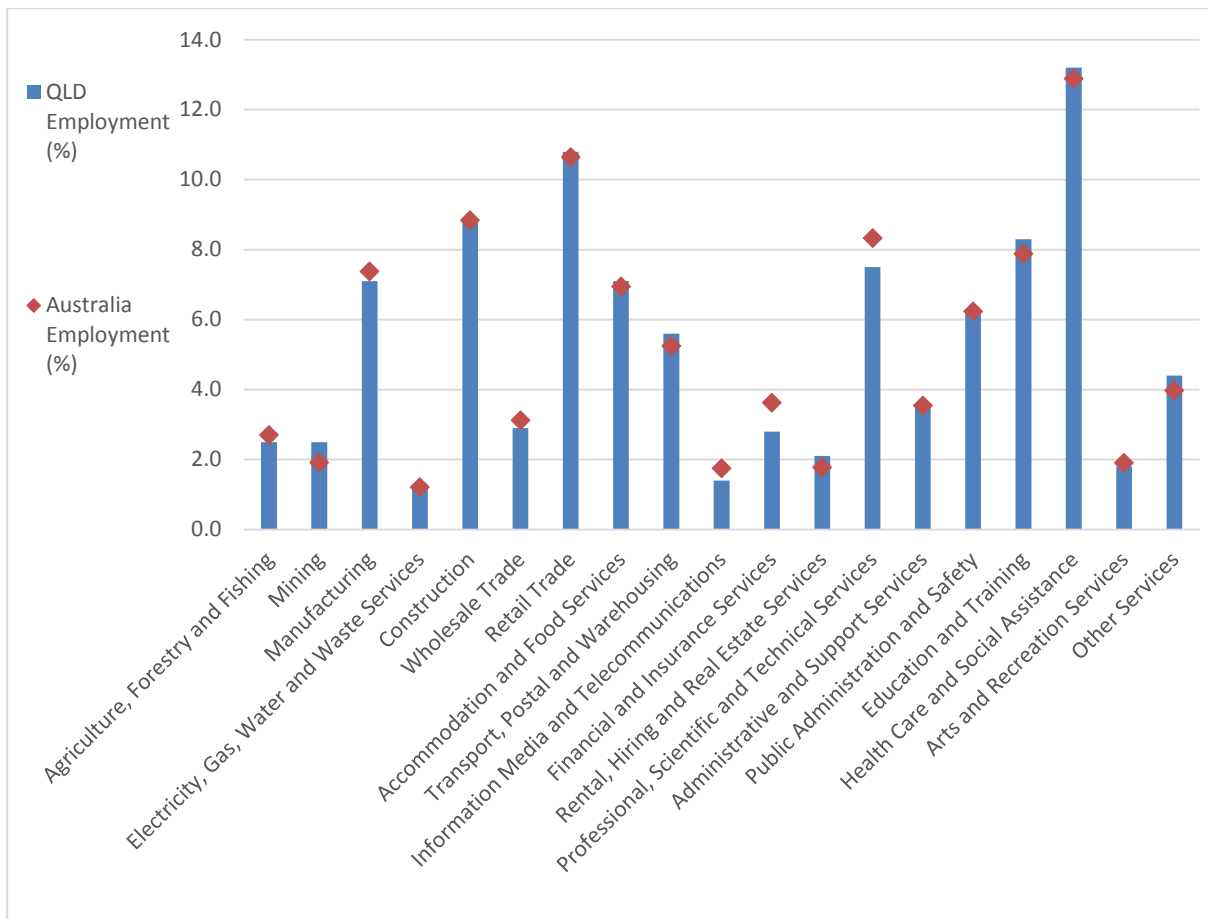
Top eight employing industries for Queensland	Industry total employment	Percentage of State employment
Health Care and Social Assistance	305,100	13%
Retail Trade	256,000	11%
Construction	204,200	9%
Education and Training	196,200	8%
Professional, Scientific and Technical services	183,000	8%
<b>Manufacturing</b>	<b>171,300</b>	<b>7%</b>
Accommodation and Food Services	168,700	7%
Public Administration and Safety	148,600	6%

Source: ABS Labour Force, Australia, 'Detailed, Quarterly; average year to Feb 2016', cat.no 6291.0.55.003<sup>vii</sup>

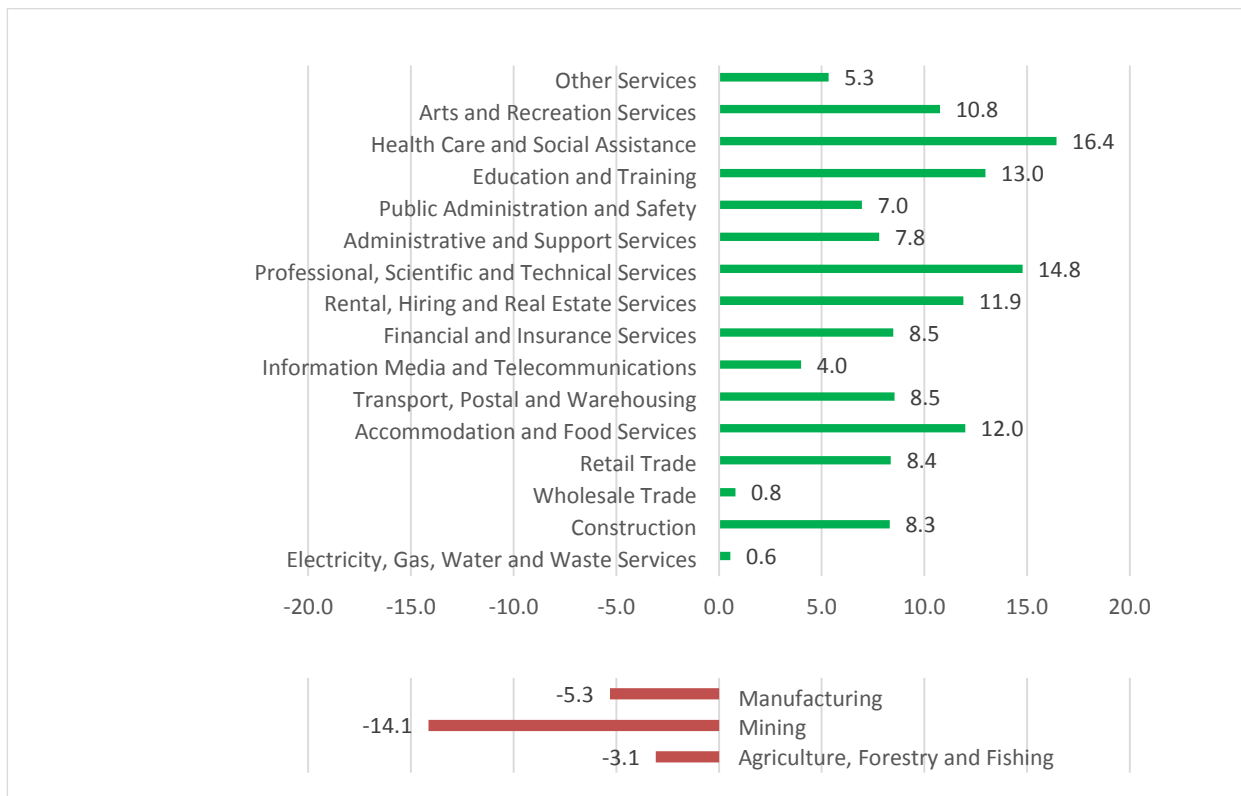


**Figure 2. Australian manufacturing exports (Australian Dollars)**

Source: ABS International Trade in Goods and Services, Australia cat.no. 5368.0.<sup>viii</sup>



**Figure 3. Share of employment by industry, Queensland and Australia**  
 Source: Average year to Feb 2016. ABS Labour Force, Australia, Detailed, Quarterly



**Figure 4. Projected increase/decrease in industry size by 2019 (%)**  
 Source: Manufacturing Data Card<sup>iii</sup>

### **1.2.2 Further causes of the decline**

Industries do not operate in isolation; changes to one industry can affect multiple other, interconnected, industries. Consequently, a decline in an industry related to Manufacturing will have a ripple effect on Manufacturing.

Queensland is known as a 'Mining State', and the strong relationship between the Mining and Manufacturing industries in Queensland cannot be ignored. One of the key areas where Manufacturing links closely to the Mining industry is in the manufacturing of infrastructure. With Mining in decline, there has been a considerable impact not only on the Mining industry, but on other secondary industries that provide support to Mining operations, including Manufacturing. Manufacturing is dependent on other industries, so a decline in Mining will have impacts on current and future Manufacturing prospects.

From a financial and economic viewpoint, the value of the Australian dollar will also have a significant effect on the Manufacturing industry. A competitive Australian dollar makes imported goods in the domestic market cheaper, which makes our exports more expensive to the international market, and as consequence leading to a decline in Manufacturing.

### 1.2.3 What are the implications?

Manufacturing employs many skilled and unskilled workers. It is estimated that about 40% of Australia's engineers are employed in Manufacturing and related consulting industries<sup>x</sup>. Manufacturing also contributes to the Australian economy: in 2013-2014, Australia contributed \$4.8 billion to business expenditure on Research and Development (R&D)<sup>x</sup>. This R&D employs scientists, engineers and skilled technicians, who mostly work to develop and adapt technologies to meet particular local needs. Even more is spent on 'non-R&D' innovation, such as new business models, systems integration, high performance work and management practices, all of which have spillover effects for other industries.<sup>xi</sup> It is this aspect of Manufacturing that has experienced considerable changes due to advances in technology.

It is not realistic to think that Manufacturing activities can be outsourced to countries with lower production costs, while simultaneously keeping high-value, high-skill design and technology jobs within Australia. This is because Manufacturing production involves constant design changes and continuous problem-solving, which require employees to be highly skilled.

The skills developed by Manufacturing industry employees are core skills that every modern economy depends upon. The Manufacturing sector trains many technical and professional people, including Engineers, Technicians, and Fitters & Turners. These people have the skills necessary to install and maintain our telecommunications, power stations, water plants and transport systems, to mention a few. Manufacturing is a net supplier of these skills to other industries, especially in the resources sector. Without it, there will be growing skills shortages in these industries.

### 1.2.4 Strategies to address the decline in Manufacturing

While there are a number of strategies used to slow the decline of various industries, they are usually centred around embracing technology, especially in the workplace. The future will require us to understand the impact of emerging technologies, such as information and communications technology. As computing power continues to increase, more and more tasks will become automated. Employees will be required to perform tasks that are less routine and not easily automated, and this will involve complex problem solving, teamwork, interpersonal skills and negotiating capabilities<sup>xii</sup>.

These strategies have been applied in many countries. For example, the OECD Global Forum on Productivity<sup>xiii</sup> states that "*Boosting productivity requires a focus on innovation through R&D policy, university-business linkages and effectiveness and efficiency of financial support for research. Ensure strong competition, regulation that accommodates new internet-platform-based businesses, sound Information and Communications Technology infrastructure and continuing education.*"

We looked specifically at Germany, which has had a long history of manufacturing success. One model for this success is the Fraunhofer Society<sup>xiii</sup>. This is a network of government-backed research institutes that combine public finance and private investment to drive exports of technologically advanced manufacturing goods. Broadly, the aim of this network is to facilitate collaboration between companies and universities to develop manufacturing technology. There are currently 67 such institutes spread throughout Germany, and each has a focus on different fields of applied science. This partnership has helped make Germany a leading manufacturing exporter, in spite of the country's relatively high wages and high levels of regulation. Furthermore, the network is particularly important for the small and medium-size companies that make up the backbone of the German economy. Germany's manufacturing contribution to the GDP in 2014 was 22.6%, as compared to 6.9% in Australia (see Figure 5). Additional comparative information between Australia and

Germany's country characteristics is provided in Table 2 Australia could certainly learn from Germany's success. Germany's innovative approach to market-friendly government research, has meant that the majority of companies are often global players but still produce locally, selling specialty products that can command premium prices around the world.



**Figure 5. Manufacturing, value added (% of GDP), 2014**

Source: <http://data.worldbank.org/indicator/NV.IND.MANF.ZS?end=2014&start=2014&view=map><sup>xiv</sup>

In a similar vein, the state of Queensland has taken steps to address the decline in Manufacturing. In 2015 the Queensland Government announced it would invest \$180 million in the Advance Queensland program<sup>xv</sup>. This program will consist of a comprehensive suite of reforms designed to create more diversity in the economy and create knowledge-based jobs both now and into the future. The Queensland Government places a strategic focus on selected industry sectors, one of which is Advanced Manufacturing.

The Queensland Government's proposed vision is that Queensland will be an internationally recognised centre for Advanced Manufacturing, with Manufacturing technologies, products, services and solutions that are innovative, sustainable and embedded in local and global supply chains. The Queensland Government has the support of a newly established Industry and Manufacturing Advisory Group (IMAG) to guide the development of the Manufacturing sector during the implementation of the 10-Year Advanced Manufacturing Roadmap. While this is a significant change in the right direction with an investment of \$180 million, the Fraunhofer Society has an annual budget of 2.1 billion euros<sup>xvi</sup>.

**Table 2. Comparative country characteristics (Australia and Germany)**

	Australia	Germany
<b>Population Size</b>	24,390,278	80,680,823
<b>Percent of the World Population</b>	0.33%	1.1%
<b>Population Density</b>	3 people per km <sup>2</sup>	232 people per km <sup>2</sup>
<b>Median Age</b>	37.6 years	46.4 years

Source: <http://www.worldometers.info/world-population/germany-population/>  
<http://www.worldometers.info/world-population/australia-population/>

Key to this has been a focus on research commercialisation, through actively seeking collaboration between academic research and product development. Through these improved links, it becomes possible to translate deep scientific knowledge into practical industrial excellence and competitiveness. In this way, Queensland's Advanced Manufacturing strategy borrows from the experiences the German Fraunhofer Society. In terms of the whole of Australia, results from the National Survey of Research Commercialisation (NSRC) showed that the total research investment from surveyed organisations increased 5.5% in real terms from 2013-2014.<sup>xvii</sup>

#### **Research Commercialisation**

A process of converting scientific knowledge or invention into a marketable product or industrial process. It ensures that investment in research brings a positive return by way of technological advances, e.g., health technology, mobile technology and cloud-based software development.

An example of an effective research commercialisation program is the Advance Queensland initiative which aims to create knowledge-based jobs that can drive improvements in productivity, are designed for the future, and facilitate investment, encourage innovation and promote entrepreneurship within Queensland. This is achieved through a number of activities, such as small business grants, business development funds, innovation partnerships, and knowledge transfer partnerships for instance through PhD industrial experience programs<sup>xviii</sup>.

A recent briefing paper<sup>xix</sup> reported that the decline in Australian Manufacturing output and employment is **not** typical of other industrial countries. Rather, it states that Australia is an exception as compared to other developed countries, and now reports the smallest share of Manufacturing in total employment of any OECD country.

The Productivity Commission paper (2003)<sup>xx</sup> indicates that there are two groups of industries that contribute the most to Manufacturing output:

1. Industries engaged in Manufacturing activities with strong links to Australia's natural endowments of food, forests and minerals, which account for a significant and growing share of Manufacturing value added.
2. Industries that produce a wide variety of products that require highly skilled workers and more R&D (e.g., medicinal and pharmaceutical goods, scientific and medical equipment).

In addition to these two groups of promising industries, small and medium-sized enterprises (SMEs) can be a source of strength in the future of Manufacturing. SMEs generally target niche markets, rather than mass markets. There have been a number of successful SMEs in the German Manufacturing industry<sup>xxi</sup>, in fields such as photoelectronics, nanotechnology, mobile communications, and computer graphics.

The top two barriers to innovation identified by manufacturing businesses include lack of access to additional funds (23%) and lack of skilled persons (20%) (See Figure 6). However, these two are closely followed by uncertainty around demand of new products (19%) and the costs associated with research and development (16%).

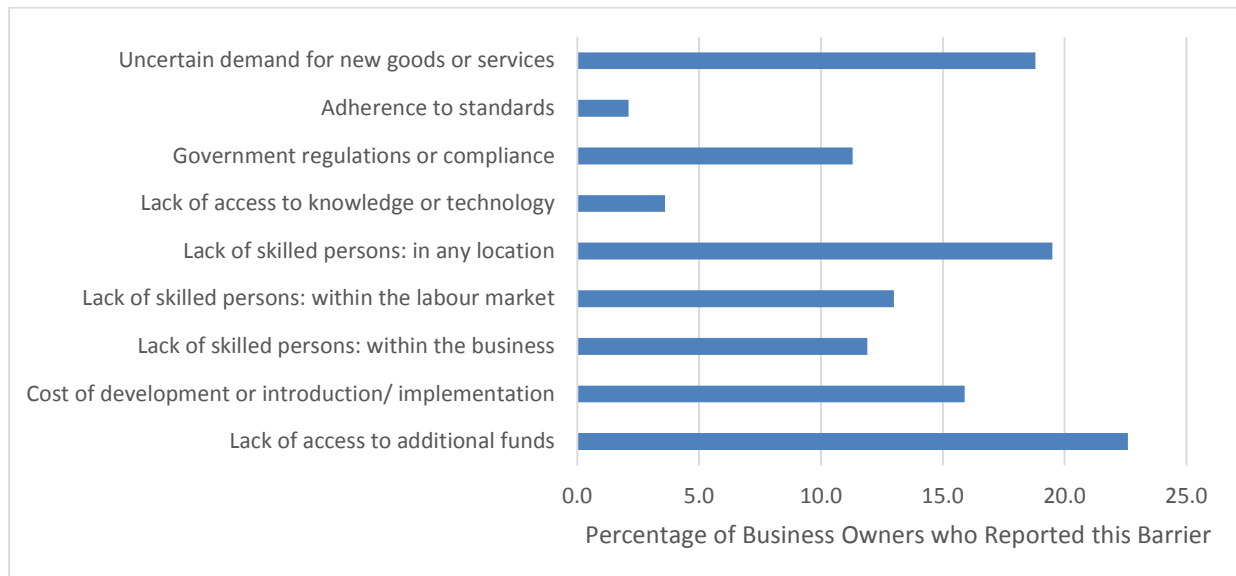
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**Advanced Manufacturing** incorporates niche market products and a range of activities from design and research and development (R&D), to production, distribution and after-sales services. It focuses not only on products, but also on value-adding across the entire value chain.<sup>xv</sup>

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**Value Chain**

The process or activities by which value is added to an article or service, including production, marketing, and the provision of after-sales service.



**Figure 6. Barriers to innovation for manufacturing businesses**

Source: ABS, 2013-2014 *Selected Characteristics of Australian Business*, 81670DO007\_201314 2013-14<sup>xxii</sup>



### **1.3 AN EXPLORATION OF QUEENSLAND INDUSTRIES**

While we have been talking about Manufacturing in broad terms, Queensland has a unique manufacturing profile. In our analysis of Manufacturing we have focused on 22 ANZSIC sub-industries identified as areas of specific interest for Queensland, listed in Table 3 and detailed in Appendix III, Table 21.

The current industry mix in Queensland shows that there are different experiences of growth depending on the industry a person is employed in.

Table 3 shows the number of persons employed in the various industries in Queensland, and provides an average growth rate between 2011 and 2015. In general, industries that have experienced relatively high volume increases also experienced high rates of growth. These are computer systems, repair and maintenance, motor vehicle and parts, and professional, scientific, and technical services. Printing, however, had the lowest growth (negative 15%) and the third smallest average number of employed persons over the 2011-2015 period. Notably, the second largest group (in terms of volume of workforce) is construction services, however, there have been on average a 3% decline every year from 2011 to 2015. Exhaustive figures of size and growth by industry, sex, age, occupation, region, labour force status are provided in Appendix IV.

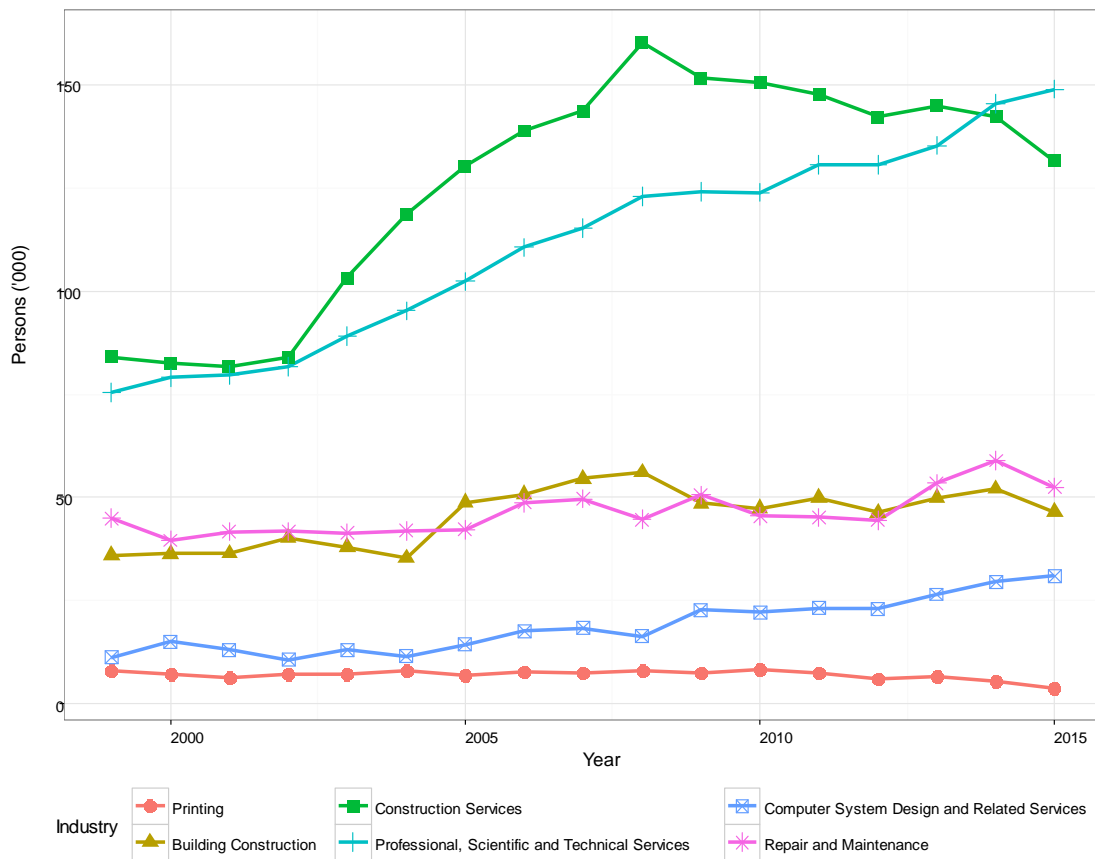
Figure 7 illustrates the growth figures over time, over the period 1999-2015, for six of the 22 selected ANZSIC sub-industries. There are four points to take away from this. First, there has been a steady growth in professional, scientific, and technical services. Second, there is steady (although much slower) growth in computer systems design and related services. Third, there has been a downward trend in printing, and this decline has continued steadily between 1999 and 2015. Fourth, there has been a downward trend in construction services (it has shed roughly 28,000 jobs since 2008).

While there has been an increased focus on renewable energy in recent years, the impact on manufacturing has been mixed. Recent figures from the ABS on employment in renewable energy activities in Australia has showed that in the last two years, the global economy added 2 million renewable energy jobs – but Australia lost 2,600<sup>xxiii</sup> .

**Table 3. Employed persons growth ranking versus industry size in Queensland**

Industry	2011-2015 Averages			
	Growth ranking	Size ranking	Growth (%)	Size ('000)
Gas Supply	1	18	14.66	4.7
Petroleum and Coal Product Manufacturing	2	21	14.36	3.6
Computer System Design and Related Services	3	5	7.62	31.1
Fuel Retailing	4	15	5.89	8.9
Metal Ore Mining	5	14	4.76	9.3
Repair and Maintenance	6	3	3.78	52.4
Motor Vehicle and Motor Vehicle Parts Retailing	7	6	3.36	25.1
Professional, Scientific and Technical Services (Except Computer System Design and Related Services)	8	1	3.34	148.8
Heavy and Civil Engineering Construction	9	7	0.71	20.3
Non-Metallic Mineral Product Manufacturing	10	16	0.4	7.4
Fabricated Metal Product Manufacturing	11	13	-0.34	12.4
Building Construction	12	4	-1.71	46.6
Machinery and Equipment Manufacturing	13	10	-2.04	16.3
Transport Equipment Manufacturing	14	11	-2.61	14.4
Construction Services	15	2	-2.83	131.5
Wood Product Manufacturing	16	17	-3.73	5.9
Pulp, Paper and Converted Paper Product Manufacturing	17	22	-4.89	1.7
Primary Metal and Metal Product Manufacturing	18	9	-5.13	16.6
Coal Mining	19	8	-5.3	19.4
Electricity Supply	20	12	-7.75	13.1
Water Supply, Sewerage and Drainage Services	21	19	-15.45	4.7
Printing (including the Reproduction of Recorded Media)	22	20	-15.64	3.9

Source: ABS Labour Force Survey Specially Commissioned Tables

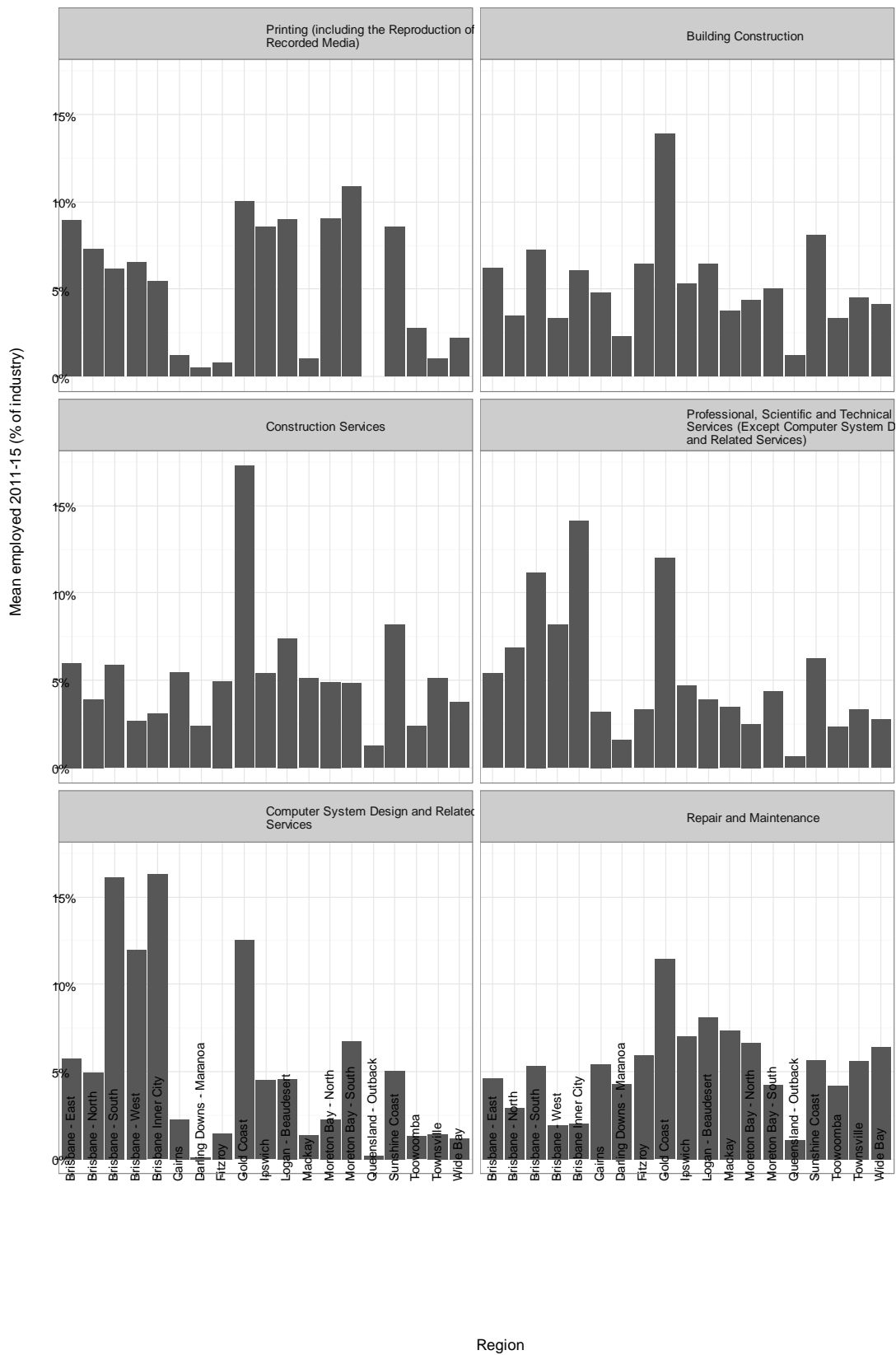


**Figure 7. Queensland employment by industry, 1999-2015.**

Source: ABS Labour Force Survey Specially Commissioned Tables.

### 1.3.1 Regional distribution of Manufacturing jobs across Queensland

In regards to the make-up of the Manufacturing workforce in Queensland, Figure 8 shows the distribution of six sub-industries by region (local administrative region reflecting the labour force patterns). These six sub-industries were selected as they represent the largest variation in their regional distribution of jobs. For detailed tables and figures of the 22 selected sub-industries please see Appendix IV. The figures show that there are regional-level variations in the distribution of jobs, which is to be expected. Professional, scientific and technical, and computer systems design have jobs distributed more heavily around Brisbane. Construction services and building construction sub-industries have jobs that are spread fairly evenly, with the exception with the Gold Coast (which has over 15% of jobs). In contrast, the remaining regions (including Sunshine Coast and Brisbane) have under 10% of the jobs in those sub-industries. Finally, the Gold Coast contains a high proportion of Manufacturing workers in all of the selected sub-industries.



**Figure 8. Distribution of workforce by region and industry**  
 Source: ABS Labour Force Survey Specially Commissioned Tables.

### **1.3.2 The profile of the Manufacturing industry in Queensland**

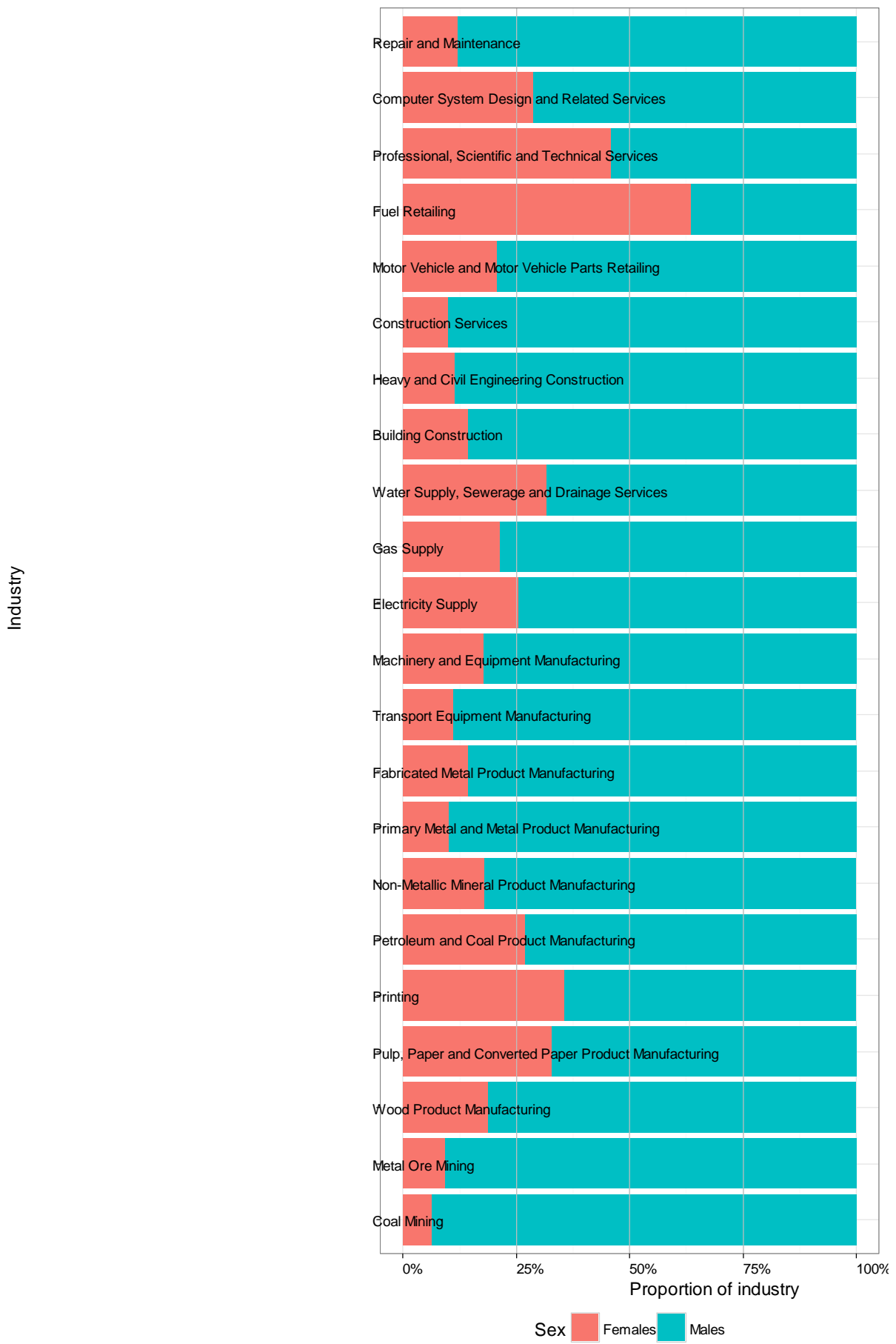
We profiled the 22 selected ANZSIC subindustries based on industrial information obtained from the Queensland ABS Labour Force Survey. Figures 9, to 13 and Table 4 provide a breakdown of the industry composition by sex, age and geographical region for the selected 22 Queensland subindustries. Males are over represented in all but the Professional, Scientific and Technical and Fuel Retailing subindustries for the Queensland Manufacturing workforce<sup>xxiv</sup>. This reflects that the type of industries which have historically been primarily male-dominated. Fuel Retailing is the only industry represented in Figure 9 that shows more women than men.

Figure 10 provides a detailed breakdown by age group, this shows that of those employed in:

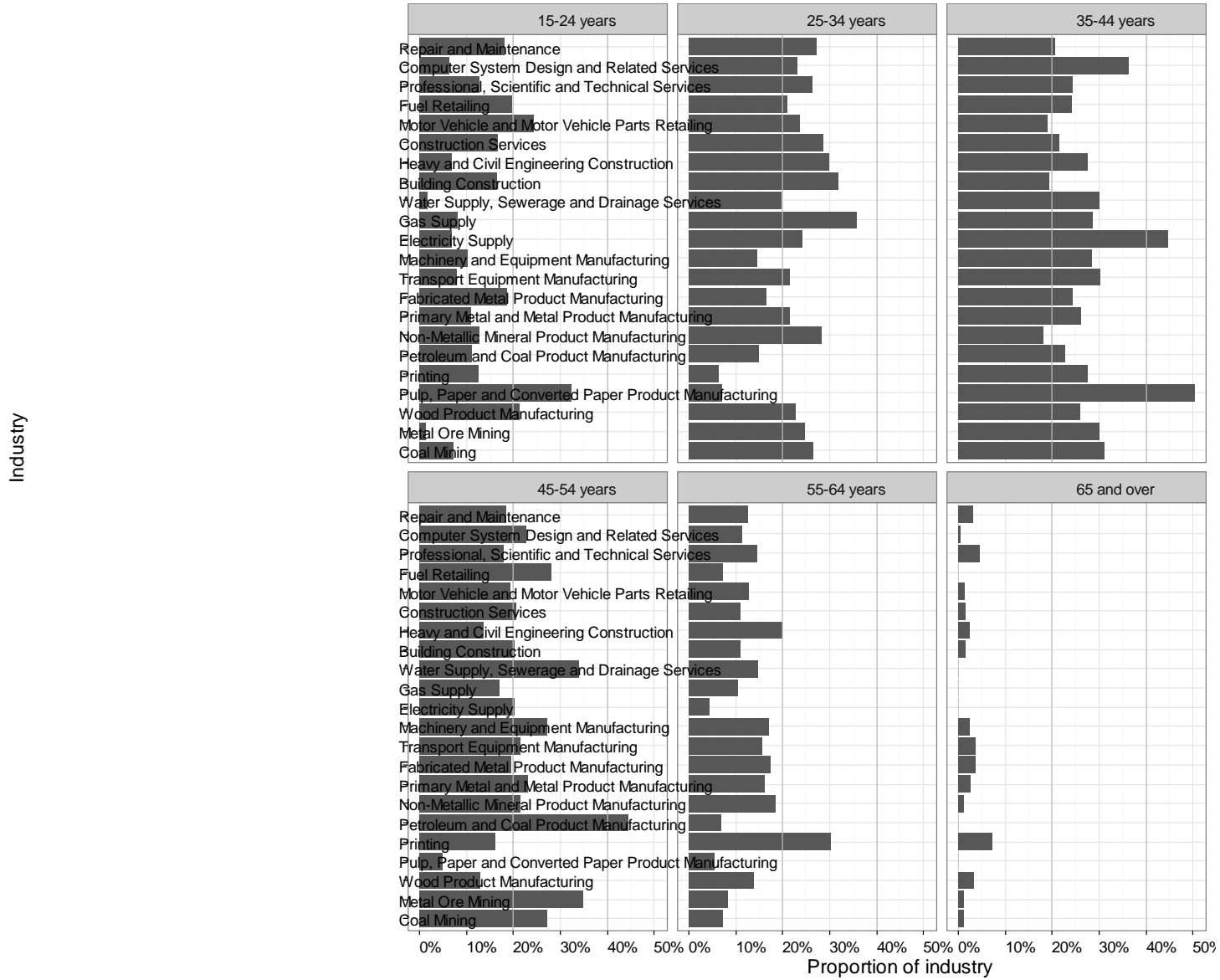
- Pulp, Paper and Converted Paper Product Manufacturing, over 50% are between 35 and 44 years old and over 30% are between 15 and 24 years old;
- Petroleum and Coal Product Manufacturing, over 40% are between 45 and 54 years old;
- Electricity Supply, over 40% are between 35 and 44 years old;
- Computer Systems Design and Related Services, over 35% are between 35 and 44 years old; and
- Gas Supply, over 35% are between 25 and 34 years old.

Figures 11, 12 and 13 show the regional distribution of jobs for selected industries, these show that of those that are employed in:

- Coal Mining, almost 50% are employed in Mackay;
- Metal Ore Mining, almost 40% are employed in the Queensland Outback; and
- Petroleum and Coal Product Manufacturing, over 30% are employed in Brisbane East;



**Figure 9. Selected Industry composition by sex**



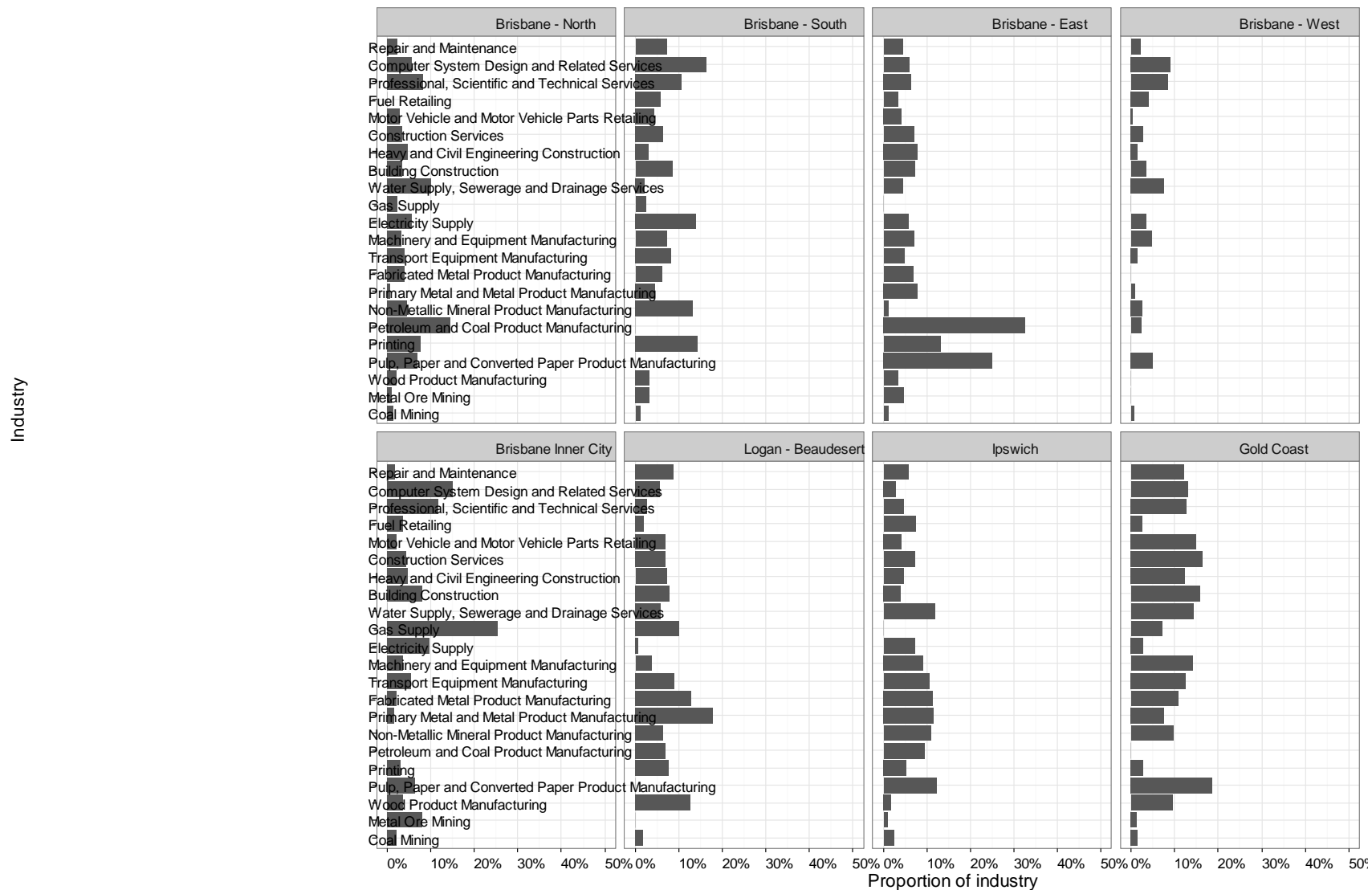
**Figure 10. Selected Industry age group composition**

Source: ABS Labour Force Survey Specially Commissioned Tables.



**Table 4. Selected Industry sex and age group compositions.**

Industry	Sex (%)		Age group (%)					
	Female	Male	15-24	25-34	35-44	45-54	55-64	65+
Coal Mining	6.2	93.8	7.1	26.4	31.1	27.1	7.2	1.1
Metal Ore Mining	9.4	90.6	1.3	24.7	30.0	34.7	8.3	1.0
Wood Product Manufacturing	18.8	81.2	21.1	22.9	26.0	13.0	13.8	3.3
Pulp, Paper and Converted Paper Product Manufacturing	32.6	67.4	32.4	6.9	50.3	4.9	5.5	0.0
Printing	35.5	64.5	12.5	6.2	27.6	16.2	30.3	7.2
Petroleum and Coal Product Manufacturing	27.0	73.0	11.1	14.9	22.9	44.4	6.8	0.0
Non-Metallic Mineral Product Manufacturing	18.1	81.9	12.6	28.3	18.2	21.5	18.5	1.1
Primary Metal and Metal Product Manufacturing	10.1	89.9	10.9	21.5	26.0	22.9	16.1	2.5
Fabricated Metal Product Manufacturing	14.1	85.9	18.6	16.4	24.4	19.5	17.4	3.7
Transport Equipment Manufacturing	11.2	88.8	7.8	21.5	30.1	21.5	15.5	3.6
Machinery and Equipment Manufacturing	17.8	82.2	10.4	14.5	28.5	27.2	17.0	2.4
Electricity Supply	25.5	74.5	6.7	24.1	44.7	20.2	4.3	0.0
Gas Supply	21.2	78.8	8.0	35.8	28.6	17.1	10.5	0.0
Water Supply, Sewerage and Drainage Services	31.6	68.4	1.8	19.6	30.0	33.9	14.7	0.0
Building Construction	14.2	85.8	16.5	31.8	19.2	20.1	10.8	1.6
Heavy and Civil Engineering Construction	11.3	88.7	6.7	29.9	27.5	13.6	20.0	2.4
Construction Services	10.0	90.0	16.7	28.6	21.4	20.6	11.0	1.6
Motor Vehicle and Motor Vehicle Parts Retailing	20.7	79.3	24.2	23.7	19.0	19.2	12.7	1.3
Fuel Retailing	63.4	36.6	19.6	21.1	24.1	28.0	7.2	0.0
Professional, Scientific and Technical Services	45.9	54.1	12.8	26.2	24.2	18.0	14.4	4.5
Computer System Design and Related Services	28.8	71.2	6.4	23.0	36.3	22.7	11.3	0.3
Repair and Maintenance	12.0	88.0	18.3	27.1	20.5	18.5	12.5	3.1

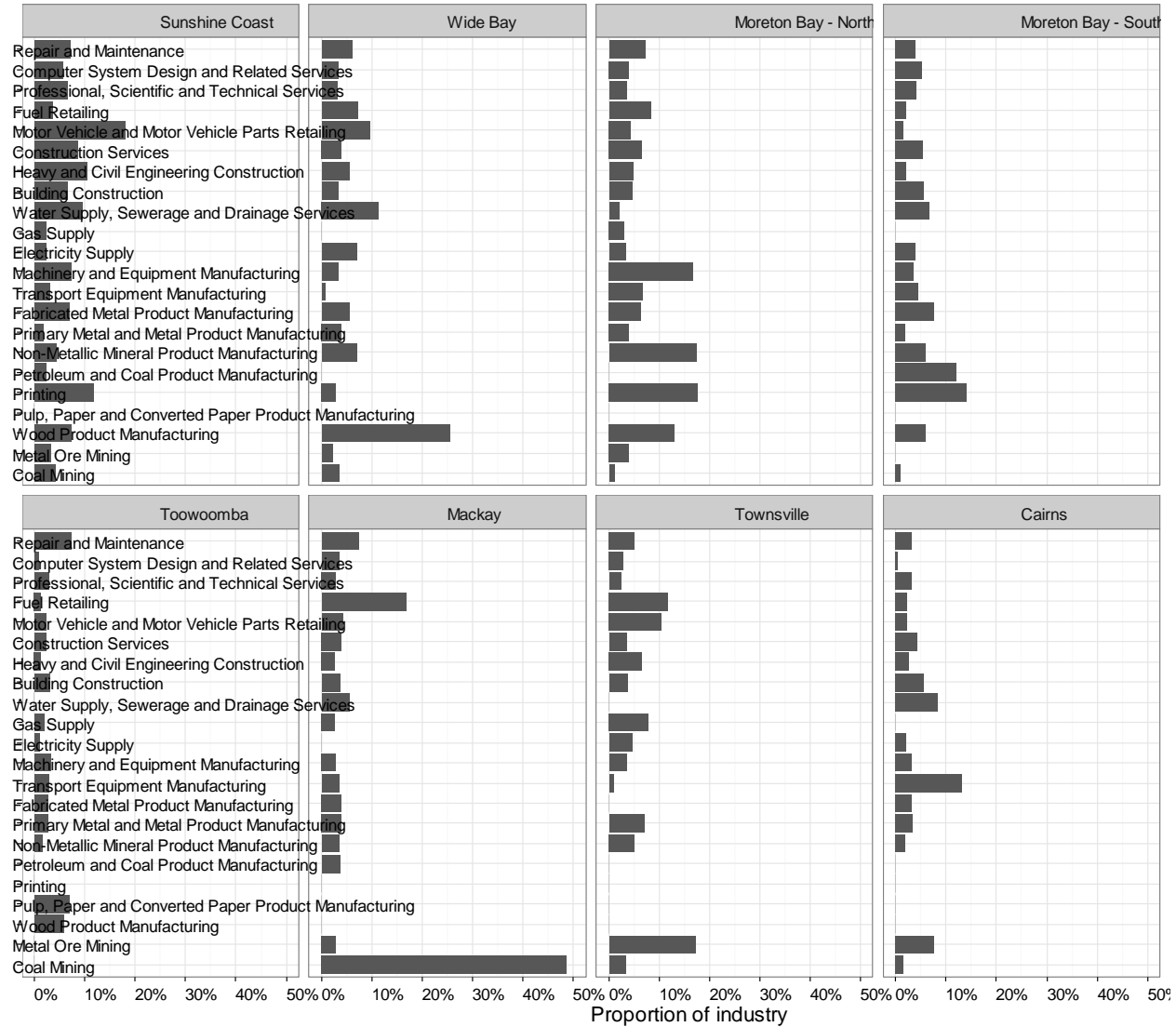


**Figure 11. Selected Industry regional composition (Brisbane Metro and Gold Coast)**

Source: ABS Labour Force Survey Specially Commissioned Tables.

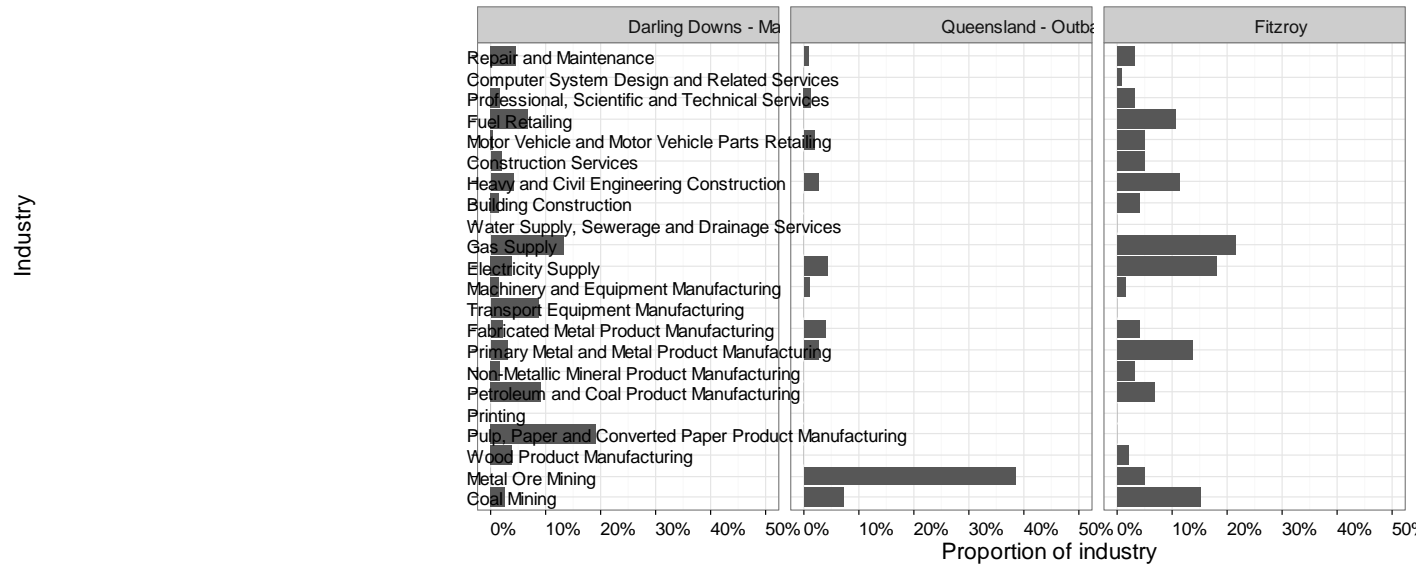
Industry

Industry



**Figure 12. Selected Industry regional composition (Inner Regional Areas)**

Source: ABS Labour Force Survey Specially Commissioned Tables.



**Figure 13. Selected Industry regional composition (Outer Regional Areas)**

Source: ABS Labour Force Survey Specially Commissioned Tables.

## 2 PROFILING OCCUPATIONS AND SKILLS

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### **FACTS UP FRONT:**

- The contemporary Australian labour market can be divided into three groups that reflect the degree of globalisation experienced by each type of employment:
  - Group 1: Positive/Opportunistic – these workers are able to change employment and job roles depending on market factors and conditions (e.g. Fitters & Turners);
  - Group 2: Vulnerable – these workers have insecure employment opportunities, with skills that are job-specific and non-transferrable (e.g. Boilermakers);
  - Group 3: Insulated – these workers have locally specific skills, training and professional qualification (e.g. Printers and Laboratory Technicians).
- It is estimated that one fifth of Australian workers (Group 1) will be able to take advantage of globalisation, while a third will be directly threatened (Group 2). The remaining (around half) possess specific protective skills and expertise that allow them to find different roles (Group 3).
- The three industries that will show the largest growth over a five year period (to 2020) are: Health Care and Social Assistance; Professional, Scientific and Technical; and Education and Training.
- Three of the selected professions have predicted growth (up to 2020) :
  - Lab Technicians, and Graphic and Web Designers (Professional, Scientific and Technical Services); and
  - Fitters & Turners (Metal Fitters and Machinists).
- Employment for Metal Fitters and Machinists is expected to decline from 2020 onwards.
- Employment for Structural Steel and Welding Trades Workers is expected to decline from 2020 onwards.
- Employment for Diesel Mechanics and Auto Technicians is expected to remain relatively steady from 2020 onwards.
- Employment of Aircraft Maintenance Engineer Mechanics is expected to decline over the next five years, and continue to decline past 2020. By 2025, there will be an estimated 30% global workforce shortfall in aircraft maintenance capacity, with the Australia and Asia Pacific region hit the hardest.

**FACTS UP FRONT:**

- Employment for Laboratory and Science Technicians is expected to grow slightly from 2020 onwards, however the opportunities may be limited in some regions.
- Employment for Graphic and Web Designers is growing and is expected to grow strongly from 2020 onwards.
- Employment for Printers is expected to decline from 2020 onwards.

There has been a rapid change and evolution of Manufacturing, including the decline in Manufacturing that has already been experienced and is predicted to continue into the future. One theory proposed to explain this change is that of survival in a declining market; and this is exemplified by the policy around 'Advanced Manufacturing'. In addition to this the manufacturing industry comprises a group of workers with a particular skill set, for example, Printers, Boilermakers, and Fitters & Turners. This is a concern because the industrial usage patterns and relevance of these skills is changing, as new technology and changing product markets alter both the nature of work and the productive use of these skills.

To properly predict future trends for industry and jobs in Queensland and provide insights into the evolution of manufacturing jobs, we need to address the specific job types that currently exist in the Manufacturing industry, as well as the workplaces in which these jobs exist. In order to achieve this we undertook a skills mapping qualitative study of the current skill sets of five key occupations that illustrate the issues facing the Manufacturing industry outlined thus far such as globalisation and the impact of advancing technology. Five interviews were undertaken to provide evidence on the current skills, qualifications and roles of workers, and demonstrates the potential evolution over time for these five key occupations. Results from the five interviews are included as case studies in Section 2.3.

Through the economic modelling approach, we use a production framework for understanding the jobs and skill level demand and supply. This modelling framework uses the concept of *Workforce Quality*<sup>xxv</sup>, a concept that covers all aspects of formal and informal training, including experience. It is a major determinant of overall firm- and economy-level production and, in the short run, productivity. Additions to Workforce Quality come from a variety of formal and informal training programs.

### **Workforce Quality**

The average human capital characteristics of the workforce. Workforce Quality may be quantified by the level of education and training, flexibility (in terms of multi-tasking capability), experience levels, and the degree of supervision required for the workforce to accomplish their objectives. An important indicator of improved Workforce Quality is a reduction in labour cost per unit output, net of capital improvements, which is usually referred to as Overall Labour Effectiveness.

### **Workforce Quality Framework**

A framework involving mapping skills and training to current and emerging work tasks, and combining external hiring, internal training, and the ability to measure the effectiveness of teams rather than individuals in a work place situation. Measures of these concepts often involve competency standards.

## **2.1 THE CONTEMPORARY AUSTRALIAN LABOUR MARKET AND GLOBALISATION**

To understand the factors that will shape the work environment of Queensland manufacturing workers, we must examine trends in the contemporary Australian labour market. The Australian labour market, along with most other advanced economies, undertook a significant structural change from the 1980's onwards as a result of globalisation and the growth in non-standard employment. These changes were highlighted by Maglen<sup>xxvi</sup> who undertook research into the changing nature of employment in Australia from the 1980's onwards. In his research Maglen identified three broad categories for the degree of globalisation of the type of employment. These groups will be referred to in the coming sections. These three groups are:

1. **Positive/opportunistic:** Workers involved in the global economy (conceptual/creative; conceptual/technical). It is estimated that 21% of the Australian workforce is within this group.
2. **Vulnerable:** Workers involved in Manufacturing, white collar clerical, blue collar operative, manual low skill occupations. It is estimated that 35% of the current Australian workforce is within this group.
3. **Insulated:** Workers involved in vocational trades, in-person professional skilled, and low skill occupations, and in occupations protected by locational factors. It is estimated that this group makes up the remaining majority (44%) of the current Australian workforce.

Group 1 are those workers who are able to change employment and job roles depending on market factors and conditions (e.g. Fitters & Turners). Group 2 are workers who have insecure employment opportunities, with skills that are job-specific and sometimes non-transferable (e.g. Boilermakers). Group 3 are those workers who have locally specific skills, training and professional qualifications (e.g. Printers). It is concerning that over one-third of the Australian workforce sits in Group 2.

We will explore those identified in Group 1 (21%) for whom globalisation has opened up new opportunities; and Group 2 those whose jobs have been made more vulnerable (35%). Subsequently, Maglen and Shah<sup>xxvii</sup>

extended Maglen's work. This provided a more detailed description of the occupations involved and the characteristics in each group. In particular they explored how globalisation and its impact on trade has on the Australian workforce, and how the different groups were structured to cope with it. By their observations, about one fifth of Australian workers are able to take advantage of globalization (these are those in Group 1), while over a third (those in Group 2) are directly threatened.

Further observations included:

- In Group 2 Males are more exposed to the impact of globalisation than females (67% versus 42%) because of the distribution of male employment.
- This exposed group are declining as a percentage of the workforce because the jobs that sustain them are becoming less prevalent, and more uncertain.
- Most of Group 1 have tertiary training, but this is not a binding condition as innovation and market awareness are also important.
- Vocational skills under-represented but opportunities supported by vocational training are becoming more significant.<sup>xxviii</sup>
- The most vulnerable workers are located in skilled Manufacturing trades, blue collar operative trades, white collar clerical and manual low-skill occupations, these categories make up 4%, 11%, 8% and 12% of those employed, respectively.
- Changes due to globalisation have masked considerable differences between full-time and part-time employment: growth in full-time employment has been largely in Group 1, indicating that full-time workers are in conceptual/creative or technical occupations.
- The main beneficiaries of this growth in globalisation and full-time employment has been workers in their middle years (aged 35-54 years), and in conceptual or creative occupations, such as graphic designers.
- Growth in employment in early years/early training years has shifted towards part-time.
- The most rapid growth can be seen in technologists and financial specialists.
- There is strong growth in the Arts, Media and Entertainment industry.
- Manufacturing has stalled in percentage terms as an employer of labour, but there has been some local growth in construction, gardening and horticulture, cooking, baking and electronic services.

## **2.2 CURRENT EMPLOYMENT AND PROJECTED JOB GROWTH FOR AUSTRALIA**

Because it is over a decade since the work of Maglen and colleagues on the identification of skills and evolution of employment, it is important to examine how these impact Australia today. The trends continue to prove largely accurate, as confirmed by the Commonwealth Department of Employment industry and occupational forecasts for 2016-2020. We also include the historical forecasts from 2010-2015 to compare the projected forecasts with achieved growth or decline between this period, where possible.



These projections are based on detailed data from the Australian Bureau of Statistics Labour Force Survey. They are derived from models that use time series to forecast employment trends, and take into account regional, industrial and occupational developments<sup>xxix</sup>. The projection for total employment growth for the 2016 Employment Projections is consistent with the Government's forecasts and projections for total employment growth, as published in the December 2015 Mid-Year Economic and Fiscal Outlook (MYEFO).

The average unemployment rate for Australia is between 5.1% and 6.7%. For unemployment rates of each state and territory, see Table 5. For the last 3 years the Australian unemployment rate has hovered around 5.5%, and is highest in Tasmania, Queensland and South Australia – so the natural (average) rate is around 5.5%.

**Table 5: Unemployment Rates (15+) by State and Territory, August 2016**

State or Territory	Unemployment Rate (%)
New South Wales	5.1
Victoria	5.7
Queensland	6.3
South Australia	6.6
Western Australia	6.2
Tasmania	6.7
Australian Capital Territory	3.6
Northern Territory	3.5
AUSTRALIA	5.7

*Source ABS cat no 6202.0, The Labour Force August 2016*

Employment in Australia is projected to increase in 16 of the 19 broad industries over the five years to November 2020. Health Care and Social Assistance is projected to make the largest contribution to employment growth (increasing by 250,200), followed by Professional, Scientific and Technical Services (151,200), Education and Training (121,700) and Retail Trade (106,000). Together, these four industries are projected to provide more than half of total employment growth over the five years to November 2020<sup>xxix</sup>. Specifically:

- Health Care and Social Assistance is projected to increase by up to 780,000 jobs.
- Professional, Scientific and Technical Services is projected to increase by up to 583,000 jobs.
- Education and Training is projected to increase by up to 503,700 jobs.<sup>xxx</sup>

Across the board, the Department of Employment has identified the job roles that are based on tertiary qualifications that will be in the greatest demand for 2015-2025, and related these to the top job roles that are based on vocational skills (these appear in Table 6).

It is important to note that the manufacture of prosthetics, orthotics and bionics, which are expected to increase due to the ageing population, are not directly covered within the health care and social assistance

sector. These fall under Photographic, Optical and Ophthalmic Equipment Manufacturing (ANZSIC code 2411) and Surgical Equipment Manufacturing (ANZSIC code 2412). However, they are clearly health and social assistance related and an expansion of demand in the general health and social assistance area would clearly generate increased demand for these products. The workforce involved in their design and manufacture would come within the Professional Scientific and Technical grouping within labour force classification.

**Table 6: Projected Job Growth in Australia by broad skill type 2015-2025**

Top Tertiary Qualification Jobs	Top Vocational Skills Jobs
1. Registered Nurses	1. Aged and Disabled Carers
2. Advertising and Sales Managers	2. Child Carers
3. Software and Applications Programmers	3. Electricians
4. Accountants	4. Nursing Support and Personal Care Workers
5. CEO and Managing Directors	5. Construction Managers
6. Secondary School Teachers	6. Real Estate Sales Agents
7. Primary School Teachers	7. Welfare Support Workers
8. Private Tutors and Teachers	8. Metal Fitters and Machinists <sup>†</sup>
9. Contract Program and Project Administrators	9. Plumbers
10. General Managers	10. Education Aides

<sup>†</sup> Vocational jobs within the Manufacturing industry

Source: "Future of Work: Top jobs for 2025 derived from Future Focus Report"  
<http://thenewdaily.com.au/money/work/2013/12/10/top-jobs-2025/>

The job growth predictions in Table 6 reflect the broader employment-by-industry predictions outlined above. For example, Registered Nurses (Tertiary), Aged and Disabled Carers, Nursing support, and Personal Care Workers, reflect the predicted growth in Health Care. Secondary and Primary Teachers, and Private Tutors and Teachers reflect the predicted growth in Education. Of most relevance to the Queensland Manufacturing industry is the predicted growth in the Professional, Scientific and Technical Services (Lab Technicians and Graphic and Web Designers), Metal Fitters and Machinists (Fitters & Turners), and Auto Electricians.

The Department of Employment also produced a measure of the level of job demand by skill level, shown in Table 7. It can be seen from Table 7 that predicted growth by skill is split between the largest group of predicted growth, Skill Level 1 (13.0% of the total predicted growth), and the second largest group, Skill Level 4 (7.1%).

**Table 7: Department of Employment Projections (2015) - Employment by Skill Level**

Skill Level	Department of Employment Projections					
	Current Employment November 2015		Projected employment November 2020		Projected employment growth Five years to November 2020	
	('000)	(%)	('000)	(%)	('000)	(%)
Skill Level 1	3723.0	31.3	4205.9	32.6	482.9	13.0
Skill Level 2	1363.8	11.5	1514.4	11.8	150.5	11.0
Skill Level 3	1733.2	14.6	1805.7	14.0	72.6	4.2
Skill Level 4	3043.1	25.6	3257.8	25.3	214.7	7.1
Skill Level 5	2037.4	17.1	2106.4	16.3	69.0	3.4
<b>Total</b>	<b>11,900.5</b>		<b>12,890.2</b>		<b>989.7</b>	<b>8.3</b>

*By way of definition Skill level 1 translates into a tertiary qualification; Doctoral, Masters, Honours or Bachelor degree, skill level 2 Associate degree, Advanced Diploma, Diploma, skill level 3, Certificate 4, Skill level 4, Certificate III*

*Source: Department of Employment Industry Projections Report<sup>xxxix</sup>*

Slightly more optimistically, the Australian Workforce and Productivity Agency Future Focus report extended the range of these projections to 2025 and forecasts that Australia will have between 5.6 million and 6.4 million job openings in the years to 2025<sup>xxx</sup>. The forecasts need to be further defined to take account of part-time and contingent positions.

### 2.3 SKILLS MAPPING OF SEVEN CORE CALLINGS

In our analysis of Manufacturing we have focused on 22 ANZSIC subindustries detailed in Appendix III, Table 21, with a more detailed investigation of seven key occupational groups (See Table 8).

In this section each occupation listed in Table 8 is examined for linked industry subgroups, skill level and future job growth prospects. To assist in this section, an Australian Bureau of Statistics concordance, modified by the Queensland Department of Education, Training and Employment (DETE) linking industry, occupation and skill and qualification data was used. With this concordance it is possible to identify closely related employment fields by skill type<sup>xxxi</sup>. This concordance relates ANZSCO code to ASCED code and AQF/Skill level, and will be used in the skills mapping exercise. The five interviews conducted as part of the qualitative skills mapping were with people that fit into the occupations outlined in Table 8. The five occupations chosen were Fitter & Turner, Boilermaker, Diesel Mechanic, Laboratory Technician and Printer. These five occupations were chosen as Fitters & Turners, Boilermakers, and Diesel Mechanics are representative of occupations that have a high representation across Queensland manufacturing so it is important to explore the impact on these occupations. Printing was chosen due to the impact of advancing technology on the demand for traditional print and the advancements in 3D printing. Laboratory Technicians were chosen as an emerging sector of scientific and medical research.

In the following sections we provide a summary of the job prospects for people employed within these key occupations, to provide an understanding of future projections and the impact on the evolution of the roles for these specific occupations.

**Table 8. Selected occupation groups for detailed analysis**

Occupation	Queensland employers
Fitter and Turner*	Hastings Deering/Arnott's
Boilermaker*	Callide Coal Mine
Diesel Mechanic*	Volvo
Auto Technician	K-Mart Tyre & Auto
Aircraft Maintenance Engineer Mechanic	QANTAS
Lab Technician*	ALS Coal
Designer	BCC
Printer*	Newspaper

\* *Qualitative Interviews Conducted*



### 2.3.1 Fitters & Turners

Metal Fitters and Machinists (ANZSCO 3232, ASCED 030700- 030711) fit and assemble fabricated metal parts into products, set up machining tools, production machines and textile machines and operate machines to shape metal stock and castings. Related industry subgroups are provided in Table 9.

**Table 9: Fitters & Turners - ASCED and Related occupations**

ASCED Code	Industry and related industry subgroup
030700	Mechanical and Industrial Engineering and Technology
030701	Mechanical Engineering
030703	Industrial Engineering
030705	Toolmaking
030707	Metal Fitting, Turning and Machining
030709	Sheet-metal Working
030711	Boiler-making and Welding

Source: Department of Education, Training and Employment (DETE) Concordance (2016)

This occupation was chosen to be included in the skills mapping, the case study is included over the page.

For a full list of the current tasks for the above subgroups see Appendix VI. The main qualifications associated with Fitters & Turners, according to the DETE concordance are:

- MEM30398 Certificate III in Engineering – Fabrication Trade
- MEM30305 Certificate III in Engineering – Fabrication Trade
- MEM30330F Certificate III in Engineering – Fabrication Trade (1<sup>st</sup> Class Sheet Metal Worker)
- MEM30205 Certificate III in Engineering – Mechanical Trade
- MEM 30105 Certificate III in Engineering – Production Systems

#### **2.3.1.1 Job Prospects for Fitters & Turners<sup>xxxii</sup>**

- Between 2016 and 2019, the number of job openings for Metal Fitters and Machinists is expected to be high (greater than 50,000). Job openings count both employment growth and turnover (defined as ‘workers leaving their occupation for other employment or leaving the workforce’).
- Employment for this occupation rose strongly (in percentage terms) in the past five years but flat-lined when viewed over the longer 10 year period, rising only slightly. Looking forward, employment for Metal Fitters and Machinists by November 2020 is expected to start to decline. Based on projections and the current outlook, there is a projected increase overall for the 2010-2025 fifteen year period. This is made up of strong growth from 2010-2015, followed by weaker growth from 2016-2020, and decline from 2021-2025.
- This is a very large occupation (117,200 people in November 2015), suggesting that opportunities should be available in most regions.
- Metal Fitters and Machinists have a very high proportion of full-time jobs (95.7%). For Metal Fitters and Machinists working full-time, average weekly hours are 42.3 (compared to 40.2 for all occupations) and earnings are above average - in the seventh decile. Unemployment for Metal Fitters and Machinists is below average.
- The most common level of educational attainment for Metal Fitters and Machinists is Certificate III/IV (77.0%).
- Metal Fitters and Machinists are mainly employed in: Manufacturing; Mining; and Other Services.

# Case Study: Fitter and Turner

Group 1: Positive/Oppportunistic. Skills are transferable, able to change job roles.

**Age:** Early thirties.

**Years in the industry:** Thirteen.

**Highest education qualification:**

Certificate III Engineering - Mechanical, currently completing Certificate IV Engineering (in own time).

**Transferable skills from apprenticeship:**

Mechanical fitting, machining, safety, risk management, time management.

**Skills developed on the job through career progression:**

1. **Senior/lead technician:** Paperwork, administration permits, and procedural writing.
2. **Leading Hand:** People management, People Skills, and Interpersonal Skills.
3. **Work Pack/Test Pack Making:** Planning, Coordination, and Scheduling.
4. **Acting Superintendent:** Project Management.

**Occupations interacted with the most:**

Electricians, Crane drivers, Riggers, Doggers, Civil Personnel, Human Resources, Vendors, Contractors, Subcontractors, Clients and Stakeholders.

**Educational Goals:** Certificate IV, Diploma of Mechanical Engineering.

**Career Goals:** Management or supervision.

**Skills Required for Career Progression:** Frontline management.

Fitters & Turners Comments Regarding:

**Education:** "I got into metalwork, woodwork, (at high school) because, it was the type of thing I want to do later. It kind of helped because some of the things we did in metalwork actually counted towards our points or competencies within our apprenticeship."

"Completing a Certificate I in school gave us a sort of little step up or a bit more confidence when approaching the apprenticeship."

**Skills:** "Yeah, it (picking up skills on the job, by taking on extra responsibilities) has (enabled me to transition into higher roles). Because I was (employed) as a commissioning technician and I was approached (to see) if I wanted to become the senior technician or the lead technician and I said, 'Yes'. From there I sort of took on extra responsibilities that other leads wouldn't take. I was approached, by my supervisor a lot, who became the superintendent on the following project, a lot to do extra work and more responsibilities."

"That's why I pushed, doing my certificate IV. Just (to) get the skill set up higher and just try to jump above everyone else, you know, eliminate that competition, basically."

**The Future:** "I reckon there's going to be a struggle on finding trades people."

"...there's not a lot of young apprentices coming through."

"I can see more and more things getting built overseas."

"Because it's cheaper and quicker and then being shipped to Australia. That's what they're doing now instead of building it from scratch."

"I reckon there could be a skill shortage within 10 years or maybe a bit after."



### 2.3.2 Boilermakers

Boilermakers (ANZSCO 3222 ACSED 030711) operate within the structural steel and welding trades. They cut, shape, join and repair metal components of iron and steel structures, boilers, pressure vessels and pipes, ships and other vessels. Boilermakers are included in the ANZSCO sub-code of Mechanical and Industrial Engineering and Technology<sup>xxxiii</sup>. The DETE concordance suggests that other closely related fields are detailed in Table 10.

**Table 10: Boilermakers - ASCED and Related occupations**

ASCED Code	Industry and related industry subgroup
030701	Mechanical Engineering
030703	Industrial Engineering
030705	Toolmaking
030707	Metal Fitting, Turning and Machining
030709	Sheet Metal Working
030711	Boiler-making and Welding
030713	Metal Casting and Patternmaking
030715	Precision Metalworking

This occupation was chosen to be included in the skills mapping, the case study is included over the page.



For a full list of the current tasks for the above subgroups see Appendix VII. Boilermakers tend to have a mixture of certificates ranging from Certificate I to III and Certificate IV, and include:

- MEA30111 Certificate III in Aircraft Surface Finishing
- MEA30107 Certificate III in Aircraft Surface Finishing
- CN941 Diploma of Engineering
- MEM40105 Certificate IV in Engineering
- CN100 Certificate III in Engineering (Fabrication- Heavy and Light)

#### **2.3.2.1 Job prospects for Boilermakers**

- For the period 2016-2019, the number of job openings for Structural Steel and Welding Trades Workers is expected to be between 25,001 and 50,000. Job openings count both employment growth and turnover (defined as 'workers leaving their occupation for other employment or leaving the workforce'). This is based on projections and the current outlook.
- Although employment for this occupation fell slightly in the past five years, over the long-term (the past ten years) employment remained relatively steady. Looking forward, employment for Structural Steel and Welding Trades Workers to November 2020 is expected to decline, mainly due to their primary skills not being easily transferable to other emerging industrial roles.
- This is a very large occupation (70,600 people in November 2015), suggesting that opportunities should be available in most regions.
- Structural Steel and Welding Trades Workers have a very high proportion of full-time jobs (95.6%). For Structural Steel and Welding Trades Workers working full-time, average weekly hours are 41.5 (compared to 40.2 for all occupations) and earnings are average - in the sixth decile. Unemployment for Structural Steel and Welding Trades Workers is below average.
- The most common level of educational attainment for Structural Steel and Welding Trades Workers is Certificate III/IV (66.8%).
- Structural Steel and Welding Trades Workers are mainly employed in: Manufacturing; Construction; and Professional, Scientific and Technical Services.

# Case Study: Boilermaker

Group 2: Vulnerable. Skills are not immediately transferable, difficulty in changing job roles.

**Age:** Early forties.

**Years in the industry:** Twenty-one.

**Highest education qualification:** Certificate III in Engineering (Fabrication – Heavy and Light).

**Transferable skills from apprenticeship:**

Communication, reading drawings, marking out fabrication, hand tool use, press use, welding, and oxy cutting.

**Other training completed:**

Dogman, rigger, elevated work platform, forklift, leadership, occupational health and safety, computer-aided drafting (CAD), computer skills, and frontline management.

**Skills developed on the job:**

Time management, personnel management, problem-solving, risk assessment and management.

**Career progression:** Boilermaker in workshops and on site, leading hand, supervisor, superintendent.

**Occupations most interacted with:**

Engineers, project managers, administration staff, electricians, pipefitters, boilermakers, mechanics, riggers, labourers, truck drivers, forklift drivers, cleaners, operators, storemen, painters, civil workers, accountants, shipwrights, managers, stakeholders, paramedics, and security guards.

**Skills required in the future:** More computer-based training, e.g. programming and planning.

Boilermakers' comments regarding...

**How the job has changed:** "When I first started we were doing small modules... now we're getting these large modules that are coming in from overseas. So a lot of the issues that we get have already been rectified by the time they get here. But the basic skills are still required."

"15 years ago, all the separate steelworks would come together and then we would have fabricated them or erected them onsite, whereas now it comes in a big module where you just land the module and then secure (it)."

**Skills shortage:** "I do think possibly in 15 or 20 years, there will be a lack of people who are skilled to do the jobs that a lot of the people on these construction jobs do."

"It (a skills shortage) is happening now... when I did my (apprenticeship), I did it with 10 other blokes and then... one of my nephews went through the same workshop... six to 10 years later and he went through with four other blokes... That's a big drop just there in that one little workshop. So if you do that across... 30 or 40 major workshops... that's a big drop in people."

"We've got a couple of apprentices on this job, they're a little bit lost because they're not getting to see a lot of the basic skills that they do need because of the nature of what we're doing. They're not really getting a good grasp of the basics. They're knowing how to fix things, but they're not knowing how to make things properly."

"... now you don't have to start learning because it's already done for you."

**The future:** "I think the industry will tend to go back towards smaller jobs, rather than these big megaprojects... hopefully then we'll create the smaller modules and things like that, so that there would be more work created that way."

"I don't think what we're doing will change a lot.... Safety becomes more prevalent, but... we still need to have that inherent risk in there because what we do is high risk."

"It (technology) might save us a little bit of paperwork... it's not really going to change the actual construction of how we put things together... there may be less (repairs) due to the fact that with technology, maybe things are made better."



### 2.3.3 Diesel Mechanics and Auto Technicians

Diesel mechanics (ANZCO code 3211- 3214, ASCED code 030500-030505) are included in the ANZSCO sub- code of Automotive Engineering and Technology. They are linked with the following broad occupational classifications, which are specified in Table 11.

**Table 11: Diesel Mechanics and Auto Technicians - ASCED and Related occupations**

ASCED Code	Industry and related industry subgroup
321211	Motor Mechanic (General)
321212	Diesel Motor Mechanic
321213	Motorcycle Mechanic
321214	Small Engine Mechanic

Source: *DETE Concordance (2016)*

This occupation was chosen to be included in the skills mapping, the case study is included over the page.

### 2.3.3.1 Closely related occupational subgroups:

The concordance, identifies occupational subgroups closely related to Diesel Mechanics as:

- Automotive Engineering
- Vehicle Mechanics
- Automotive Electrics and Electronics
- Automotive Vehicle Refinishing
- Automotive Body Construction

For a full list of the current tasks for the above subgroups see Appendix VIII. The same concordance may be used to identify the principal levels of training associated with Diesel Mechanics. People employed in these roles tend to have a mixture of Certificate III and Certificate IV qualifications, and include:

- AUR40212 Certificate IV in Automotive Mechanical Diagnosis
- AUR40812 Certificate IV in Automotive Mechanical Overhauling
- AUR30495 Certificate III in Automotive Mechanical Technology
- AUR30412 Certificate in Agricultural Mechanical Technology
- AUR31512 Certificate III in Automotive Diesel Engine Technology
- AUR31412 Certificate in III in Automotive Diesel Fuel Technology
- AUR31612 Certificate III in Automotive Drivetrain Technology
- AUR30899 Certificate III in Automotive (Mechanical – Heavy Vehicle Road Transport)
- AUR32412 Certificate III in Automotive Refinishing Technology
- AUR30605 Certificate III in Automotive Specialist
- AUR30605DF Certificate III in Automotive Specialist (Diesel Fitting)
- 22015VIC Certificate in Automotive Studies (pre-vocational)
- AUR50205 Diploma of Automotive Technology
- AUR50212 Diploma of Automotive Technology
- AUR40208 Certificate IV in Automotive Technology

### 2.3.3.2 Job Prospects for Diesel Mechanics and Auto Technicians<sup>xxxii</sup>

Recent projections of job growth in this sub occupational group are difficult to obtain. The conclusions below are based on the Commonwealth Department of Employment, job prospects projection exercise which covered the years 2015-2019 inclusive.<sup>xxxii</sup>

- Over the period 2015-2019, the number of job openings for Diesel Mechanics and Auto Technicians is expected to be between 25,001 and 50,000. Job openings count both employment growth and turnover (defined as workers leaving their occupation for other employment or leaving the workforce).
- Taken over a ten-year period there has been a slight increase in employment in this occupation, however this rate of growth has accelerated over the last 5 years (in percentage terms). Employment for this occupation rose strongly (in percentage terms) in the past five years and rose slightly in the long-term (the past ten years). Looking forward, employment for Diesel Mechanics and Auto Technicians to November 2020 is expected to remain relatively steady. This is based on projections and the current outlook.

- This is a very large occupation (100,700 people in November 2015) suggesting that opportunities should be available in most regions.
- Diesel Mechanics and Auto Technicians have a very high proportion of full-time jobs (94%). For Diesel Mechanics and Auto Technicians working full-time, average weekly hours are 41.0 (compared to 40.2 for all occupations) and earnings are below average - in the third decile. Unemployment for Motor Mechanics is average.
- The most common level of educational attainment for Diesel Mechanics and Auto Technicians is Certificate III/IV (70.7%).
- Diesel Mechanics and Auto Technicians are mainly employed in Other Services; Retail Trade; and Transport, Postal and Warehousing.

# Case Study: Diesel Mechanic

Group 1: Positive/Oppportunistic. Skills are transferable, able to change job roles.

**Age:** Under 30.

**Years in the Industry:** Five.

**Highest Education Qualification:**

Certificate of Completion Automotive (Mechanical – Heavy Vehicle Road Transport).

**Transferrable Skills from apprenticeship:**

Mechanical Skills for servicing trucks, trailers and engines; Time Management, Documentation, Record Keeping, Risk Assessments, Chemical Handling, Operating Procedures, Inventory Management, Written and Verbal Communication Skills, Interpersonal Skills, and Customer Service.

**Skills developed on the job:** Diagnostic Computers, programming, reprogramming, and emissions control.

**Will the skills required change:**

Yes, you will need more computer skills and emissions training. Cars, vans and trucks become more computerised and they will be even stricter with emissions.

**Occupations interacted with the most:**

Foreman, other work colleagues, the customer, the customer's boss, parts and towing workers, and vehicle manufacturers.

Diesel Mechanics Comments Regarding:

**Education:**

"I would still be using all the skills that I've learned."

"... being a mechanic there's no skill, really, that you learn, that you don't really use again."

"Seeing it was such a small workshop, as a first year, instead of sweeping the floors I was actually doing services and already on the tools."

"I had to learn quicker, which is good."

"They would need to put a lot more into the electronic side of things in the future, including how electronics work, doing the diagnostics programming, reprogramming, re-learning and general diagnostic computer work."

**Technology:**

"(New) ambulances, they've got more computers than the first rocket to the moon had."

**The Future:**

"...bigger trucks, they're not as computerised and I think in the future they're going to be a lot more computerised."

'I'm sure there's going to be a lot more programming and sensors and all that sort of thing. They're going to monitoring (emissions and performance) a lot more so they're going to need a lot more of the electronic side of things.'



Stoyan Yotov / Shutterstock.com

### 2.3.4 Aircraft Maintenance Engineer (AME) Mechanics

AME Mechanics (ANZSCO 323112, ASCED 031500-031599) maintain and repair aircraft structures and avionic and mechanical systems. The DETE concordance indicates that they are included in the ANZSCO sub-code of Aerospace Engineering and Technology. From the concordance, the other closely related fields included in this sub-code are provided in Table 12.

**Table 12: AME Mechanics - ASCED and Related occupations**

ASCED Code	Industry and related industry subgroup
031501	Aerospace Engineering
031501	Aircraft Maintenance Engineering
031505	Aircraft Operation
031507	Air Traffic Control
031599	Aerospace Engineering and Technology, n.e.c.

Source: DETE Concordance (2016)

For a list the main current tasks of AME mechanics please see Appendix VIV. Main Qualifications of AME Mechanics (Certificate IV and Diplomas), according the DETE concordance for AME Mechanics (ANZSCO 323112, ASCED 031500-031599) include:

- MEA40615 Certificate IV in Aero-skills (Avionics)
- MEA40602 Certificate IV in Aero-skills (Avionics)
- MEA40610 Certificate IV in Aero-skills (Avionics)
- MEA40611 Certificate IV in Aero-skills (Avionics)
- MEA50207 Diploma of Aero-skills (Mechanical)
- MEA50210 Diploma of Aero-skills (Mechanical)
- MEA50211 Diploma of Aero-skills (Mechanical)
- MEA40715 Certificate IV in Aero-skills (Mechanical)
- MEA40702 Certificate IV in Aero-skills (Mechanical)
- MEA40707 Certificate IV in Aero-skills (Mechanical)
- MEA40710 Certificate IV in Aero-skills (Mechanical)
- MEA40711 Certificate IV in Aero-skills (Mechanical)
- MEA40802 Certificate IV in Aero-skills (Mechanical)
- MEA40807 Certificate IV in Aero-skills (Mechanical)
- MEA40810 Certificate IV in Aero-skills (Mechanical)
- MEA41311 Certificate IV in Aero-skills (Mechanical)

#### **2.3.4.1 Job Prospects of AME Mechanics<sup>xxix</sup>**

- Between 2016 and 2019, the number of job openings for AME Mechanics is expected to be low (equal to or less than 5,000). Job openings count both employment growth and turnover (defined as 'workers leaving their occupation for other employment or leaving the workforce').
- Over the last ten years, employment levels in this occupation have fell markedly, and this downward trend has accelerated over the last 5 years. Looking forward, employment for AME Mechanics to November 2020 is expected to decline.
- This is a small occupation (9800 people in November 2015), suggesting that opportunities may be quite limited in some regions.
- AME Mechanics have a very high proportion of full-time jobs (94.2%). For AME Mechanics working full-time, average weekly hours are 39.9 (compared to 40.2 for all occupations) and earnings are high - in the ninth decile. Unemployment for AME Mechanics is average.
- The most common level of educational attainment for Aircraft Maintenance Engineers is Certificate III/IV (64.2%).
- AME Mechanics are mainly employed in: Manufacturing; Transport, Postal and Warehousing; and Public Administration and Safety.



- Based on current projections, the Australian workforce needs to expand by about 30% from current staffing levels<sup>xxxiv</sup>. Specifically:
  - By 2025, there will be an estimated 30% global workforce shortfall in aircraft maintenance capacity, with Australia and the Asia Pacific region particularly hard hit. Therefore Australia has both a strong need and excellent opportunity to help meet this shortfall in the region.
  - There is a significant need to rebuild aircraft maintenance and maintenance training industries by 2020 to permit Australia to handle a high proportion of its own needs across the civilian airline, general aviation and Defense sectors.
  - There is considerable opportunity to capitalise on Australia's strong safety standards and high end maintenance capability, by building a maintenance and training capacity capable of competing aggressively in the highest-value niches of the global market.



### 2.3.5 Laboratory Technicians (Science Technicians)

Science (Lab) Technicians (ANZSCO, 3112-3114) perform tests and experiments, and provide technical support functions to assist with research, design, production and teaching in chemistry, earth sciences, life sciences, and physical science. In ANZSCO groupings, according to the DETE concordance they are linked with the Other Natural and Physical Sciences. If your profession is *Medical Laboratory Technician* in accordance with the Australian and New Zealand Standard Classification of Occupations (ANZSCO) 3112-13, you are currently in demand by employers in Australia. Linked occupations according to the concordance, and are provided in Table 13.

**Table 13: Laboratory Technicians - ASCED and Related occupations**

ASCED Code	Industry and related industry subgroup
11411	Chemistry Technician
311412	Earth Science Technician
311413	Life Science Technician
311414	School Laboratory Technician
311499	Science Technicians

Source: DETE Concordance (2016)

This occupation was chosen to be included in the skills mapping due to the enhanced opportunities for Laboratory Technicians within the emerging sector of scientific and medical research. The case study is included over the page.

For a full list of the current tasks for the above subgroups see Appendix V.V. The main skills qualifications or these workers range from Certificates III and IV, but mainly higher education diplomas and include:

- RUV50104 Diploma of Animal Technology
- ACM50110 Diploma of Animal Technology
- AHC51210 Diploma of Community Coordination and Facilitation
- SFI50411 Diploma of Fisheries Compliance
- SFI40411 Certificate IV in Fisheries Compliance
- PML60104 Advanced Diploma of Laboratory Operations
- PML30104 Certificate III in Laboratory Skills
- MSL301109 Certificate III in Laboratory Skills
- MSL401109 Certificate IV in Laboratory Techniques
- PML40104 Certificate IV in Laboratory Techniques
- MSL501109 Diploma of Laboratory Technology
- PML50104 Diploma of Laboratory Technology

#### **2.3.5.1 Job Prospects for Laboratory/Science Technicians**

- During the period 2016-2019 the number of job openings for Science Technicians is expected to be below average (between 5,001 and 10,000). Job openings count both employment growth and turnover (defined as 'workers leaving their occupation for other employment or leaving the workforce').
- Over the last ten years there has been a slight growth in employment in this occupation. However, this growth has accelerated over the last 5 years. Looking forward, employment for Science Technicians to November 2020 is expected to grow slightly.
- This is a medium sized occupation (16,100 people in November 2015), suggesting that opportunities may be limited in some regions.
- Science Technicians have an above average proportion of full-time jobs (78.4%). For Science Technicians working full-time, average weekly hours are 36.4 (compared to 40.2 for all occupations) and earnings are average - in the fifth decile. Unemployment for Science Technicians is average.
- The most common level of educational attainment for Science Technicians is Certificate III/IV (28.3%).
- Science Technicians are mainly employed in: Education and Training; Manufacturing; and Professional, Scientific and Technical Services.

# Case Study: Laboratory Assistant

Group 3: Insulated. Possess technical expertise. Skills are transferable, able to change job roles.

**Age:** Late thirties.

**Years in the industry:** Five.

**Highest education qualification:** Certificate III.

**Transferable Skills:** Time management, forklift licence, computer skills.

**Essential abilities:** Follow JSAs (Job Safety Analysis) and work procedures to the letter.

**Will the skills required change:** Only if the required equipment or information changes.

**Training:** On the job training to use all the specialised equipment.

**Future skills:** It is not expected that the skills required will change in the future.

**Career progression:**

Not available at the current workplace. Would have to seek employment elsewhere, outside of current industry.

**Skills required for career progression:**

Administration, Additional Computer Skills (more than Excel and formulas), Interpersonal Skills, People Management Skills, and Business Management Skills.

**Occupations interacted with the most:** Miners, Couriers, and Tradespeople.

Laboratory Assistants Comments Regarding:

**Transferable Skills:**

"...time management was definitely a big part. The forklift as well."

"...I was the only one there at the time with a full forklift licence. So, that was very helpful."

**Education:**

"you have to go through an actual course to become a qualified... There's different levels of Certificate for that. But, I was just starting that when the course was dropped by upper management. So didn't quite get to complete that."

(For future jobs I would need) "...more (people) management skills,... maybe more admin, just general... computer skills as well actually, rather than just using Excel and formulas. Probably a few more interpersonal skills as well because you don't really get a lot of contact with outside people when you're in the lab."

**Technology:**

"... unless they change the type of equipment that we use then there's not a great deal, really, that can be improved or changed about the process that we do."

"...they're pretty specific about what they're chasing... unless they start wanting more and even more detailed analysis and start adding more procedures then there's pretty much not a lot that's going to change."

**The Future:**

"Unfortunately there's nowhere else I can go in this organisation."



### 2.3.6 Graphic and Web Designers

Graphic and Web Designers (ANZSCO 232411- 232414, ASCED 100300) produce information for visual and audio communication, publication and display using print, film, electronic, digital and other forms of visual and audio media. Related occupations are provided in Table 14.

**Table 14: Graphic and Web Designers - ASCED and Related occupations**

ASCED Code	Industry and related industry subgroup
232411	Graphic Designer
232412	Illustrator
232413	Multimedia Designer
232414	Web Designer

Source: DETE Concordance (2016)

For a full list of the current tasks for the above subgroups see Appendix VVI. Most occupations in this unit group have a level of skill commensurate with a bachelor degree or higher qualification. At least five years of relevant experience may substitute for the formal qualification. In some instances relevant experience and/or on-the-job training may be required in addition to the formal qualification (ANZSCO Skill Level 1). The skills concordance indicates that formal qualifications associated with graphic and web designers include:

- 30673QLD Certificate III in Commercial Arts (Graphic Design and Desktop Publishing)
- ICA50211 Diploma of Digital and Interactive Games
- IC50911 Diploma of Digital Media Technologies
- ICA40811 Certificate IV in Digital Media Technologies
- CU60411 Advanced Diploma of Graphic Design
- 49148QLD Diploma of Graphic Design
- CUV50311 Diploma of Graphic Design

#### **2.3.6.1 Job Prospects for Graphic and Web Designers<sup>xxxii</sup>**

- Over the period 2016-2019, the number of job openings for Graphic and Web Designers, and Illustrators is expected to be above average (between 25,001 and 50,000). Job openings count both employment growth and turnover (defined as workers leaving their occupation for other employment or leaving the workforce)
- Employment for this occupation has risen moderately when considered over the last 10 years but has fallen slightly in the last 5 years. Looking forward, employment for Graphic and Web Designers, and Illustrators to November 2020 is expected to grow strongly.
- This is a very large occupation (46,500 people in November 2015), suggesting that opportunities should be available in most regions.
- Graphic and Web Designers, and Illustrators have an above average proportion of full-time jobs (78.1%). For Graphic and Web Designers, and Illustrators working full-time, average weekly hours are 39.4 (compared to 40.2 for all occupations) and earnings are average - in the sixth decile. Unemployment for Graphic and Web Designers, and Illustrators is average.
- The most common level of educational attainment for Graphic and Web Designers, and Illustrators is Bachelor degree (48.8%).
- Graphic and Web Designers, and Illustrators are mainly employed in: Professional, Scientific and Technical Services; Manufacturing; and Information Media and Telecommunications.



### 2.3.7 Printers - Manufacturing Engineering and Technology

Printers (ANZSCO 3923, ASCED 030100) have wide and varied roles setting up and operating letterpress, lithographic, flexographic, gravure, newspaper, instant, digital and offset printing presses. They are employed under the ANZSCO subgroup *Printing*. Printing machinists set up and operate small offset printing presses used in instant print shops or for in-house printing (Skill Level 3). However, there are some specialised roles involved with the operation of specific machines with higher skill levels required. The related occupations associated with this job profile are detailed in Table 15. For a full list of the current tasks for the subgroups in see Table 15 and Appendix V.VII.

**Table 15: Printers: Manufacturing Engineering and Technology - ASCED and Related occupations**

ASCED Code	Industry and related industry subgroup	Specialisations
392311	Printing Machinist	Flexographic Printing Machinist Gravure Printing Machinist Label Printing Machinist
392312	Small Offset Printer	Letterpress Printing Machinist Lithographic Printing Machinist Reel Fed Printer Sheet Fed Printer

Source: DETE Concordance (2016)

This occupation was chosen to be included in the skills mapping due to the changes impact of changing technology on the demand for traditional print and 3D printing. The case study is included over the page.

### **2.3.7.1 Indicative Skill Level**

Most occupations in this unit group have a level of skill commensurate with the qualifications and experience outlined below. In Australia, AQF Certificate III includes at least two years of on-the-job training. The qualifications of people in these roles typically include:

- Diploma of Printing and Graphic Arts (Digital Production)
- Certificate IV in Printing and Graphic Arts (Multimedia)
- Certificate IV in Printing and Graphic Arts (Print Finishing 1)
- Certificate IV in Printing and Graphic Arts (Print Finishing 2)
- Certificate IV in Printing and Graphic Arts (Print Finishing 3)
- Certificate IV in Printing and Graphic Arts (Printing)
- Certificate IV in Printing and Graphic Arts (Printing)
- Certificate III in Printing and Graphic Arts (Printing)
- Certificate III in Printing and Graphic Arts (Screen Printing)

### **2.3.7.2 Job Prospects for Printers**

- Between the years 2016- 2019, the number of job openings for Printers is expected to be low (equal to or less than 5,000). Job openings count both employment growth and turnover (defined as 'workers leaving their occupation for other employment or leaving the workforce').
- Long-term employment for this occupation has remained relatively steady over the last 10 years but more recently (last 5 years) has started to decline. Looking forward, employment for Printers to November 2020 is expected to decline. This is based on projections and the current outlook.
- This is a medium sized occupation (13,700 people in November 2015), suggesting that opportunities may be limited in some regions.
- Printers have a high proportion of full-time jobs (91.3%). For Printers working full-time, average weekly hours are 38.6 (compared to 40.2 for all occupations) and earnings are below average - in the third decile. Unemployment for Printers is below average.
- The most common level of educational attainment for Printers is Certificate III/IV (60.0%).
- Printers are mainly employed in: Manufacturing; Information Media and Telecommunications; and Wholesale Trade.



## Case Study: Printer

Group 3: Insulated. Possesses technical expertise. Skills are transferable, able to change job roles.

**Age:** Early sixties.

**Years in the industry:** Fifty.

**Highest education qualification:** Apprenticeship - Letter Press Machinist.

**Transferrable skills from career:**

Machine Maintenance, Time Management, 'Make-Ready', Setting the Rollers to .918 (type high), Interpersonal Skills, Risk Management, Press Operation, Registration, and Chemical Safety.

**Occupations interacted with the most:**

Electricians, Computer Technicians, Maintenance Fitters, Management, Publishing Room Operators, and Printer's Assistants.

Printers Comments Regarding:

**Employment:**

"...you're fairly lucky to have a career in one trade these days."

**Education:**

"The biggest transition was probably to offset."

"Lucky for me there was an apprentice that was working on the next press to me and he gave me a crash course in it (offset) because there was really no vehicle to up skill..."

**Technology:**

"...the presses were very slow in those days, so you might only be doing 5,000 or 6,000 copies an hour. That was a fairly fast speed (back then)."

"...these ones do 70,000 (newspapers) an hour."

"(Moving from letter press to offset), everything that you knew (about printing) was thrown out the door."

"They use Offset now. It's a lot more computerised now though."

"Most of the things now are controlled by computers, because on the presses there's cameras now that pick up registration marks and can make adjustments to counteract if the registrations out. There's densitometers built into them. Densitometers read the value of the ink that's on the paper and they can automatically adjust the ink flow to make sure that it's at its optimum. Basically the whole machine is just a big computer with a printing press attached."

**The Future:**

"...they'll be a lot more computer orientated. We'll see a lot more mechanisation and I'd dare say that we will see the advent of digital newspaper presses... What I think you would see then is that it would give you the opportunity to really tailor make papers for people with different needs or requirements. If there was someone that wanted a lot of the financial things that were going on in the world you could tailor make papers."

"...they're having a lot of trouble figuring out how they monetise the digital model."

"...there's not going to be anyone entering the printing trade now... I wouldn't imagine that there'd be that many places that would be taking on apprentices or trainees... because there's not the future for it."

The current predictions for the occupation selected for a detailed analysis described in detail above are summarised in Table 16.

**Table 16: Selected occupation groups for detailed analysis - Job Predictions**

Occupation	Default Skill Level	Short to Medium term Job Prediction
Diesel Mechanic/ Auto Technician	Skill Level 3&4	Slowdown in Growth/Steady State
AME Mechanic	Skill Level 2&3	Contrasting Predictions- Department of Employment- steady state; IRRC predicting 30% growth by 2025
Fitter & Turner	Skill Level 4	Above average employment growth 50,000 new positions in Australia by 2025
Boilermaker	Skill Level 3	Similar to Fitter & Turner, in USA, Department of Labor predicting 9% growth between 2014-2024 <sup>xxxv</sup>
Graphic and Web Designer	Skill Level 1 & 2	Strong Growth predicted by Department of Employment post 2020
Printer	Skill Level 3 & 4	Declining employment post 2020

The data shown in Table 16 indicates that, despite Manufacturing being in decline, the selected workforce areas have moderate to strong growth prospects, with the ANZSCO categories Fitter & Turner, Graphic Art and Web Design and (possibly) AME Mechanic all predicted to display strong growth and Boilermakers to achieve some growth in demand. The employment position for Diesel Mechanics is expected to be in a steady state and the employment numbers of Printers are expected to decline.

In an economic sense, the real determinant of growth in employment numbers in these and other occupations can be derived from a consideration of:

- The rate of growth in aggregate output or real demand sectoral changes in the relative importance of industries.
- Shifts in the marginal importance associated with both labour and investment in skills related to the occupation.

Underlying these figures are significant changes in industry and occupations: a freefall in heavy manufacturing offset in part by new 'advanced' manufacturing processes; a downturn in mining construction and housing associated with the mining industry which formerly provided jobs in manufacturing; and outsourcing manufacturing to countries with lower production costs. In addition, free and bi-lateral trade agreements have increased the number of trade commodities and reduced the number of insulated employment positions, making these employment types more precarious. We discuss how people employed in these callings within manufacturing can adapt through transferring their skills to similar or related roles.

## 2.4 SKILLS TRANSFER AND ADAPABILITY TO OTHER ROLES

The skills mapping exercise conducted for these seven jobs have highlighted the need for evolution of traditional manufacturing if these core callings are going to survive in future. While some are more ready than others, the key point that comes out is that people employed in roles that have allowed them to develop some additional skills are better placed to transfer to other roles, in manufacturing or other industries.

Transferable skills fall into 2 broad categories, hard and soft. Hard skills are essentially job-specific skills and technical knowledge and can be transferred directly (with minimal additional training), to only those occupations that are within a defined ANZSCO and ANSZIC grouping related to the field of expertise. So, for example, Fitters & Turners have skills that can directly be applied across Tool Making, Metal Fitting, Turning and Machining, Sheet Metal Working, and Boiler Making and Welding, but more generally in Mechanical and Industrial Engineering and Technology, Mechanical Engineering and Industrial Engineering,

While these hard skills are essential to a particular occupation they are limited in their transferability between industries and across occupations. So, in the above example the hard skill transferability is mostly contained within the ANZSO codes 4112-01 to 4112-11 (i.e. directly related to Fitters & Turners). In the current environment, no one of the sub-occupations listed above are likely to grow at a rate significantly greater than the others and all depend upon the general rate of growth in the economy and the extent to which manufacturing is locally sourced. Nevertheless, it is advisable to maximise the direct transferability of these skills by as much as practicable, for instance through enhanced training and having common training modules. At present these would be within the Certificate III training modules.

Moving forwards however, transferability of these core callings will depend on how easily people currently employed in these roles can move into the developing field of advanced manufacturing. But this will require training significantly above the Certificate III level discussed above. In particular, people will need to develop key skills specifically in computing, information technology, and digitisation. Advanced manufacturing covers a whole host of new industrial processes that improve upon the traditional methods in quality, speed and cost<sup>xxxvi</sup>. This involves training and further education, and in the United States of America there are lessons to be learnt from community colleges which are helping to bridge the skills gap through tailoring training packages to meet the needs of industry.

One emerging area where a generalised engineering apprenticeship, combined with additional skills of computing and information technology is in the area of 3D printing. Because the technology is new and fast developing, this provides an ideal opportunity for people who can understand, operate and innovate with printing and design. This was articulated in the case study with the printer who identified having to develop these key skills to adapt from traditional print media to the new media using digital technologies.

Soft skills are those more personal attributes, such communication, teamwork and collaboration, problem solving and management that develop over time, and complement the technical (hard) skills that form the core of a person's job. It is these soft skills that are transferrable between different roles, and more specifically industries. For the seven core callings, the Laboratory Technician, Web Designer and Printer are the occupations where skills transfer is easily accomplished to other roles. This because they tend to possess significant soft skills in applied clerical management, research and planning. For instance, applied clerical

skills include general clerical and administrative support, presentation and data management, while research and planning skills involve critical thinking and problem solving, time management and project planning.

### 3 FUTURE TRENDS IN MANUFACTURING INDUSTRIES AND OCCUPATIONS IN QUEENSLAND

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**FACTS UP FRONT:**

- Three major challenges face vocational education and training providers in Australia and globally, these are: a changing and broadening learner base, increased competition from other providers, and weaker signals of demand from industry.
- The projected growth (2011-2041) in Professional, Scientific and Technical Services (2.6%) and Electricity, Gas, Water and Waste Services (2.9%) are almost twice as high as the growth rate for Mining (1.5%), Manufacturing (1.6%), and Construction (1.5%).
- Based on the assumption that Queensland has a growth rate of 3% over the next 5 years, the results showed the following occupation job growth predictions:
  - Lab and Scientific Assistants (3.8%);
  - Graphic and Web Designers (3.5%);
  - Fitters & Turners (3.2%);
  - Diesel and Motor Mechanics (2.4%); and
  - Boilermakers (2.1%).
- Free and bi-lateral trade agreements increase the number of trade commodities and reduce the number of insulated employment positions making these employment types more precarious.
- Emerging jobs of interest:
  - Automotive Engineering Technician;
  - Manufacturing Production Technicians; and
  - Web Administrators.

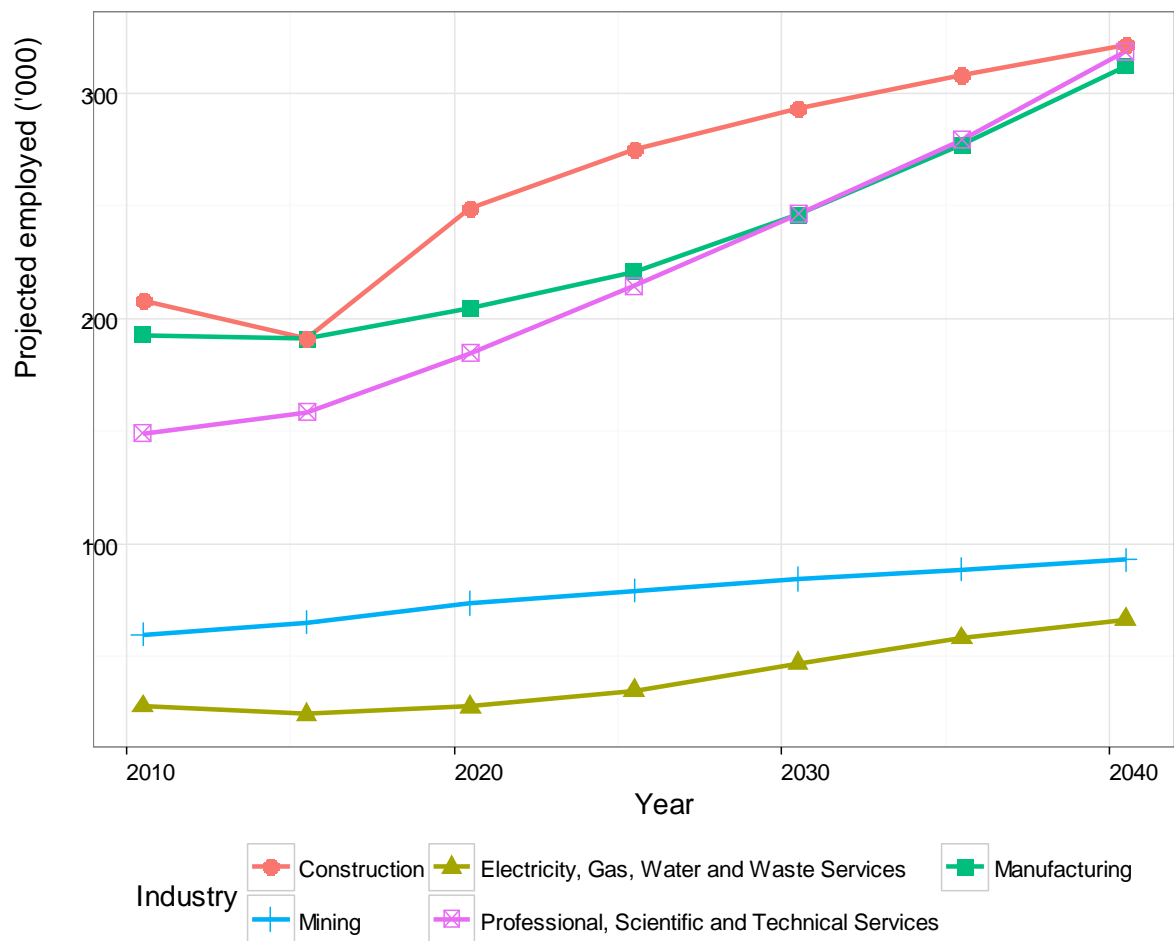
### 3.1 PROJECTION<sup>1</sup> OF THE FUTURE LABOUR MARKET CHANGE IN QUEENSLAND

One of the key aims of the project was to provide some projections of the Manufacturing employment trends of the future outlook of the Manufacturing industry. While we are projecting employment in the Manufacturing industry over the next 25 years these projections are based on, and consistent with, the Queensland Government population projections. They are produced on a 'no policy change' basis, and therefore should not be considered as future employment growth. Rather, they provide long term projections of possible future employment growth derived from the range of assumptions and information used in their construction (for instance, population change, especially the number of working aged people, the productivity, i.e. the average output per hour worked, and age-specific labour force participation, and state budget forecasts). This is applied to each region in Queensland, and the projections are made for each industry<sup>xxxvii</sup>. The data provide an overview of the projected employment patterns over time and geography, and pays particular attention to how this future employment will affect place of work, type of industry and location of residence. However, the focus of this work is to consider projections at ANZSIC division level industries.

Based on the projections for 2015-2040, as shown in Figure 14 and Table 17, there is a projected growth in Mining at a rate of 1.5% per year. Similar rates are projected for Manufacturing and Construction which has a predicted growth rate of 1.6% per year, and 1.5% respectively. This shows that there is projected growth in Manufacturing in the long term. These growth rates are slightly higher than the growth rates to population growth (projected annually at a rate of 1.4%). However, Professional, Scientific and Technical Services and Electricity, Gas, Water and Waste Services have almost twice as high (2.6%) a growth rate for Mining, Manufacturing, and Construction. While the growth depicted in Figure 14 seems considerable this growth levels out when you adjust for the population growth (see figure 15).

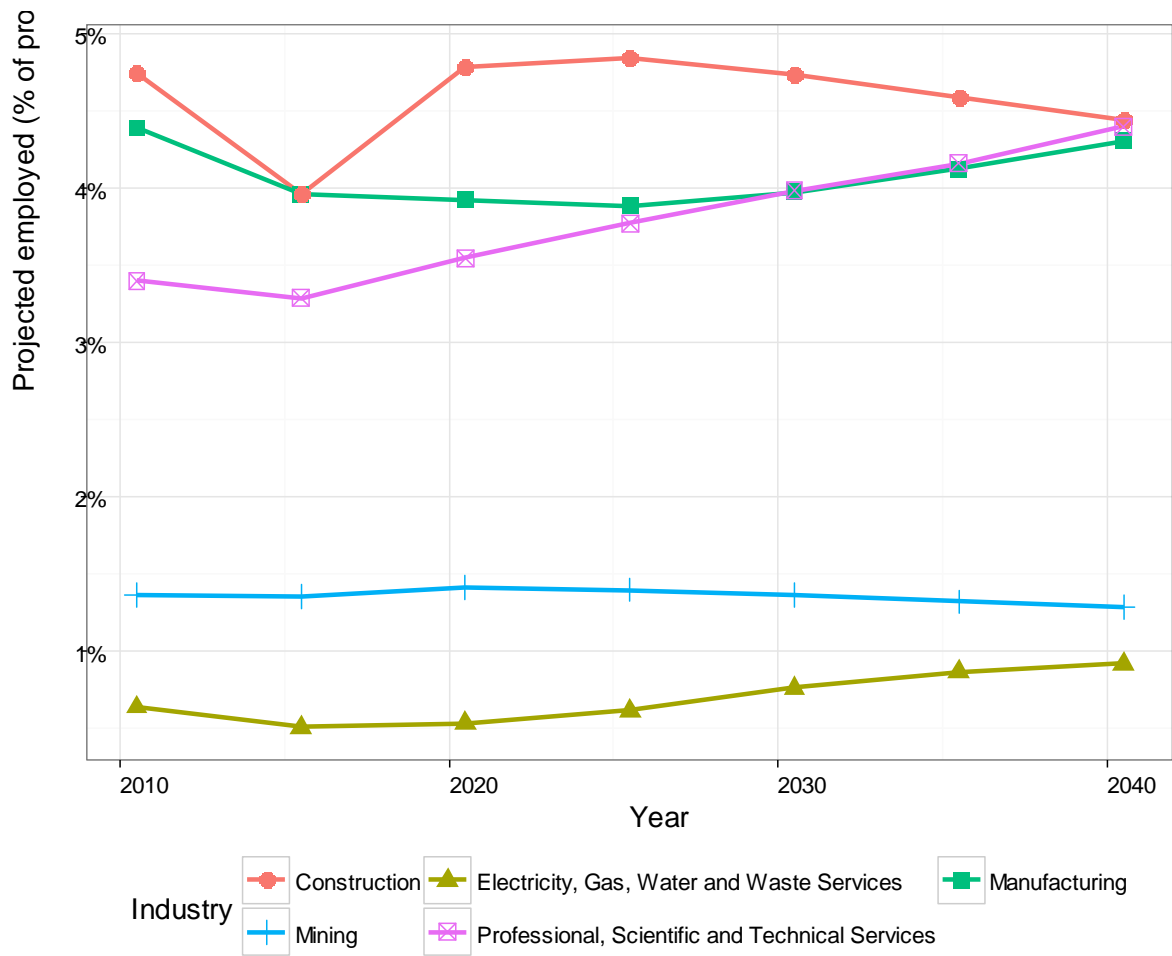
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<sup>1</sup> It is important to note that all projections are subject to uncertainty. In reality, job growth will be impacted both by unexpected events and by decisions made over this period – in particular, by government policies. Nonetheless, these projections are a useful indication of future trends from an authoritative source, based on ABS time series data and knowledge of existing policy, and are consistent with Commonwealth Treasury macro-economic forecasts.



**Figure 14: Projected Employed persons by selected industry, in Queensland 2011 to 2041**

Source: Queensland Government Statistics Office – <http://www.qgso.qld.gov.au/products/tables/reg-employment-proj/index.php>



**Figure 15: Projected Proportion of Queensland Employed persons by selected industry, 2011 to 2041**

Source: Queensland Government Statistics Office Queensland Government population projections, 2015 edition, and ABS, Australian demographic statistics, Mar 2015 cat no. 3101.0<sup>xxviii</sup>



**Table 17: Queensland projected employed persons by selected industry, 2011 to 2041**

Industry	Financial Year Projection							Mean yearly growth
	2010-11	2015-16	2020-21	2025-26	2030-31	2035-36	2040-41	2010-2041
Electricity, Gas, Water and Waste Services	27,822	24,426	27,724	34,836	47,015	58,090	66,404	2.9%
Professional, Scientific and Technical Services	148,987	158,476	184,539	214,246	246,390	279,152	318,476	2.6%
Manufacturing	192,593	190,761	204,230	220,721	245,818	276,686	311,839	1.6%
Construction	208,002	190,707	248,984	275,094	292,868	307,536	321,292	1.5%
Mining	59,794	65,120	73,497	79,254	84,234	88,527	92,857	1.5%

Source: Queensland Government Statistics Office – Regional employment projections, 2010–11 to 2040–41<sup>xxxvii</sup> <http://www.qgso.qld.gov.au/products/tables/reg-employment-proj/index.php>

**Queensland Non-Linear Multi-Regional Model (QNLMRM)**

An economic model constructed at the University of Queensland which measures economic linkages between industries and the impacts of economic investments in one or more sectors on the Queensland economy as a whole. The model is specified for each Queensland statistical district as well as for the rest of Australia. It quantifies the economic impact by a range of factors such as economic output, income, employment and public finance. In this application (in regards to the selected occupations) the model assumes different growth rates in Queensland and then the potential employment aspects by each industry sector are estimated. A concordance is then used to translate this assumed employment growth rate into the demand for various occupational groups, and the related specific job growth predictions.

### 3.2 ECONOMIC MODEL PREDICTIONS OF EMPLOYMENT TRENDS IN QUEENSLAND FOR FIVE OCCUPATIONAL GROUPS

To examine potential employment growth in the selected occupations, the Queensland Non-Linear Multi-Regional Model (QNLMRM) may be used. The economic modelling undertaken in this report makes use of a specifically constructed non-linear (marginal coefficients) input output tables for Queensland within the QNLMRM. The QNLMRM has been described in some detail in earlier studies.<sup>xxxix</sup>

In essence the quantification of economic impact relies on the quality of input data and the ability of the modelling process to correctly interpret that data. In this case, we wish to examine the impact of a standard 3% growth rate in the Queensland economy over a 5 year period and in particular, how that would impact upon expected employment demand in the sectoral areas of:

- Laboratory and Scientific Technicians (using Professional, Scientific and Technical workers as a proxy);
- Graphic and Web Designers (using Information Media and Telecommunications, which is a different industrial classification, as a proxy);
- Fitters & Turners;
- Motor Mechanics; and
- Boilermakers (using Fabricated Metal Product Manufacturing which includes Structural Steel Manufacturing and Boiler, Tank and other Heavy Gauge Metal Manufacturing as a proxy).

A number of limitations need to be taken into account when reviewing this analysis. For example, the standard QNLMRM does not contain the level of disaggregation required to individually examine such sub groups as Web Designers or even the larger group of Boilermakers. As a result, these groups had to be modelled through their larger ANZSIC categories (e.g. Fabricated Metal Product Manufacturing for Boilermakers and Information Media and Telecommunications for Graphic and Web Designers). This is a serious limitation as it does not allow for shifts in the relative importance of each sub-sector within the ANZSIC sector as a whole. On the other hand, the non-linear aspects of the model, operated by the external estimates of elasticities, allows for shifts in the relative importance of each ANZSIC sector on the whole economy. Table 18 presents the results.

**Table 18: Selected Occupational Job Growth Predictions 2016-2020 for Queensland**

Occupational Group <sup>†</sup>	Growth rate if Qld Economy grows by...		
	3%	2.5%	2.0%
Lab and Scientific Technicians	3.8	3.15	2.4
Graphic and Web Designers	3.5	2.80	2.3
Fitters and Turners	3.2	2.6	1.9
Diesel and Motor Mechanics	2.4	1.9	1.55
Boilermakers	2.1	1.75	1.35

<sup>†</sup>Printers were not considered as the industry is in decline (in employment terms) and would not be able to be modelled under the assumption of fixed proportions.

Source: Derived from QNLMRM (2015)

These results are broadly in line with the conclusions shown in the job prospect summaries shown in Table 17 for each occupational group, with some added insights. Firstly, the rate of growth in Fitters & Turners and Boilermakers display seasonally varying trends. For example, if the economy in aggregate grows by 3% per annum over the 5 years 2016-2020 (inclusive), the rate of growth for Fitters & Turners will exceed the aggregate growth (3.2% compared to 3%). However, under subdued growth (aggregate growth of 2%), the rate of expected increase in the job demand for Fitters & Turners drops to 1.9%, indicating that these types of jobs are pro-cyclical and need a certain threshold of aggregate growth before they grow above the expected trend. Boilermakers display the same pattern but at each projected growth rate, employment in this sector is below that of the economy wide average, indicating that employment numbers in this occupation are unlikely to grow rapidly. Secondly, Graphic and Web Designers and Laboratory Technicians exceed State average growth rates, however, their job advantage declines as average growth rates decline.

Nonetheless, the changing labour market and the subsequent changing skills market (for supply and demand) has placed new challenges on workers and employers, and makes even relatively short-term predictions less reliable. Industry growth projections are no longer linear. The perpetuation of free and bi-lateral trade agreements is increasing the number of traded commodities, reducing the number of insulated employment positions to significantly less than the 44% originally estimated by Maglen (in Group 3), and making vulnerable jobs more vulnerable.

Skill providers and trainers are now faced with added complexity, risk and uncertainty. Consumers' purchasing patterns and the platform by which they consume is changing rapidly; funding is less certain; students are more demanding; and competition is fiercer. Three major challenges face vocational education and training providers in Australia and globally: a changing and broadening learner base, increased competition from other providers, and weaker signals of demand from industry. As a consequence, the final section of this report examines emerging job opportunities and examines the extent to which the current profile of manufacturing workers would be suited to these emerging jobs, both in terms of current skill and/or augmented skill by training.

### **3.3 ROLE OF EMERGING TECHNOLOGIES**

We acknowledge that new and emerging technologies have played a significant role in the Manufacturing industry in recent years. However, it should be noted that we did not specifically examine the role of technologies as part of this research as this was not within the scope of this project. However the basis of change underpinning growth trends is technological advancement on a global scale.

### **3.4 EMERGING JOBS OF INTEREST**

A recent World Economic Forum (WEF) argued that major changes in the workplace in the next 5 years would transform labour markets and result in the loss of 5 million jobs in the developed world. They call this phenomena the "fourth industrial revolution" driven by technological and socio economic changes<sup>xl</sup>. It also predicted that this job loss could be offset by jobs growth in the innovation economy. As might be expected, most of the job growth in the innovation economy comes via digital and other IT-based platforms. However, the increasingly integrated role of Manufacturing in the broader economy indicates job opportunity growth in so-called 'traditional industries'.

Within Manufacturing, most experts suggest that digitisation and technology based pathways, leading to roles within Advanced Manufacturing as the area where job opportunities can be achieved within the broad skill level of Associate Degree (Skill Level 2) or Certificate IV (Skill Level 3). In this regard, there are a number of new and emerging roles<sup>xii</sup> that lie within the broad skill set of current manufacturing workers. Three such roles will be discussed as examples in detail below: Automotive Engineering Technicians, Manufacturing Product Technicians, and Web Administrators.

### **3.4.1 Automotive Engineering Technicians**

Automotive Engineering Technicians assist engineers in determining the practicality of proposed product design changes, and plan and carry out tests on experimental test devices or equipment for performance, durability, or efficiency. The tasks they undertake include:

- Document test results, using cameras, spreadsheets, documents, or other tools;
- Set up mechanical, hydraulic, or electric test equipment in accordance with engineering specifications, standards, or test procedures;
- Read and interpret blueprints, schematics, work specifications, drawings, or charts;
- Inspect or test parts to determine nature or cause of defects or malfunctions; and
- Monitor computer-controlled test equipment, according to written or verbal instructions.

### **3.4.2 Manufacturing Production Technicians**

Manufacturing Production Technicians set up, test, and adjust manufacturing machinery or equipment, using any combination of electrical, electronic, mechanical, hydraulic, pneumatic, or computer technologies. The tasks they undertake include:

- Adhere to all applicable regulations, policies, and procedures for health, safety, and environmental compliance;
- Inspect finished products for quality and adherence to customer specifications;
- Set up and operate production equipment in accordance with current good Manufacturing practices and standard operating procedures;
- Calibrate or adjust equipment to ensure quality production, using tools such as callipers, micrometres, height gauges, protractors, or ring gauges; and
- Set up and verify the functionality of safety equipment.

The growth in the significance of this occupation is linked with improved quality control and work place safety. It also uses a skill set comparable with the average skill set among manufacturing workers, in particular the AQF Associate Degree, Advanced Diploma or Diploma.

### **3.4.3 Web Administrators**

Web Administrators manage web environment design, deployment, development and maintenance activities, and perform testing and quality assurance of web sites and web applications. This represents an extension of web design work. Their tasks include:

- Back up or modify applications and related data to provide for disaster recovery;
- Determine sources of Web page or server problems, and take action to correct such problems;
- Review or update Web page content or links in a timely manner, using appropriate tools;
- Monitor systems for intrusions or denial of service attacks, and report security breaches to appropriate personnel; and
- Implement Web site security measures, such as firewalls or message encryption.

Qualifications required are at the Skill level 1 and Skill level 2, compatible with current Graphic Web Designers but represent an increase in their value added component.

The above examples, though not exhaustive, indicate a potential strategy for manufacturing workers in terms of upskilling to increase occupational coverage.

## 4 CONCLUSION AND RECOMMENDATIONS

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The structure of the Queensland economy has changed significantly in the past decade. Manufacturing, as a component of Gross Domestic Product (GDP), has declined from 10.4 % in 2004-2015 to 7.2% in 2014-2015. The sector's contribution to State employment has declined from 10.0% to 7.2%. This decline in GDP and employment is projected to decline further. Before reviewing the employment trends and projections at the sub-industry level, it may be useful to conceptualise the types of employment within the Manufacturing Industry and fit these into three broad groups which reflect the degree of globalisation experienced by each type of employment:

- Group 1: Positive/Opportunistic – these workers are able to change employment and job roles depending on market factors and conditions because their skills are transferable (e.g. Fitters & Turners);
- Group 2: Vulnerable – these workers have insecure employment opportunities, with skills that are job-specific and non-transferrable (e.g. Boilermakers);
- Group 3: Insulated – these workers have locally specific skills, training and professional qualification (e.g. Printers).

It is important to consider these employment types when reviewing the trends, as this provides additional insight into some of the factors contributing to the trends. Reviewing the employment growth trends over the next 5 years, there are sub-industries within Manufacturing that are expected to grow: Laboratory and Science Technicians, Graphic and Web Designers, Metal Fitters and Machinists (Fitters & Turners), Constructions Managers, Diesel Mechanics and Auto Technicians. However, there are a number of sub-industries where employment opportunities are expected to decline, such as: Structural Steel and Welding Trades Workers, Printers, and Aircraft Maintenance Engineer Mechanics.

From 2020 onwards, there are sub-industries within Manufacturing that are expected to grow, such as: Laboratory and Science Technicians, Graphic and Web Designers and Diesel Mechanics and Auto Technicians. However, there are a number of sub-industries where employment opportunities are expected to decline after 2020, such as: Metal Fitters and Machinists (Fitters & Turners), Structural Steel and Welding Trades Workers, Printers, and Aircraft Maintenance Engineer Mechanics. In fact, by 2025, there will be an estimated 30% global workforce shortfall in aircraft maintenance capacity, with the Australia and Asia Pacific region hit the hardest. A number of emerging jobs that may be of interest are: Automotive Engineering Technician; Manufacturing Production Technicians; and Web administrators.

Underlying these figures are significant changes in industry and occupations: a freefall in heavy manufacturing offset in part by new 'advanced' manufacturing processes; a downturn in mining construction and housing associated with the mining industry which formerly provided jobs in manufacturing; and outsourcing manufacturing to countries with lower production costs. In addition, free and bi-lateral trade agreements have increased the number of trade commodities and reduced the number of insulated employment positions, making these employment types more precarious.

In becoming more globalised, knowledge-intensive and interdependent with service design, robotics and digitalisation, manufacturing matters more than ever for advanced economies. This is because it drives

innovation and technological change. Without a policy for advanced manufacturing, there is a real prospect of losing even more of the science and engineering expertise in research and production that may have taken generations to nurture<sup>xix</sup>. These skills are not only critical to new growth industries but are part of the core infrastructure on which every modern economy depends<sup>xlii</sup>.

The future success of Queensland Manufacturing industry depends to a large extent on strategic investment and coordination by government, research institutions and business to promote global opportunities for emerging knowledge based enterprises, particularly in advanced manufacturing. By subsidising specific private investments in the development of innovative capability, knowledge diffusion and inter-firm linkages and networks, especially including those which include research and educational institutions, the state can seek to reconcile private and social returns and to increase both.

An important step that begins to address these issues is the recently announced 10-Year Advanced Manufacturing Roadmap<sup>xv</sup>, developed by the State Government with the support of a newly established Industry and Manufacturing Advisory Group (IMAG), to guide the development of the sector. The IMAG has the potential to provide the government with high level industry advice on strategic matters in building the sector in Queensland. The longer term success of such an initiative will depend on the extent to which it is institutionally embedded in the policy process and is not seen as a window dressing exercise. Successful models such as the Fraunhofer Society and Germany's apprenticeship system could be reviewed to guide initiatives in Australia.

It is essential for policy makers to recognize that the integration of research and industry works in both directions. R&D in manufacturing, for example, can lead to innovations in engineering processes, new materials technologies and micro-processing. It provides significant opportunities for capital investment and jobs growth. In addition policy must ensure that, where possible, public procurement supports Manufacturing industry engaged in new value-added activities and innovation.

Increased public policy attention needs to be focused on rebalancing the economy with new sources of innovation and productivity, to offset diminishing industry sectors associated with commodity exports and heavy manufacturing. Successful policy must take into account factors such as employment generation and retention, regional economic development, the promotion of high quality and high paid work, and an equitable distribution of income. It requires a more integrated strategic approach to economic policy, combining active macro-economic demand management with interventionist microeconomic supply side measures designed to facilitate networking and cross-fertilisation of private sector producers<sup>xliii</sup>.

The following demand side elements need to be considered within this context:

- A great deal of private investment activity depends on a foundation of public investment. Public capital expenditure provides the infrastructural support (e.g. transport and communications enhancements) for private sector activity. Critically, such public investment in infrastructure must be assessed in terms of its contribution to public criteria of social and economic development rather than its contribution to a particular industry or enterprise.
- The interdependence of production provides opportunities for the development of *networks and collaborative organizations* by firms and with public agencies and research institutions. Networks should embrace plans for fostering innovation through public-private and private-private cooperation in research and development, linking facilities to research centres and promoting data sharing,

demonstration and information provision. These practices should intensify the engagement of industry with research institutions<sup>ix</sup>.

- Public policy support is also required for the development of collaborative clusters and networks, which will be a powerful attraction to foreign direct investment and will provide a platform to participate in global markets and supply chains more effectively.
- This has implications for regional areas, such for Queensland but can be enhanced through the creation of good jobs that balance better employment opportunity with satisfaction and stability.
- There is an important role for industry policy via public procurement, which may be deployed as it has in Europe to encourage cross fertilisation and innovation and the development of local supplier capability<sup>xiv</sup>.

Interventionist supply side measures are also needed to broaden and deepen the available shared concentration of knowledge, capabilities and resources within the Manufacturing industry sector:

- The creation and sponsorship of *clusters of collaborative industry groups* (vertical, horizontal, sectoral) for the dissemination and use of knowledge central to economic activity including information sharing, joint production and joint problem-solving. This should also involve sponsoring targeted support for the integration of firms and clusters into domestic and global supply chains<sup>i</sup>.
- Workplaces will need to be supported to develop greater *absorptive capacity*, to allow them to integrate and diffuse new and existing technologies, production processes and skills. Ad hoc practices of knowledge and information retrieval and utilisation need to be replaced by targeted, publicly supported information systems and practices. Because innovation is risky and expensive, and information is costly to acquire and use, government has a role in reducing risk and encouraging the uptake of new technologies and skills<sup>xiii</sup>.
- There is a need to integrate policies concerning the efficiency and performance characteristics of enterprises with public policies that influence the quality and availability of highly skilled labour including industrial relations policies, active labour market policies and, in particular, training policies<sup>i</sup>.
- This includes more effective and collaborative partnership between employees and employers, between unions and employers and the government and unions to ensure that there is a shared interest in problem solving .



# APPENDIX I: TECHNICAL DESCRIPTION OF THE QUEENSLAND NON-LINEAR MULTI-REGIONAL MODEL (QNLMRM)

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It is an input output model which has been modified to have non-linear properties by the use of the IO-8 software developed by Guy West from the Centre of Economic Policy Modelling at the University of Queensland. The model is regularly updated both by the addition of newly available data and by recalibration of the elasticity estimates that are used as external inputs into the model. The latest update of the model occurred in 2015, when data on Retail services and power usage were added to the IO table and the table constrained to the latest estimates of State GSP.

In the economic modelling lexicon, non-linear modelling sits somewhere between traditional (average coefficients) input-output modelling and computable equilibrium modelling (CGE). For a modelling exercise such as this it has advantages over both alternative methods: For example, the Non-Linear Input-Output Model (NLIO) removes one of the major limitations of standard input-output analysis by removing the assumption of linear coefficients for the household sector and allowing marginal income coefficient adjustment. This is because, as is widely known, the household (consumption) sector is a dominant component of multiplier effects in an input-output table. As a result, using marginal income coefficients for the household sector will provide a more accurate and empirically more valid, estimate of the multiplier effects, which in turn, provides results closer to those of a computable general equilibrium (CGE) model. NLIO has the advantage over CGE in that it retains the flexibility and relative data parsimony of an IO model in comparison with CGE, which is structured to estimate elasticities internally and therefore, has much higher base data requirements. As well, NLIO is better suited to the evaluation of partial equilibrium (one off projects) or events such as changes in one part of an industry sector as well as being better suited to regional evaluation. The non-linear component is introduced into the model by the interaction of estimated and externally imposed elasticity coefficients upon the multipliers, particularly the employment and factor income multipliers.

## APPENDIX II DATA SOURCES

### II.I ABS LABOUR FORCE SURVEY

The specialised data provided by the Australian Bureau of Statistics (ABS) contained information on industry employment from 1999 to 2015. It contained 4 distinct datasets, consisting of counts of employed persons cross-tabulated with year, region, industry, and one of the following;

- (i) Gender,
- (ii) Labour force status,
- (iii) Age group,
- (iv) Occupation.

Table 20 lists the possible categories of each variable.

**Table 19: ABS Data Categories**

Variable	Categories
Year, or year groups	1999 to 2015 1999-2002, 2003-2006, 2007-2010, and 2011-2015
Region	Queensland, Brisbane - East, Brisbane - North, Brisbane - South, Brisbane - West, Brisbane Inner City, Cairns, Darling Downs - Maranoa, Fitzroy, Gold Coast, Ipswich, Logan - Beaudesert, Mackay, Moreton Bay - North, Moreton Bay - South, Queensland - Outback, Sunshine Coast, Toowoomba, Townsville, and Wide Bay
Industry	Coal Mining, Metal Ore Mining, Wood Product Manufacturing, Pulp, Paper and Converted Paper Product Manufacturing, Printing, Petroleum and Coal Product Manufacturing, Non-Metallic Mineral Product Manufacturing, Primary Metal and Metal Product Manufacturing, Fabricated Metal Product Manufacturing, Transport Equipment Manufacturing, Machinery and Equipment Manufacturing, Electricity Supply, Gas Supply, Water Supply, Sewerage and Drainage Services, Building Construction, Heavy and Civil Engineering Construction, Construction Services, Motor Vehicle and Motor Vehicle Parts Retailing, Fuel Retailing, Professional, Scientific and Technical Services, Computer System Design and Related Services, and Repair and Maintenance
Gender	Male, Female, and Persons
Labour force status	Employed full-time, employed part-time, and employed total
Age group	15-24, 25-34, 35-44, 45-54, 55-64, and 65+
Occupation	Clerical and Administrative Workers, Community and Personal Service Workers, Labourers, Machinery Operators and Drivers, Managers, Professionals, Sales Workers, Technicians and Trades Workers, and Total Occupations

## APPENDIX III: ADDITIONAL DETAILED TABLES

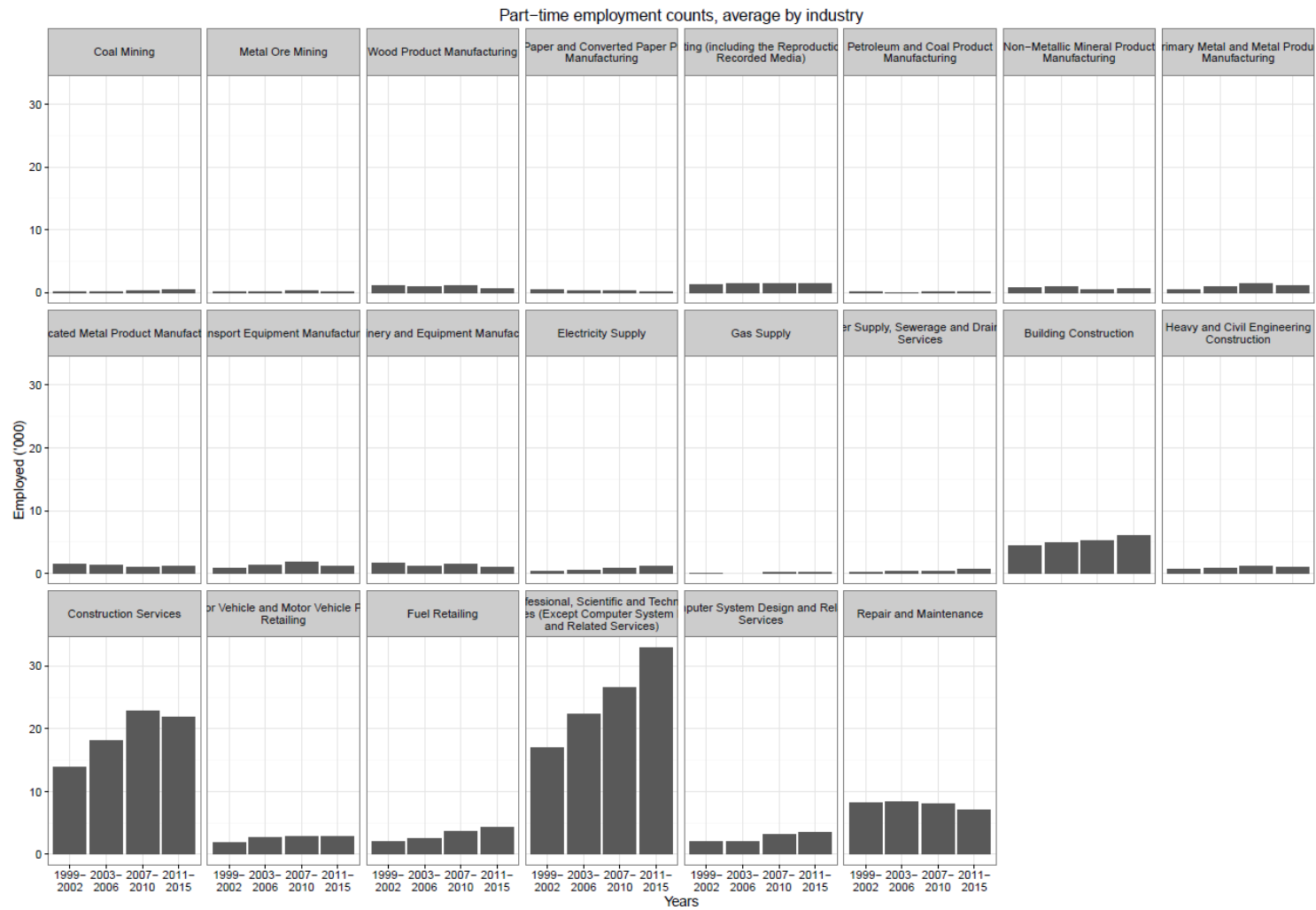
**Table 20: 22 Selected Australian and New Zealand Standard Industrial Classification (ANZSIC) subindustries**

Division		Sub-division	
<b>B</b>	<b>Mining</b>		
		06	Coal Mining
		08	Metal Ore Mining
<b>C</b>	<b>Manufacturing</b>		
		14	Wood Product Manufacturing
		15	Pulp, Paper and Converted Paper Product Manufacturing
		16	Printing (including the Reproduction of Recorded Media)
		17	Petroleum and Coal Product Manufacturing
		20	Non-Metallic Mineral Product Manufacturing
		21	Primary Metal and Metal Product Manufacturing
		22	Fabricated Metal Product Manufacturing
		23	Transport Equipment Manufacturing
		24	Machinery and Equipment Manufacturing
<b>D</b>	<b>Electricity, Gas, Water and Waste Services</b>		
		26	Electricity Supply
		27	Gas Supply
		28	Water Supply, Sewerage and Drainage Services
<b>E</b>	<b>Construction</b>		
		30	Building Construction
		31	Heavy and Civil Engineering Construction
		32	Construction Services
<b>G</b>	<b>Retail Trade</b>		
		39	Motor Vehicle and Motor Vehicle Parts Retailing
		40	Fuel Retailing
<b>M</b>	<b>Professional, Scientific and Technical Services</b>		
		69	Professional, Scientific and Technical Services (Except Computer System Design and Related)
		70	Computer System Design and Related Services
<b>S</b>	<b>Other Services</b>		
		94	Repair and Maintenance

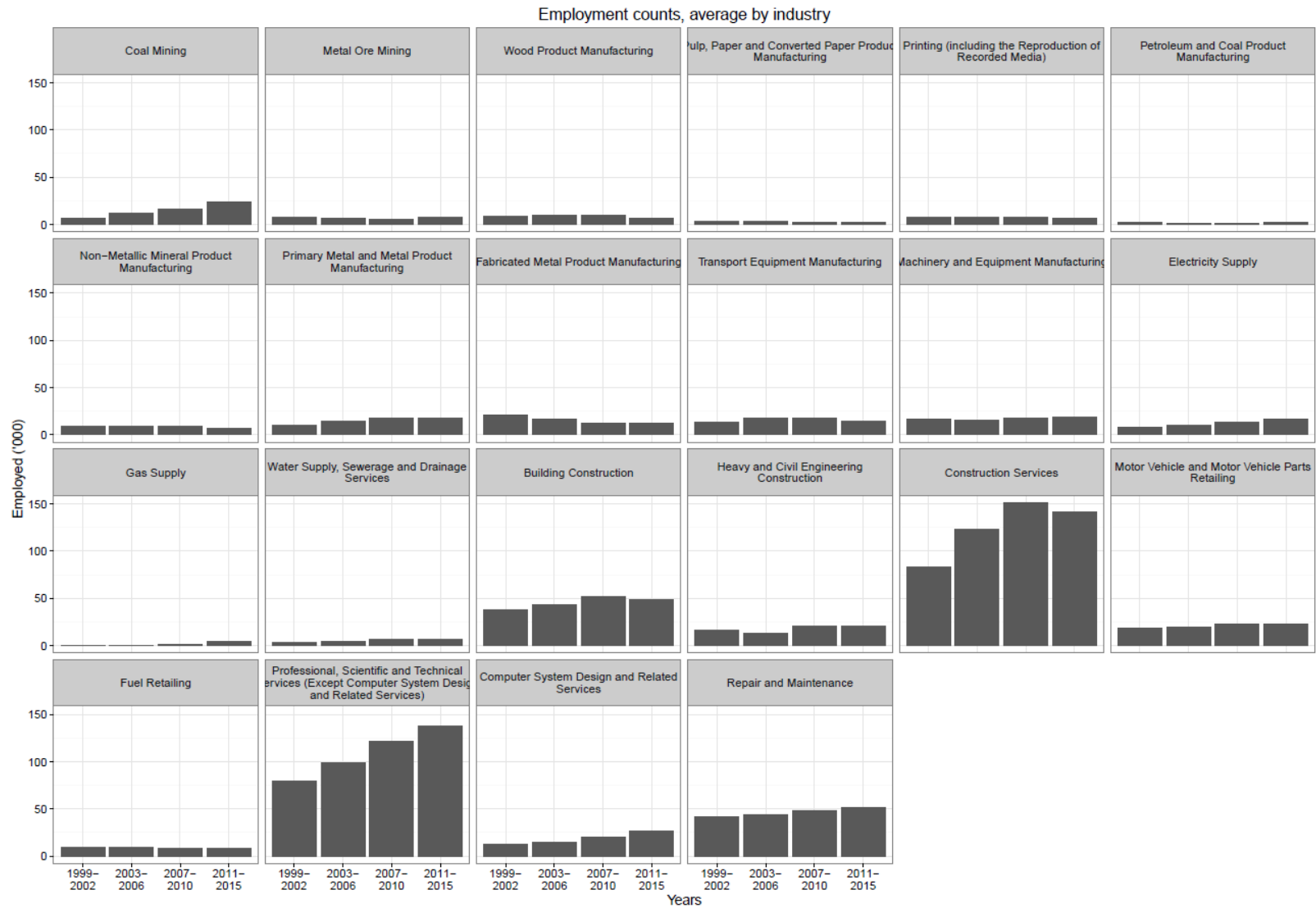
**Table 21: Four Custom Tables for Secondary Analysis requested from ABS LFS Team.**

Table Number	Details
<u>Table 1:</u>	<ul style="list-style-type: none"> <li>- Employed Total</li> <li>- Male / Female / Persons</li> <li>- Queensland Labour Force Regions (SA4)</li> <li>- Manufacturing subdivisions (Industry standard ANZSIC06)</li> <li>- Average of 4 quarters in a calendar year between 1999 and 2015</li> </ul>
<u>Table 2:</u>	<ul style="list-style-type: none"> <li>- Employed Total</li> <li>- Persons (only)</li> <li>- Age groups (15-19, 20-24, 25-34, 35-44, 45-54, 55-64 and 65+)</li> <li>- Queensland Labour Force Regions (SA4)</li> <li>- Manufacturing subdivisions (Industry standard ANZSIC06)</li> <li>- Average of 4 quarters in a calendar year between 1999 and 2015</li> </ul>
<u>Table 3:</u>	<ul style="list-style-type: none"> <li>- Employed Total</li> <li>- Occupation (managerial/professional/technicians/community/.../labourers)</li> <li>- Queensland Labour Force Regions (SA4)</li> <li>- Manufacturing subdivisions (Industry standard ANZSIC06)</li> <li>- Average of 4 quarters in a calendar year between 1999 and 2015</li> </ul>
<u>Table 4:</u>	<ul style="list-style-type: none"> <li>- Employed Total</li> <li>- Type of employment (fulltime, part-time) <i>NB// casual jobs not identified</i></li> <li>- Queensland Labour Force Regions (SA4)</li> <li>- Manufacturing subdivisions (Industry standard ANZSIC06)</li> <li>- Average of 4 quarters in a calendar year between 1999 and 2015</li> </ul>

# APPENDIX IV: ADDITIONAL DETAILED FIGURES

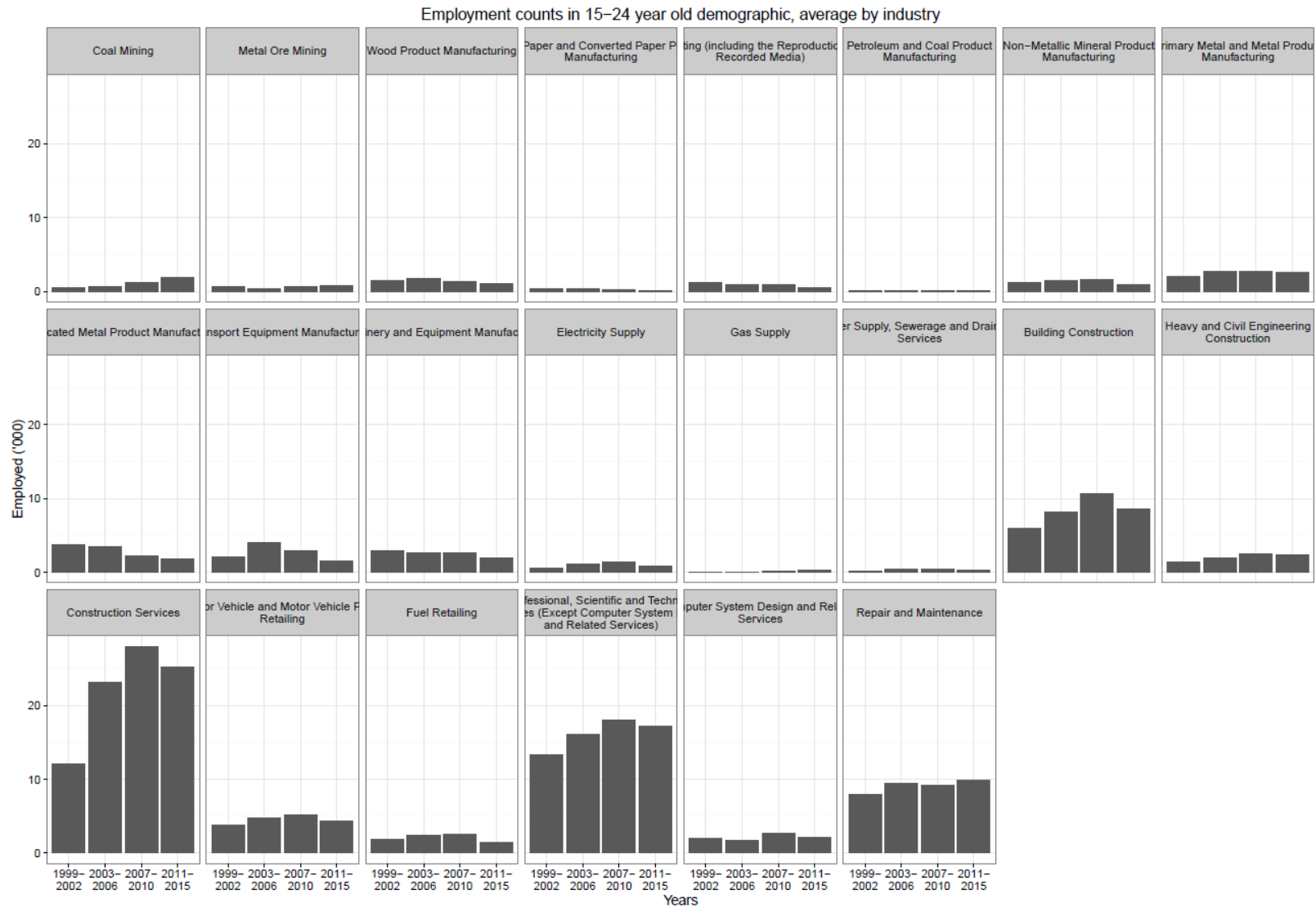


**Figure 16: Number of People Employed Part-time in selected Queensland Sub-Industries**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015



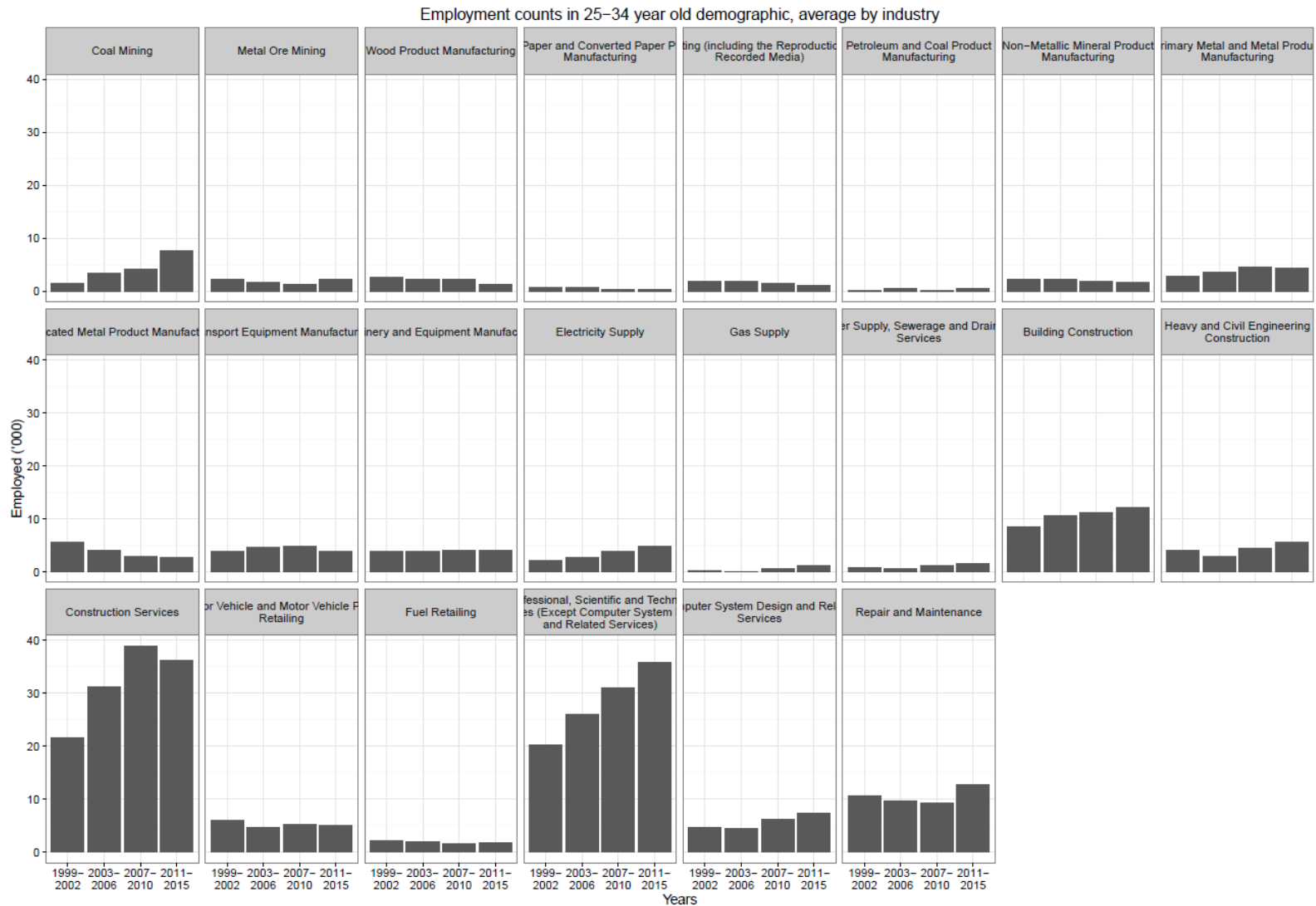
**Figure 17: Number of People Employed in selected Queensland Sub-Industries**

Source: ABS, Labour Force Survey Customised report, 1999-2015



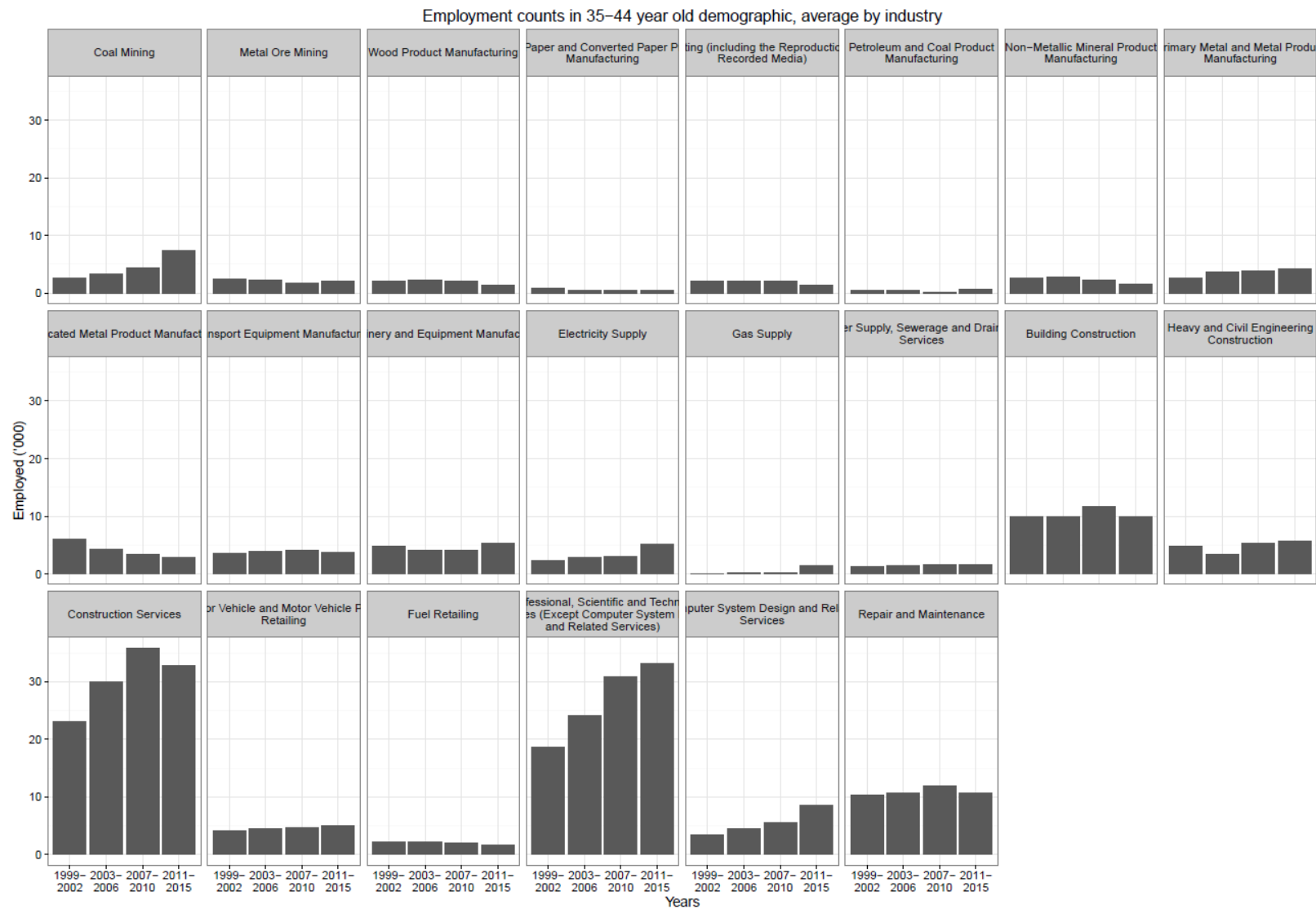
**Figure 18: Number of 15-24 year olds Employed in selected Queensland Sub-Industries**

Source: ABS, Labour Force Survey Customised report, 1999-2015



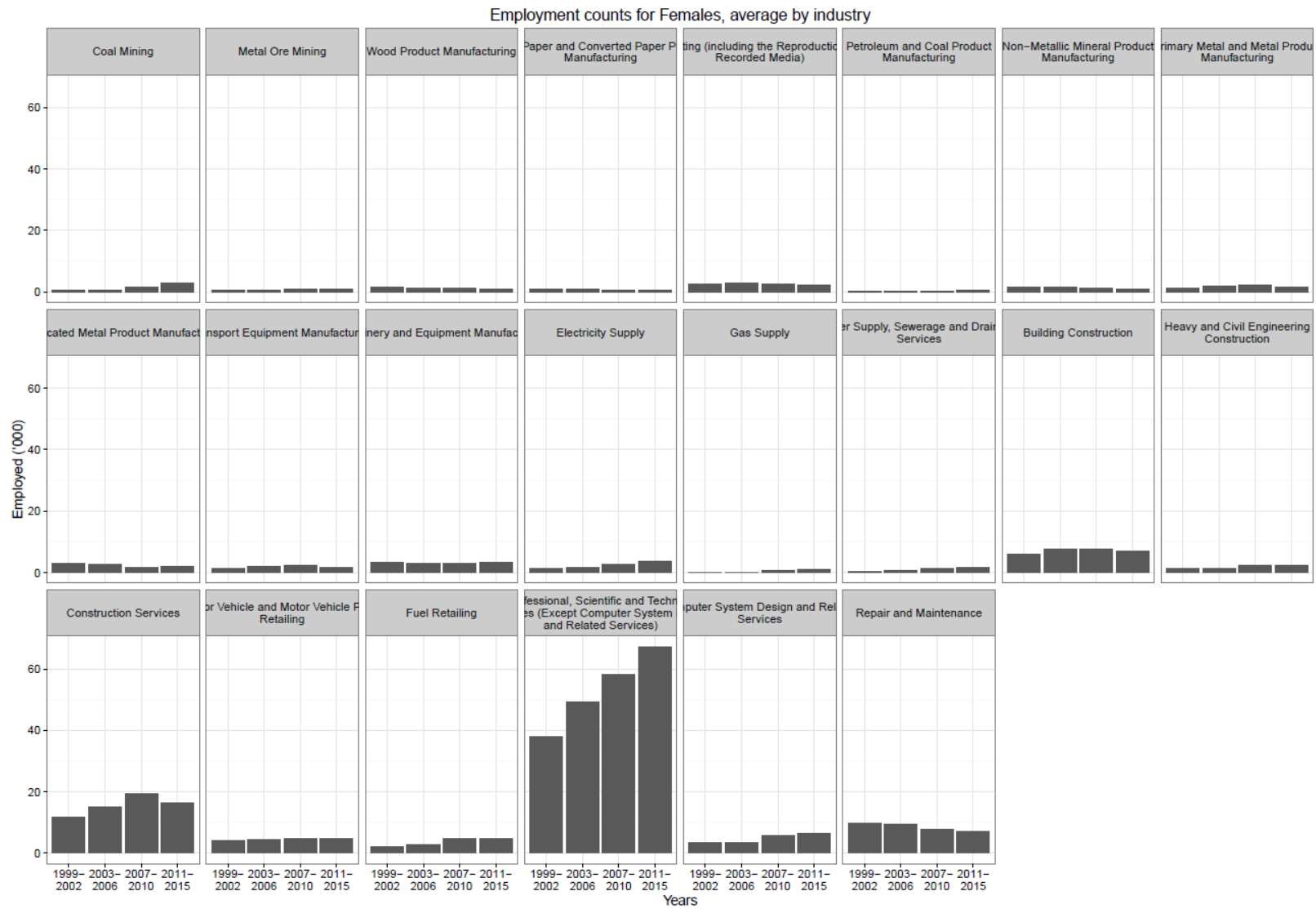
**Figure 19: Number of 25-34 year olds Employed in selected Queensland Sub-Industries**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015



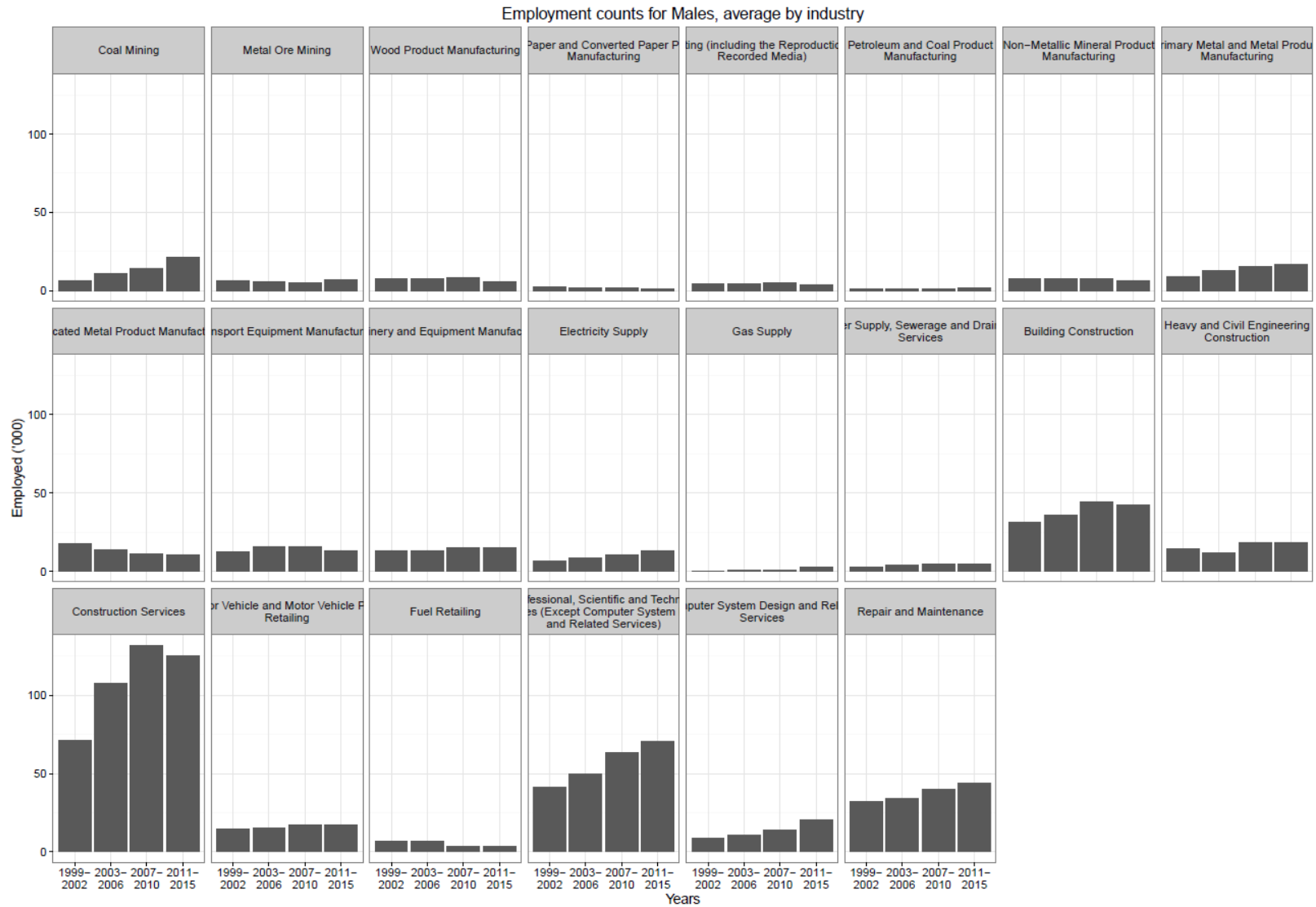


**Figure 20: Number of 35-44 year olds Employed in selected Queensland Sub-Industries**

Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 21: Number of Females Employed in selected Queensland Sub-Industries**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 22: Number of Males in selected Queensland Sub-Industries**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 23: Number of People employed in Selected Occupations by selected Queensland Sub-Industries**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 24: Queensland Employment Mean Growth by Sub-Industry, 2011-2015**

Source: ABS, Labour Force Survey Customised report, 1999-2015

Part-time employment mean growth, in industries > 500 people on average 2011-2015

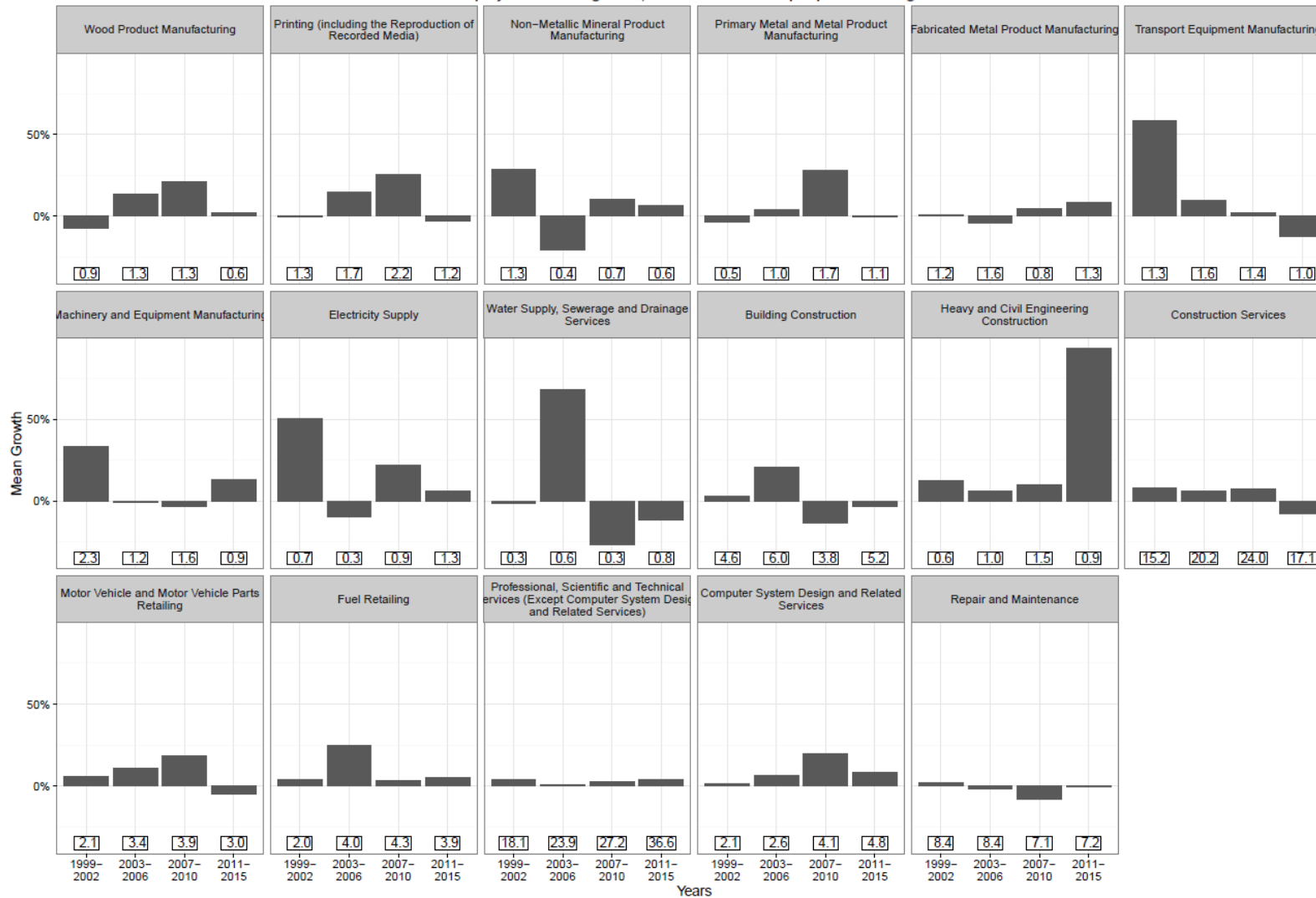
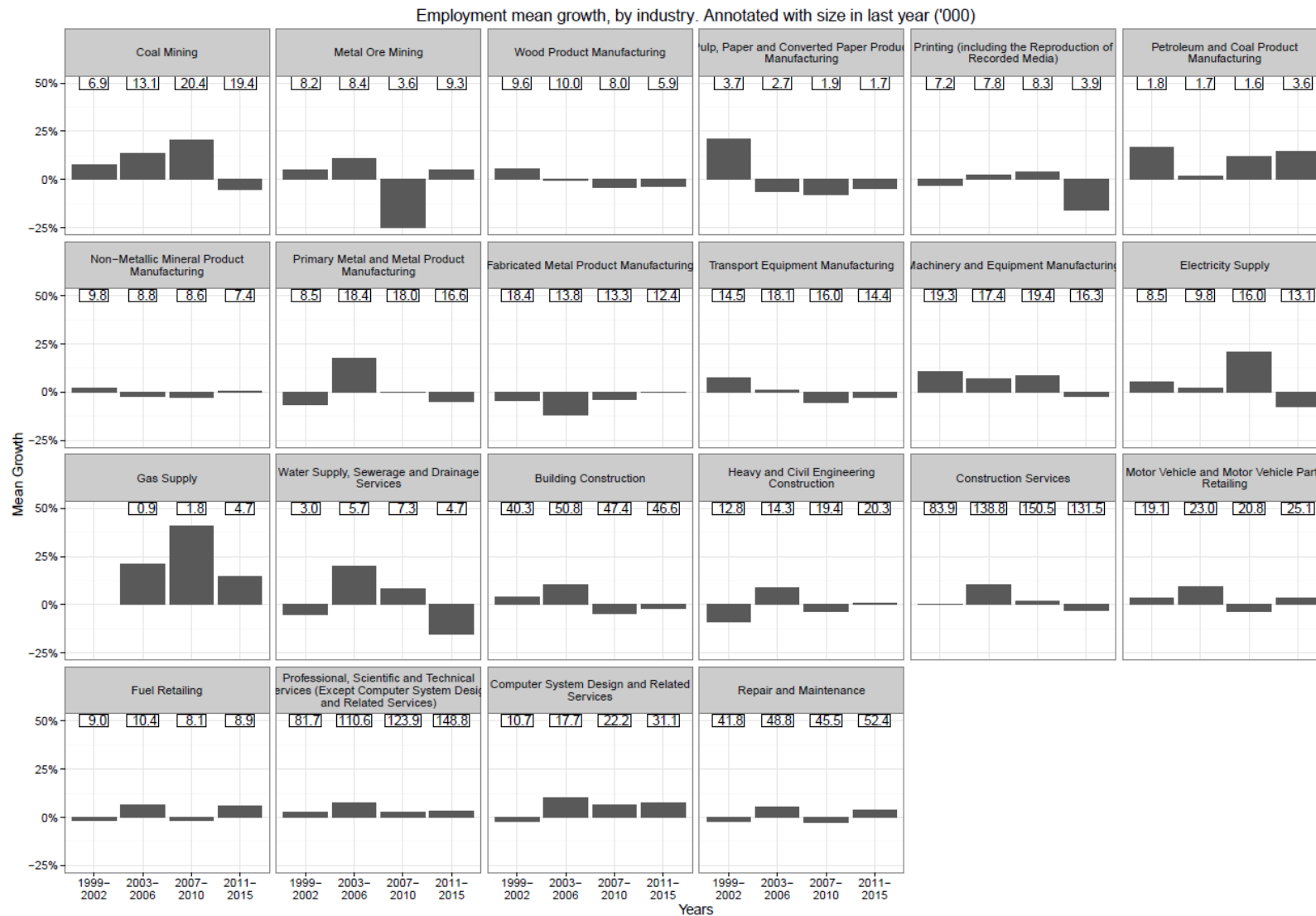
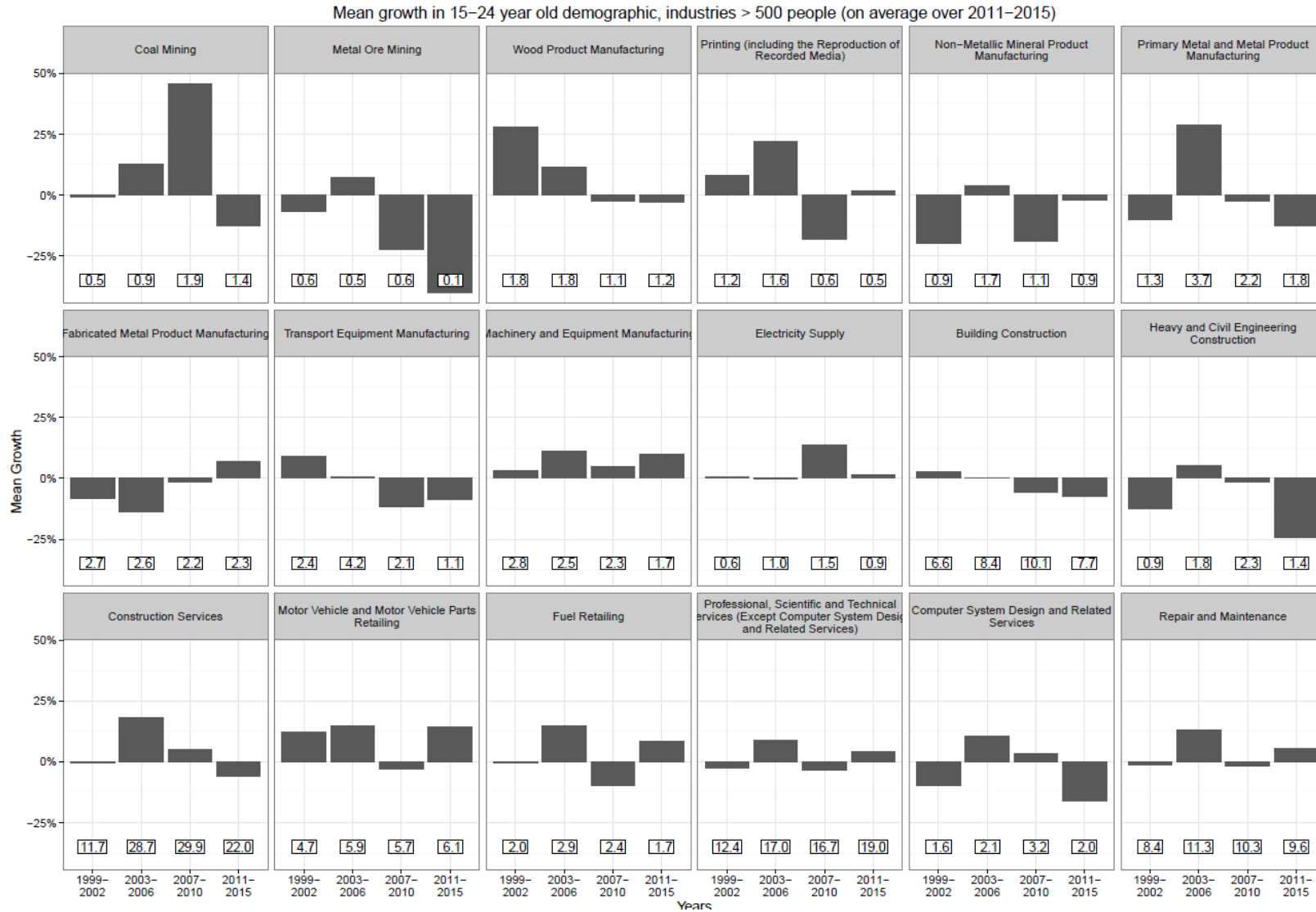


Figure 25: Queensland Part-time Employment Mean Growth by Sub-Industry, with >500 People in 2015.

Source: ABS, Labour Force Survey Customised report, 1999-2015



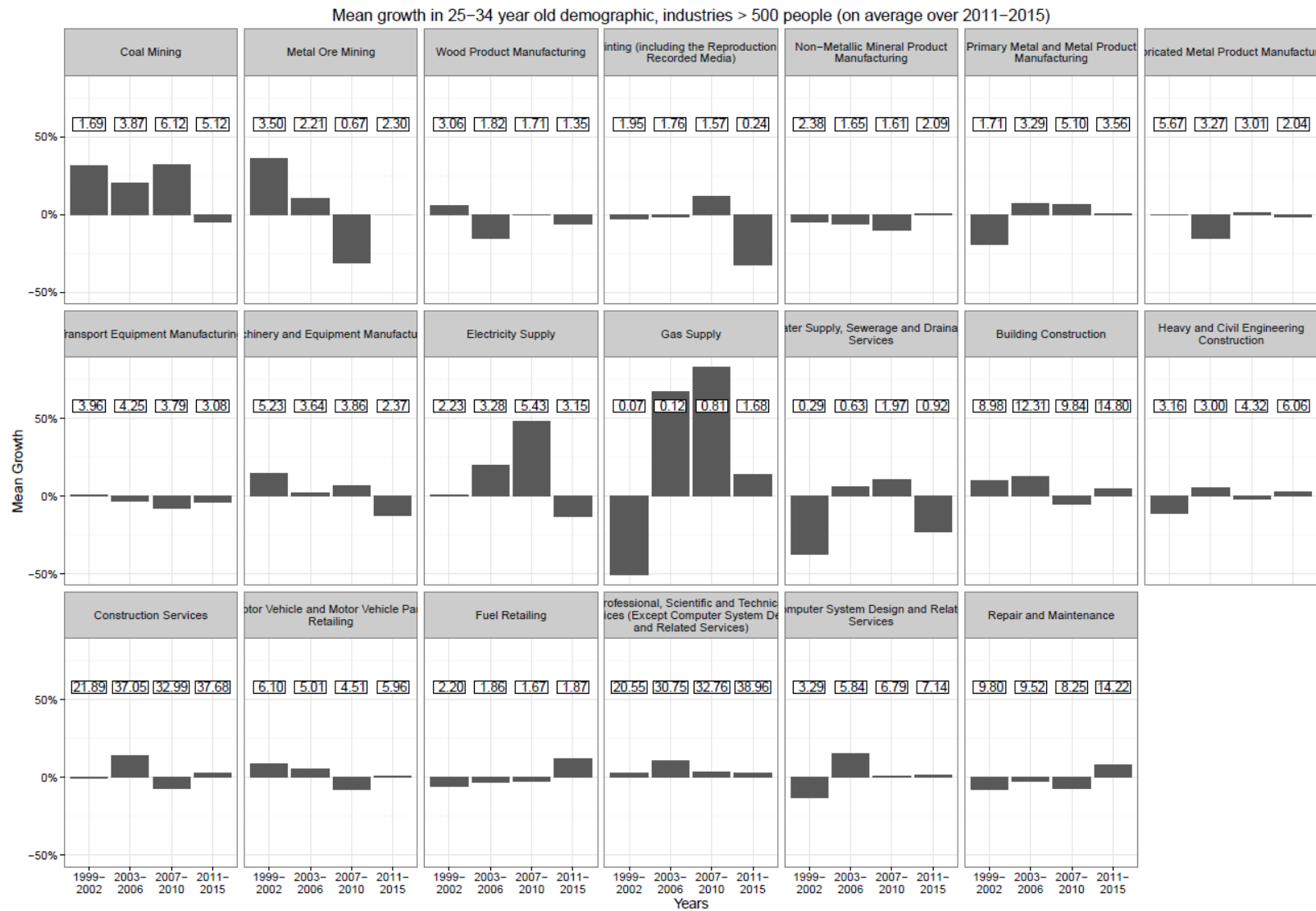
**Figure 26: Queensland Full-time Employment Mean Growth by Sub-Industry, with >500 People in 2015.**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 27: Queensland 15-24 Age Group Mean Growth by Sub-Industry, with >500 People in 2015.**

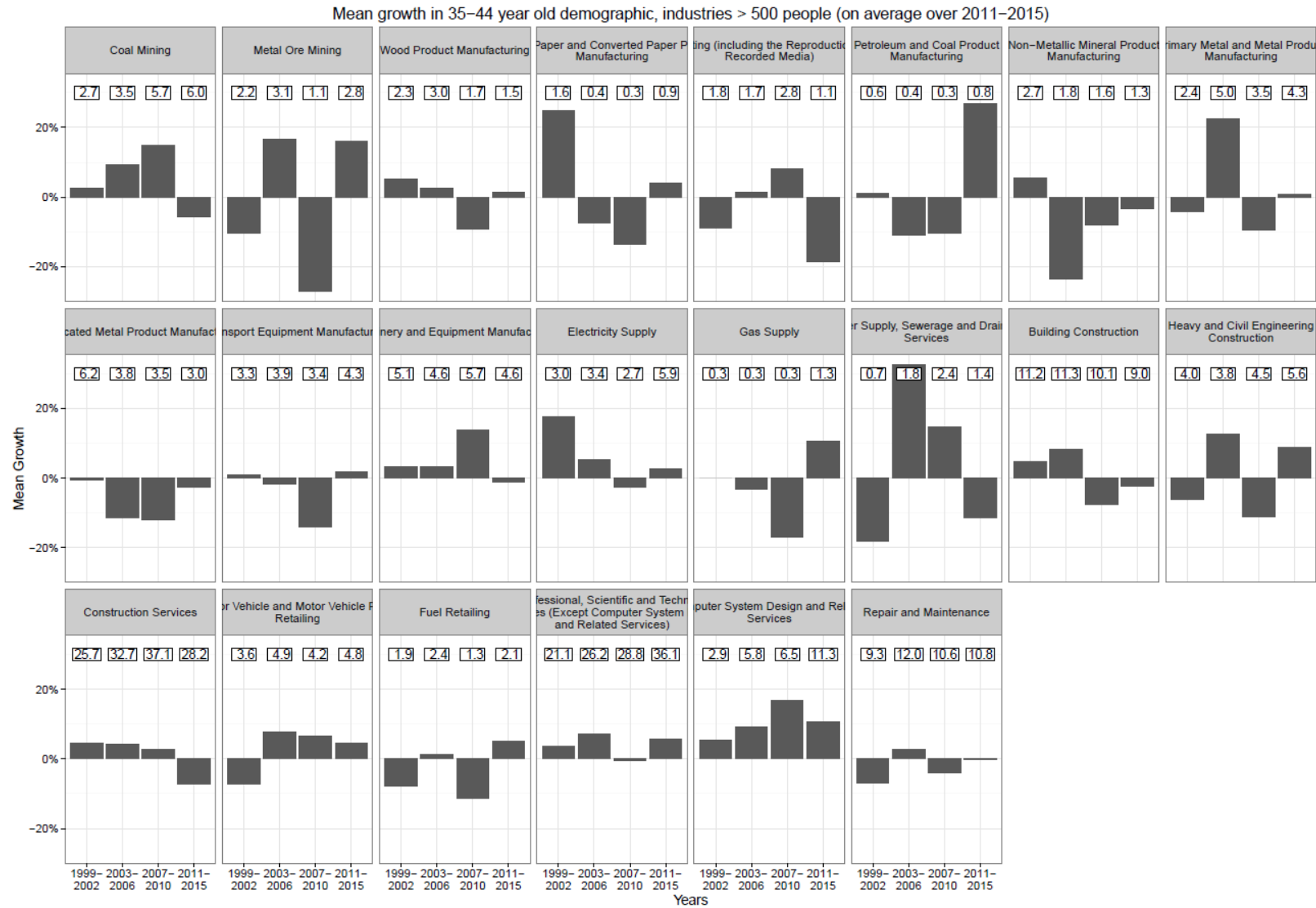
Source: ABS, Labour Force Survey Customised report, 1999-2015



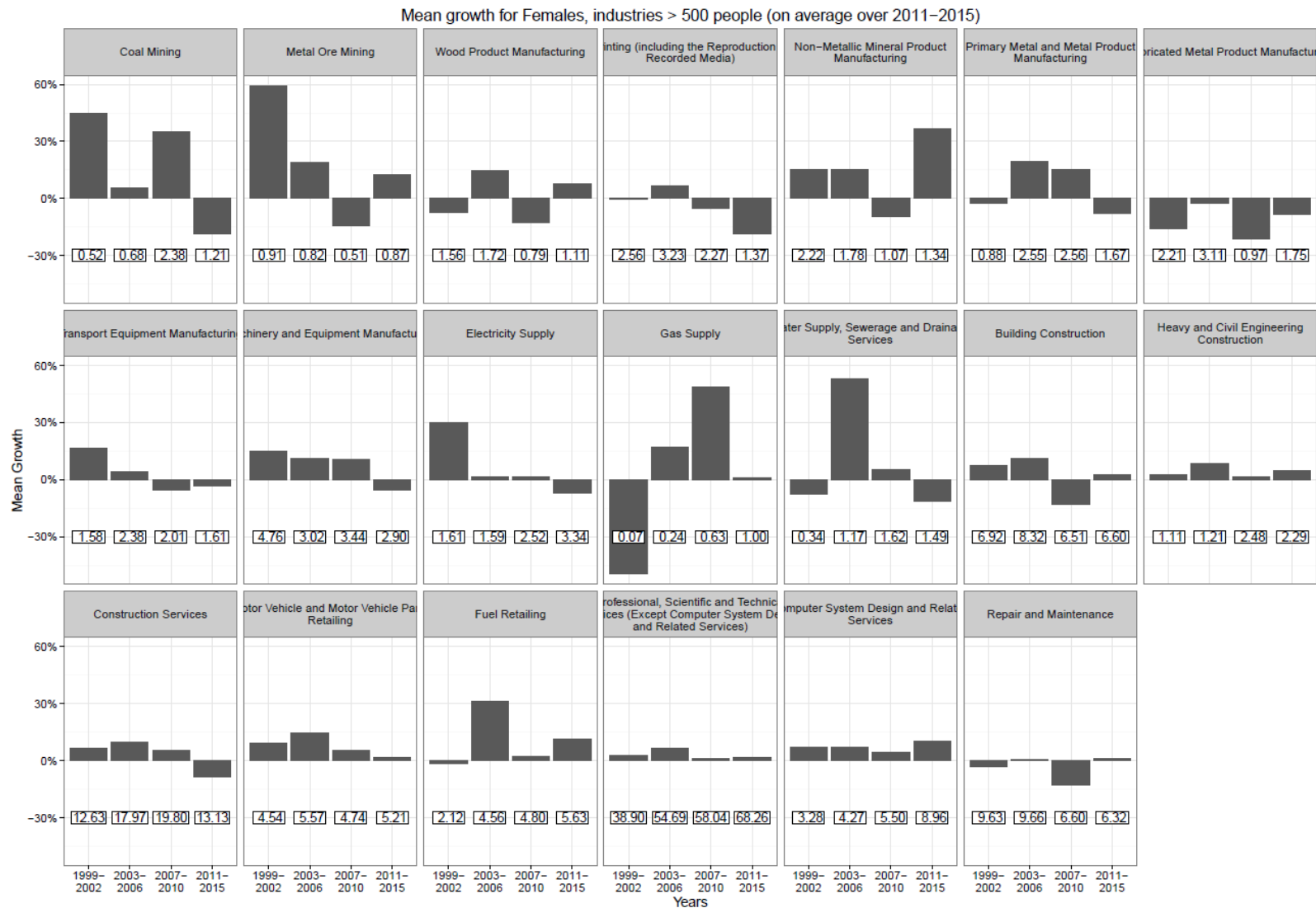


**Figure 28: Queensland 25-34 Age Group Mean Growth by Sub-Industry, with >500 People in 2011-2015.**

Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 29: Queensland 35-44 Age Group Mean Growth by Sub-Industry, with >500 People in 2011-2015.**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 30: Mean Growth of Females by Sub-Industry, in Queensland with >500 People in 2011-2015**

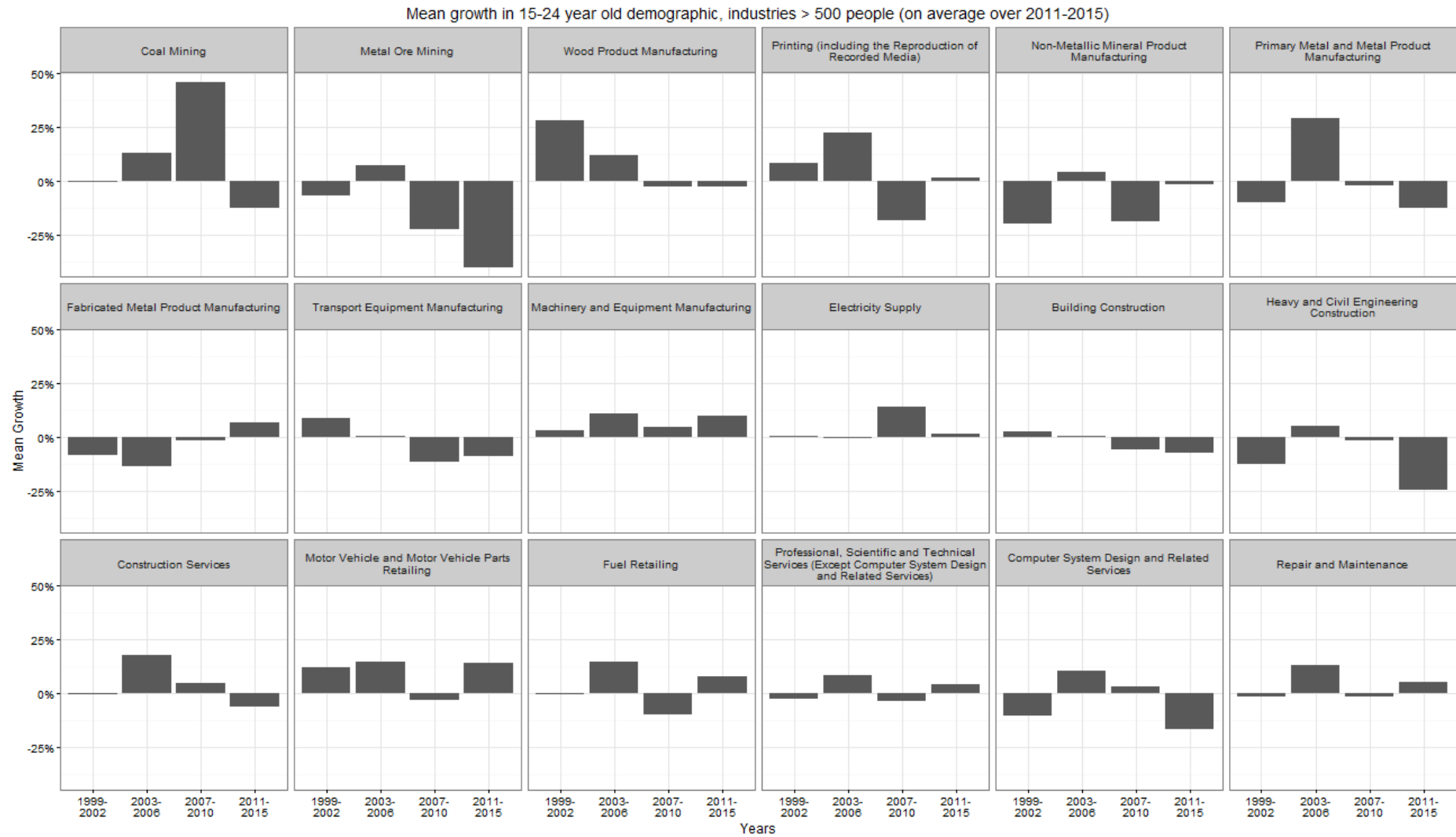
Source: ABS, Labour Force Survey Customised report, 1999-2015



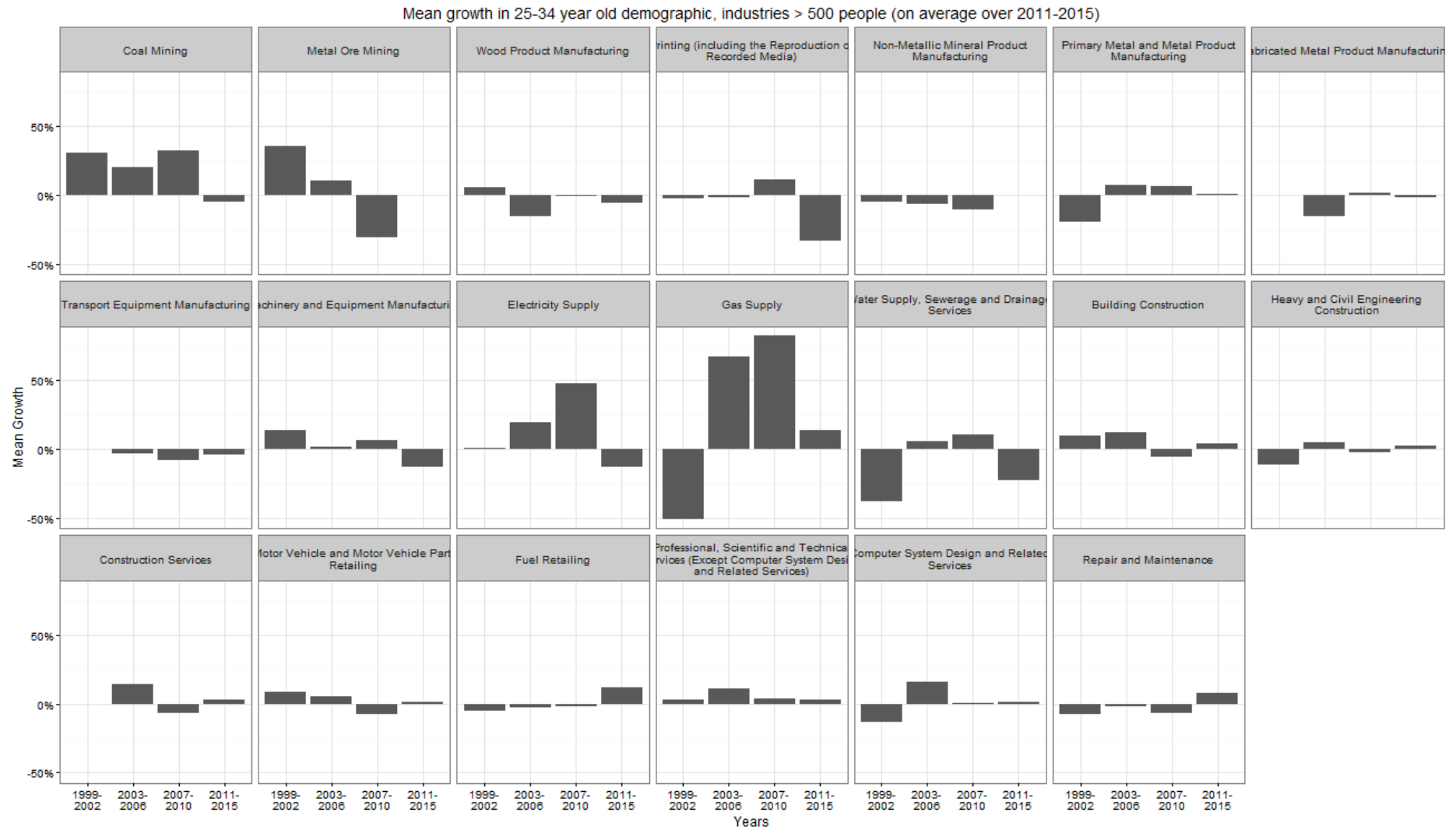
**Figure 31: Mean Growth of Males by Sub-Industries, in Queensland with >500 People in 2011-2015.**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015



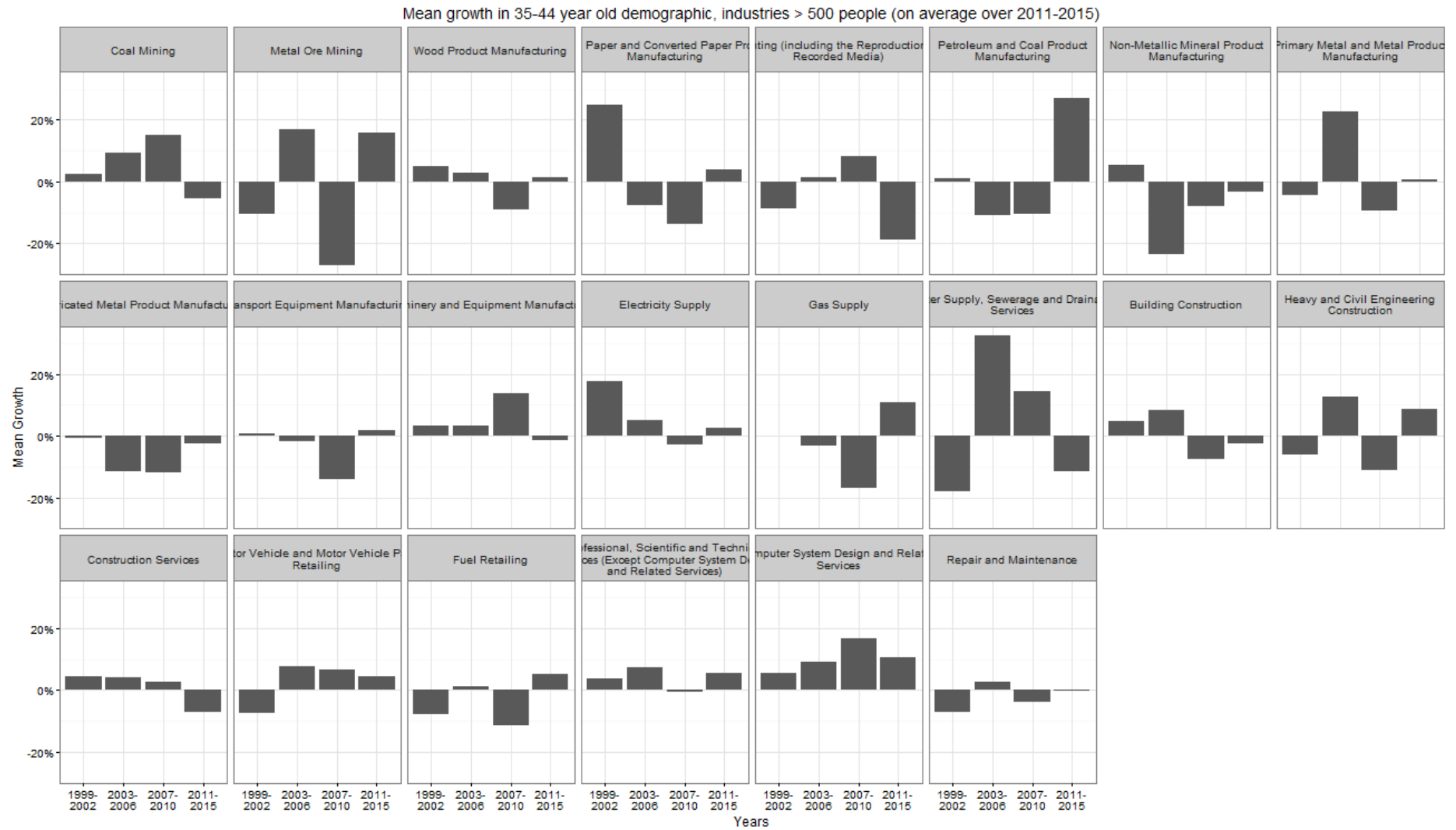
**Figure 32: Queensland Occupational Mean Growth by Sub-Industry, with > 500 People, 2011-2015**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 33: Average Mean Growth by Age (15-24 year old) for selected Sub-Industries, in Queensland 2011-2015**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 34: Average Mean Growth by Age (25-34 year old) for selected Sub-Industries, in Queensland 2011-2015**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015

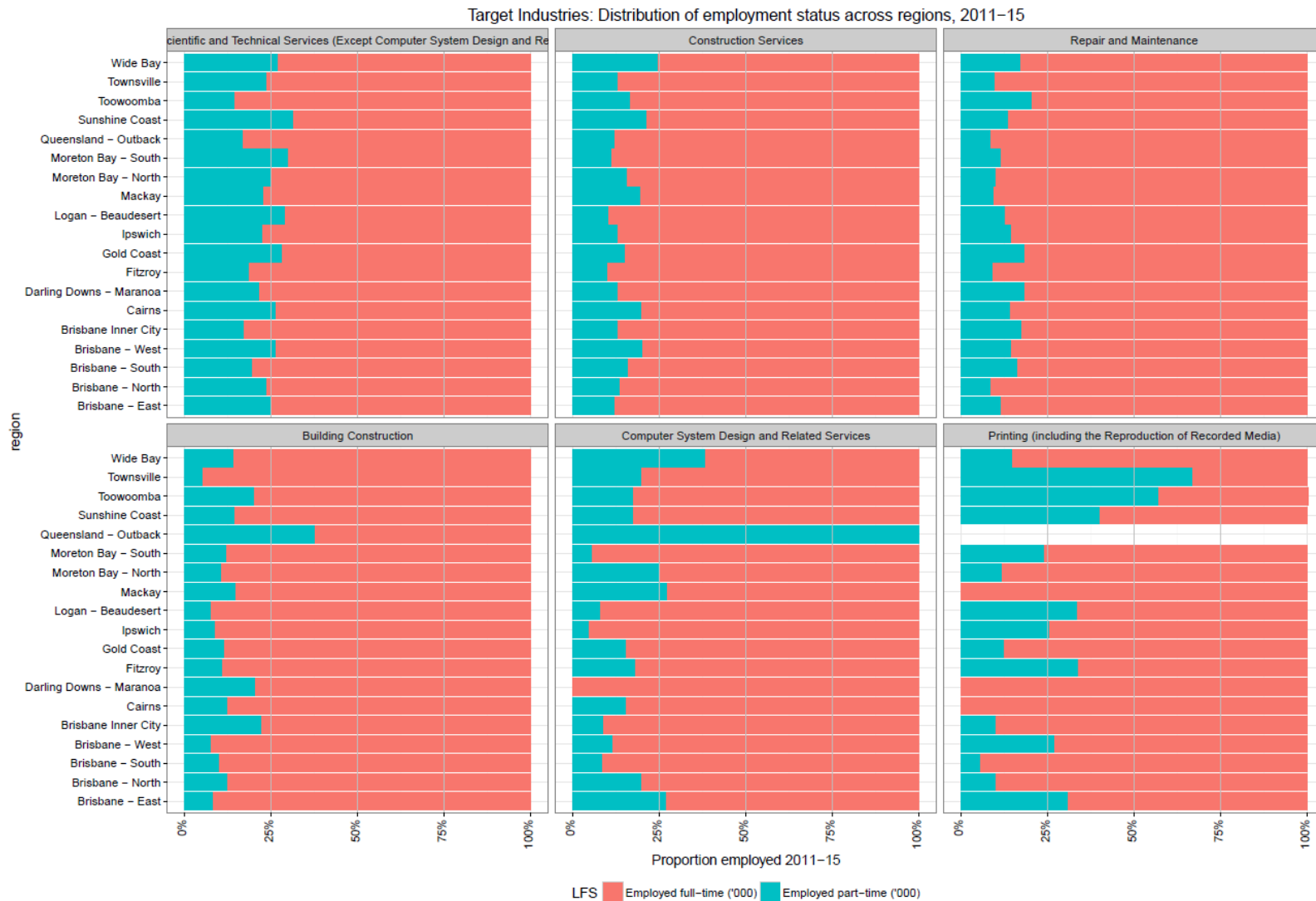


**Figure 35: Average Mean Growth by Age (35-44 year old) for selected Sub-Industries, in Queensland 2011-2015**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015





**Figure 36: Average Mean Growth for Occupations by selected Sub-Industries, in Queensland 2011-2015**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 37: Queensland Distribution of Part-time and Full-time Employment Across Regions for Targeted Industries, 2011-2015**

Source: ABS, Labour Force Survey Customised report, 1999-2015

Target Industries: Distribution of age across regions, 2011–15

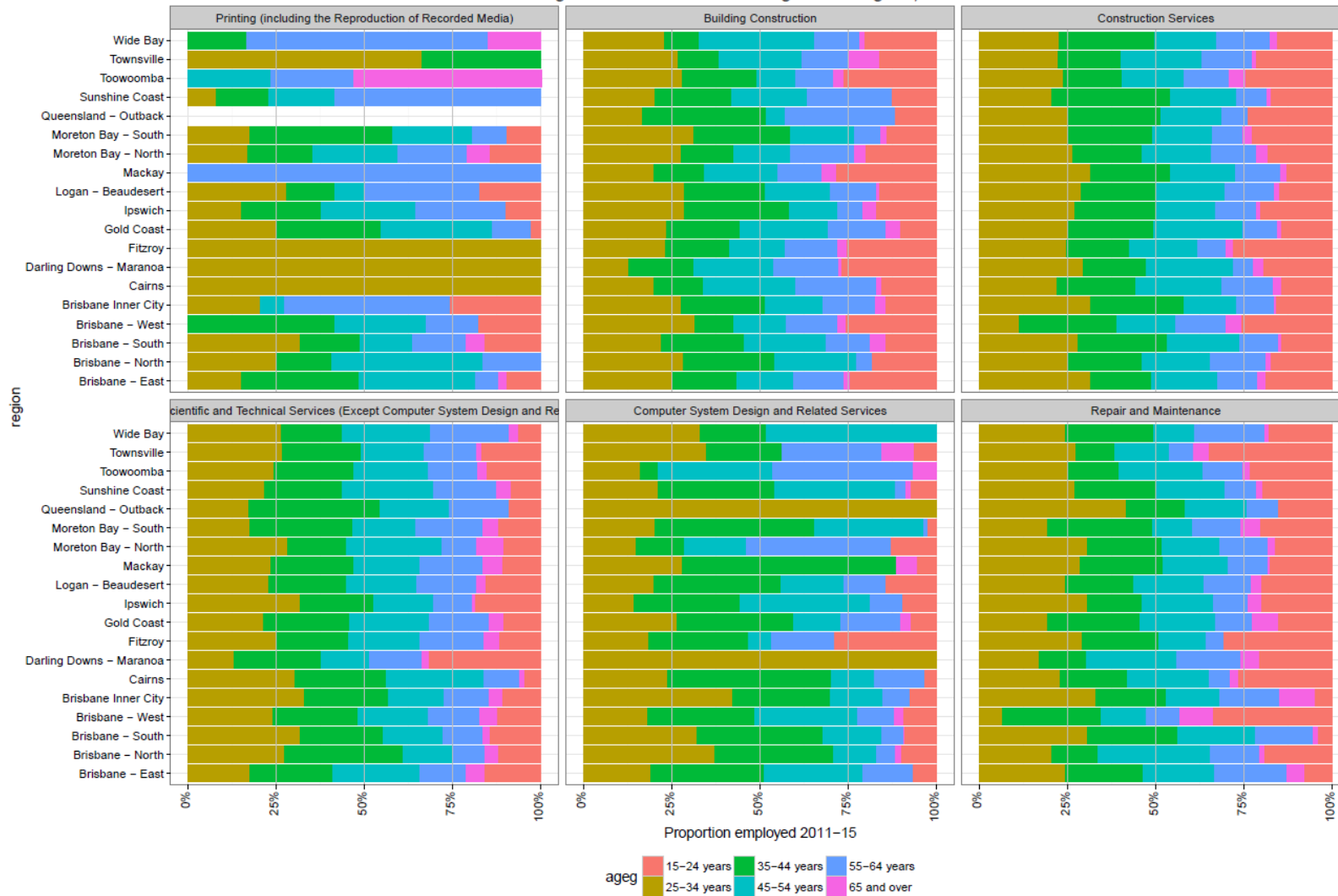
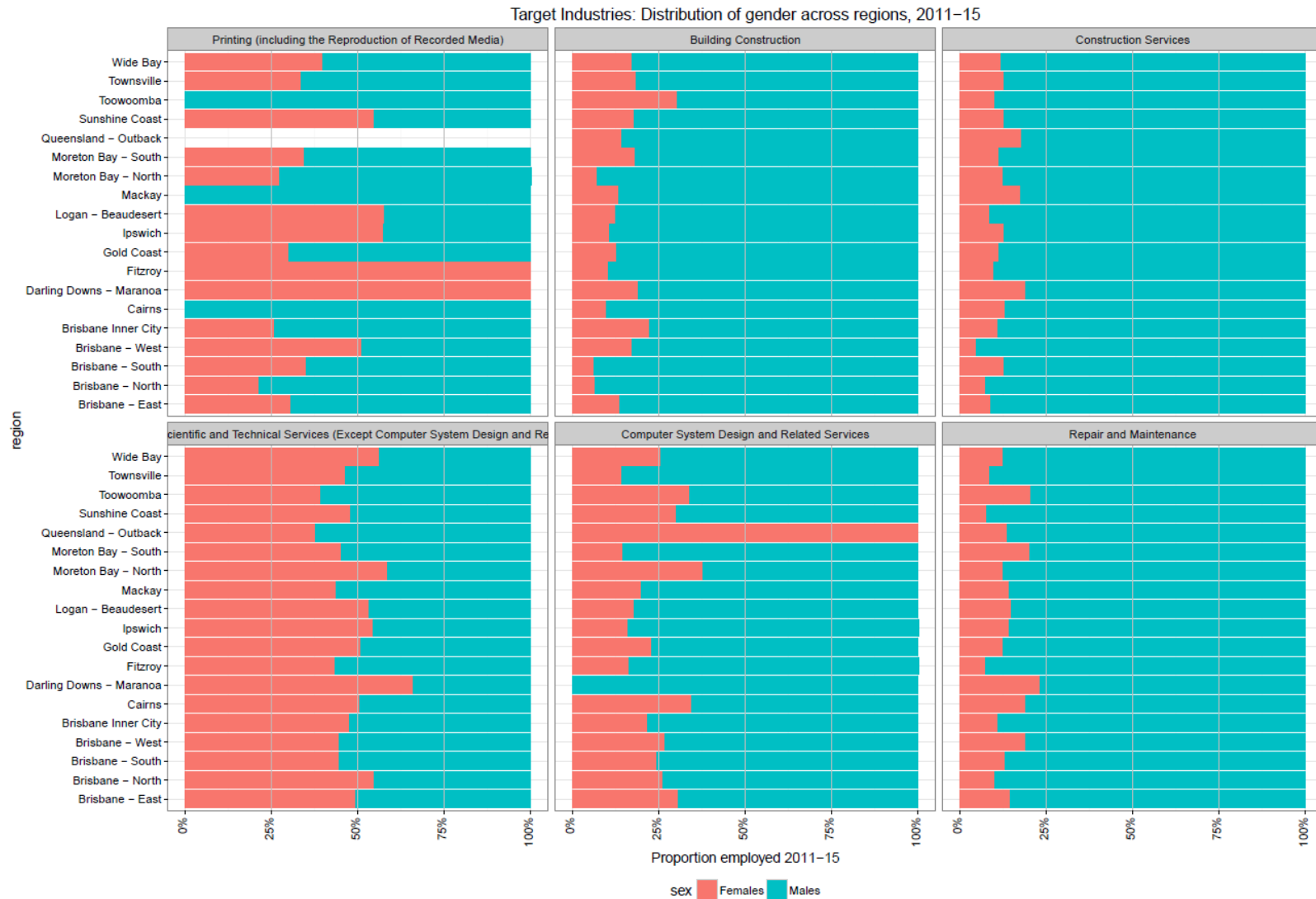


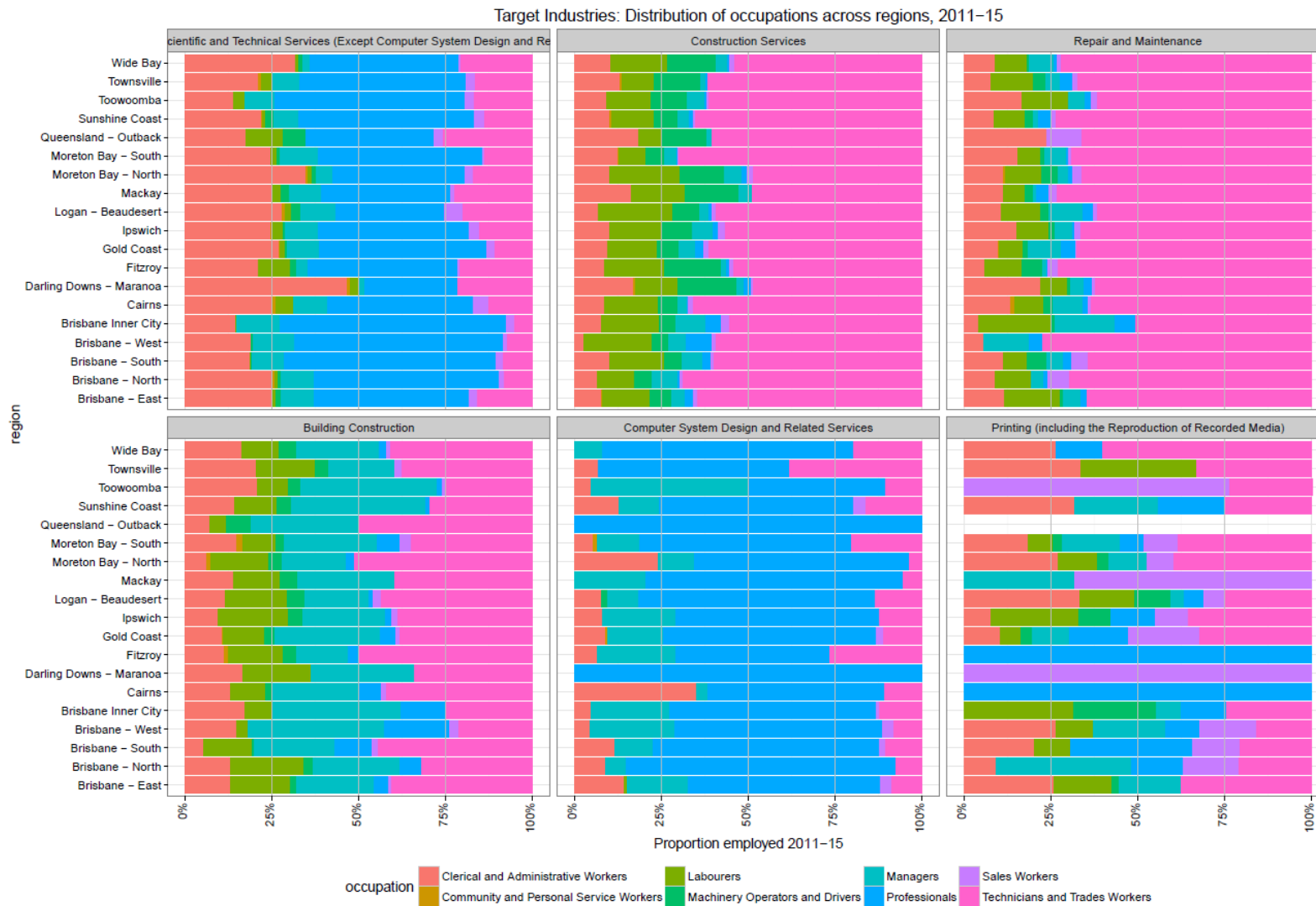
Figure 38: Queensland Distribution of Age across Regions for Targeted Sub-Industries, 2011-2015

Source: ABS, Labour Force Survey Customised report, 1999-2015

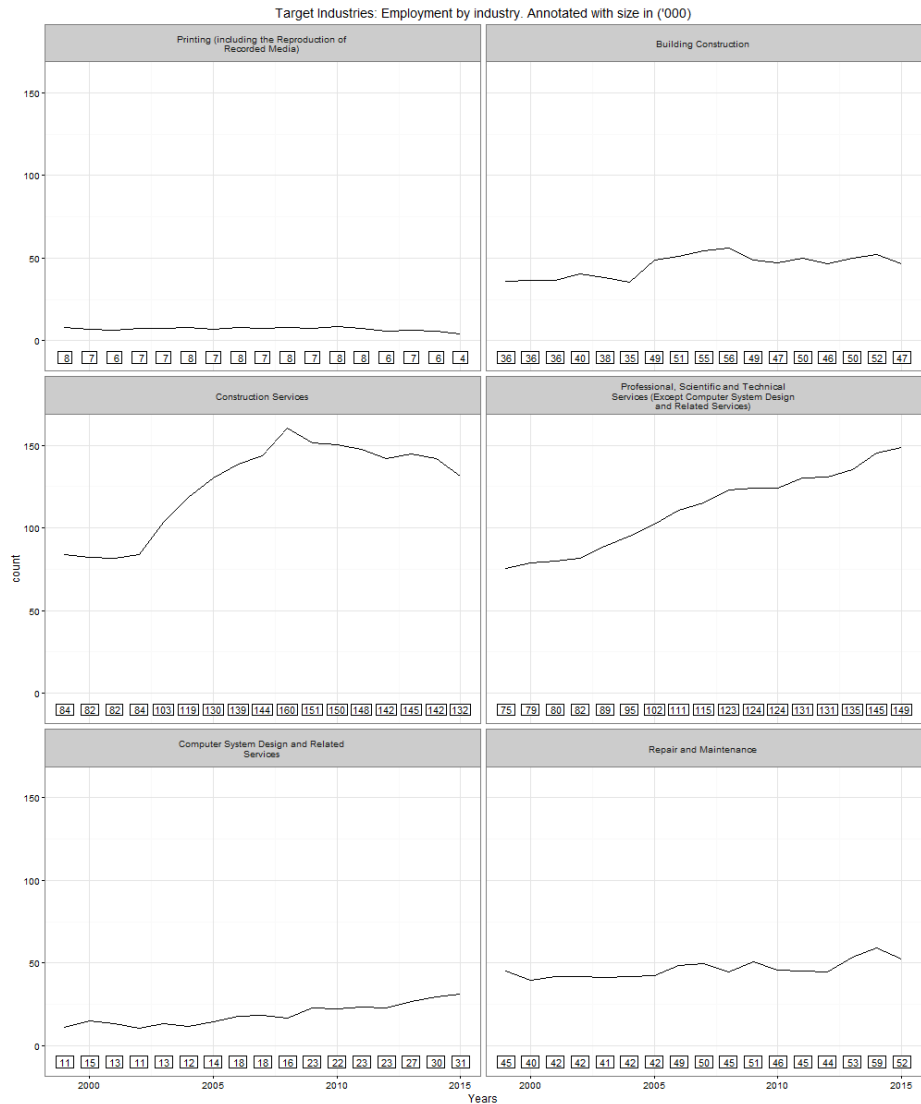


**Figure 39: Queensland Distribution of Gender across Regions for Targeted Sub-Industries, 2011-2015**

Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 40: Queensland Distribution of Occupations across Regions for Targeted Sub-Industries, 2011-2015**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 41: Queensland Employment by Industry for Targeted Sub-Industries, 1999-2015**  
 Source: ABS, Labour Force Survey Customised report, 1999-2015

Target Industries: Distribution of industries across regions, 2011-15

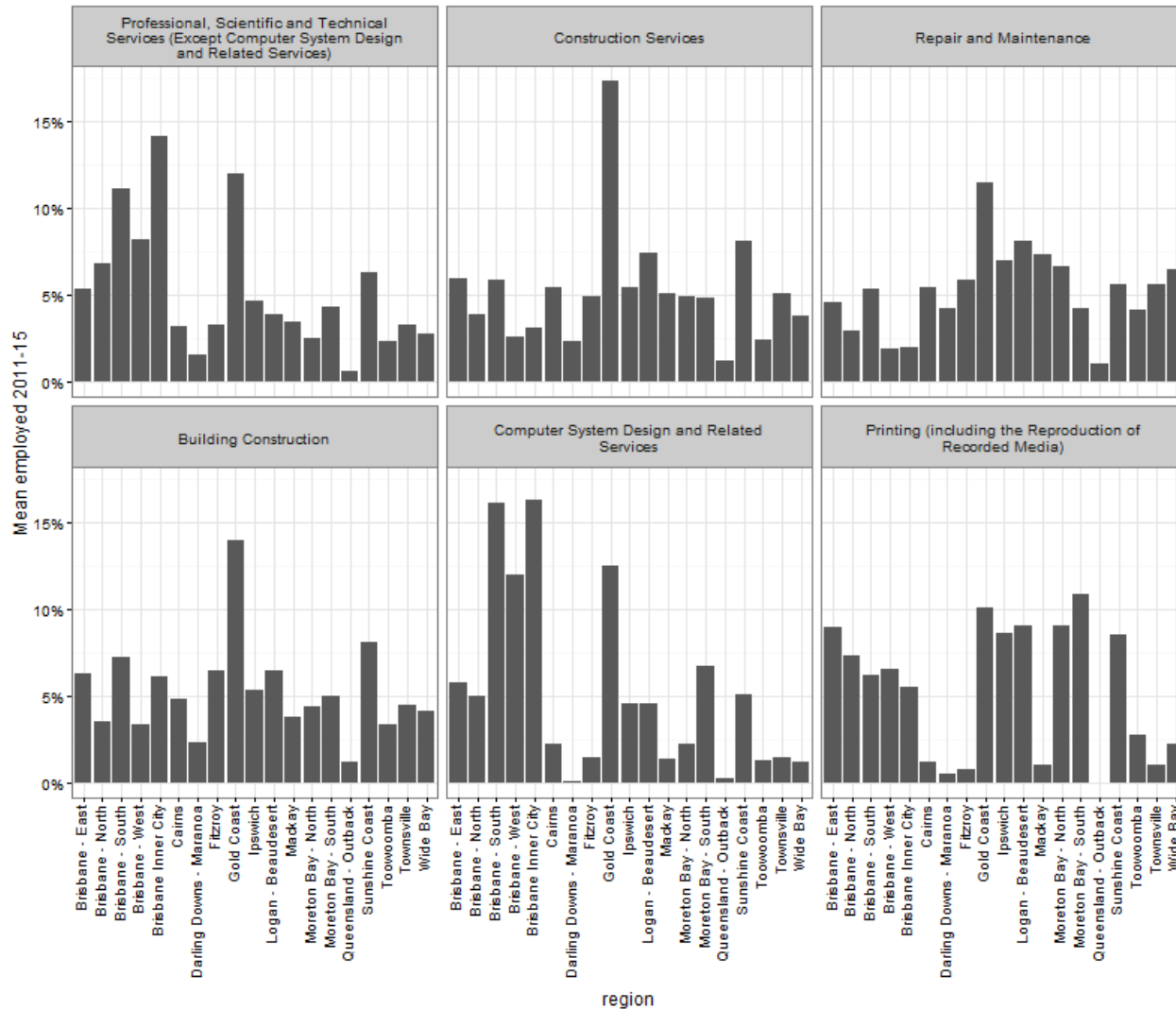
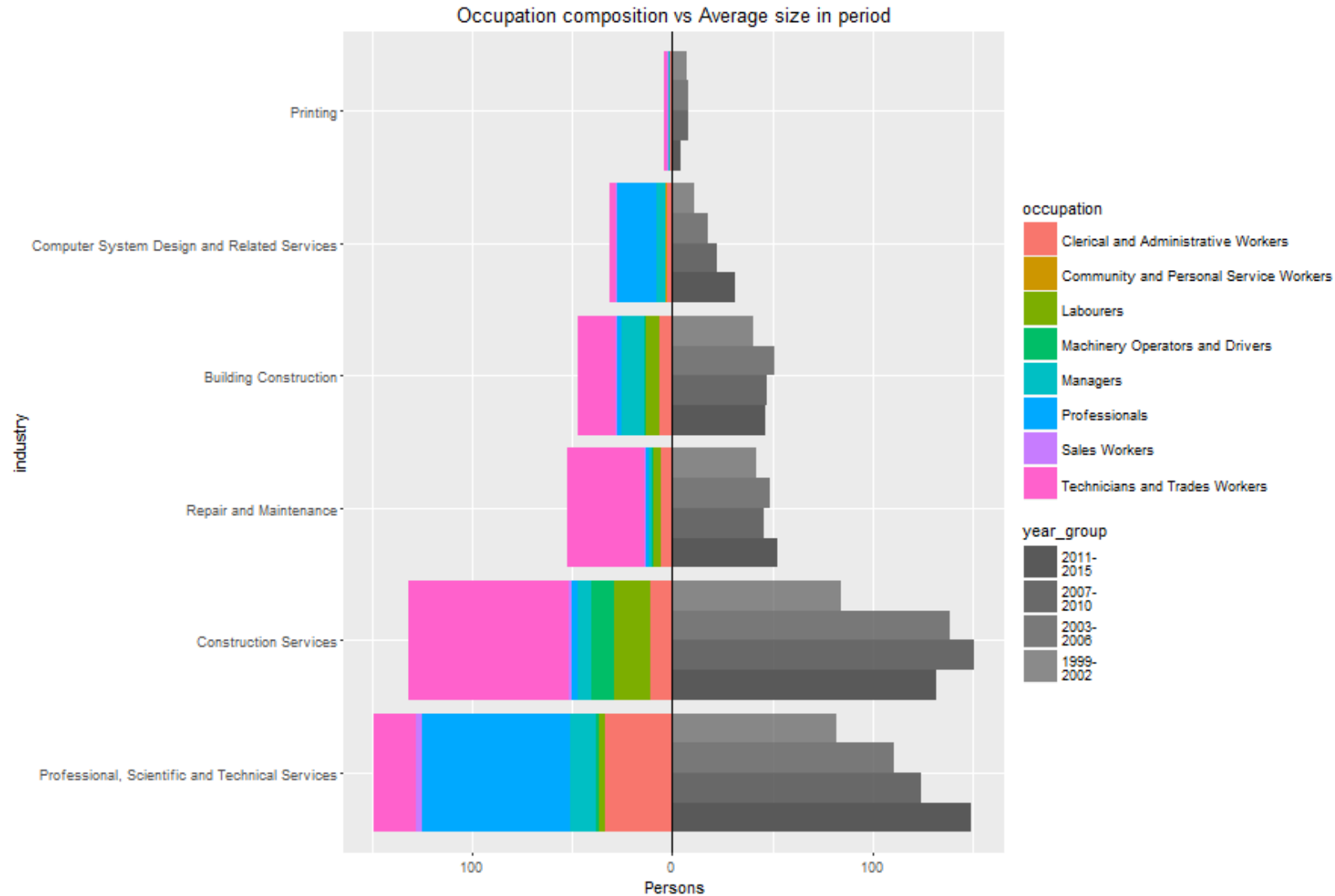


Figure 42: Queensland Distribution of Industries across Regions for Targeted Sub-Industries, 2011-2015.

Source: ABS, Labour Force Survey Customised report, 1999-2015



**Figure 43: Occupation Composition vs Average Size for Year Groups, 1999-2011**

Source: ABS, Labour Force Survey Customised report, 1999-2015



## 5 APPENDIX V: ADDITIONAL DETAILED LISTS

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### **V.I The main current tasks of Fitters & Turners, (ANZSCO 3232, ASCED 030700- 030711)**

- studying drawings and specifications to determine suitable material, method and sequence of operations, and machine settings
- fitting fabricated metal parts into products and assembling metal parts and subassemblies to produce machines and equipment
- checking fabricated and assembled metal parts for accuracy, clearance and fit using precision measuring instruments
- setting guides, stops and other controls on machining tools, setting up prescribed cutting and shaping tools and dies in machines and presses, and setting controls for textile machines
- forming metal stock and castings to fine tolerances using machining tools to press, cut, grind, plane, bore and drill metal
- cutting, threading, bending and installing hydraulic and pneumatic pipes and lines
- preparing pattern mechanisms to control the operation of textile machines used to spin, weave, knit, sew and tuft fabric
- diagnosing faults and performing operational maintenance of machines, and overhauling and repairing mechanical parts and fluid power equipment
- may erect machines and equipment on-site

### **V.II The main tasks related to the roles of Boilermakers, (ANZSCO 3222 ACSED 030711)<sup>xiv</sup>**

- studying blueprints, drawings and specifications to determine job requirements
- selecting, cleaning and preparing metal stock
- cutting marked-out metal sections and shapes using hand tools, flame cutting torches and metal cutting machines
- shaping and bending metal sections and pipes using hand and machine tools, and by heating and hammering
- aligning parts to be joined using hand tools and measuring instruments
- joining metal sections using various welding techniques, bolting and riveting
- examining welds for width of bead, penetration and precision
- finishing products by cleaning, polishing, filing and bathing in acidic solutions
- cleaning and smoothing welds by filing, chiseling and grinding

**V.III The main current tasks of Diesel Mechanics and Auto Technicians, (ANZCO code 3211- 3214, ASCED code 030500-030505)**

- detecting and diagnosing faults in engines and parts
- dismantling and removing engine assemblies, transmissions, steering mechanisms and other components, and checking parts
- repairing and replacing worn and defective parts and reassembling mechanical components, and referring to service manuals as needed
- performing scheduled maintenance services, such as oil changes, lubrications and engine tune-ups, to achieve smoother running of vehicles and ensure compliance with pollution regulations
- reassembling engines and parts after being repaired
- testing and adjusting mechanical parts after being repaired for proper performance
- diagnosing and testing parts with the assistance of computers
- may inspect vehicles and issue roadworthiness certificates or detail work required to achieve roadworthiness.

**V.IV The main current tasks of AME Mechanics, according the DETE concordance for AME Mechanics (ANZSCO 323112, ASCED 031500-031599)**

- Aircraft maintenance
- Engineer (Electrical)
- Aircraft maintenance
- Engineer (radio)
- Avionics technicians (defence)
- Licensed aircraft maintenance engineers(electrical)
- Aircraft maintenance Engineer (airframes)
- Aircraft maintenance Engineer (Engines)
- Aircraft technician ( Air Force, Army)
- Licensed Aircraft Maintenance Engineer (Airframes)
- Licensed Aircraft Maintenance Engineer (Engines)

**V.V The main current tasks related to the roles of Laboratory Technicians, (ANZSCO, 3112-3114)<sup>xlv</sup>**

- preparing materials for experimentation such as freezing and slicing specimens and mixing chemicals
- collecting information and samples
- conducting field and laboratory experiments, tests and analyses
- presenting results in graphic and written form by preparing maps, charts, sketches, diagrams and reports

- performing routine mathematical calculations, and computations of measurements
- controlling the quality and quantity of laboratory supplies by testing samples and monitoring usage
- checking, calibrating and maintaining test equipment
- participating in fabricating, installing and modifying equipment to ensure that critical standards are met
- preparing experiments and demonstrations for science classes

**V.VI The main current tasks related to the roles of Graphic and Web Designers, (ANZSCO 232411- 232414, ASCED 100300)<sup>xlv</sup>**

- determining the objectives and constraints of the design brief by consulting with clients and stakeholders
- undertaking research and analysing functional communication requirements
- formulating design concepts for the subject to be communicated
- preparing sketches, diagrams, illustrations and layouts to communicate design concepts
- negotiating design solutions with clients, management, sales and production staff
- selecting, specifying or recommending functional and aesthetic materials and media for publication, delivery or display
- detailing and documenting the selected design for production
- supervising or carrying out production in the chosen media
- may archive information for future client use

**V.VII The main current tasks related to the roles of Printers, (ANZSCO 3923, ASCED 030100)<sup>xlv</sup>**

- setting, adjusting and monitoring substrate-feed mechanisms, delivery mechanisms, inking systems and other printing machine functions
- mixing ink and solvents to standard, and regulating paper and ink supply during print runs
- monitoring, evaluating and determining press operations manually and by computer to check print quality standards against proofs and detect malfunctions
- producing a variety of printed products using relief, lithographic, flexographic and gravure printing presses, and in-line finishing systems
- preparing plates, blankets and impression cylinders on small offset lithographic printing presses
- loading paper into feeding mechanisms

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<sup>i</sup> Boreham, P., Parker, R., Thompson, P. and Hall, R (2008). *New Technology @ Work*. London. New York, Routledge.

<sup>ii</sup> Gratton, L. (2015). *What will artificial intelligence do for work? The Future of Work*. Viewed 1 August 2016 <<http://lyndagrattontofutureofwork.typepad.com/lynda-gratton-future-of-work/>>.

<sup>iii</sup> Australian Bureau of Statistics *Labour Force Survey Detailed Quarterly*. ABS Catalogue Number 6291.0.55.003 Viewed 27 July 2016 <<http://www.abs.gov.au/ausstats/abs@.nsf/mf/6291.0.55.003>>.

<sup>iv</sup> Australian Bureau of Statistics (March 2014). *Australian National Accounts: National Income, Expenditure and Product*. ABS Catalogue Number 5206.0. Viewed 26 July 2016 <[http://www.ausstats.abs.gov.au/ausstats/meisubs.nsf/0/1D45684501575F51CA257CEC001D0A30/\\$File/52060\\_Mar%202014.pdf](http://www.ausstats.abs.gov.au/ausstats/meisubs.nsf/0/1D45684501575F51CA257CEC001D0A30/$File/52060_Mar%202014.pdf)>.

<sup>v</sup> Australian Bureau of Statistics. *International Trade in Goods and Services, Australia*. cat.no. 5368.0. Viewed 27 July 2016 <<http://www.abs.gov.au/ausstats/abs@.nsf/mf/5368.0>>.

<sup>vi</sup> Australian Bureau of Statistics (September 2015). *Manufacturing Data Card, September Quarter*. Viewed 1 August 2016, <<http://www.industry.gov.au/INDUSTRY/MANUFACTURINGPERFORMANCE/Pages/ManufacturingDataCard.aspx>>.

<sup>vii</sup> Australian Bureau of Statistics. *Labour Force, Australia, 'Detailed, Quarterly; average year to Feb 2016'*, cat.no 6291.0.55.003. Viewed 26 July 2016 <<http://www.abs.gov.au/ausstats/abs@.nsf/mf/6291.0.55.003>>

<sup>viii</sup> Australian Bureau of Statistics. *International Trade in Goods and Services, Australia* cat.no. 5368.0 Table 32a. Merchandise Exports, Industry (ANZSIC 2006), FOB Value. Viewed 27 July 2016. <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5368.0Jul%202016?OpenDocument>

<sup>ix</sup> Kaspur, A. (2011). *The Engineering Profession A Statistical Overview*. Barton, ACT Institution of Engineers Australia.

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