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CELEBRATING
OUR CENTENARY

Engineers and Industry: A decade of change

Cover image:

Australian Engineering Excellence Awards, National Finalist, Bunjil Place
Taylor Thomas Whitting

Engineers and Industry: A decade of change 2006 to 2016

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Table of Contents

<i>Engineers and Industry: A decade of change</i>	
<i>Glossary</i>	9
<i>Executive Summary</i>	10
Core and non-core engineering industries	10
Geographic spread of engineers	10
Employment prospects for male and female engineers	11
Overseas-born engineers and engineers under 30	11
Engineer earning capacity and work week	11
1. Introduction	12
Impact of wider economic change	12
Resources boom	12
Transition to service-based economy	12
Changes to business models	13
A report to inform policy-making	13
Companion study	13
2. Report Approach and Methodology	14
Benchmarks for growth in engineering employment	14
‘Engineering occupation’ definition	14
Granularity of industry classifications	15
Core and non-core industries	15
Growth in industry demand for engineers	15
3. Overview of Industry Employment	16
Numbers of engineers by industry	16
Employment growth has been about skills	19
Growth in general employment	19
Growth in skilled employment	19
Growth in employment of engineers	20
Core and non-core engineering industries	20

Table of Contents

Proportions of engineers in engineering roles by core industry	20
Proportions of engineers in engineering roles by non-core industry	20
Comparison of core and non-core industry employment of engineers	21
Other factors affecting the figures	23
Employment growth in core industries	23
Core industries influenced by the resources boom	23
Core industries requiring specialised skills	24
Core industry in decline	27
Employment growth in non-core industries	28
The largest industry employers in Australia	28
Other non-core industries that are growing	29
Non-core industries in decline	30
Decade of change for core and non-core industries	31
4. Aggregated Sub-industry Analysis	32
The top sub-industries of general employment	32
The top sub-industries for qualified engineers	32
Top sub-industries for engineers nationwide	32
Top sub-industries for engineers by state	34
5. Core Engineering Industries	36
Professional, scientific and technical services	37
Architectural, engineering and technical services	37
Computer system design and related services	39
Management and related consulting services	40
Geographical distribution of professional services sub-industries	41
Manufacturing	43
Machinery and equipment manufacturing	44
Transport equipment manufacturing	45
Primary metal and metal production manufacturing	47
Food product manufacturing and basic chemical and chemical product manufacturing	48

Table of Contents

Construction	49
Heavy and civil engineering construction	49
Building installation services	52
Residential and non-residential building construction	53
Public Administration and Safety	54
Defence	54
Regulatory services	54
Mining	54
Metal ore mining	55
Oil and gas extraction mining	57
Coal mining	58
Electricity, gas, water and waste services	59
Water supply, sewerage and drainage services	60
Electricity generation, transmission and distribution	61
Information media and telecommunications	64
Telecommunications services	64
6. Non-Core Engineering Industry Analysis	66
Transport, postal and warehousing	66
Air and space transport	68
Other transport services	68
Rail passenger transport and rail freight transport	69
Wholesale trade	71
Other machinery and equipment wholesaling	71
Education and training	72
Tertiary education	73
Financial and insurance services	74
Depository financial intermediation	74
Health care and social assistance	75
Hospitals	75

Table of Contents

Accommodation and food services	76
Retail trade	76
Administrative and support services	77
Other services	77
Rental, hiring and real estate services	79
Agriculture, forestry and fishing	80
Arts and other recreation services	80
Inadequately described or not stated	81
7. Engineers in the Public Sector: Industries of Work	82
Distribution of engineers across public and private sectors	82
Engineer numbers in each level of government	83
Industries of Commonwealth government engineers	84
Industries of state government engineers	85
Industries of local government engineers	86
8. Engineer Diversity, Age and Salaries: Industry Comparisons	87
Engineer gender diversity by industry	87
Proportions of male and female engineers working in engineering roles	87
Top industries that employ female engineers and male engineers	88
Overseas-born engineers by industry	90
Proportions of Australian-born and overseas-born engineers in core and non-core industries	90
Distribution of overseas-born engineers in core industries	91
Distribution of overseas-born engineers in non-core industries	92
Age of engineers by industry	93
Distribution of engineers in core and non-core industries by age	93
Distribution of engineers in core industries by age	94
Distribution of engineers in non-core industries by age	96
Level of salary by industry	97
Comparison of engineer income in core and non-core industries	97
Engineer income in core industries	98

Table of Contents

Engineer income in non-core industries	99
Hours of work per week by industry	100
Hours of work in core industries	101
Hours of work in non-core industries	102
9. Conclusions	104
2006 to 2011	104
2011 to 2016	104
Core vs non-core industries	104
Policy implications	105

Glossary

ANZSIC: The Australia and New Zealand Standard Industrial Classification (ANZSIC) has been jointly developed for use in both countries for the production and analysis of industry statistics. ANZSIC is a hierarchical classification with four levels to provide a number of categories which provide a broad overall picture of the economy.

ANZSCO: The Australia and New Zealand Standard Classification of Occupations (ANZSCO) is a statistical classification designed to aggregate and organise data collected about jobs or individuals. The classification definitions are based on the skill level and specialisation usually necessary to perform the tasks of the specific occupation.

Compound annual growth: the measure of growth (in this report as a percentage) over multiple time periods. It gives the indication of the growth in a number over an annual compounded basis.

Core industry: an industry in which the proportion of engineers in the industry employed in engineering occupations is higher than the national average.

Engineer/Engineering employment: all individuals in the Australian economy employed in Australian industries with engineering qualifications. These are qualifications at least to the standard or advanced diploma or associate degree level.

Engineering occupation: an occupation that has a demonstrated degree of attachment to engineering. Of the 358 listed ANZSCO occupations, we analysed and found 51 that fit the criteria of an engineering occupation.

General employment: includes all individuals in the Australian economy employed in Australian industries. This includes both skilled and unskilled workers.

Non-core industry: an industry in which the proportion of engineers in the industry employed in engineering occupations is lower than the national average.

One-digit/Two-digit/Three-digit/Four-digit industry: the four hierarchical levels of industry classification. One-digit is the highest level (least disaggregated) of industry classification, while four is the lowest level (most disaggregated) of industry classification.

Skilled employment: all individuals in the Australian economy employed in Australian industries that are skilled. This includes qualifications to the stipulated level in any field, minus engineering.

Sub-industry: an industry classification that is lower in the hierarchy, primarily the four-digit industry classification.

[< BACK TO TABLE OF CONTENTS](#)

Executive Summary

In the space of ten years, Australia has seen strong population growth, a resources boom and a global recession. During that time, the economy has been transitioning towards service-based industries. This has meant that manufacturing and industries that build products have a falling share of workers as people move into industries that provide specialised services. Engineers have not been immune to these changes, and this is reflected in the growing numbers of engineers employed in service-based industries.

Core and non-core engineering industries

Engineers feature much more prominently in a select number of industries, which are classified in this report as **core industries**. The remaining industries are classified as **non-core**. The core industries have both a high number of engineers and a high proportion of those engineers working in actual engineering occupations.

Overall, the number of employed engineers increased in Australia over the decade. There was a rise in engineer numbers in every industry besides manufacturing. The first half of the decade, from 2006 to 2011, saw particularly strong growth in numbers of engineers working in core industries. The number of those employed in engineering occupations also increased.

This trend changed in the second half of the decade, between 2011 and 2016, and growth in engineer numbers occurred primarily in the non-core industries. As growth slowed at the end of the resources boom, the oversupply of engineers in the economy resulted in engineers searching for work in non-traditional industries.

Even so, the industries that have employed the most engineers have remained constant, those being the professional services, manufacturing and construction industries. While the employment prospects for engineers in these industries have varied over the decade, professional services, manufacturing and construction have consistently been the largest employers of engineers.

Geographic spread of engineers

Despite rising numbers of engineers over the decade, growth was not consistent in each industry, nor across the different parts of Australia.

There was solid growth in the number of engineers working in Australia's capital cities, primarily due to large numbers of urban-based engineers working in construction, professional services, wholesale trade, financial services and even mining. Some regional areas experienced growth in engineer numbers, though this was dwarfed by capital city growth. Regional growth tended to be connected with a few key core industries, such as the utilities and manufacturing, which require specialised 'location-specific' work.

Employment prospects for male and female engineers

Engineering is a heavily male-dominated profession. However, observing the percentage of male engineers and female engineers who work in each industry allows a comparison of the top industries for men and women.

The top industry employers of male and female engineers are similar, with some small subtle differences. A large share of all male and female engineers work in professional services, education and telecommunications.

Male engineers are more likely to be employed in metal ore mining, defence, machinery and equipment wholesaling, air transport and building installation.

Female engineers are more likely to be employed in industries such as state and local government, management consulting and depository financial intermediation. However, female engineers working in non-core industries are less likely to be employed in engineering occupations than male engineers employed in non-core industries.

Overseas-born engineers and engineers under 30

New migrant engineers and younger engineers find it harder to get jobs in core industries.

Engineers who migrated to Australia after 2011 were more likely to be working in non-core industries such as retail trade, accommodation and food services, and administrative services than Australian-born and earlier-arriving migrant engineers.

This is a similar situation for engineers under 30, who form a large share of the engineers working in accommodation, food services and retail trade. This gives a snapshot of the difficulty some new engineering graduates have had finding engineering work after university. Meanwhile, older engineers tended to be strongly represented in industries such as public administration and transport, and postal and warehousing.

Engineer earning capacity and work week

Engineers working in core industries were more likely to be earning the top salary brackets, particularly if they were employed in an engineering occupation. They were also more likely to be working longer hours.

Engineers working in the non-core industries, especially industries with low numbers in engineering occupations, tended to work fewer hours a week on average, with a notable proportion working a part-time load of under 25 hours. So while engineers working in traditional engineering roles in the core industries were working longer hours, they were also being compensated with higher earnings.

1.

Introduction

This report examines the size, growth and character of engineering industry employment in Australia to improve the understanding of the dynamics of the engineering profession. The number of engineers working in different industries has changed over the decade 2006 to 2016 as the economy has continued a slow transition from a manufacturing-based economy to a service-based economy.

Impact of wider economic change

Australia's population grew significantly over the decade, pushed by a strong migration policy and solid economic growth. Australia also weathered the worst effects of the Global Financial Crisis, even as many other major developed economies went into recession.

RESOURCES BOOM

The engineering profession was affected by these national and international events, with the numbers working in engineering going through a boom-bust cycle. The Australian engineering workforce grew significantly to meet the demand fuelled by the resources boom. The extraordinary demand for engineers in the resources sector somewhat obscured the high demand for engineers in other parts of the economy. As the boom came to an end, the industry distribution of engineers adjusted.

This report confirms that engineers are required in all areas of the Australian economy. This is borne out by the widespread distribution of engineers across

industries. However, demand was not spread evenly across all industries, as some were more strongly influenced by the resources boom.

Additionally, this report reaffirms that a number of core industries continue to employ large numbers of engineers, and that these engineers are in highest demand in our largest urban areas. Not everyone who is a qualified engineer will practice as an engineer in their industry. However, industry distribution of engineers shows that engineering skills are readily adaptable to other occupations.

TRANSITION TO SERVICE-BASED ECONOMY

Engineers have not been fully immune to broader changes in the Australian workforce as the shift to service-based industries from manufacturing becomes more apparent. Large numbers of engineers are following that shift.

CHANGES TO BUSINESS MODELS

At the same time, there was evidence to suggest that many businesses changed the way they operated. The Australian economy is moving away from vertically integrated businesses that undertake most steps in producing goods and services, towards collaborative networks where businesses partner with professional service providers. It is a new arrangement designed for efficiency, performance and cost savings, and many engineering service businesses thrive under this model.

A report to inform policy-making

Engineers are expected to play a vital role in the future of the Australian economy, but their influence will be determined by the policies pursued by governments. These policies include industry policy (most notably in manufacturing) and the continued push for technical (STEM) skills in the formative years of education, as well as future migration policies.

Careful analysis of the economic forces and employment dynamics affecting highly skilled workers should inform future policy development in these areas. Government policies will continue to be crucial in the push for a highly technical and innovative economy, and for Australia's future prosperity.

Companion study

This report should be read alongside *Australia's Engineering Capability: How the last ten years will influence the future*. The latter analyses and presents statistics describing the characteristics and size of Australia's engineering profession over the period 2006 to 2016. It is the first report covering the three population censuses over the boom and bust cycle during these years.

Engineers are expected to play a vital role in the future of the Australian economy, but their influence will be determined by the policies pursued by governments

2. Report Approach and Methodology

This report uses data sourced from the 2006, 2011 and 2016 Censuses. All data was collected using Census TableBuilder Pro, an online self-service tool provided by the Australian Bureau of Statistics (ABS).

To determine the changes in engineering employment, we assessed:

- geographic distribution of engineers
- gender
- age
- migrant engineers
- salary
- hours worked.

All of these categories are based on census classifications for each group.

Benchmarks for growth in engineering employment

To place engineering within wider employment trends, we established benchmarks for national growth in:

- **General employment**, which includes all individuals employed in Australian industries, skilled and unskilled.
- **Skilled employment**, which includes all individuals employed in Australian industries, with academic qualifications that are at least to the standard of an advanced diploma or associate degree in any field, minus engineering qualifications.
- **Qualified engineering employment**, which includes all individuals employed in Australian industries, with qualifications stipulated in engineering. This refers to individuals who have an academic qualification in engineering consistent with the engineering team that is at least to the standard of an advanced diploma or associate degree.

Qualified engineering employment does not necessarily mean that all engineers in this cohort are working in engineering-specific roles in the economy. For this reason, the report also considered an additional category:

- **Qualified engineers working in engineering occupations**, which includes all individuals employed in Australian industries, with qualifications stipulated in engineering, who are also working in a specific engineering occupation.

In some cases, we aligned the engineering, skilled and general employment categories to facilitate a fair comparison. This was achieved by insisting that the same level of qualifications is required for each group: at least an associate degree or advanced diploma from a university or college. The only difference between the two groups is that engineers are expected to have their qualification in engineering.

‘Engineering occupation’ definition

To conduct our analysis, we needed to determine what qualified as an engineering occupation and what did not. To do this, we established a profile of the demand for, and supply of, engineers in the 2006 Census. This involved systematically applying pre-determined criteria to 358 ‘four-digit’ occupations in the Australian and New Zealand Standard Classification of Occupations (ANZSCO).

The criteria for an engineering occupation included that the occupant was at a work level consistent with the engineering profession, and that the occupation concerned demonstrated an acceptable degree of attachment to engineering. By our analysis, 51 of the 358 occupations were engineering occupations.

Granularity of industry classifications

We used Australian and New Zealand Standard Industry Classification (ANZSIC) industry classifications when observing the numbers for general employment, skilled employment, qualified engineers and engineers working in engineering occupations.

ANZSIC classifications were developed for use in the compilation and analysis of industry statistics in Australia and New Zealand¹. They follow a hierarchical classification model, with the **one-digit level** being the top (least disaggregated) level of classification, and the **four-digit level** being the bottom (most disaggregated) level of classification. In this report, we analysed general employment, skilled employment, qualified engineers, and engineers working in engineering occupations at the one-digit level.

Core and non-core industries

Engineers feature much more prominently in a select number of industries, which are classified in this report as ‘core industries.’ The remaining industries are classified as ‘non-core industries.’ Our analysis required us to find a logical place to split one-digit industries into core and non-core.

We split industries according to whether the average number of employed engineers working in engineering occupations was above or below the economy-wide average. In subsequent sections, the number of qualified engineers, and those in engineering occupations, is analysed down to the three-digit level (discussed as **sub-industry**).

Growth in industry demand for engineers

Growth in demand is measured by employment growth in that particular industry. This growth is estimated as the **annual compound growth rate** necessary for the observed change between the census periods of 2006, 2011 and 2016.

The character of engineering employment is measured by both the increase in qualified engineers, and that of qualified engineers working in engineering occupations. Demand in industries where the proportion in engineering occupations is high is more likely to be influenced by factors specific to engineering like the resources boom. Conversely, demand in industries where the proportion in engineering occupations is low is likely to be influenced by factors generic to skilled employment, such as the changes in the way businesses operate.

3.

Overview of Industry Employment

This section outlines the employment of engineers in industry and how these distributions compare to skilled employment, and to overall (general) employment in the Australian economy.

Our analysis reveals that skilled employment fuelled overall growth. While skilled employment growth slowed over the decade, it was still three times the rate of overall general employment. In the first half of the decade, engineering employment growth outmatched even that of skilled employment.

However, the end of the resources boom led to a slowdown in engineering job growth. By the second half of the decade, growth of employment for engineers fell to match skilled employment growth because the impetus provided by the resources boom in the earlier period had disappeared.

The slowdown in growth also resulted in an oversupply of engineers with a big drop in engineers working in engineering occupations. Employment growth for engineers working in engineering occupations more than halved, and growth was slower than in skilled employment generally.

Numbers of engineers by industry

We measured the number of engineers at each census count. This information gives a foundational view of the breakdown of engineers by broad industry, and informs our analysis throughout this report.

Employment of male and female engineers by broad industry is set out in Table 3.1. Table 3.2² shows the employment of engineers in engineering occupations. This distinction is important because possessing recognised qualifications in engineering does not mean that the individuals concerned want to, or are able to, find work in an engineering occupation.

In every census, some responses to questions are inadequate or missing. Rather than spell out the various ways this occurs, the relevant statistics have been grouped under 'Inadequately described' in all tables and in subsequent report sections.

Table 3.1: Employment of qualified engineers in industry, 2006 to 2016

Broad industry	2006			2011			2016		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Agriculture, Forestry and Fishing	1626	137	1763	1641	155	1796	2346	277	2623
Mining	6764	601	7365	12238	1315	13553	14087	1618	15705
Manufacturing	33172	3462	36634	37185	3961	41146	34655	4148	38803
Electricity, Gas, Water and Waste Services	6848	684	7532	9951	1134	11085	10992	1520	12512
Construction	12909	756	13665	19492	1411	20903	26680	2170	28850
Wholesale Trade	8610	1003	9613	10491	1229	11720	10748	1474	12222
Retail Trade	5807	1213	7020	6936	1542	8478	10831	2437	13268
Accommodation and Food Services	2700	626	3326	3587	866	4453	6666	1677	8343
Transport, Postal and Warehousing	10976	740	11716	15148	1203	16351	19044	1701	20745
Information Media and Telecommunications	6045	658	6703	7398	840	8238	9878	1422	11300
Financial and Insurance Services	3833	766	4599	4848	1052	5900	6414	1623	8037
Rental, Hiring and Real Estate Services	1565	170	1735	1766	239	2005	2760	501	3261
Professional, Scientific and Technical Services	38361	4042	42403	53717	6940	60657	54560	8268	62828
Administrative and Support Services	2984	471	3455	3765	729	4494	5294	1162	6456
Public Administration and Safety	15211	1651	16862	16696	2248	18944	19817	3075	22892
Education and Training	6654	1324	7978	8010	1814	9824	10302	2951	13253
Health Care and Social Assistance	2383	932	3315	3115	1431	4546	4671	2358	7029
Arts and Recreation Services	808	125	933	1081	201	1282	1689	349	2038
Other Services	3273	309	3582	4228	422	4650	5572	662	6234
Inadequately described or not stated	3972	424	4396	4033	478	4511	12907	1553	14460
Total	174501	20094	194595	225326	29210	254536	269913	40946	310859

Table 3.2: Employment of qualified engineers in engineering occupations by industry, 2006 to 2016

Broad industry	2006			2011			2016		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Agriculture, Forestry and Fishing	254	5	259	240	15	255	411	29	440
Mining	5532	508	6040	10061	1110	11171	11181	1365	12546
Manufacturing	21472	1730	23202	24037	2134	26171	21303	2269	23572
Electricity, Gas, Water and Waste Services	5341	558	5899	7802	908	8710	8155	1146	9301
Construction	8922	508	9430	13985	1052	15037	18334	1578	19912
Wholesale Trade	4506	368	4874	5442	480	5922	5792	667	6459
Retail Trade	1060	120	1180	1175	155	1330	1895	297	2192
Accommodation and Food Services	199	20	219	192	24	216	335	24	359
Transport, Postal and Warehousing	6742	372	7114	9290	710	10000	10108	954	11062
Information Media and Telecommunications	4116	424	4540	5283	554	5837	7117	992	8109
Financial and Insurance Services	1648	251	1899	2298	444	2742	3427	752	4179
Rental, Hiring and Real Estate Services	483	32	515	535	40	575	773	107	880
Professional, Scientific and Technical Services	31877	2992	34869	45212	5381	50593	45654	6294	51948
Administrative and Supportive Services	1032	82	1114	1336	161	1497	1278	174	1452
Public Administration and Safety	10803	1111	11914	11516	1499	13015	13370	2041	15411
Education and Training	4092	561	4653	4896	765	5661	6014	1098	7112
Health Care and Social Assistance	865	82	947	937	171	1108	1396	258	1654
Arts and Recreation Services	228	29	257	323	39	362	461	72	533
Other Services	954	58	1012	1299	92	1391	1459	149	1608
Inadequately described or not stated	2160	152	2312	2135	187	2322	6747	601	7348
Total	112286	9963	122249	147994	15921	163915	165210	20867	186077

[← BACK TO TABLE OF CONTENTS](#)

2. Note: The broad industry total in Table 3.2 may differ slightly to the totals in the tables listed in Sections 5 and 6. This is caused by the ABS methodology used to maintain confidentiality in small number groups, which causes a small discrepancy in the final total number.



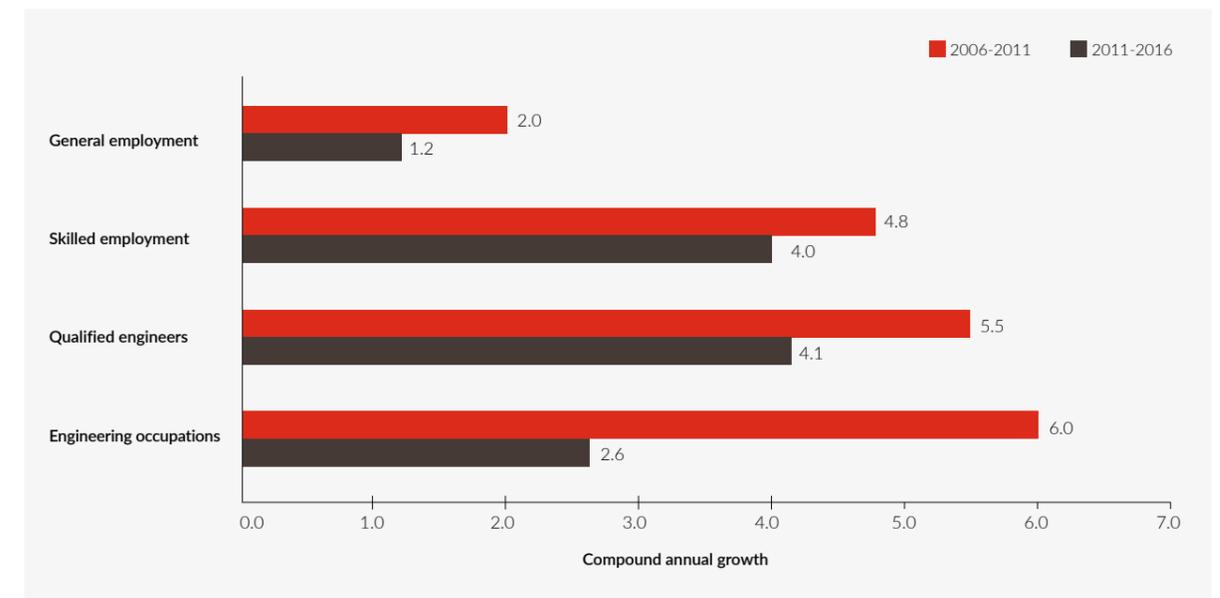
Employment growth has been about skills

Over the decade, much of the discussion about engineering in Australia focused on skills shortages and engineering job shortages. The engineering profession has weathered interchanging periods of boom and bust employment cycles, and at times there has been unprecedented growth in the demand for skilled people across the board, accompanied by much slower growth in demand for people with no formal skills base³.

The distribution of workers in Australian industries shifted over the course of the decade towards industries that were predominately skills-based at the expense of manufacturing jobs. This influenced the skilled profession of engineering; and, as described below, there have been increases in the numbers of engineers over the decade.

The growth of general employment, skilled employment, qualified engineers and qualified engineers working in engineering occupations is set out in Figure 3.1.

Figure 3.1: Compound annual growth of general employment, skilled employment, qualified engineers, and qualified engineers working in engineering occupations, between census periods



GROWTH IN GENERAL EMPLOYMENT

General employment growth was fairly steady, but slowed in the second half of the decade. In the first half, the annual growth rate was 2.0%, with over 950,000 workers added to the Australian economy. However, in the second half, growth slowed to 1.2% per annum as the number of workers added to the economy during this time dropped to 620,000. The growth over this period, however, was not uniform across the industries.

GROWTH IN SKILLED EMPLOYMENT

Growth in skilled employment (minus engineers) was even stronger. It grew at 4.8% per annum in the first half of the decade, adding 580,000 skilled workers to

the economy; and at 4.0% per annum in the second half, adding over 600,000. This growth was fuelled by skilled migrants and by individuals within the economy upskilling. Although there was a slowdown in the latter five years, there was still a stronger demand overall for skilled workers in the Australian economy.

Technological change resulted in some jobs becoming obsolete or new technology requiring less labour. At the same time, new jobs were created in industries that value higher qualifications and skills. In the second half of the decade, all of the growth in general employment was fuelled by the skilled employment portion of the general labour force. In fact, general employment minus skilled employment actually fell during this period⁴.

3. Kaspura, A. 2019, Engineers Australia: Australia's Engineering Capability: How the last ten years will influence the future.

GROWTH IN EMPLOYMENT OF ENGINEERS

Engineers have skills which are highly desired in a modern workforce, and the growth in the number of engineers was significant over the decade. In the first half of the decade, the number of employed engineers grew by almost 60,000 individuals, with growth of 5.5% per annum, and 6% per annum for engineers working in engineering occupations. During the resources boom, the demand for engineers was high and spread across all areas of the economy; and for a time, there was an engineering skills shortage.

In the second half of the decade, growth was still reasonably strong, with 56,000 engineers added to the economy and growth of 4.1% per annum. However, growth in numbers of engineers working in engineering occupations was much lower at 2.6%, resulting in an oversupply of engineers. This caused engineers to find work in non-traditional (or non-core) engineering industries.

Core and non-core engineering industries

The historical base for engineering employment has been in what are referred to as core engineering industries. In Engineers Australia research, these industries are defined as industries in which the proportion of engineers in the industry who are actually employed in engineering occupations is higher than the national average. Seven of the ANZSIC one-digit industry groups have consistently met this definition across the three census periods of 2006, 2011 and 2016, other than manufacturing in 2011.

PROPORTIONS OF ENGINEERS IN ENGINEERING ROLES BY CORE INDUSTRY

The percentage of engineers in each core industry who are employed in engineering occupations appears in Table 3.3.

Table 3.3: The core engineering industries, based on the percentage of qualified engineers in engineering occupations

Core Engineering Industries	2006	2011	2016
Professional, Scientific and Technical Services	82.2	83.4	82.7
Mining	82.0	82.4	79.9
Electricity, Gas, Water and Waste Services	78.2	78.6	74.3
Information Media and Telecommunications	67.8	70.9	71.8
Construction	69.0	71.9	69.0
Public Administration and Safety	70.7	68.7	67.3
Manufacturing	63.3	63.6	60.7
Economy-wide average	62.8	64.4	59.9

Core industries are important because they employ the most engineers. In 2006 and in 2011, core engineering industries accounted for over two-thirds of employed qualified engineers, and over three-quarters of employment of qualified engineers in engineering occupations.

Proportions of engineers in engineering roles by non-core industry

The percentage of engineers in each non-core engineering industry who are employed in engineering occupations is set out in Table 3.4.

Table 3.4 The non-core engineering industries, based on the percentage of qualified engineers in engineering occupations

Non-Core Engineering Industries	2006	2011	2016
Education and Training	58.2	57.6	53.6
Transport, Postal and Warehousing	60.7	61.2	53.3
Wholesale Trade	50.7	50.5	52.9
Financial and Insurance Services	41.3	46.6	52.0
Rental, Hiring and Real Estate Services	29.4	28.8	26.8
Arts and Recreation Services	27.5	28.4	26.3
Other Services	28.4	30.0	25.8
Health Care and Social Assistance	28.7	24.3	23.5
Administrative and Support Services	32.3	33.3	22.5
Agriculture, Forestry and Fishing	15.0	14.0	16.8
Retail Trade	16.8	15.7	16.5
Accommodation and Food Services	6.4	4.8	4.3
Inadequately described or not stated	52.7	51.6	50.8
Economy wide average	62.8	64.4	59.9

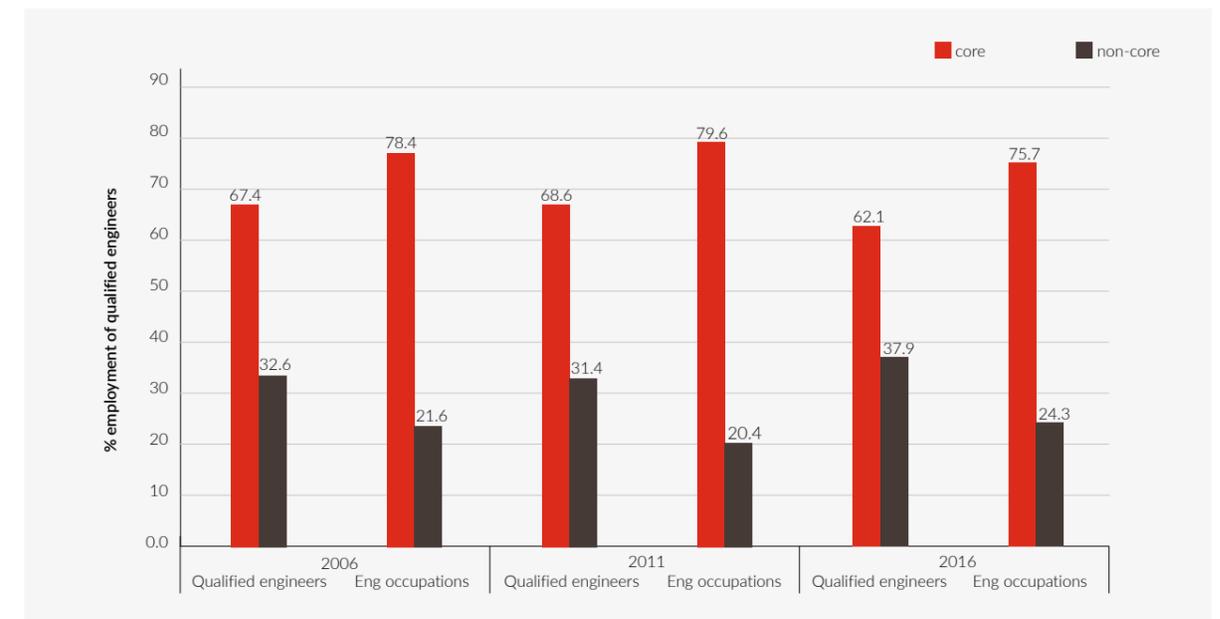
COMPARISON OF CORE AND NON-CORE INDUSTRY EMPLOYMENT OF ENGINEERS

The importance of the core industries to the engineering labour force is evident in Figure 3.2, which shows the proportions of engineers and engineers working in engineering occupations in the core and non-core industries.

Core industries have a high concentration of the engineering occupations roles (see Figure 3.2). An engineer working in a core industry is much more likely to be working in an engineering-specific role in the economy.

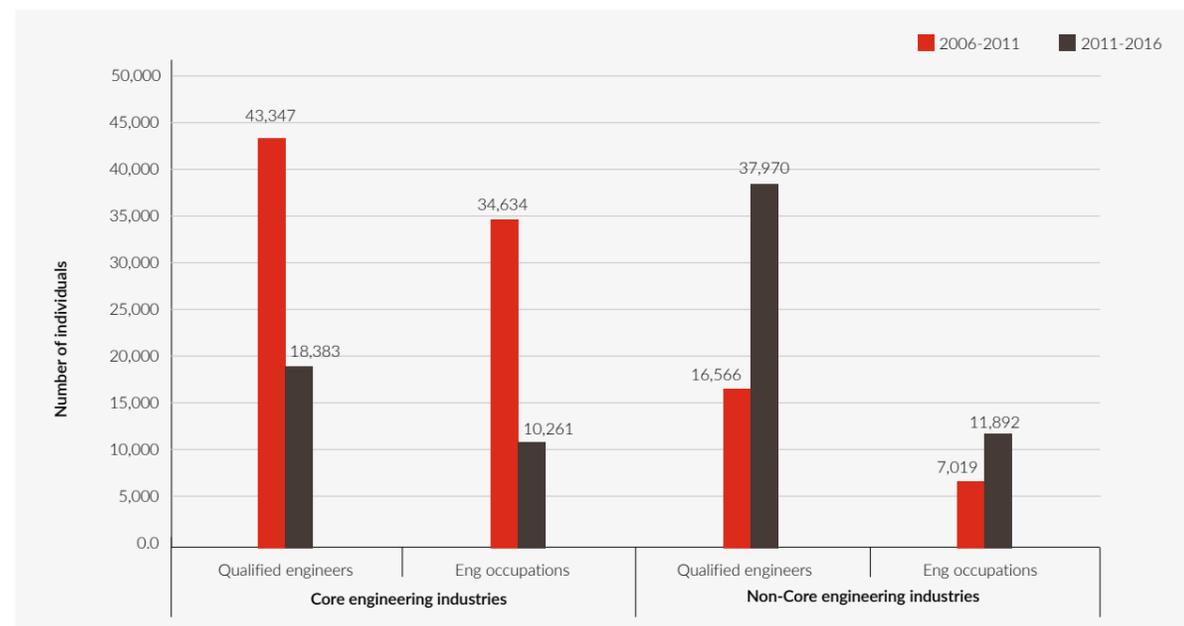
The actual growth in numbers of engineers and those working in engineering occupations in the core and non-core engineering industries is presented in Figure 3.3.

Figure 3.2: The importance of core engineering industries to the engineering labour force



4. Between 2011 and 2016, the numbers in skilled employment (which included engineering employment) grew by approximately 660,000. The other employment numbers, which make up the rest of general employment numbers, actually fell by approximately 38,000.

Figure 3.3: The growth in numbers of qualified engineers, and those engineers working in engineering occupations, in core and non-core industries, between census periods



Core industries supplied most engineering jobs in the first half of the decade

There was strong growth in the number of employed engineers in the first half of the decade, and most of that growth occurred in the core industries. Between 2006 and 2011, an additional 59,913 engineers were employed in the Australian economy – 43,347 in core industries and 16,566 in non-core industries.

Engineers in core industries were much more likely to be working in engineering occupations. Of the additional 59,913 engineers employed between 2006 and 2011, 41,653 found employment in engineering occupations, with 34,634 finding employment in core industries and only 7,019 finding employment in non-core industries.

Major redistribution of engineers in the second half of the decade

We have already noted the significant reduction in growth of engineering employment in the second half of the decade. This change had important consequences for the distribution of engineering employment. An additional 56,353 engineers were employed. However, the numbers employed in the core and non-core industries changed dramatically.

Of the 56,353 qualified engineers added to the economy, 18,383 were in core industries, while 37,970 were added to the non-core industries.

Although the number of engineers added to the non-core industries was significant, those numbers did not translate into engineers working in engineering occupations. Figure 3.2 showed just how important core industries are to engineers because of the high rates employed in actual engineering occupations. The numbers added in the second half of the decade show how important core industries are to engineers working in engineering occupations:

- Of the 18,383 that were added to the core industries, 10,261 were in engineering occupations.
- Whereas, of the 37,970 added to non-core industries, 11,892 were in engineering occupations.

These figures confirm aggregate analysis which showed a dramatic slowdown in engineering job growth. They show that the slowdown in the second half of the decade predominantly occurred in the core industries – the historical base for engineering employment. Overall, employment opportunities for engineers in engineering occupations more than halved, with engineering occupations spread evenly

between core and non-core industries, replacing the heavy skew towards core industries that existed before 2011.

In the first half of the decade, the resources boom and strong infrastructure development attracted engineers to the professional services industries, along with mining and construction, and this flowed on to all the core industries. But by the second half of the decade, employment growth in core industries slowed considerably; and, critically, there was no longer a shortage of engineers.

OTHER FACTORS AFFECTING THE FIGURES

Additionally, in every census, some respondents will select 'inadequately described' for their circumstances. In 2016, 7,347 qualified engineers in engineering occupations selected this option compared to only 2,326 in 2011. This huge jump accounts for 22.7% of the total growth in engineers employed in engineering occupations between 2011 and 2016. It is feasible that some of these individuals should have been attributed to core industries. Another explanation is that these individuals moved from conventional jobs into single-person consultancies and obtained some work; but it is likely that many were underutilised or effectively unemployed. It is also possible that some were affected by the online glitches on census night in 2016.

The slowdown in the second half of the decade predominantly occurred in the core industries – the historical base for engineering employment

Employment growth in core industries

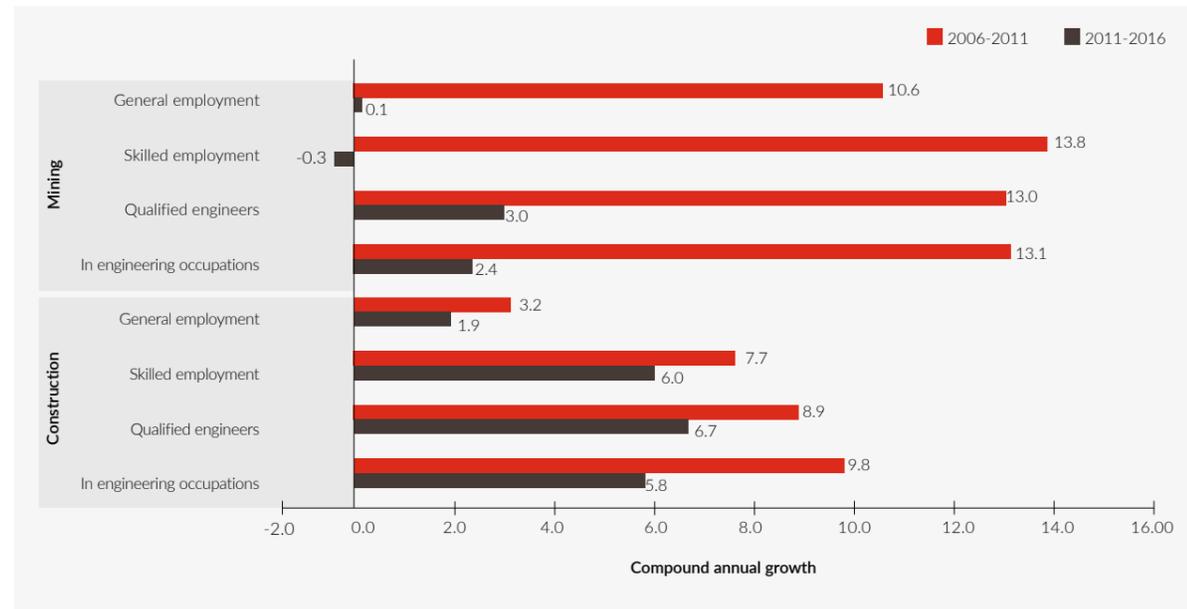
Employment growth in core industries was affected by wider economic change. The mining and construction industries rode the highs and lows of the mining boom. Core industries offering specialised skills benefited from the broader transition towards a service-based economy, while manufacturing was negatively impacted by that transition.

CORE INDUSTRIES INFLUENCED BY THE RESOURCES BOOM

In the first half of the decade, Australia was still in the midst of a resources boom, which had spread out to almost every industry in the economy. The two industries at the centre of the boom were mining and construction. Mining was boosted by overseas demand for mining commodities, and the demand for engineers in this industry was strong. The construction phase of the resources boom meant the demand for engineers to help deliver large construction and infrastructure projects was also strong.

Annual growth of general employment, skilled employment, engineers and engineers working in engineering occupations is shown in Figure 3.4.

Figure 3.4: Compound annual growth of general employment, skilled employment, qualified engineers, and engineers employed in engineering occupations, in industries heavily influenced by the resources boom



During the resources boom in the first half of the decade, there was strong growth for general employment, skilled employment and employment of engineers in both mining and construction (see Figure 3.4). Construction was the fourth largest industry employer of Australians, employing over 900,000 individuals in 2016, and making up 8.5% of overall employment. Mining is a relatively small employer, employing 177,000 individuals, and making up around 1.7% of overall employment in 2016.

Engineers in the mining industry buck decline though growth slows

Although mining is a relatively small employer, there was significant growth in this industry during the resources boom. During the first half of the decade, general and skilled employment grew by over 10% per annum, as did employment of engineers. In terms of numbers of workers, general employment in mining industries grew by almost 70,000 individuals, including over 5,000 engineers.

In the second half of the decade as the resources boom ended, employment growth in mining industries stalled for general and skilled employment. Against this trend, the number of engineers and those in engineering occupations continued to grow, but at a much lower rate than the previous five years. Engineers are still valuable to mining industries, and this is evident through the continued growth in numbers in the industry, even after the boom.

Construction engineers transition to urban infrastructure

The growth in the number of Australians working in construction industries was also significant during the resources boom. In the first half of the decade, there was growth of 3.2% per annum in general employment, with almost 120,000 individuals added to the industry. The growth in skilled employment and in employment of engineers was even greater, due to strong demand for these individuals during the construction phase of the boom.

As with the mining industry, employment growth in construction slowed in the second half of the decade. Despite this, there was still significant growth in skilled employment and employment of engineers, with annual growth of 6.7% per annum. In the second half of the decade, the construction industry employed almost 8,000 more engineers as the focus shifted from major resource projects to large urban infrastructure projects.

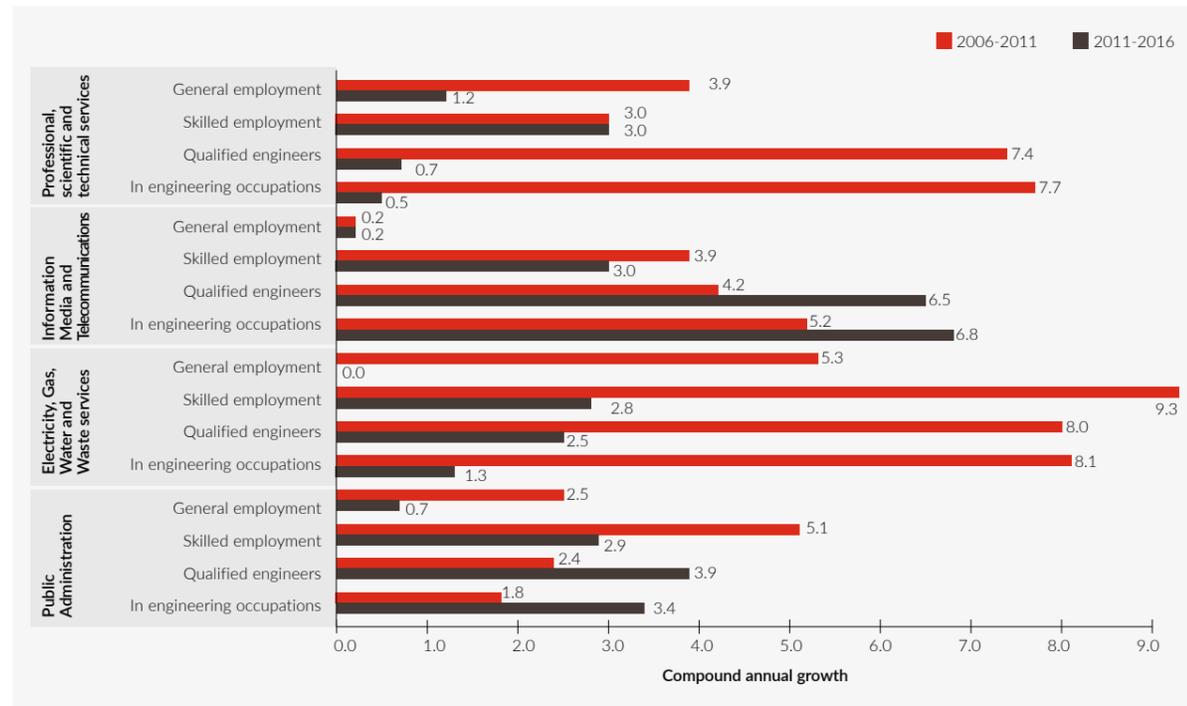
CORE INDUSTRIES REQUIRING SPECIALISED SKILLS

Over the decade, other core industries experienced growth in engineer numbers. These were industries requiring specialised skills: professional services, information media and telecommunications, utilities services and public administration. The annual growth in these industries for each employment category appears in Figure 3.5.



Australian Engineering Excellence Awards, National Finalist, Wynyard Walk
Taylor Thomas Whitting, PSM – Pells Sullivan Meynink, CPB Contractors

Figure 3.5: Compound annual growth of general employment, skilled employment, qualified engineers, and engineers in engineering occupations in core industries requiring specialised skills



Growth slows in second half of decade for professional services engineers

Professional, scientific and technical services is the largest industry employer of engineers in Australia, employing over 62,000 in 2016. Historically, this industry has only made up between 6 to 8% of general employment, and around 13% of skilled employment. However, it employs between 20 to 24% of all engineers.

In the first half of the decade, the number of Australians working in professional services grew strongly at 3.9% per annum. The number of engineers working in the industry grew even more strongly at 7.4% per annum and 7.7% per annum for those in engineering occupations. The demand for engineers during this period was strong, and much of it was a by-product of the resources boom as consulting and design engineers (who fall under this classification) were in high demand.

During this time, there was a shift in the way that many businesses operated, with many moving away from vertically integrated business models to

collaborative networks and business partnerships. As a result, consulting and design engineers were in high demand. There was also strong demand for computer software engineers (who also fall under this classification) from the technological push as businesses entered a marketplace with strong benefits to digitisation.

In the following five years, this changed. There was still consistent growth in the number of skilled workers entering this industry, but the demand for consulting engineers fell after the resources boom, resulting in much smaller growth (under 1% per annum). In fact, this growth was attributable to continued demand for computer software engineers.

Other specialised skill industries enjoy solid growth over the decade

In many of the specialised skill industries, skilled employment growth has been larger than general employment growth over the decade, as seen in Figure 3.5. The growth in the numbers of engineers working in telecommunications has been strong over the decade, with stronger growth recorded in the latter

five years. In the utilities, the growth in the numbers of engineers and those in engineering occupations was stronger in 2006-2011, but still outpaced general employment. In public administration, general employment growth was stronger than growth in numbers of qualified engineers, but not growth in skilled employment. In the following five years, the growth in the number of qualified engineers was larger than both.

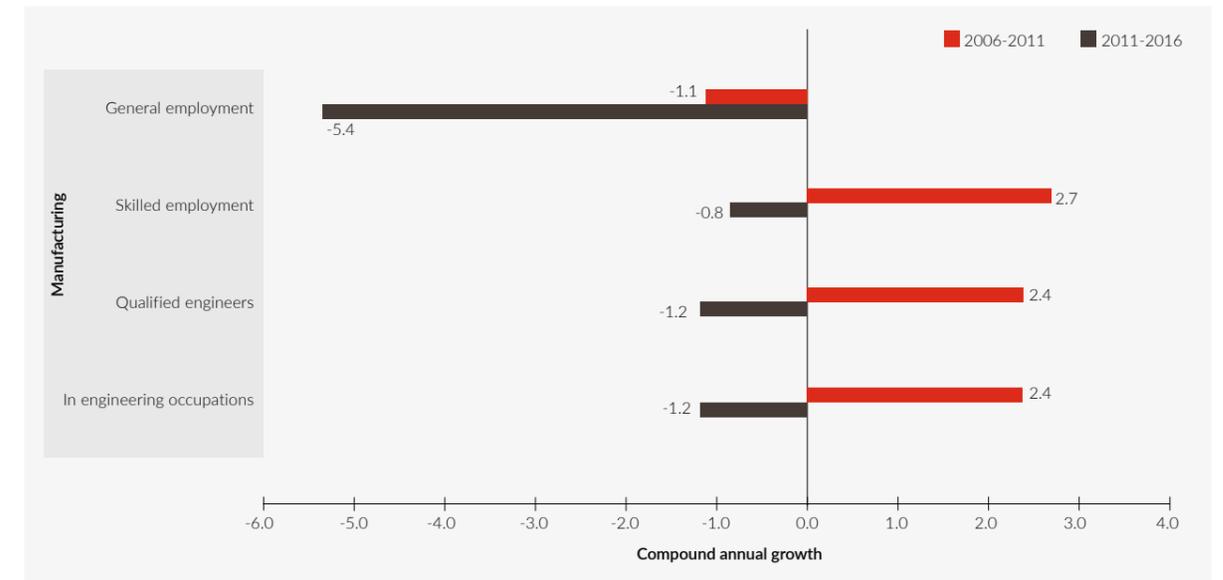
The general trend in these highly skilled industries is a premium on skilled workers. This includes large numbers of engineers. The number of qualified engineers in telecommunications grew from 6,700 in 2006 to 11,300 in 2016. For qualified engineers in the utilities, the number grew from 7,500 in 2006 to 12,500 in 2016. The number working in public administration grew from 16,800 in 2006 to 22,900 in 2016.

CORE INDUSTRY IN DECLINE

Manufacturing has consistently been the second-largest employer of qualified engineers over the decade. However, its share of engineers is falling. At the same time, the number of Australians working in manufacturing industries has declined significantly.

The annual growth between the census periods of general employment, skilled employment, engineers and those working in engineering occupations in manufacturing is presented in Figure 3.6.

Figure 3.6: Compound annual growth of general employment, skilled employment, qualified engineers, and engineers in engineering occupations in core industries in decline



The decline in general employment in manufacturing is significant (see Figure 3.6). In 2006, there were 950,000 Australians employed in manufacturing, which dropped to 684,000 in 2016. Manufacturing in Australia has come under pressure from competing countries, as companies outsource low-value activities offshore for a competitive advantage. As a result, manufacturing fell from a 10.5% share of the total overall employment in Australia in 2006 to a 6.4% share in 2016.

In the first half of the decade, the number of skilled workers and engineers working in manufacturing actually increased, even though there was an overall decline in general employment. It could be argued that this increase was due to flow-on effects of the resources boom, because in the second half of the decade, the numbers of skilled workers and engineers fell. Even so, this fall is nowhere near as strong as the fall in general employment. This suggests that the retention of highly skilled workers such as engineers may have helped mitigate the loss in numbers.

In 2006, there were 36,600 engineers employed in manufacturing, growing to 41,100 in 2011. By 2016, this number had fallen back to 38,800. In 2016, manufacturing had a 12.5% share of engineers in the Australian economy. Since the 2016 census, Australia has seen a decline in manufacturing industries such as car manufacturing, so it is unclear at this stage if this share of engineers working in manufacturing fell further after 2016.

At the same time, there has been hope in recent years that manufacturing will undergo a transformation in Australia to refocus on ingenuity and product design. This would fuel new job opportunities for highly skilled workers. A boost in defence industry manufacturing may also play a role in maintaining engineer numbers in this industry.

Employment growth in non-core industries

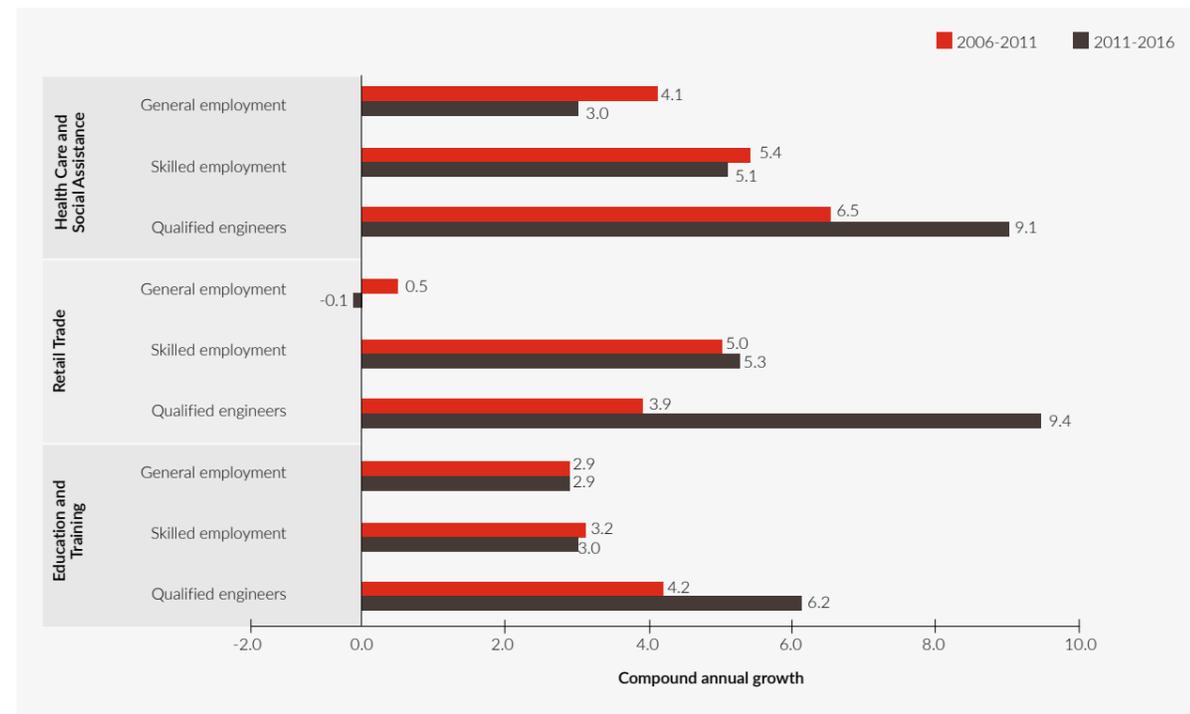
All non-core industries experienced growth in numbers of engineers. However, for some – agriculture, fisheries and forestry, and wholesale trade – growth was small; and, in the case of agriculture, came off a very low base. The three biggest industry employers in Australia all enjoyed good growth in engineer numbers, with growth accelerating in the second half of the decade.

THE LARGEST INDUSTRY EMPLOYERS IN AUSTRALIA

The three largest industries employing Australians in 2016 were health care and social assistance, retail trade, and education and training. These industries are non-core engineering industries.

The compound annual growth of general employment, skilled employment and number of engineers in these industries is set out in Figure 3.7. The growth in engineering occupations is not shown, as the percentage of engineers working in these occupations is below the economy-wide average.

Figure 3.7: Compound annual growth of general employment, skilled employment, and qualified engineers in the three largest industries of general employment in Australia in 2016



Growth in engineer numbers in health sector, but off a low base

Health care and social assistance was the largest industry employer of Australians in 2016, making up 12.7% of total overall employment. Growth was strong throughout the decade, with 950,000 workers at the start of the decade growing to 1.35 million by the decade's end. There was also growth in the number of skilled workers in this industry and in the number of engineers, although this was off a small base.

In 2006, there were 3,500 engineers working in health care, growing to 6,200 in 2016. The number of health sector engineers may continue to grow in coming decades as engineering expertise is required for smart devices, bionics, and diagnostics and informatics products.

Rise in engineers working in retail after resources boom ends

In 2016, retail trade was the second largest employer of Australians, with over 1 million Australians employed in this industry. Although this is an impressive figure, this industry actually saw a fall in numbers between 2011 and 2016. In 2011, retail trade made up 10.5% of total Australian employment, dropping to 9.8% in 2016.

The number of engineers who work in this industry increased over the decade, most notably between 2011 and 2016. During this time, many engineers were forced

to find work in non-core industries as the resources boom ended. As a result, the number of engineers in retail trade increased from 8,400 in 2011 to 13,200 in 2016.

Engineers in the education and training industry

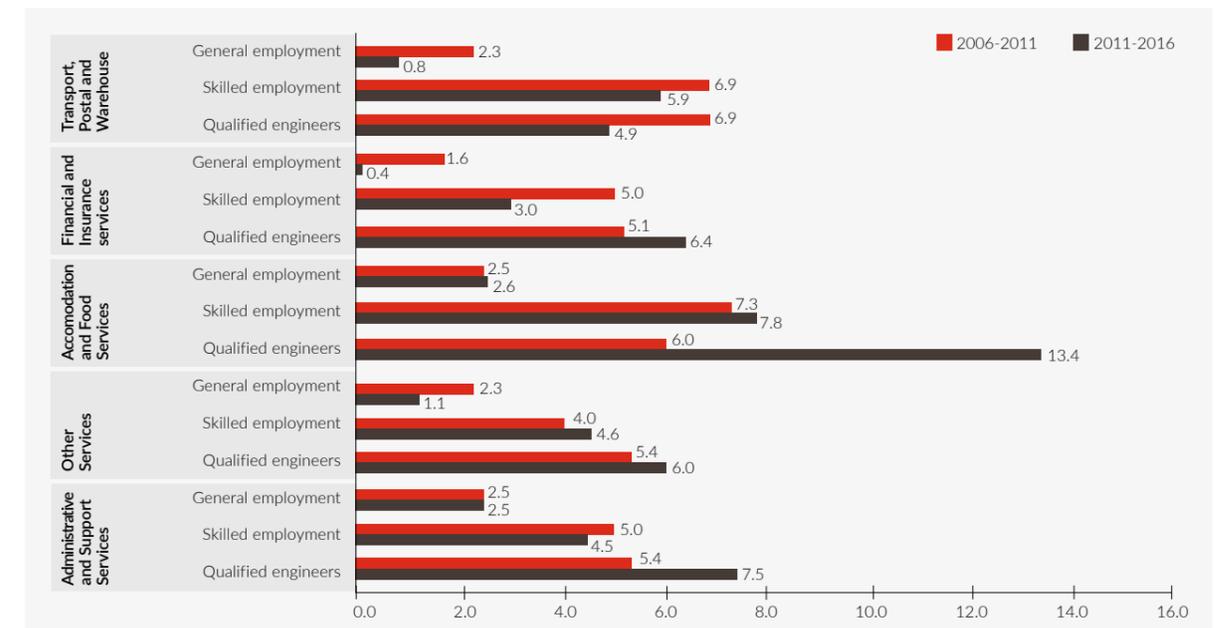
The education and training industry started the decade with a 7.7% share of the total general employment. By the decade's end, it had grown its share of total employment to 8.7%, with over 925,000 Australians employed in these industries. In 2006, education and training was the largest industry employer of skilled workers, with 20.4% of all skilled workers working in this industry. In 2011, the percentage share dropped to 18.8%; and in 2016, it had fallen even further to 17.9% of total skilled employment. Despite these falls, the numbers actually increased over the same period, up from 448,000 in 2006 to 608,000 in 2016.

For engineers working in education and training, overall numbers have increased from just under 8,000 in 2006 to 13,200 in 2016, making up 4.3% of the industry share of engineers employed in the economy.

OTHER NON-CORE INDUSTRIES THAT ARE GROWING

Other non-core industries that experienced growth in general employment over the decade to 2016 are shown in Figure 3.8⁵.

Figure 3.8: Compound annual growth of general employment, skilled employment and qualified engineers in other growing non-core industries



5. Two industries which are very small and not included in this figure are rental, hiring and real estate services, and arts and recreation services.

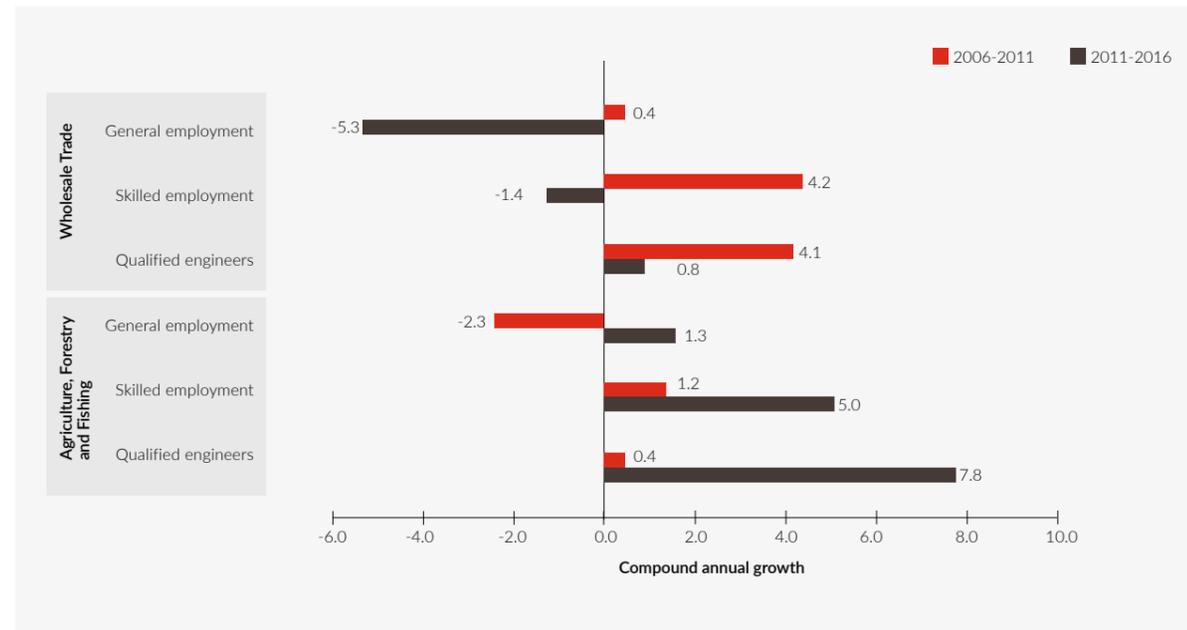
There has been growth in a number of non-core industries over the decade (see Figure 3.8). For engineers, the largest industry in this group is transport, postal and warehousing. In 2016, this industry employed 20,700 engineers, up from 11,700 in 2006. At the end of the decade, it had a 6.7% share of all employed engineers.

Engineers have enjoyed strong employment growth in many of these non-core industries, most notably in the second half of the decade at the end of the resources boom. This is most significant in accommodation and food services, and in administrative and support services.

NON-CORE INDUSTRIES IN DECLINE

The two industries in which general employment declined over the course of a decade were agriculture, forestry and fishing, and wholesale trade. Compound annual growth for these industries is presented in Figure 3.9.

Figure 3.9: Compound annual growth of general employment, skilled employment, and qualified engineers working in non-core industries in decline



General employment in agriculture declined in the first half of the decade, before it experienced a small recovery in the second half. Wholesale trade showed the reverse trend, falling sharply between 2011 and 2016.

Numbers of engineers in both industries increased over the course of a decade, although in agriculture, the increases came off a small base. In 2006, there were 1,700 engineers employed in agriculture, growing to 2,600 in 2016. The numbers in wholesale trade are much more significant. In 2006, there were 9,600 engineers employed in this industry, making up 4.9% industry share for engineers. The number of engineers grew to 12,200 in 2016, however the proportion share of this industry dropped to 3.9%.

Decade of change for core and non-core industries

In the decade from 2006 to 2016, the Australian economy saw a steady upward trend in the employment figures for education, food services, healthcare and legal and accounting services. These remained the dominant industries in Australia. At the same time, the numbers in manufacturing industries fell dramatically. In 2006, manufacturing was the second largest employer of Australians. In 2016, this dropped to the eighth largest.

The resources boom fuelled engineering job growth

In the first half of the decade, there was solid growth in the economy on the back of the resources boom; and the number of engineers working in professional services, mining, construction and telecommunications grew strongly. These industries drove the overall growth in engineering numbers. The flow-on effects of the resources boom also saw increased demand for engineers in other industries including non-core industries.

When the boom ended, many engineers moved to non-core industries

In the second half of the decade, the resources boom ended, and the fortunes of many engineers changed. The professional services industry – the biggest employer of engineers – experienced stalled growth

with swathes of engineers retiring, and many new engineers forced to find work in non-core industries. Those moving to non-core industries frequently found themselves in jobs not related to engineering.

While there was still solid growth in the industries of construction, public administration and mining during this time, this was somewhat overshadowed by the slowdown in the professional services and manufacturing industries – the two largest industry employers of engineers. The demand for engineers in professional services stalled, and the demand in manufacturing fell.

Manufacturing decline changed the employment landscape for engineers

Total Australian employment in manufacturing declined sharply over the decade. Despite this, the number of engineers employed in manufacturing actually increased between 2006 and 2011, before falling back between 2011 and 2016. However, there are still more engineers in manufacturing in 2016 than there were in 2006, and the industry remains the second largest employer of qualified engineers in Australia.

The future of manufacturing in Australia will have a great influence on the engineering workforce, which has historically depended on this industry for a significant number of jobs. Growth in the demand for engineers in construction has pushed the numbers in this industry closer to manufacturing numbers, but these industries cannot immediately replace the importance of manufacturing jobs to engineers.

4. Sub-industry Analysis

This section looks at the growth and distribution of the sub-industries (three-digit industries) which fall under the one-digit core engineering industries described in Section 3. The top ten sub-industries are displayed below for Australia and for each state and territory.

In the subsequent sections, each broad industry is further disaggregated to the sub-industries, showing the numbers of qualified engineers, the percentage in engineering occupations and the compound annual growth rates. In those sections, we offer additional analysis of the larger sub-industries that employ qualified engineers.

The top sub-industries of general employment

The largest sub-industries that employ Australians are those that fall under the larger 'broad industries' outlined in Section 3. In 2016, these sub-industries were:

- school education, with over 550,000
- cafes, restaurants and takeaway food services, with 480,000
- hospitals, with 420,000.

Other large industries include:

- supermarket and grocery stores, with 250,000
- legal and accounting services, with 230,000
- residential care services with 228,000
- tertiary education with 214,000.

There were some interesting changes to general employment levels. Road freight transport was the

eighth largest industry of employment in 2006, but is not even in the top 20 in 2016. Similarly, residential building construction was seventh in 2006, but also did not make the top 20 in 2016. Industries such as sheep, beef cattle and grain farming have also declined. At the same time, we have seen an increase in the number of Australians working in building cleaning, pest control and gardening services, as well as building completion services.

The top sub-industries for qualified engineers

There is a similar pattern for engineers, where the largest sub-industries follow the pattern of the largest broad industries.

TOP SUB-INDUSTRIES FOR ENGINEERS NATIONWIDE

The top ten sub-industries employing engineers over the decade are listed in Table 4.1.

Table 4.1: The top ten 3-digit industries of employment for qualified engineers in Australia, 2006, 2011 and 2016

Rank	Qualified Engineers 2006		Qualified Engineers 2011		Qualified Engineers 2016	
	Industry	Number	Industry	Number	Industry	Number
1	Architectural, Engineering and Technical Services	25,499	Architectural, Engineering and Technical Services	38,985	Architectural, Engineering and Technical Services	34,994
2	Computer System Design and Related Services	9,031	Computer System Design and Related Services	12,071	Computer System Design and Related Services	16,358
3	Tertiary Education	5,565	Heavy and Civil Engineering Construction	6,971	Tertiary Education	9,103
4	Telecommunications Services	5,020	Tertiary Education	6,935	Heavy and Civil Engineering Construction	8,878
5	Defence	4,860	Telecommunications Services	6,265	Telecommunications Services	8,250
6	Other Machinery and Equipment Wholesaling	4,797	Other Machinery and Equipment Wholesaling	6,091	Metal Ore Mining	6,436
7	Motor Vehicle and Motor Vehicle Part Manufacturing	4,461	Defence	5,399	Other Machinery and Equipment Wholesaling	6,326
8	State Government Administration	4,459	Management and Related Consulting Services	4,735	Defence	6,177
9	Heavy and Civil Engineering Construction	3,800	Air and Space Transport	4,585	Cafes, Restaurants and Takeaway Food Services	5,914
10	Local Government Administration	3,592	Metal Ore Mining	4,467	Local Government Administration	5,481

The dominant sub-industry employing engineers was architectural, engineering and technical services (see Table 4.1). This sub-industry represents Australia's consulting and design engineers. Engineer numbers in this industry grew significantly in the first half of the decade due to strong demand during the construction phase of the mining boom and within the mining boom itself. In 2016, this industry was still the largest employer of engineers. However, it fell back in numbers from the 2011 peak.

The next biggest industry employer of engineers was computer system design and related services, which increased by around 7,000 engineers over the decade. The third biggest industry was tertiary education, which grew to over 9,000 in 2016.

The big improver in the first half of the decade was heavy and civil engineering construction,

which grew in line with major construction projects in infrastructure, and on the back of the resources boom. Although its ranking fell slightly in 2016, the number of engineers employed in this industry continued to grow. Employment in manufacturing industries in Australia declined over the decade, and this was evident in the decline of motor vehicle and motor vehicle part manufacturing. This fell in numbers and down the rankings over the decade.

During the decade, we saw the public sector industries of defence and state government administration drop down the rankings. While metal ore mining and air and space transport experienced solid growth. Interestingly, there was also strong growth in the number of engineers working in cafes, restaurants and takeaway food services, suggesting a tough time for some engineers finding work in engineering occupations.

TOP SUB-INDUSTRIES FOR ENGINEERS BY STATE

The top ten sub-industries employing engineers for each state are listed in Table 4.2.

Table 4.2: The top ten 3-digit industries of employment for qualified engineers in the Australian state and territories, 2016

Rank	NSW		VIC		QLD		SA	
	Industry	Number	Industry	Number	Industry	Number	Industry	Number
1	Architectural, Engineering and Technical Services	9,862	Architectural, Engineering and Technical Services	8,427	Architectural, Engineering and Technical Services	7,767	Architectural, Engineering and Technical Services	2,019
2	Computer System Design and Related Services	6,926	Computer System Design and Related Services	5,419	Heavy and Civil Engineering Construction	1,785	Defence	851
3	Telecommunications Services	3,660	Telecommunications Services	3,129	Computer System Design and Related Services	1,752	Computer System Design and Related Services	702
4	Heavy and Civil Engineering Construction	2,998	Motor Vehicle and Motor Vehicle Part	2,854	Coal Mining	1,523	Tertiary Education	623
5	Tertiary Education	2,837	Tertiary Education	2,706	Tertiary Education	1,499	Other Transport Equipment Manufacturing	445
6	Other Machinery and Equipment Wholesaling	2,776	Other Machinery and Equipment Wholesaling	2,062	Air and Space Transport	1,411	Metal Ore Mining	419
7	Building Installation Services	1,919	Heavy and Civil Engineering Construction	2,001	Local Government Administration	1,407	Heavy and Civil Engineering Construction	392
8	Local Government Administration	1,868	Cafes, Restaurants and Takeaway Food Services	1,830	State Government Administration	1,039	Cafes, Restaurants and Takeaway Food Services	362
9	Defence	1,845	Management and Related Consulting Services	1,556	Oil and Gas Extraction	1,035	State Government Administration	337
10	Depository Financial Intermediation	1,779	Local Government Administration	1,323	Cafes, Restaurants and Takeaway Food Services	841	Professional and Scientific Equipment	322
Rank	WA		TAS		NT		ACT	
	Industry	Number	Industry	Number	Industry	Number	Industry	Number
1	Architectural, Engineering and Technical Services	5,701	Architectural, Engineering and Technical Services	403	Architectural, Engineering and Technical Services	297	Defence	948
2	Metal Ore Mining	4,269	Electricity Generation	144	Defence	237	Central Government Administration	907
3	Oil and Gas Extraction	1,790	Tertiary Education	139	Heavy and Civil Engineering Construction	170	Architectural, Engineering and Technical Services	524
4	Heavy and Civil Engineering Construction	1,414	Local Government Administration	112	Air and Space Transport	147	Computer System Design and Related Services	520
5	Cafes, Restaurants and Takeaway Food Services	947	Water Supply, Sewerage and Drainage Services	87	Electricity Generation	136	Tertiary Education	313
6	Computer System Design and Related Services	944	Metal Ore Mining	71	Metal Ore Mining	108	State Government Administration	143
7	Tertiary Education	941	Heavy and Civil Engineering Construction	70	State Government Administration	92	Airport Operations and Other Air Transport	108
8	Building Installation Services	709	Computer System Design and Related Services	69	Oil and Gas Extraction	90	Scientific Research Services	97
9	Management and Related Consulting Services	696	State Government Administration	65	Cafes, Restaurants and Takeaway Food Services	82	Cafes, Restaurants and Takeaway Food Services	93
10	Air and Space Transport	668	Basic Non-Ferrous Metal Manufacturing	63	Public Order and Safety Services	70	Public Order and Safety Services	86

In every jurisdiction besides the Australian Capital Territory, architectural, engineering and technical services is the largest industry which employs engineers (see Table 4.2). This is to be expected, as it is the largest sub-industry nationally, as seen in Table 3.2. In the Australian Capital Territory, defence and government administration were the two largest industries due to a high number of public servant engineers.

In New South Wales and Victoria, architectural, engineering and technical services followed by computer system design were the two largest industries for engineers. Both states also had large numbers in the telecommunications and construction industries. In Queensland, construction and computer system design ranked highly, with coal mining and oil and gas extraction also in the top ten. In South Australia, defence was the second largest industry, and transport equipment manufacturing also featured high.

In Western Australia, resources and construction featured heavily, with metal ore mining, oil and gas extraction and civil engineering construction all having large numbers of engineers. In Tasmania, public services such as electricity supply, government administration and water services all featured in the top ten. In the Northern Territory, defence ranked second and civil engineering construction third.

In every jurisdiction besides the Australian Capital Territory, architectural, engineering and technical services is the largest industry which employs engineers

5. Core Engineering Industries

As discussed in previous sections, the core engineering industries are those that have an above-average economy-wide percentage of engineers working in engineering occupations. These industries employ the vast majority of engineers in engineering occupations, which is why they are of particular importance to the engineering profession.

The percentage share of engineers working in engineering occupations by core industry is set out in Figure 5.1.

Figure 5.1: Employment in engineering occupations in core industries as shares of total employment in engineering occupations



Core industries consistently employed over 75% of engineers working in engineering occupations over the decade, as seen in Figure 5.1. The largest shares are in professional services, manufacturing and construction. In the first half of the decade, the percentage employed in core industries grew from 78.4% to 79.6%, due to the demand for engineers in professional services, construction and mining.

In the following five years, the percentage in core industries fell from 79.6% to 75.7% as the mining boom ended and the professional services and manufacturing industries both experienced falls. In the second half of the decade, the only core industries that increased their share of employment were construction, telecommunications and public administration (although this is down from 2006).

[← BACK TO TABLE OF CONTENTS](#)

The share of engineers in the non-core industries increased significantly in the second half of the decade, growing from 20.4% to 24.3%. As seen in previous sections, there was strong growth in the non-core industries, including growth for those engineers working

in engineering occupations in these industries. This growth will be discussed in more detail in Section 6.

This section will look at the movements in each of the sub-industries of the core industries.

Professional, scientific and technical services

Table 5.1: Engineering employment in Professional, Scientific and Technical Services, 2006, 2011 and 2016

Professional, Scientific and Technical Services	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Architectural, Engineering and Technical Services	25499	90	38985	90	34994	89	8.9	-2.1
Computer System Design and Related Services	9031	77	12071	77	16358	82	6.0	6.3
Management and Related Consulting Services	3376	76	4735	75	4863	76	7.0	0.5
Scientific Research Services	1952	78	2168	75	2186	72	2.1	0.2
Legal and Accounting Services	910	34	1122	32	1705	41	4.3	8.7
Professional, Scientific and Technical Services (except Computer System Design and Related Services), nfd	488	64	184	71	708	74	-17.7	30.9
Other Professional, Scientific and Technical Services	392	41	500	30	691	30	5.0	6.7
Professional, Scientific and Technical Services, nfd	62	73	99	62	430	78	9.8	30.9
Market Research and Statistical Services	421	24	465	19	424	27	2.0	-1.8
Advertising Services	241	33	289	35	422	32	3.7	7.9
Veterinary Services	26	23	29	31	41	39	2.2	7.2
Total	42398	82	60647	83	62822	83	7.4	0.7

Engineering employment in professional, scientific and technical services is shown in Table 5.1. These industries have historically made up about 6 to 8% of general employment, and about 12 to 15% of skilled employment. This compares to 21 to 25% of engineering employment.

The professional services sub-industries are some of the most prolific employers of engineers: most notably, architectural, engineering and technical services. This sub-industry is the largest employer of engineers, even though the overall number of engineers in this industry fell in the second half of the decade. Of the engineers that work in this industry, over 90% work in engineering occupations, and almost 90% are male. Other notable sub-industries include computer system design and related services, and management and related consulting services. These will be analysed in further detail below.

Scientific research services and legal and accounting services are other sub-industries that employ large numbers of engineers. Both these industries have

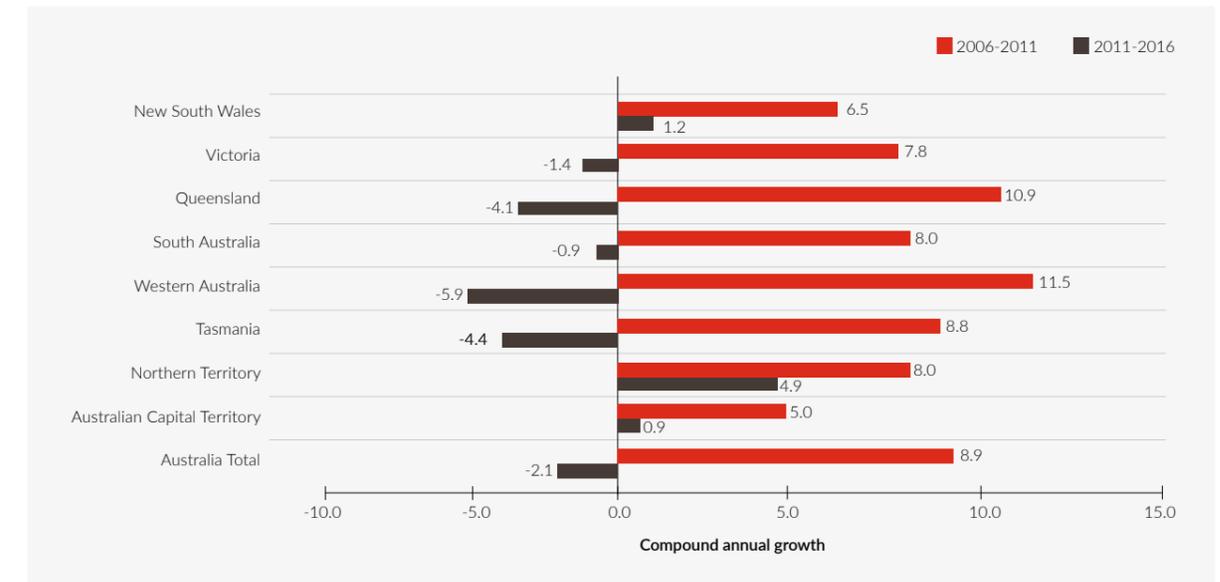
only low numbers comparative to other professional services industries. Less than half of the engineers working in legal and accounting services do so in engineering occupations.

There was also strong growth in the second half of the decade in the number of engineers who classified themselves as 'professional, scientific and technical services not further defined'. These are engineers who fit this major industry classification, but cannot identify their specific industry in the sub-groups.

ARCHITECTURAL, ENGINEERING AND TECHNICAL SERVICES

Architectural, engineering and technical services is the biggest sub-industry employer of engineers, and includes engineering design and consulting engineers. Compound annual growth in numbers of engineers employed in architectural, engineering and technical services is shown in Figure 5.2. Around 85% of the engineers that work in these industries work as engineering designers or engineering consultants.

Figure 5.2: Compound annual growth rates of qualified engineers working in architectural, engineering and technical services, in each jurisdiction, between census periods



A noticeable trend, mirrored in almost every jurisdiction, is made stark in Figure 5.2. In the first half of the decade, there was strong growth in the number of engineers working in this industry, followed by a period of falling numbers in the second half of the decade.

Engineers working in these industries are primarily involved in the development and utilisation of machines, materials, instruments, structure, processes and systems. These engineers prepare plans and designs, provide technical services during construction and installation phases, and conduct inspections and evaluations.

Resources boom a major influence in first half of the decade

In the first half of the decade, the number of engineers working in these industries grew from around 25,500 to just under 39,000. This number then fell back to 35,000 in 2016. In between 2006 and 2011, there was strong growth in the resources states of Queensland and Western Australia, as both states recorded double-digit figures in growth. At the same time, the numbers in New South Wales and Victoria also grew on the back of already large numbers in those states.

End of the boom particularly affected this industry in resources states

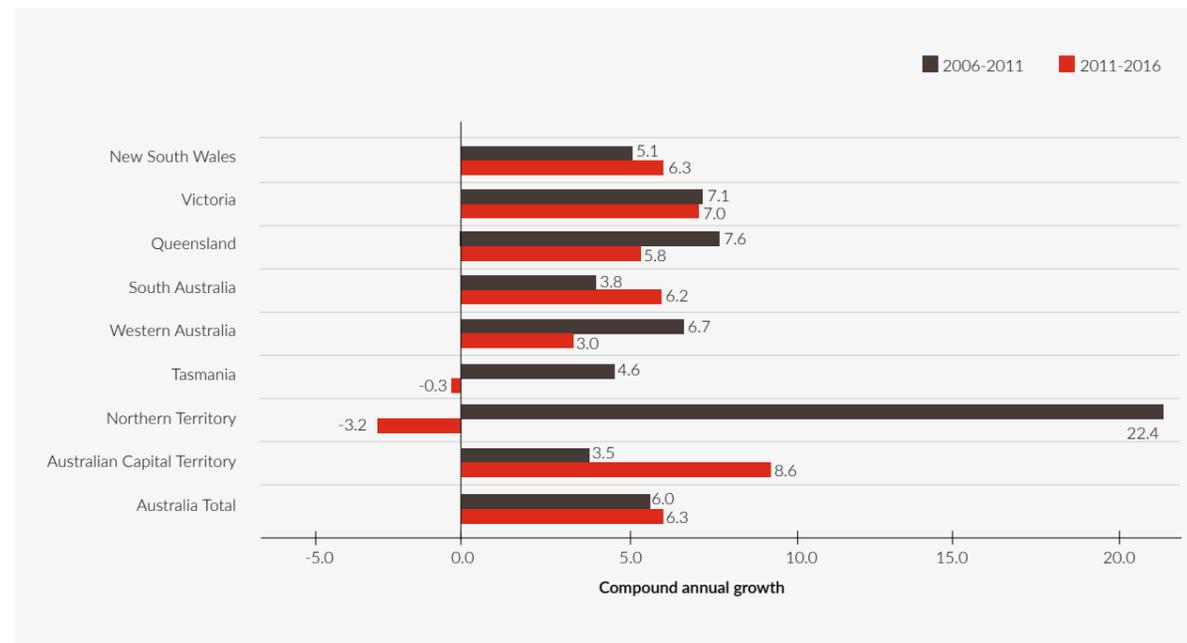
In the second half of the decade, the numbers in the resources states fell. In Queensland in 2011, there were over 9,500 engineers in these industries: the highest of any state. But by 2016, this number had fallen back to around 7,800. The same trend was seen in Western Australia, with 7,700 recorded in 2011, dropping back to 5,700 in 2016. Even though many of these engineers may not consider themselves mining engineers, the influence of the resources boom in these resource-heavy states is apparent on consulting and design engineers.

Between 2011 and 2016, the numbers working in Victoria also fell, but this was at a smaller rate than in Queensland and Western Australia, falling from 9,000 in 2011 to 8,400 in 2016. In New South Wales, the numbers increased during this period, and New South Wales became the largest employer of engineers in these industries. In 2011, there were 9,300 engineers, growing to almost 9,900 in 2016.

COMPUTER SYSTEM DESIGN AND RELATED SERVICES

The computer system design industry also employs a large proportion of engineers in Australia, and this number has consistently increased over the decade (see Table 5.1). Compound annual growth in numbers of engineers employed in computer system design and related services is presented in Figure 5.3.

Figure 5.3: Compound annual growth rates of qualified engineers employed in computer system design and related services, in each jurisdiction, between census periods



Strong growth in number of engineers in this industry, particularly in New South Wales and Victoria

There has been close to uniform growth in the number of engineers working in this industry over the decade, as is evident in Figure 5.3. The majority of these engineers were located in New South Wales and Victoria, with smaller numbers in Queensland and Western Australia. The large growth seen in the Northern Territory is significant. However, it came off a very small base number in 2006.

The number of computer system design engineers grew consistently over the decade from just over 9,000 in 2006 to over 16,300 in 2016. New South Wales and Victoria, the two areas where the majority of these engineers reside, saw consistent growth over the decade. New South Wales grew from just under 4,000 engineers in 2006, to just under 7,000 in 2016. Victoria grew from 2,700 in 2006 to 5,400 in 2016. In 2016, there were over 1,700 engineers in this industry in Queensland, and just under 1,000 in Western Australia.

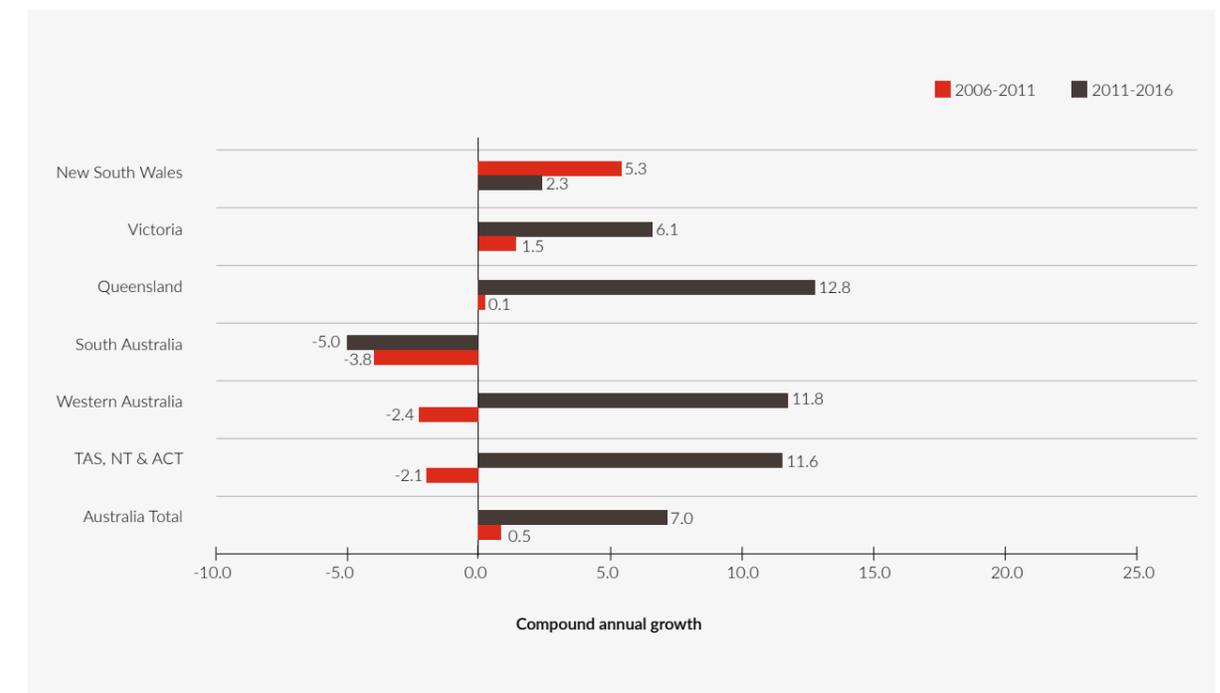
Service-based economy drives demand for technology skills

Australia's shift to a more service-based economy created demand for workers with skills in technology – in this case, information technology. This in turn drove demand for engineers specialising in this area. Engineers in this industry mostly worked in the field of information technologies. Their work largely involved writing, modifying, testing or supporting software, as well as planning or designing computer systems that integrate computer hardware, software and communications technologies. This would also include a consulting process, in which many engineers specialise. In 2016, about 82% of the engineers who worked in these industries worked in engineering occupations.

MANAGEMENT AND RELATED CONSULTING SERVICES

Management and related consulting services is also a large employer of engineers in Australia. Compound annual growth rates in each jurisdiction for numbers of engineers working in management and consulting is set out in Figure 5.4.

Figure 5.4: Compound annual growth rates of qualified engineers employed in management and related consulting services, in each jurisdiction, between census periods



The most populous states of New South Wales and Victoria experienced a growth in the numbers of engineers working in this industry over the decade; and the numbers in both states were extremely similar. In 2006, there were just under 1,100 engineers employed in this industry in New South Wales and Victoria respectively, and by 2016, both jurisdictions had seen this number rise to just over 1,500.

In Queensland, there was strong growth, with numbers increasing from just over 400 in 2006, to just under 750 in 2011. This number changed only slightly in 2016. In Western Australia, there was also strong growth in the first half of the decade, with the number of engineers growing from 450 to 785. Those numbers dropped back to just under 700 in 2016.

At the same time, the numbers in South Australia fell consistently over the decade. The jurisdictions of Tasmania, the Northern Territory and the Australian Capital Territory have been grouped together due to the small numbers recorded.

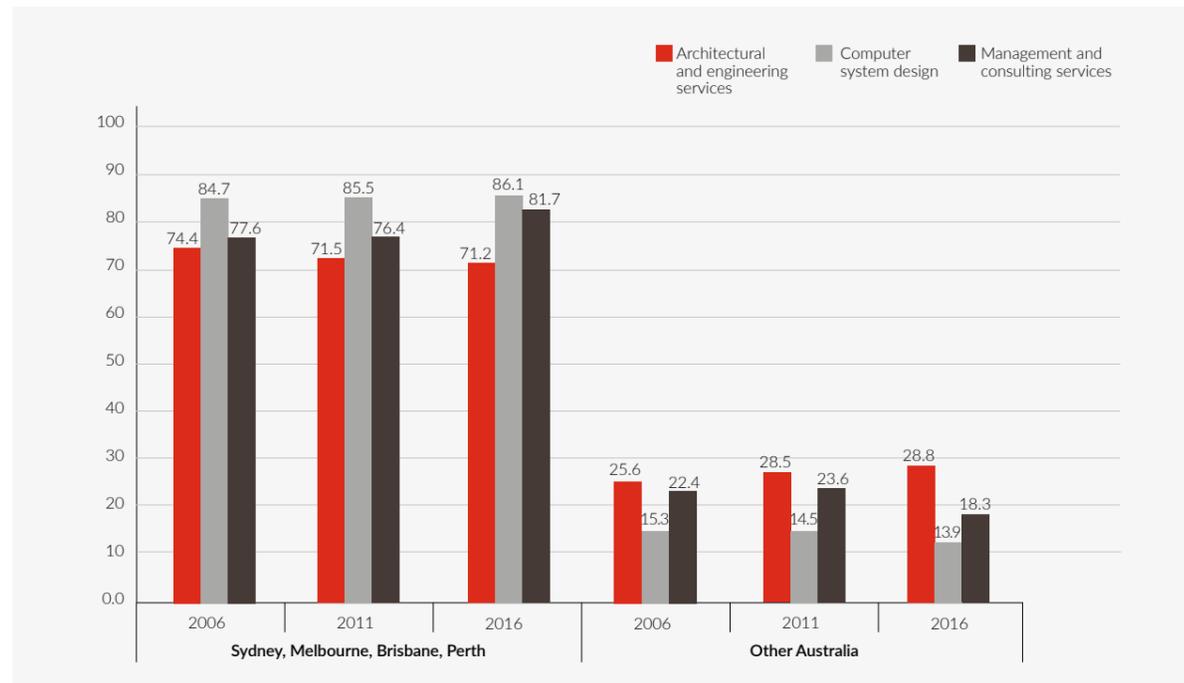
Engineers working in these industries differ from engineering consulting and design engineers, although there may be some slight cross-over in the classification. This classification is for engineers who

provide management advice, or related consulting services for business or personnel management policies or practices. So the industry classification covers engineers who specialise in agricultural management, business management, efficiency and environmental and forestry management. Around 76% of the engineers working in these industries in 2016 worked in engineering occupations.

GEOGRAPHICAL DISTRIBUTION OF PROFESSIONAL SERVICES SUB-INDUSTRIES

Architectural, engineering and technical services, computer system design and related services, and management and related consulting services are big employers of engineers. Indeed, these three sub-industries are by far the largest employers of engineers in the professional services industry. The percentage of these engineers who reside in one of the four largest Australian cities, in comparison to the more regional areas of Australia, is presented in Figure 5.5.

Figure 5.5: The concentration in the major cities of the largest professional services industries, 2006 to 2016



The greatest demand for engineers working in the largest professional services industries was in the four major cities (see Figure 5.5). For architectural and engineering services, over 70% were in the major cities; for computer system design engineers, over 85% resided in one of these cities; and for management and consulting services, it was over 80%.

Architectural and technical services engineers prefer the major cities

Over 40% of engineers working in architectural, engineering and technical services resided in Sydney or Melbourne. This has been quite a steady percentage over the decade. In Brisbane and Perth, the proportion working in one of these two cities. This dropped to just over 28% in 2016 after the resources boom. This highlights that for design and consulting engineers, the major cities are more desired, or that their work can be completed from an urban office base, or with some travel to the required work sites.

Computer system design engineers prefer Sydney and Melbourne

The vast majority of computer system design engineers worked in Sydney and Melbourne,

compared to the rest of Australia. Jobs for these engineers are overwhelmingly located in the two largest capital cities in Australia, with around 40% in Sydney over the decade. Melbourne's share has increased in recent years from 29% in 2006 to 34% in 2016. Meanwhile, the proportion working in other locations in Australia fell from 30% in 2006 and 2011 to 24% in 2016. The next largest job market for these engineers was in Brisbane, but this makes up less than a quarter of the Sydney job market.

End of boom caused some management and consulting engineers to relocate

During the resources boom, the demand for management and consulting services engineers grew nationally at a compound annual rate of 7.1% in the first half of the decade. There was strong growth in the large city centres of Sydney and Melbourne, but the largest growth was in Perth, Brisbane, regional New South Wales and regional Queensland. After 2011, and as the resources boom ended, the demand for these engineers fell, with the biggest falls in the resource-dependent areas of Perth and regional Queensland, which both recorded annual falls of over 10% during this time. However, at the same time there was small growth in these jobs in Sydney and Brisbane, which helped to lessen the change in the overall numbers.

Manufacturing

Table 5.2: Engineering employment in Manufacturing, 2006, 2011 and 2016

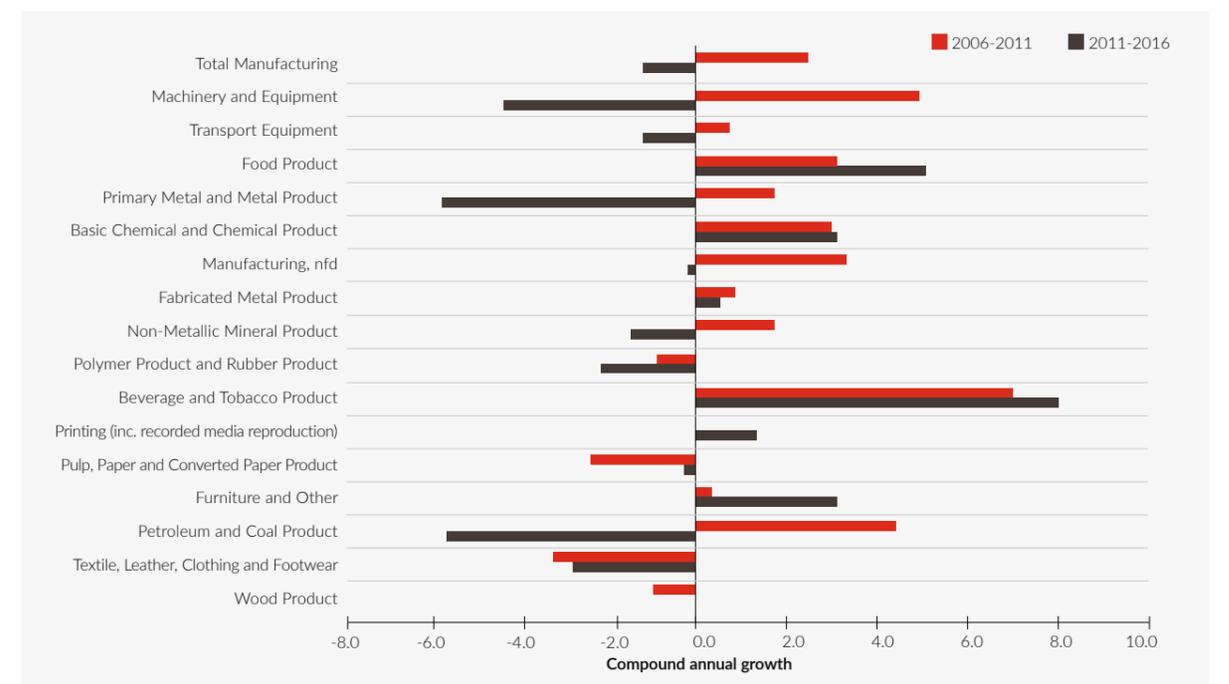
Manufacturing Industry	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Machinery and Equipment Manufacturing	8922	72	11344	72	9127	71	4.9	-4.3
Transport Equipment Manufacturing	6698	70	6907	70	6517	67	0.6	-1.2
Food Product Manufacturing	2997	47	3482	45	4460	43	3.1	5.1
Primary Metal and Metal Product Manufacturing	3878	71	4202	71	3140	67	1.6	-5.7
Basic Chemical and Chemical Product Manufacturing	2206	64	2557	66	2971	66	3.0	3.1
Manufacturing, nfd	2495	60	2933	58	2908	60	3.3	-0.2
Fabricated Metal Product Manufacturing	1982	60	2058	59	2107	57	0.8	0.5
Non-Metallic Mineral Product Manufacturing	1355	65	1471	63	1366	64	1.7	-1.5
Polymer Product and Rubber Product Manufacturing	1529	51	1464	51	1316	49	-0.9	-2.1
Beverage and Tobacco Product Manufacturing	509	50	714	48	1050	54	7.0	8.0
Printing (including the Reproduction of Recorded Media)	715	71	714	28	761	30	0.0	1.3
Pulp, Paper and Converted Paper Product Manufacturing	820	25	728	57	719	53	-2.4	-0.3
Furniture and Other Manufacturing	596	37	604	39	702	37	0.3	3.1
Petroleum and Coal Product Manufacturing	708	74	875	73	657	68	4.3	-5.6
Textile, Leather, Clothing and Footwear Manufacturing	793	35	671	37	581	36	-3.3	-2.8
Wood Product Manufacturing	432	50	410	48	409	44	-1.0	-0.1
Total	36635	63	41134	64	38791	61	2.3	-1.2

Engineering employment in manufacturing sub-industries is shown in Table 5.2.

These manufacturing industries have historically made up about 8 to 11% of general employment, compared

to 4 to 5% of skilled employment. This compares to 16 to 19% of engineering employment, showing how important these manufacturing industries are to Australian engineers.

Figure 5.6: Compound annual growth rates of qualified engineers employed in manufacturing industries, between census periods



The most notable manufacturing sub-industries include machinery and equipment manufacturing, transport equipment manufacturing, food product manufacturing, and primary metal and metal product manufacturing. In the top two industries, at least 67% of engineers were employed in engineering occupations; while for food product manufacturing, this drops to 43%. Engineers working in manufacturing industries were also predominately male.

The compound annual growth in numbers of engineers in each of the manufacturing sub-industries is set out in Figure 5.6. It shows that there were some large sub-industries which experienced falls in the second half of the decade, and some smaller sub-industries that experienced falls between both census periods. Only a few manufacturing industries recorded growth throughout the whole decade.

The machinery and equipment manufacturing industry employs the most engineers, and this sub-industry significantly increased its numbers in the first half of the decade before dropping back in the second. Although there was a significant fall in 2016, this sub-industry remained the largest employer of engineers within the manufacturing industry. Other big employers

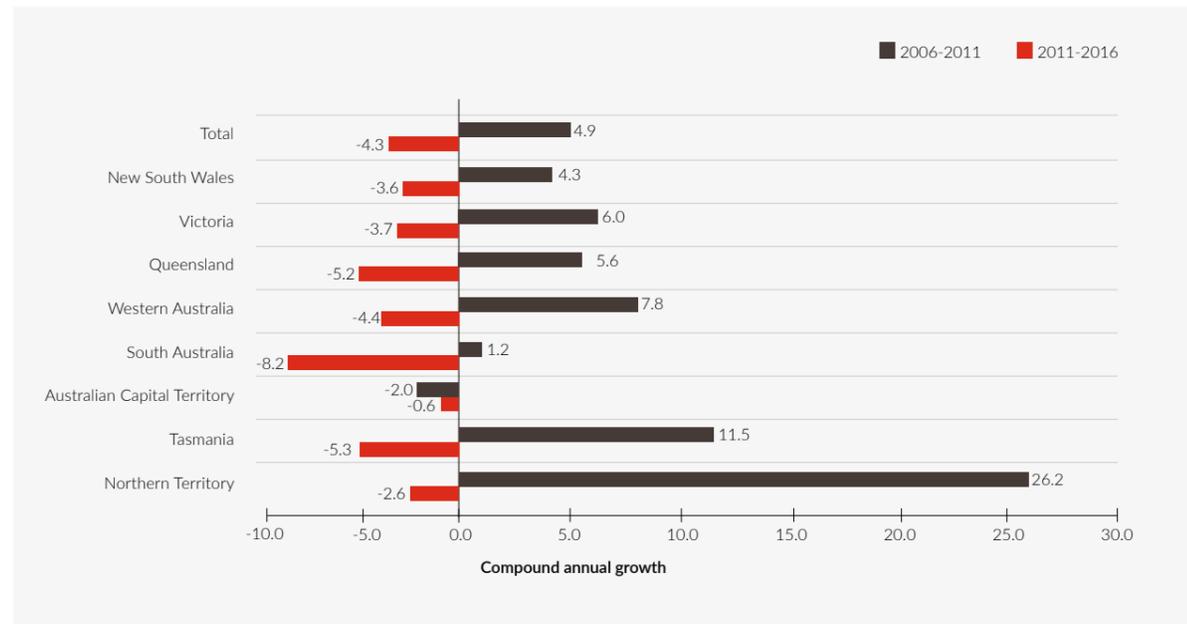
of engineers are the transport equipment manufacturing and primary metal and metal product manufacturing sub-industries. These sub-industries also saw a small fall in their numbers of engineers in the second half of the decade, but still retained high numbers.

Remarkably, while the contraction in overall manufacturing jobs was significant, there were a few smaller sub-industries bucking the trend. Over the decade, including in the second half, we have seen an increase in the number of engineers working in food product manufacturing and basic chemical and chemical product manufacturing. These two sub-industries will be discussed further below.

MACHINERY AND EQUIPMENT MANUFACTURING

The machinery and equipment manufacturing sub-industry is the largest employer of engineers within the manufacturing industry. The type of work that engineers in this industry do includes the manufacture of scientific, electronic, electrical, appliance, agricultural, mining, agricultural specialised and other equipment and machinery. The growth in this industry by jurisdiction is presented in Figure 5.7.

Figure 5.7: compound annual growth rates in qualified engineers working in machinery and equipment manufacturing, in each jurisdiction, between census periods



There was growth in this industry in the first half of the decade for all jurisdictions besides the Australian Capital Territory (see Figure 5.7). In second half of the decade, there was a fall in numbers across every jurisdiction.

The two jurisdictions with the largest number of engineers working in this industry were New South Wales and Victoria. In New South Wales, the number grew from just under 3,500 in 2006 to 4,300 in 2011. In 2016 this dropped back to 3,600. In Victoria, there were 2,600 in 2006, growing to just under 3,500 in 2011 before falling back to 2,900 in 2016.

TRANSPORT EQUIPMENT MANUFACTURING

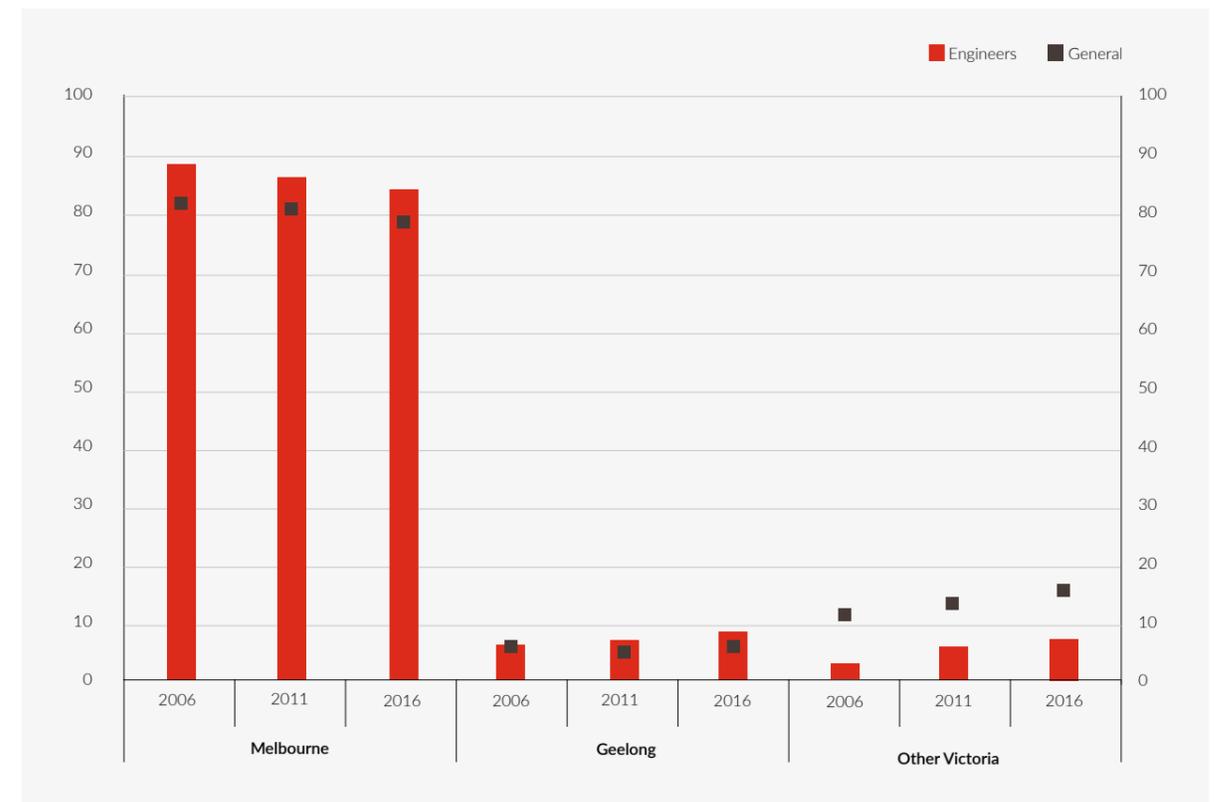
The transport equipment manufacturing sub-industry is the second largest employer of engineers within the manufacturing industry. In 2016, it employed over 6,500 engineers. This industry can also be split into two sub-industries of motor vehicle and motor

vehicle part manufacturing, and other transport equipment manufacturing. These two sub-industries will be analysed further.

Motor vehicle and motor vehicle part manufacturing

Within the transport manufacturing industry, a large number of engineers work in motor vehicle and motor vehicle part manufacturing. This was an industry that was heavily influenced by the decline of the auto-manufacturing industry in Australia over the second half of the decade. Of the engineers that work in this industry, almost 80% resided in Victoria. Figure 5.8⁶ below shows a breakdown of the number of engineers working in motor vehicle and vehicle part manufacturing jobs in Victoria, and compares this distribution to general employment.

Figure 5.8: The percentage of Motor Vehicle and Motor Vehicle Part Manufacturing Engineers in Victoria, compared to the general employment 2006-2016



6. The geographical divisions in the 2006 census data are slightly different to the 2011 and 2016 versions. The best estimates for the region of Geelong and Other Victoria were used for the 2006 data displayed in Figure 5.8.

In Victoria, the vast majority of workers in the auto-manufacturing industry were based in Melbourne (see Figure 5.8). However, a slightly higher proportion of engineers were based there than the overall general employment in this industry.

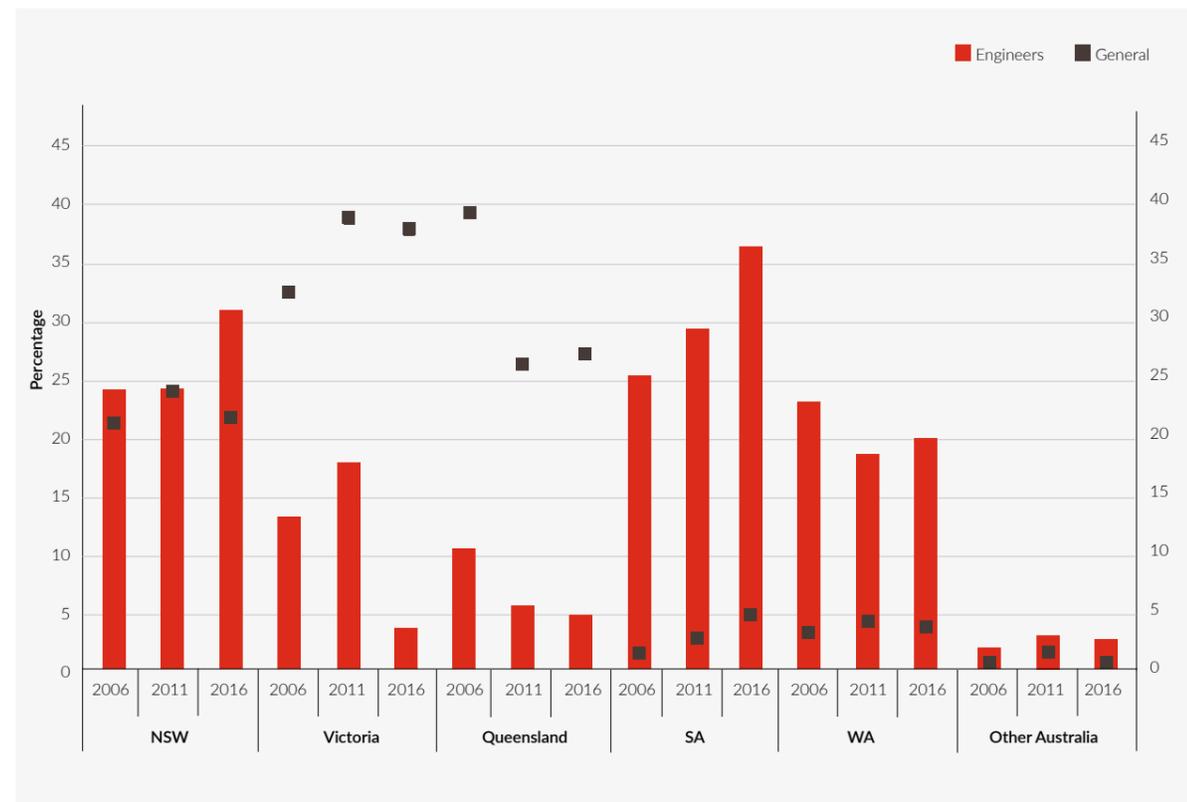
In Geelong, the proportion was very similar.

However, in this industry, a higher proportion of the overall workforce compared to engineers was located in other parts of Victoria. Those other parts of Victoria more popular with the general population than the engineering population included the Mornington Peninsula and Ballarat. As with other manufacturing industries, engineers were much more likely to work out of a large city than in a regional area, even if some of the work is region-based. Figure 5.8 reinforces this perception.

Other transport equipment manufacturing

Another large subset of the transport equipment manufacturing industry group is other transport equipment manufacturing. This includes sub-categories of shipbuilding and repair services, boatbuilding and repair services and aircraft manufacturing and repair services. Figure 5.9 shows the geographical distribution of engineers working in shipbuilding and boatbuilding⁷ compared to engineers working in aircraft manufacturing and related services.

Figure 5.9: The distribution of engineers working in shipbuilding and repair services compared to Aircraft Manufacturing and repair services in Australia, 2006 - 2016



7. Due to the relatively small number of boatbuilding engineers, numbers for these engineers have been combined with those for shipbuilding engineers.

Engineers working in the shipbuilding and boatbuilding industries are for the most part located in different regions of Australia (see Figure 5.9).

The number of engineers working in the shipbuilding and boatbuilding industries increased from 753 engineers in 2006, to 1,011 in 2011 and grew only slightly to 1,016 in 2016. As seen in Figure 5.9, engineers working in these industries are increasingly concentrated in New South Wales and South Australia. In 2016, almost 37% of engineers working in this industry were located in South Australia, which shows how important this industry is to South Australian engineers. At the same time, the numbers in Victoria fell significantly from 2011 to 2016, and the state share of these engineers has dropped from 18% to just 4%.

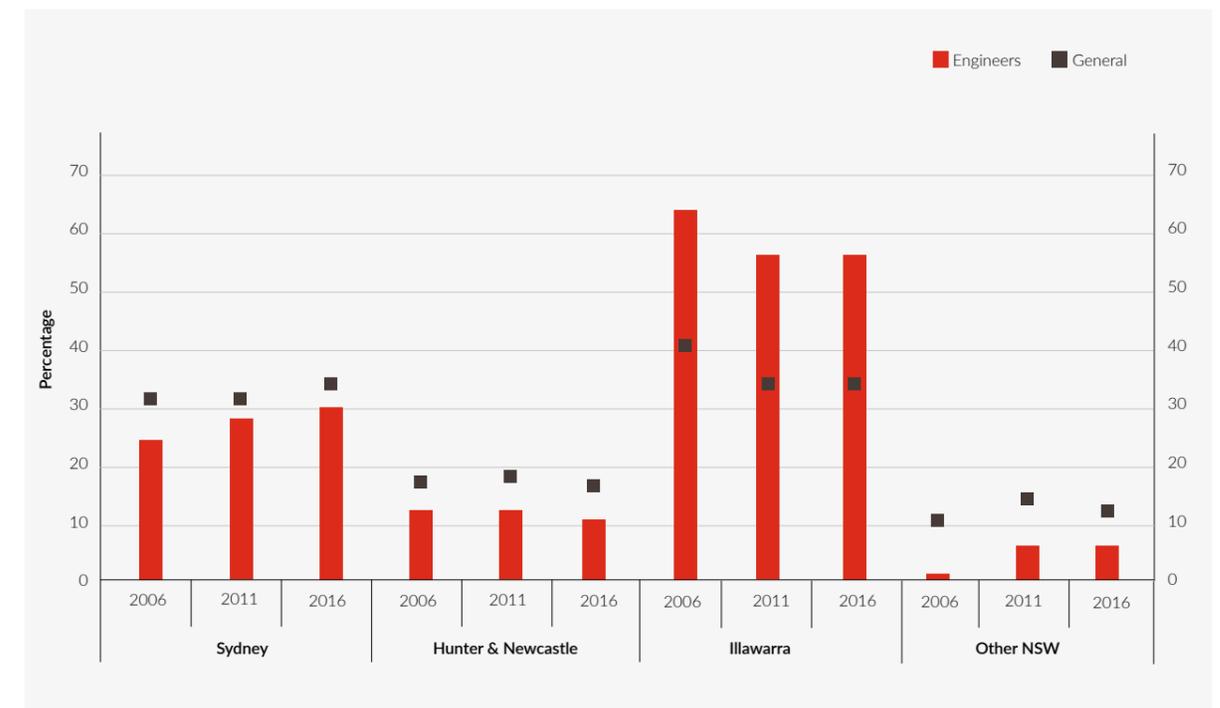
Engineers working in aircraft manufacturing and repair services are much more heavily concentrated in New South Wales, Victoria and Queensland. The number of engineers working in these industries has grown very slightly over the decade from 1,034 in 2006 to 1,052 in 2011 to 1,179 in 2016. Over 36% of these engineers were located in Victoria in 2016, and almost 31% were located in New South Wales.

PRIMARY METAL AND METAL PRODUCTION MANUFACTURING

The number of engineers working in primary metal and metal production manufacturing grew from 3,878 to 4,202 between 2006 and 2011. However, in 2016, this fell quite dramatically to 3,140. This sub-industry includes the production of a number of different metals, including alumina, aluminium, copper, silver, lead and zinc.

Approximately 50% of the engineers in this sub-industry worked in iron smelting and steel manufacturing, with a majority of these engineers employed in New South Wales. In New South Wales, there were 1,136 engineers in 2006, growing slightly to 1,141 engineers in 2011. In 2016, this number fell back dramatically to just 850 engineers.

Figure 5.10: The distribution of the general labour force, and the engineering labour force working in Iron and Steel Metal Manufacturing in NSW, 2006 - 2016



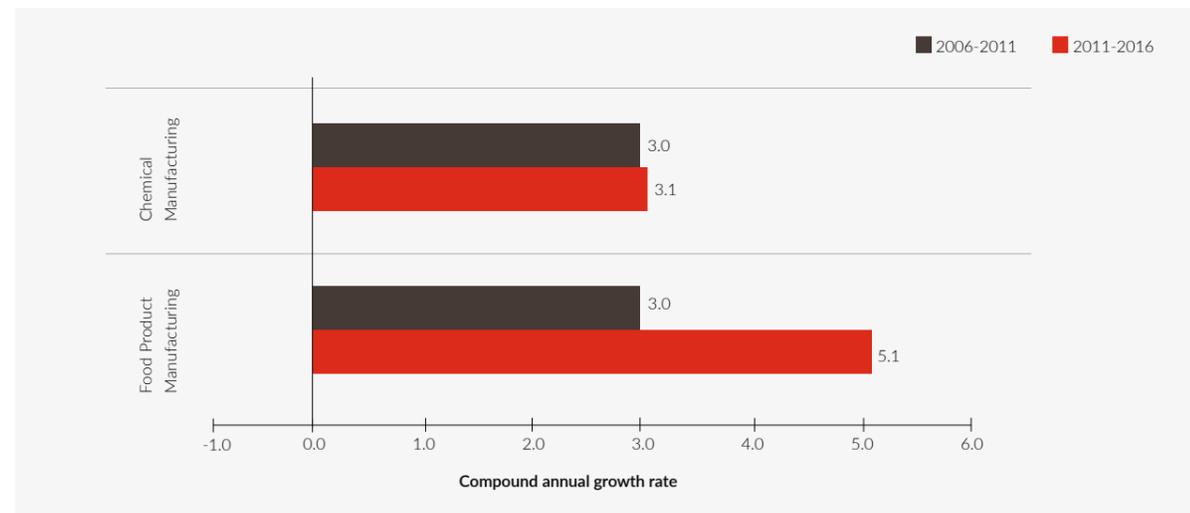
The distribution of engineers employed in the iron smelting and steel manufacturing industries in New South Wales is set out in Figure 5.10. The graph compares engineer distribution with the distribution of overall general employment working in this industry. As seen in Figure 5.10, the Illawarra region is the dominant region for engineers employed in these industries, and its percentage share is higher than Sydney, Newcastle and the Hunter region.

The percentage share in the Illawarra region has been steadily declining for engineers and the general population over the three census periods, coinciding with declining numbers in this industry. At the same time, the numbers in Sydney have remained fairly stable, so the percentage share in Sydney has slowly increased over the decade.

FOOD PRODUCT MANUFACTURING AND BASIC CHEMICAL AND CHEMICAL PRODUCT MANUFACTURING

Food product manufacturing and basic chemical and chemical product manufacturing are two larger manufacturing industries where the number of employed engineers increased over second half of the decade. Compound annual growth in the numbers of engineers employed in these two industries is set out in Figure 5.11.

Figure 5.11: Compound annual growth in engineers working in food product manufacturing and chemical manufacturing, between the two census periods



Steady growth in numbers of chemical manufacturing engineers

Around two-thirds of engineers in the chemical manufacturing industry worked in engineering occupations. Engineers working in this industry work in basic chemical manufacturing, polymer, fertiliser and pesticide manufacturing, pharmaceutical and medicinal manufacturing, and cleaning compound manufacturing. Numbers of engineers are increasing. In 2006, there were just under 2,200 engineers working in these industries, growing to over 2,550 in 2011 and to just under 3,000 in 2016. In 2016, over 30% of these engineers were located in Melbourne, and around a quarter were located in Sydney.

Growth in numbers of food product engineers, but less than half in engineering roles

Only around 40% of engineers in the food product manufacturing industry worked in engineering-specific occupations. Engineers working in these industries work in meat processing, seafood processing, dairy products manufacturing, fruit and veg, oil and fat, grain, bakery and sugar manufacturing. In 2006, there were just over 3,000 engineers working in these industries, growing to almost 3,500 in 2011 and continuing to almost 4,500 in 2016.

In 2016, the majority of food production engineers worked in Brisbane and Melbourne, which made up about 40% of all engineers working in these industries. This was followed by 19% in Sydney and 10% in regional Queensland in areas such as Townsville and Ipswich.

Construction

Table 5.3: Engineering employment in Construction, 2006, 2011 and 2016

Construction Industry	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Heavy and Civil Engineering Construction	3800	85	6971	86	8878	86	12.9	5.0
Building Installation Services	2152	45	3236	46	4969	45	8.5	9.0
Non-Residential Building Construction	2263	86	3511	88	3794	84	9.2	1.6
Residential Building Construction	2116	69	2560	70	3305	69	3.9	5.2
Construction, nfd	877	80	1052	82	2153	81	3.7	15.4
Building Construction, nfd	572	69	787	74	1389	70	6.6	12.0
Building Completion Services	594	18	717	13	1234	20	3.8	11.5
Land Development and Site Preparation Services	463	61	754	65	1128	69	10.2	8.4
Other Construction Services	399	26	540	31	908	29	6.2	11.0
Building Structure Services	370	53	654	63	894	55	12.1	6.5
Construction Services, nfd	52	60	119	54	198	53	18.0	10.7
Total	13658	69	20901	72	28850	69	8.9	6.7

The biggest engineer employers in the construction sub-industries are listed in Table 5.3. These industries have historically made up around 7 to 9% of the general employment, compared to just 1 to 3% of skilled employment. However, for engineers, these industries have made up about 7 to 9% of engineering employment.

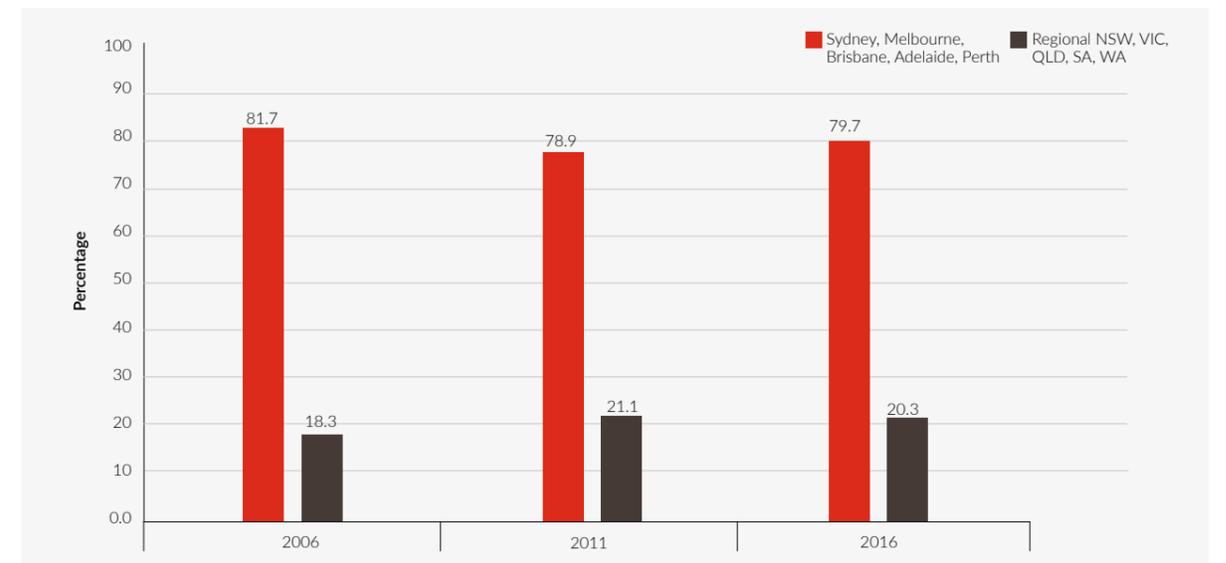
Over the decade, there has been significant growth in the number of engineers employed in construction industries, with big growth in heavy and civil engineering construction – the largest engineer employer. Engineers employed in this sub-industry are predominantly male, and at least 85% of these engineers work in engineering occupations.

Other large construction sub-industries which employ engineers are building installation services, non-residential building construction, residential building construction and 'construction not further defined'. Over 90% of engineers employed in all construction industries are male.

HEAVY AND CIVIL ENGINEERING CONSTRUCTION

Heavy and civil engineering construction includes road and bridge construction along with other engineering construction, and is the sub-industry with the largest proportion of engineers of all the construction industries.

Figure 5.12: The concentration of heavy and civil engineering construction engineering jobs in the major cities of Australia





Australian Engineering Excellence Awards, National Finalist
Victorian International Container Terminal - BMD Constructions

Construction engineers predominantly work in Australia's big cities

A comparison of urban-based and regional-based heavy and civil engineers is given in Figure 5.12. In 2006, there were 3,699 engineers working in this industry, which grew to 6,835 in 2011. This growth continued through to 2016, when there were 8,871 recorded.

As seen in Figure 5.12, engineers working in construction are much more likely to be working in one of Australia's major urban centres. As the majority of construction work is completed in these densely populated areas, engineers are more readily able to find work in these areas.

Strong growth in numbers of urban-located construction engineers over the decade

In 2016, Sydney was the area which employed the largest number of these engineers, with 2,226. This was followed by Melbourne, with 1,771; Perth, with 1,227; and Brisbane, with 1,206.

There was steady growth in the number of engineers in these industries employed in Sydney and Brisbane over the decade – both more than doubled in number. Melbourne saw slower growth in the first half of the decade, but grew significantly in the second. Perth saw

rapid growth during the resources boom years of 2006 and 2011 before growth slowed in the years to 2016. The numbers in Adelaide were much smaller (374 in 2016), but more than doubled over the decade.

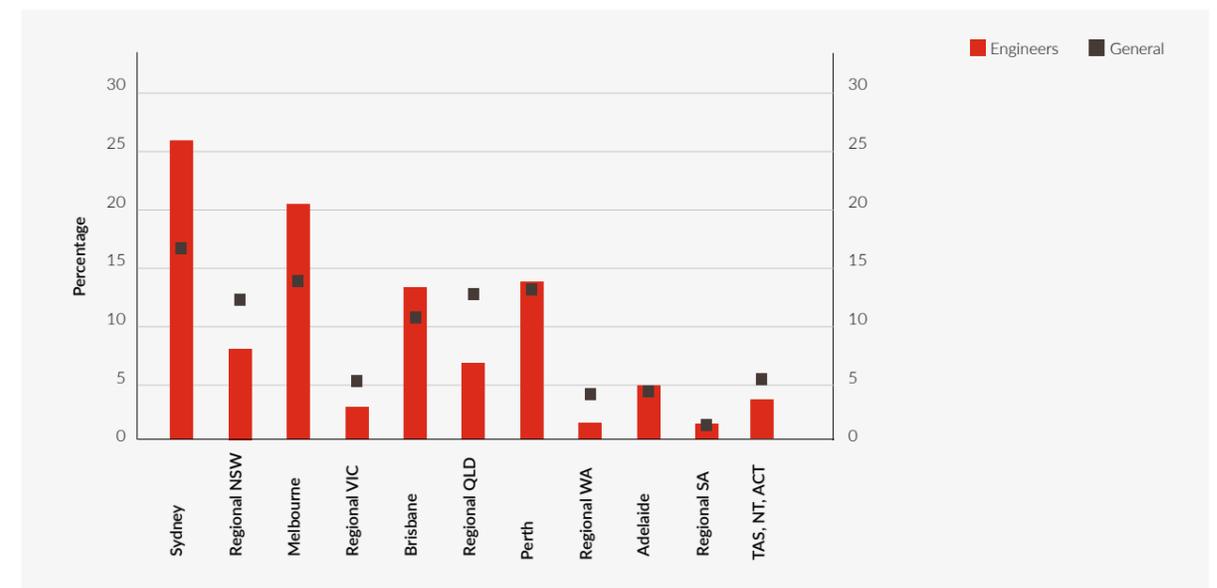
Regional-based construction engineers more affected by end of boom

In regional New South Wales, there were notable numbers of engineers employed in this industry in Newcastle, the Hunter, Illawarra and Coffs Harbour and the Central Coast. In regional Queensland, larger numbers were located on the Gold Coast, in the Moreton Bay region, Fitzroy region, Ipswich, Mackay and Logan. In Western Australia, there were notable engineering numbers in these industries in the Pilbara and in Bunbury. Between 2011 and 2016, much of the growth in the regional areas of Queensland and Western Australia had reversed, and returned to similar levels to those recorded in 2006.

Geographical distribution of engineers versus general population

A comparison of the geographical distribution of engineers with general employment working in heavy and civil engineering construction is presented in Figure 5.13.

Figure 5.13: Heavy and civil engineering construction industry regional distribution, for general workforce and the engineering workforce in 2016



Engineers working in these industries were much more likely to be working in the major cities compared to overall general employment (see Figure 5.13). This is in line with a number of other industries which have higher proportions of engineers working out of a major city.

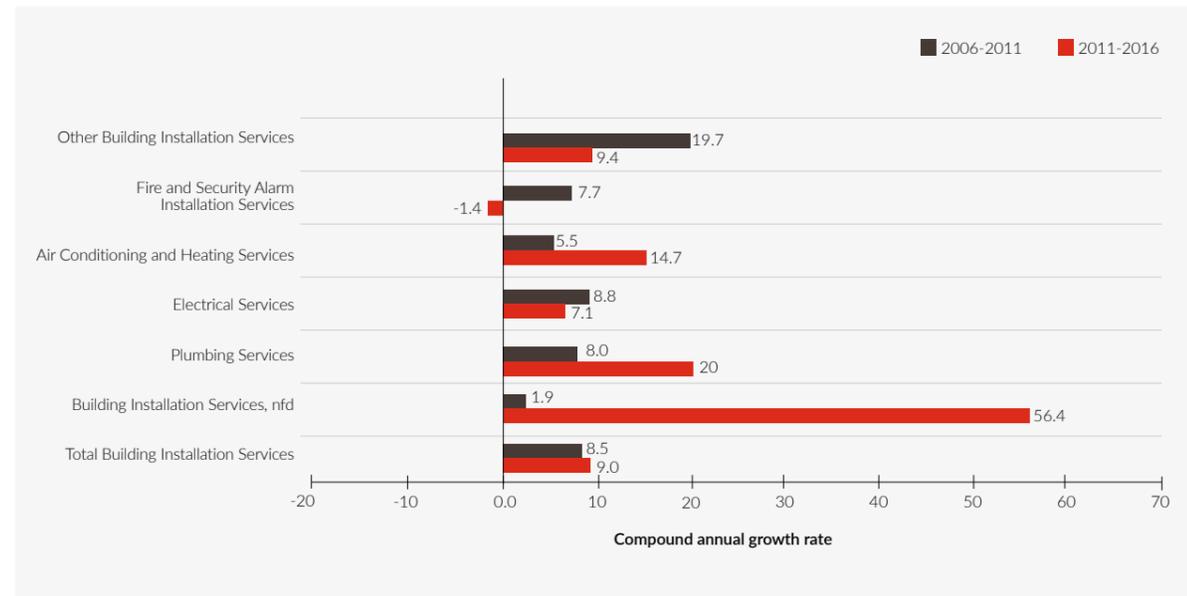
This indicates that projects within major cities (most notably Sydney or Melbourne) include more engineering-intensive construction work than in the regional areas, or that much of the engineering work that directly relates to heavy construction in a regional area can be completed from a city base. Meanwhile, a more significant proportion of the general workforce in construction is required to be where the work is located.

Additionally, much of the construction work carried out in major cities could be seen as more engineering-intensive, as project timeframes are likely to be longer, and the type of construction work is likely to be larger to service a larger population.

BUILDING INSTALLATION SERVICES

The building installation services industry is a big employer of engineers, with just over 2,000 engineers employed in this industry in 2006, growing to almost 5,000 in 2016. However, only 45% of these engineers work in engineering occupations. Figure 5.14 shows the compound annual growth rates of numbers of engineers employed in building installation industries.

Figure 5.14: Compound annual growth of qualified engineers employed in building installation services, between the two census periods



The largest employers of engineers in the building installation industry were electrical services and airconditioning and heating services. At the end of the decade, 2,914 engineers worked in electrical services and 1,012 in air conditioning and heating. Due to these large numbers, most of the overall growth recorded in the building installation sector is due to these two sub-industries. Overall growth over the decade was strong, with the number of building installation engineers rising from 2,152 in 2006 to 4,973 in 2016.

As mentioned above, only 45% of these engineers worked in engineering occupations. It is likely that the number of engineers working in these industries moved from engineering work to more trade-based work in air-conditioning, electrical and plumbing services.

RESIDENTIAL AND NON-RESIDENTIAL BUILDING CONSTRUCTION

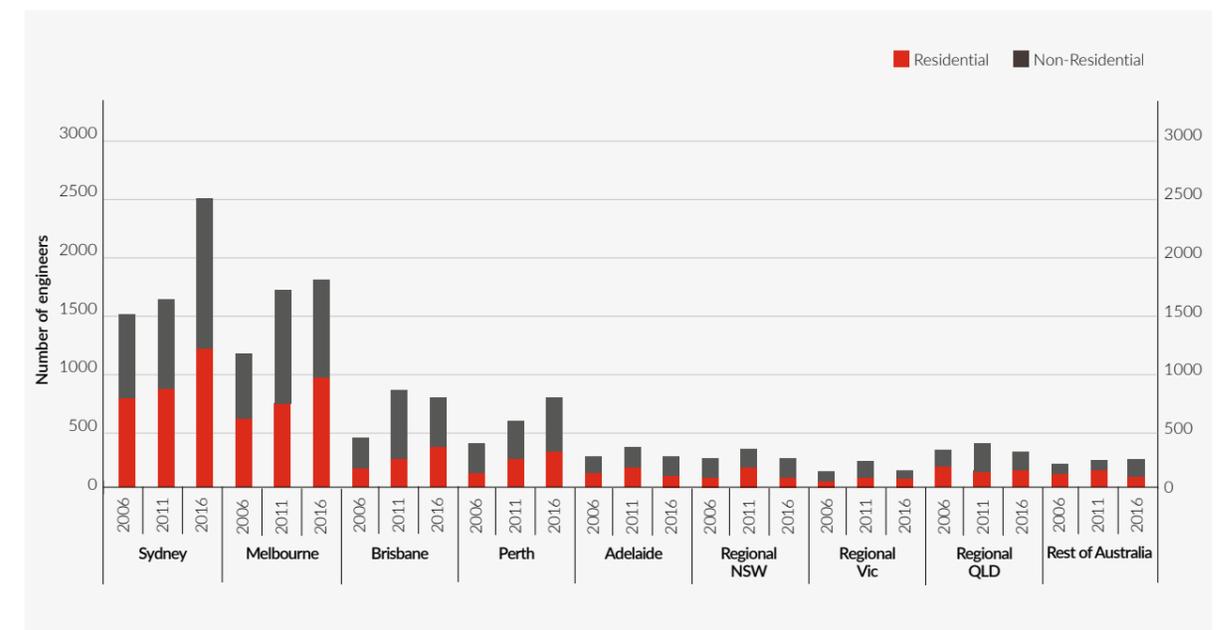
The number of engineers working in both residential and non-residential building construction has grown over the decade. Non-residential building construction engineer numbers have grown from around 2,300 to just under 3,800 by the decade's end. Meanwhile, residential building construction engineer numbers have grown from around 2,200 to 3,300. Figure 5.15 below shows the distribution of these engineers in Australia over the decade to 2016.

Sydney and Melbourne are the dominant regions for employment of both residential and non-residential building construction engineers, as seen in Figure 5.15 above. Moreover, the number of these engineers has been growing over the decade. The numbers seen in Sydney and Melbourne are likely due to the demand for engineers from a small boom in the population of these two cities, which increased building construction development to accommodate a larger number of people.

Engineers in the residential building construction industries work in the construction of residential houses and buildings, and alterations or renovations. Just under 70% of those engineers work in engineering occupations.

Engineers working in non-residential building construction industries work in the construction of non-residential buildings: hotels, motels, hospitals and prisons or other buildings, as well as additions or renovations. Around 85% of the engineers working in these industries are working in engineering occupations.

Figure 5.15: Engineers working in residential and non-residential construction by region over the past decade



Public Administration and Safety

Table 5.4: Engineering employment in Public Administration and Safety, 2006, 2011 and 2016

Public Administration and Safety	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Defence	4860	77	5399	76	6177	75	2.1	2.7
Local Government Administration	3592	81	4223	80	5481	81	3.3	5.4
State Government Administration	4459	80	4388	76	4374	72	-0.3	-0.1
Public Order and Safety Services	1825	31	2171	29	3110	29	3.5	7.5
Central Government Administration	1294	45	1923	54	2166	52	8.3	2.4
Regulatory Services	394	75	482	70	1070	78	4.1	17.3
Public Administration, nfd	226	63	191	60	277	65	-3.3	7.7
Public Administration and Safety, nfd	92	72	39	54	91	66	-15.8	18.5
Justice	80	38	89	45	91	36	2.2	0.5
Government Representation	22	41	35	26	36	31	9.7	0.6
Public Order, Safety and Regulatory Services, nfd	16	38	4	100	23	70	-24.2	41.9
Total	16860	71	18944	69	22896	67	2.4	3.9

Within the public administration and safety industry, most engineers work in the administration of central government, state government and local government. This is evident in Table 5.4, which shows the breakdown of engineer numbers by sub-industry. More detailed analysis of engineers working in the public sector is in Section 7.

DEFENCE

Defence is the largest sub-industry employer of engineers in the public administration and safety sector. Engineers working in defence are involved in military defence (including agencies staffed by civilian personnel) at home or abroad. The defence sub-industry also encompasses defence administration, defence research and development policies.

The number of engineers working in this industry has seen continuous growth over the decade. From a starting point of 4,800 in 2006, numbers grew to just under 6,200 in 2016. Over 75% of these engineers were employed in engineering occupations. Of the engineers

working in this industry in 2016, the biggest share was located in New South Wales with approximately:

- 30% in New South Wales
- 17% in Victoria
- 15% in the Australian Capital Territory
- 14% in South Australia
- 13% in Queensland.

REGULATORY SERVICES

In the second half of the decade, there was strong growth in the number of engineers working in regulatory services. Moreover, the majority of these engineers were employed in engineering occupations. Engineers in this industry work in enforcing regulations, licensing and inspection activities. This could include roles in consumer protection, licensing and permit issuance and motor vehicle testing, along with regulation of food and agricultural standards, qualification standards, and weights and measures.

Mining

Table 5.5: Engineering employment in Mining, 2006, 2011 and 2016

Mining	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Metal Ore Mining	2492	85	4467	85	6436	82	12.4	7.6
Oil and Gas Extraction	1389	81	3266	82	3637	81	18.7	2.2
Coal Mining	1407	83	2561	82	2947	79	12.7	2.9
Other Mining Support Services	715	80	1474	80	919	74	15.6	-9.0
Exploration	555	79	821	77	871	78	8.2	1.2
Mining, nfd	535	77	624	78	498	72	3.1	-4.4
Construction Material Mining	127	70	173	82	190	69	6.4	1.9
Other Non-Metallic Mineral Mining and Quarrying	130	84	146	73	176	78	2.4	3.8
Non-Metallic Mineral Mining and Quarrying, nfd	12	92	11	45	15	100	-1.7	6.4
Exploration and Other Mining Support Services, nfd	4	75	0	0	7	43	-100.0	N/A
Total	7366	82	13543	82	15696	80	13.0	3.0

Mining industries have historically made up 3 to 6% of total engineering employment. This is much higher than the equivalent figures for general employment. Generally, mining only employs about a 1 to 2% share of the general working population, and even less of the skilled working population.

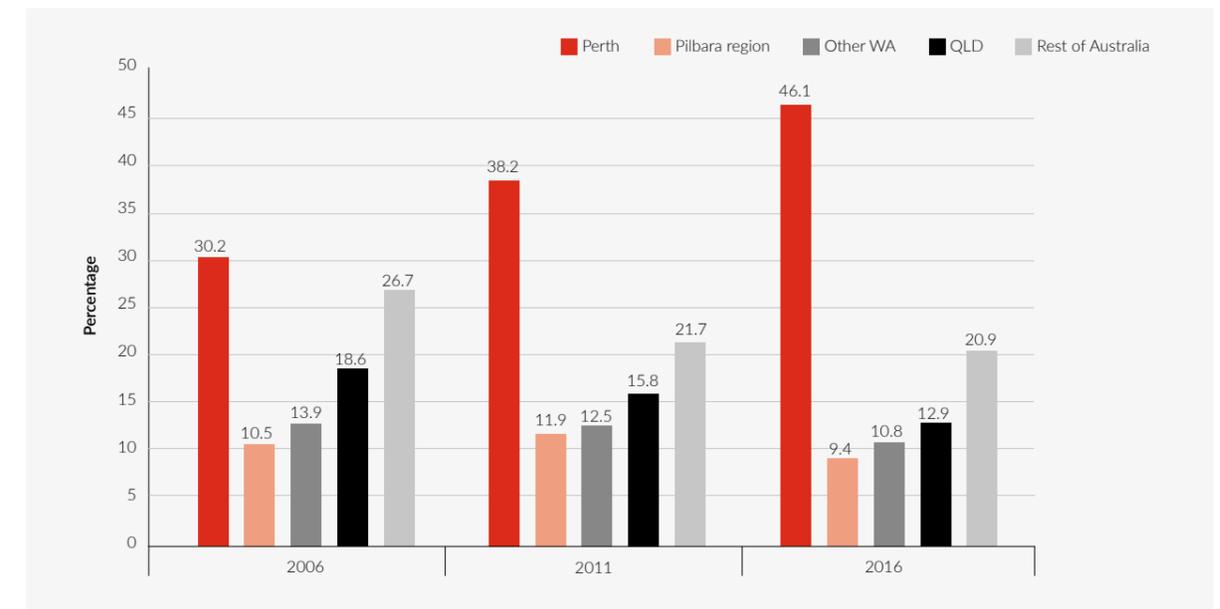
Mining industries employ a range of engineers, and they are spread widely across mining sub-industries. All of these industries are male-dominated, with at least 89% of the engineers employed in these industries being male. The largest mining sub-industries that employ engineers are metal ore mining, coal mining and oil and gas mining. These three industries employ at least 80% of engineers in engineering occupations.

METAL ORE MINING

Metal ore mining engineers work in the mining of ore, mineral sand, silver-lead-zinc and other metals.

The number of engineers working in metal ore mining grew strongly over the decade. In the first half of the decade there was national annual growth of 12.4%, and this was 15.4% in Western Australia. In the second half of the decade, this annual growth national slowed to 7.6%, with Western Australia once again leading the way with growth of 8.8%.

Figure 5.16: The percentage of Metal Ore Mining Engineers by region in Australia



LION'S SHARE OF METAL ORE MINING ENGINEERS LOCATED IN WESTERN AUSTRALIA

The number of metal ore mining engineers grew strongly in correlation with the resources boom. Due to the boom, a large majority based themselves in Western Australia – more metal ore mining engineers were located there than in all the other states combined (see Figure 5.16). In 2006, 55% were located in Western Australia, growing to 63% in 2011 and 66% in 2016.

The concentration of metal ore mining engineers in Western Australia is made stark by Figure 5.16. It shows the proportion of those engineers based in Perth, the Pilbara region, Other Western Australia, Queensland and the rest of Australia.

MOST BASE THEMSELVES IN PERTH AND WORK REMOTELY

Perth has the largest share of these engineers, growing from 30.2% to 46.1% over the decade. At decade's end, there were just under 3,000 in Perth. This compares to a share of just 9.4% in the Pilbara, despite this area being synonymous with metal ore mining. This indicates that much of the engineering work done in these industries can be done remotely from the state capital.

STEADY GROWTH IN QUEENSLAND ON THE BACK OF GROWING RESOURCES SECTOR

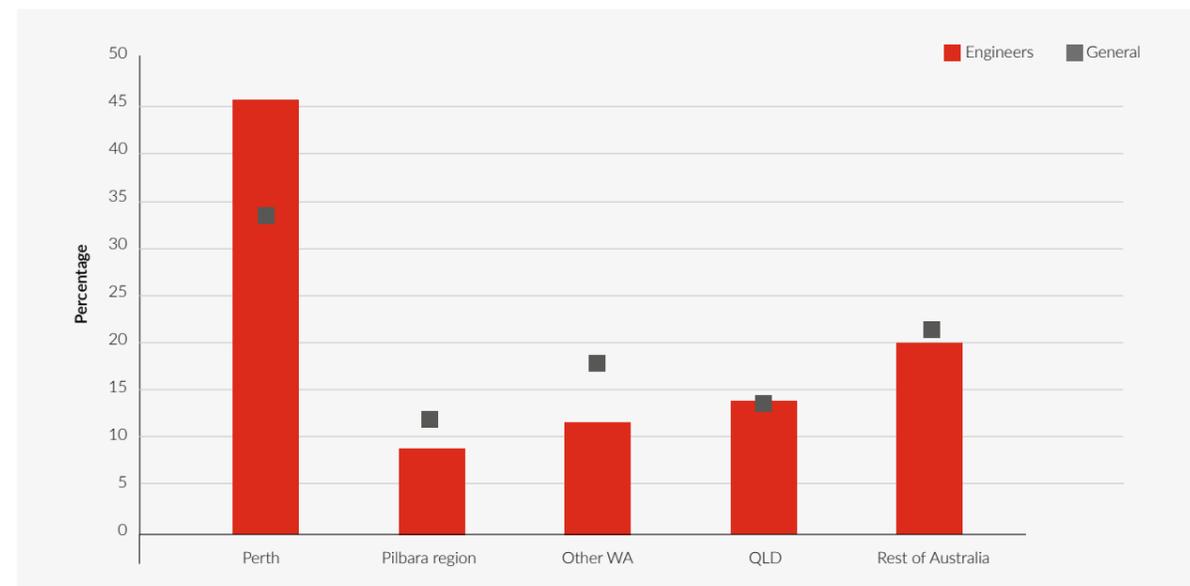
The number of metal ore mining engineers working in Queensland also increased over the decade, however the large growth in Perth meant its

percentage share fell. In 2006, there were 465 Queensland-based metal ore mining engineers, which grew to 704 in 2011 and 831 in 2016 on the back of the growing resources sector in that state.

IN THIS INDUSTRY, PROPORTIONATELY MORE ENGINEERS THAN GENERAL WORKER POPULATION ARE IN PERTH

To further investigate the concentration of metal ore mining engineers in Perth, Figure 5.17 shows the distribution of these engineers in 2016 compared to general labour population working in the same industry.

Figure 5.17: The distribution of Metal Ore Mining engineers by region in comparison to the general labour force, 2016



Metal ore mining engineers are much more likely to work in Perth compared to metal ore mining industry workers at large (see Figure 5.17).

However, although there is striking similarity in the concentration of the two groups in Western Australia, distribution within the state differs.

While a large portion of the general labour population in this industry work out of Perth,

engineers are more likely to live there. Again, this highlights the ability for engineers to work remotely, as opposed to the general labour force, who are more likely to be needed onsite. This is reflected with higher proportions of the general labour force based in the Pilbara and other regional parts of Western Australia where the mining actually takes place.

OIL AND GAS EXTRACTION MINING

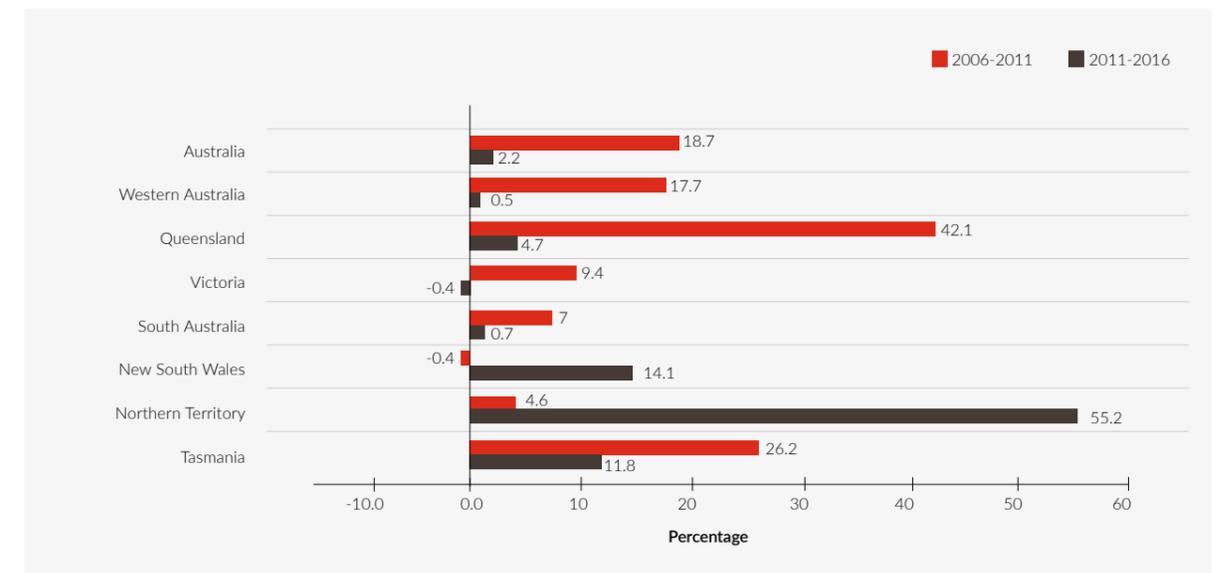
Engineers working in the oil and gas extraction industry are engaged in producing crude oil, natural gas or condensate through the extraction of oil and gas deposits. The number of engineers working in this industry grew rapidly between 2006 and 2011 from around 1,300 to 3,200. This growth continued to 2016, but growth in this five-year period was slower, with just over 3,600 recorded in 2016. Over 80% of these engineers were employed in engineering occupations.

The compound annual growth of oil and gas extraction by region is set out in Figure 5.18.

In most states, growth was strong in first half of decade, but slowed in second

For most jurisdictions, growth was strong in the first half of the decade (particularly in Queensland), but slowed in the second half. New South Wales and the Northern Territory were the only jurisdictions to buck that trend. However, the massive growth seen in the Northern Territory was from a low base – in 2016, just under 100 oil and gas extraction engineers were located there.

Figure 5.18: The compound annual growth in qualified engineers working in the oil and gas extraction mining industry by state



Most oil and gas extraction engineers call Western Australia home

Western Australia maintained its position as home to the largest number of oil and gas extraction engineers, with around 50% of all engineers in this sub-industry located there. Of these engineers, over 89% were located in Perth, and around 8% in the Pilbara. Growth in the number of oil and gas extraction engineers has been strong in the state over the five-year period of 2006 and 2011, with smaller growth in the five years to 2016. In 2016, there were almost 1,800 oil and gas extraction engineers based in Western Australia.

Queensland records strong growth in engineer numbers

Over the same period of time, the growth of the number of oil and gas extraction engineers in Queensland was significant, with over 1,000 engineers recorded in 2016. In the state, almost three quarters of these engineers were located in Brisbane, with other areas such as Central Queensland (Gladstone, Rockhampton), Moreton Bay and the Gold Coast also recording notable numbers.

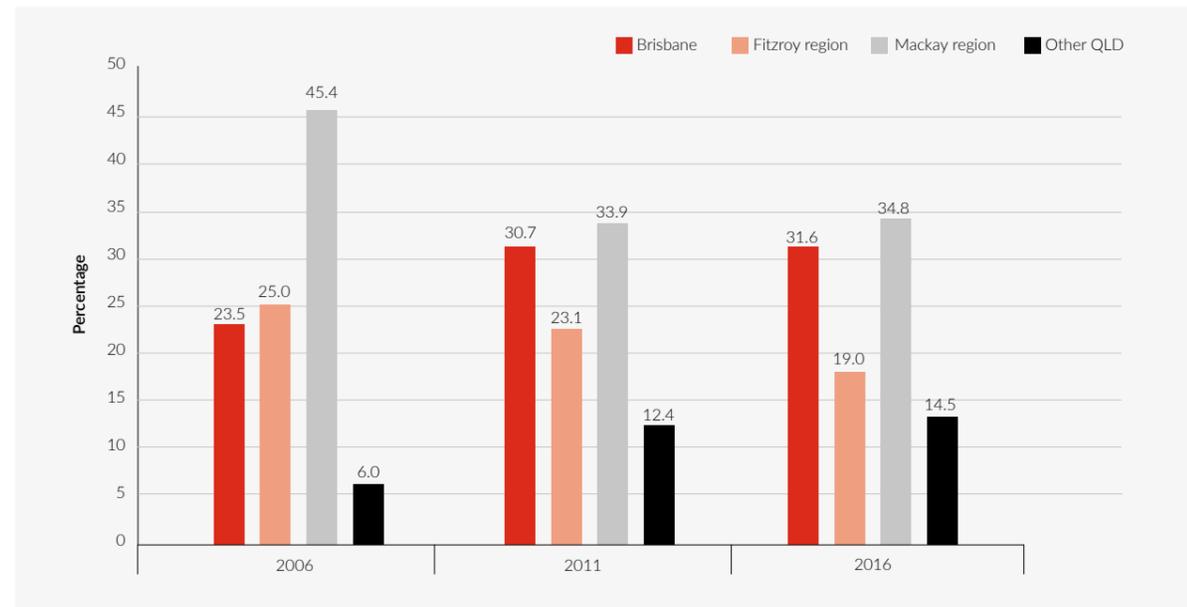
COAL MINING

The demand for engineers in coal mining industries has increased over the decade. In 2006 there were approximately 1,400 coal mining engineers, which grew to just under 3,000 in 2016. Most growth occurred between 2006 and 2011 at the height of the resources boom. Engineers who work in these industries tend to be employed in actual engineering occupations with a proportion of around 80% over the decade.

Coal mining engineers are predominately located in New South Wales and Queensland. Historically, around 40 to 45% of all coal mining engineers have been located in New South Wales, and 50 to 55% in Queensland. Figures 5.19 and 5.20 show the distribution of engineers working in coal mining industries by state region in Queensland and in New South Wales.

Queensland coal mining engineers experience decade of growth

Figure 5.19: The geographical distribution of qualified engineers employed in coal mining in Queensland, over the past decade

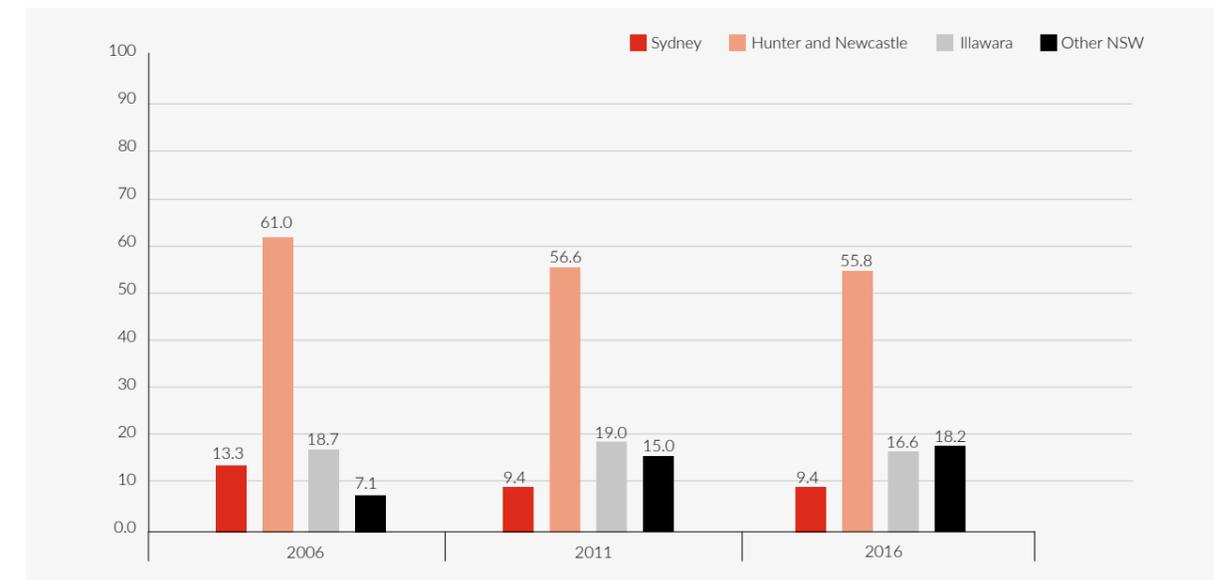


In Queensland, the top three locations for coal mining engineers were Brisbane and the Fitzroy and Mackay regions. The Fitzroy region covers the central highlands, Gladstone and Rockhampton. This is home to the Gladstone and Stanwell power stations. The Mackay region encompasses Mackay and the Bowen Basin, which holds large coal reserves.

Growth in all three regions was strong in the first half of the decade, and slowed in the second half. However, Brisbane recorded steady growth over the full decade. This suggests that engineering work in relation to coal mining can increasingly be completed remotely from a city centre such as Brisbane, or in close proximity to regional power stations such as Tarong power station and Kogan Creek power station.

In New South Wales, more than half of coal mining engineers are in Hunter-Newcastle

Figure 5.20: The geographical distribution of qualified engineers employed in coal mining in New South Wales, over the past decade



The dominant location of coal mining engineers in New South Wales was the Hunter and Newcastle region, followed by Illawarra (see Figure 5.20). This correlates with the location of coal industries and power plants. The Hunter and Newcastle region is home to some of Australia's largest coal-fired power plants such as Bayswater and Liddell, which drives demand for coal mining engineers.

New South Wales did not follow Queensland in the trend towards more coal mining engineers conducting their work from the state capital. The proportion of coal mining engineers based in Sydney was low (compared to Brisbane) and recorded no growth over the decade.

Electricity, gas, water and waste services

Table 5.6: Engineering employment in Electricity, Gas, Water and Waste Services, 2006, 2011 and 2016

Electricity, Gas, Water and Waste Services	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Water Supply, Sewerage and Drainage Services	2640	83	3478	81	3717	79	5.7	1.3
Electricity Distribution	1919	78	3283	80	3627	74	11.3	2.0
Electricity Generation	1064	73	1453	74	1601	72	6.4	2.0
Electricity Supply, nfd	405	74	483	71	884	72	3.6	12.9
Electricity Transmission	541	86	774	89	753	81	7.4	-0.6
Gas Supply	379	79	676	79	586	74	12.3	-2.8
On Selling Electricity and Electricity Market Operation	260	65	510	71	555	69	14.4	1.7
Waste Treatment, Disposal and Remediation Services	86	69	157	61	287	59	12.8	12.8
Waste Collection Services	125	51	166	54	284	52	5.8	11.3
Electricity, Gas, Water and Waste Services, nfd	96	67	95	82	151	68	-0.2	9.7
Waste Collection, Treatment and Disposal Services, nfd	16	25	6	50	73	56	-17.8	64.8
Total	7531	78	11081	79	12518	74	8.0	2.5

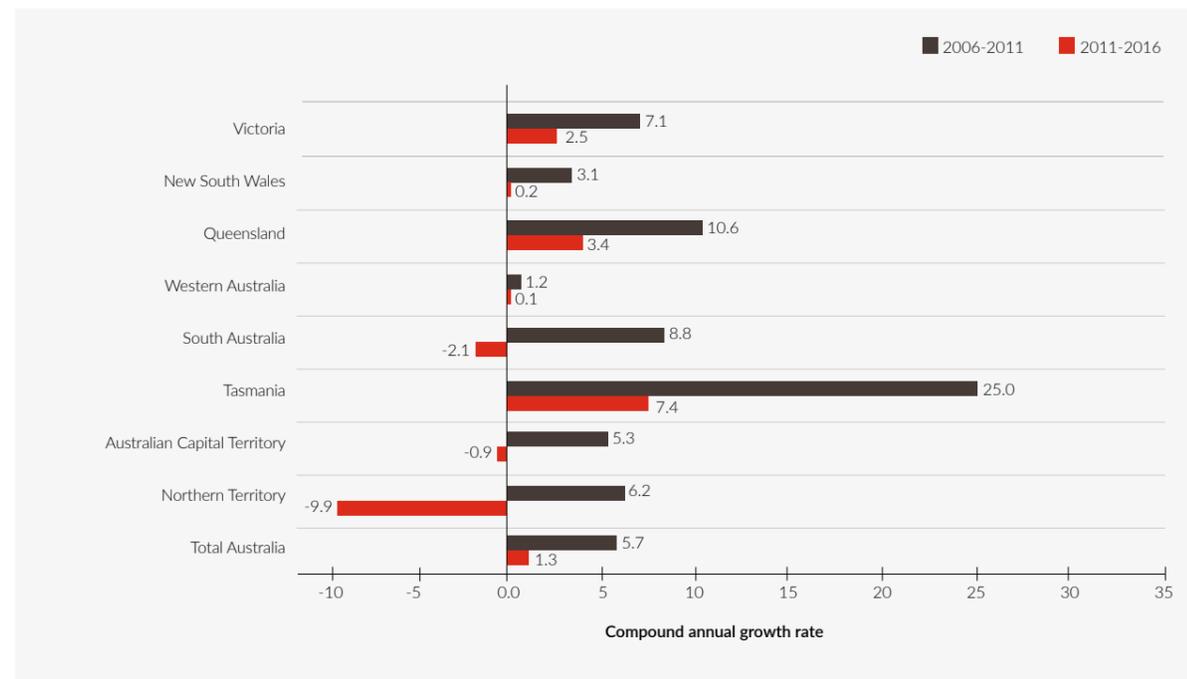
The electricity, gas, water and waste services industry employs significant numbers of engineers. Historically, the sector has employed around 3 to 5% of the engineering population. This is much higher than equivalent figures for general and skilled labour working in the industry. Only around 1% of the general working population work in the electricity, gas, water and waste services industry, and the figure is even lower for skilled employment.

Numbers of engineers working in this industry have steadily increased over the course of the decade. Within the sector, the water supply, sewerage and drainage services sub-industry employs the largest number of engineers, followed by electricity distribution and electricity generation. 70% of engineers employed in the industries of electricity generation, transmission and distribution work in engineering occupations. These industries are also heavily male-dominated, with at least 85% of engineers in the electricity generation, transmission and distribution industries being male.

WATER SUPPLY, SEWERAGE AND DRAINAGE SERVICES
The number of engineers employed in the water supply, sewerage and drainage industry grew over the decade, though growth slowed in the latter half. Of these engineers, the vast majority worked in water supply services. In 2006, there were just over 2,600 engineers working in this sector, increasing to 3,700 in 2016. Most of the growth occurred in the first five years, with annual growth of 5.7%, compared to growth of 1.3% for the following five years.

By region (see figure 5.21), Victoria has the largest proportion of water supply, sewerage and drainage engineers, closely followed by New South Wales, with over 1,000 such engineers in each state. Both states have also enjoyed consistent growth. Queensland and Western Australia also have significant numbers of these engineers, with numbers in both states continuing to grow.

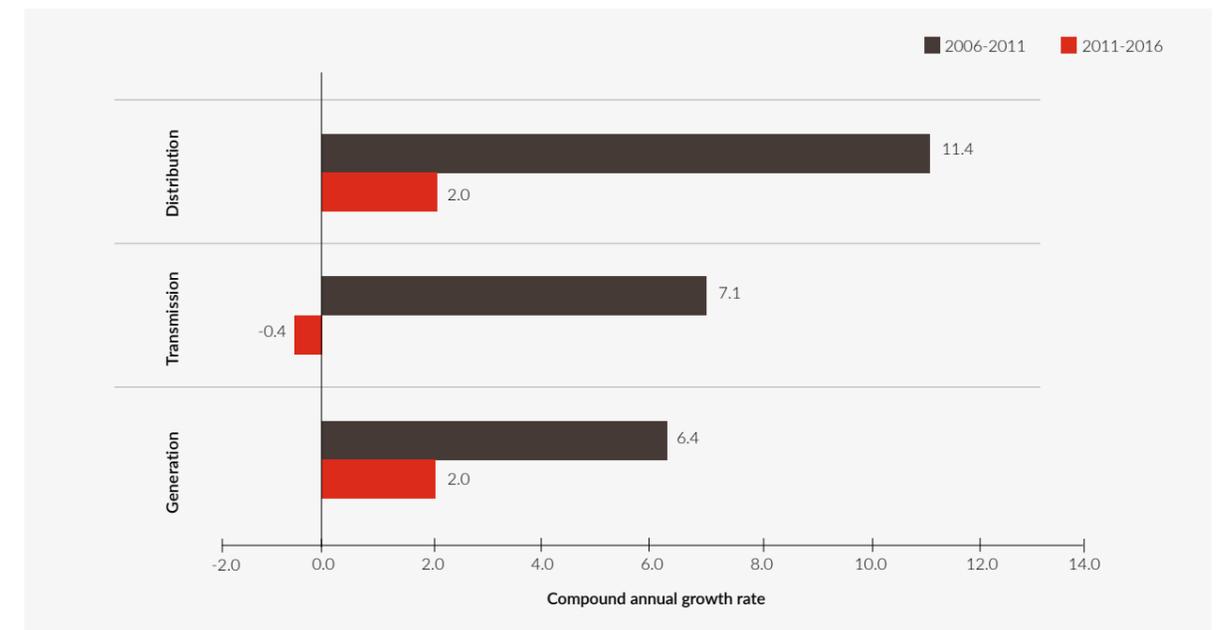
Figure 5.21: Compound annual growth of qualified engineers employed in water supply, sewerage and drainage services, in each jurisdiction, between census periods



ELECTRICITY GENERATION, TRANSMISSION AND DISTRIBUTION
 Engineers are vital to a successful electricity system, and are involved in all stages of energy production, including generation, transmission and distribution (see Table 5.6). In 2016, there were over 3,600

engineers working in electricity distribution, over 1,600 working in electricity generation, and over 750 working in transmission. All of these numbers rose over the course of the decade. Additionally, over 70% of the engineers who work in these industries work in engineering occupations.

Figure 5.22: Compound annual growth rates of qualified engineers employed in electricity generation, transmission and distribution, in between census periods



Growth strong in first half of decade, but slow in second

In the first half of the decade, there was strong growth in engineer numbers across all three stages of energy supply (see Figure 5.22). However, growth slowed in the second half of the decade for electricity distribution and generation, and stalled completely for electricity transmission.

In 2016, there were over 3,600 engineers working in electricity distribution, up from just under 1,900 in 2006. Of these, almost 40% resided in New South Wales, 23% in Queensland, 21% in Victoria, 11% in Western Australia and 5% in South Australia. The strongest growth was in the first half of the decade, with New South Wales recording 13.9% growth, Queensland 10.8% and Victoria 12.2%. This growth slowed in the latter half of the decade.

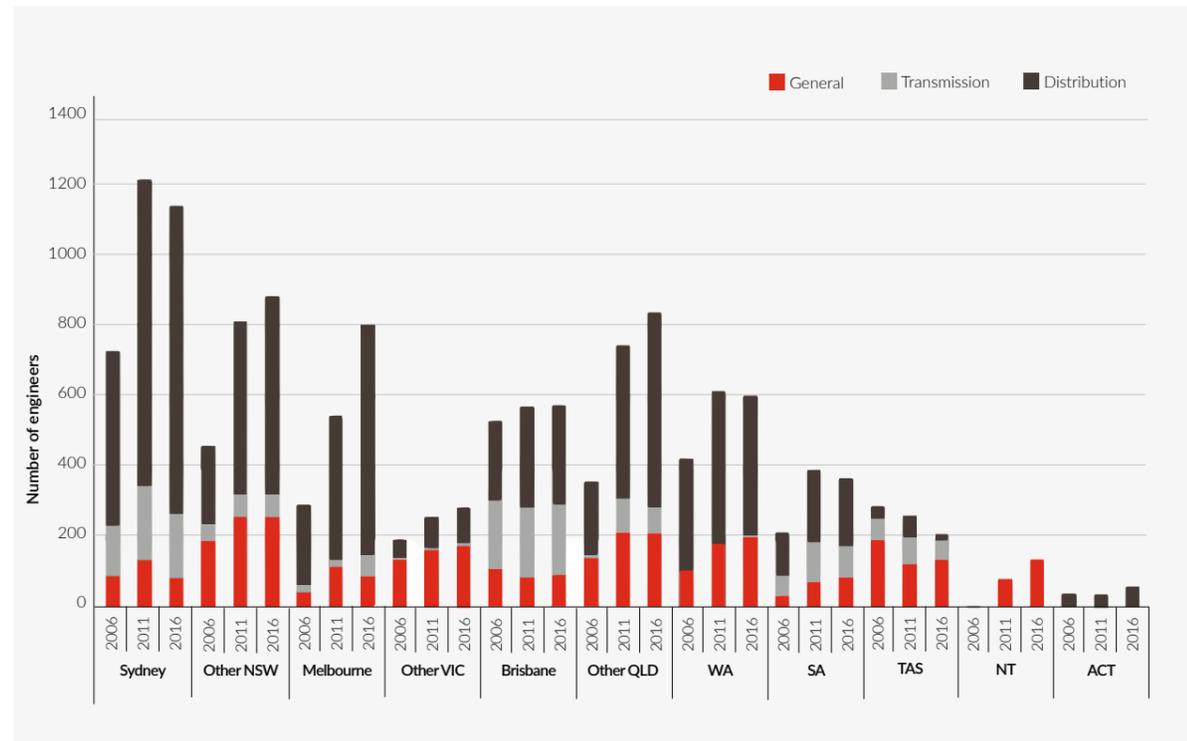
In 2016, there were 750 engineers working in electricity transmission, down from 765 in 2011, but up from 540 in 2006. The three largest states of New South Wales, Victoria and Queensland were where the majority of these engineers resided.

In 2016, there were just over 1,600 engineers employed in electricity generation, up from 1,063 recorded in 2006. There was strong growth between 2006 and 2011, mostly in Victoria, South Australia and Western Australia. In the following five years, growth slowed in all jurisdictions. The geographical distribution of these engineers is plotted further below.

Wide distribution across Australia of engineers working in energy supply

The geographical distribution of engineers employed in these three electricity supply industries is set out in Figure 5.23.

Figure 5.23: The geographical distribution of engineers employed in electricity generation, transmission and distribution over the last decade



Engineers working in all three parts of energy supply are spread throughout the different states and territories, with some regional areas having large numbers (see Figure 5.23). Generation engineers were also spread across Australia, though there is more differentiation when viewed according to generation types. This is explored further in Figure 5.24.

Transmission engineers are located predominately in Sydney, Brisbane and Adelaide. Distribution engineers in Australia are located in most capital cities in Australia, with high numbers in Sydney, Melbourne, Perth and Brisbane, along with notable numbers in regional Queensland and New South Wales.

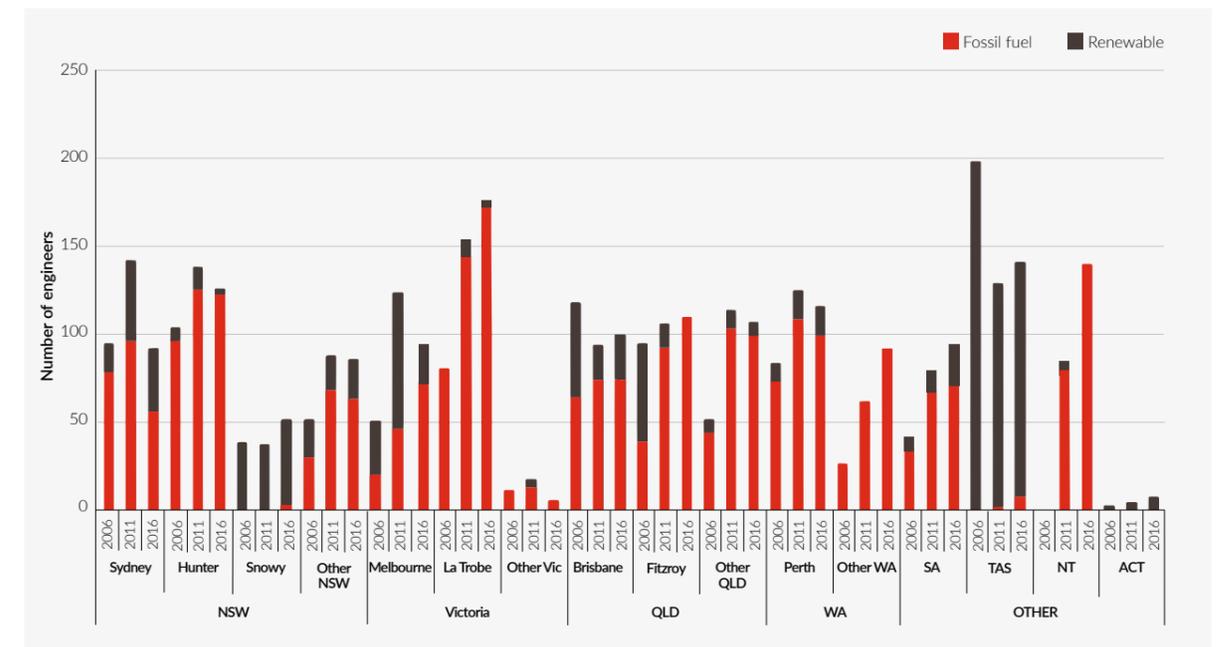
There has also been a sizable increase in the number of engineers working in 'electricity supply, not further defined.' This is a group of nearly 900 engineers who do not fit the standard classifications, and should not be discounted when looking at Figure 5.23.

Fossil fuel engineers widely distributed, but Tasmania leads with renewable engineer numbers

The number of engineers working in electricity generation industries has increased over the decade, although this increase has only been moderate when compared to electricity distribution. In 2016, there were just over 1,600 engineers: an increase on 1,060 ten years earlier.

The electricity generation industries can be split into three subsets of fossil fuel, hydro and other generation. Other generation is made up of solar, wind, geothermal, biomass and tidal generation. Figure 5.24 below shows the distribution of engineers working in these industries by region. The categories of hydro and other have been combined to 'Renewable'.

Figure 5.24: Fossil fuel and renewable generation engineers by location in Australia



Engineers working in the electricity generation industries were spread throughout Australia (see Figure 5.24). There were large numbers of engineers working in fossil fuel generation in New South Wales, predominantly in Sydney and the Hunter region. In Victoria, the La Trobe Valley continued to be the largest employment region for engineers working in fossil fuel generation, increasing in number over the decade. This region will be closely monitored in subsequent surveys to see if recent closures impact engineer numbers.

South Australia, Western Australia and Queensland all had large numbers of fossil fuel generation engineers in their capital cities, with Queensland also having a sizable contingent in its Fitzroy region. The Northern

Territory recorded significant growth in the number of fossil fuel generation engineers in 2016, with over 140 engineers on the ground.

For engineers working in renewable generation, Tasmania remains the largest concentration point in the country, even though numbers were down from 2006. In 2016, Hobart had over 120 engineers working in renewable generation due to large hydro resources in the state. The same can be seen in the Snowy Mountains region of New South Wales with the influence of the Snowy Hydro operation. The number of renewable engineers in Melbourne peaked in 2011, coinciding with a large number of renewable projects around that time⁸.

8. www.arena.gov.au/projects.

Information media and telecommunications

Table 5.7: Engineering employment in Information Media and Telecommunications, 2006, 2011 and 2016

Information Media and Telecommunications Industry	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Telecommunications Services	5020	73	6265	76	8250	76	4.5	5.7
Internet Service Providers and Web Search Portals	325	69	484	77	911	74	8.3	13.5
Data Processing, Web Hosting and Electronic Information Storage Services	82	74	113	60	554	74	6.6	37.4
Television Broadcasting	363	53	380	57	400	53	0.9	1.0
Newspaper, Periodical, Book and Directory Publishing	418	40	448	40	353	44	1.4	-4.7
Motion Picture and Video Activities	157	23	198	29	224	29	4.8	2.5
Information Media and Telecommunications, nfd	70	61	47	53	173	62	-7.7	29.8
Radio Broadcasting	52	56	60	40	90	56	2.9	8.5
Broadcasting (except Internet), nfd	51	78	38	63	86	65	-5.7	17.8
Libraries and Archives	41	37	35	37	70	33	-3.1	14.9
Internet Publishing and Broadcasting	36	67	67	66	66	68	13.2	-0.3
Sound Recording and Music Publishing	8	63	23	57	35	43	23.5	8.8
Software Publishing	19	47	47	89	32	88	19.9	-7.4
Publishing (except Internet and Music Publishing), nfd	21	33	33	27	29	72	9.5	-2.6
Internet Service Providers, Web Search Portals and Data Processing Services, nfd	4	125	3	133	16	100	-5.6	39.8
Motion Picture and Sound Recording Activities, nfd	4	100	0	0	6	0	-100.0	N/A
Library and Other Information Services, nfd	0	0	0	0	0	0	N/A	N/A
Other Information Services	16	81	8	63	0	0	-12.9	N/A
Total	6687	68	8249	71	11295	72	4.3	6.5

Historically, the information media and telecommunications industries have made up around 1 to 2% of general employment, and 2 to 3% of skilled employment. This compares to about 3 to 4% of engineering employment. Engineers working in these industries are heavily concentrated in the industry of telecommunications services (see Table 5.7). Other smaller employers of engineers in this broad industry group include internet service providers and web search portals, newspaper, periodical, book and directory publishing and television broadcasting.

In the second half of the decade, there was strong growth in the number of engineers working in data processing, web hosting and electronic information storage services, with around three-quarters working in engineering-specific occupations. Engineers

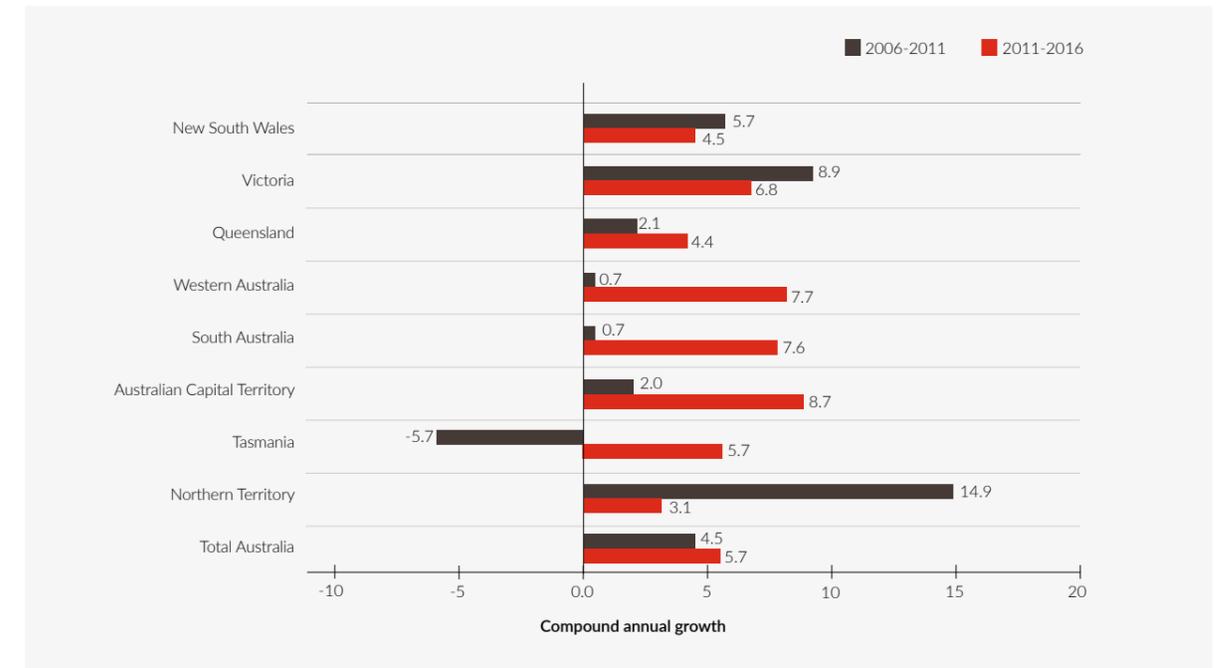
working in these industries are involved in computer and data processing, data capture processing and service, automated data processing, data and electronic storage and retrieval services.

TELECOMMUNICATIONS SERVICES

The telecommunications industry is by far the biggest sub-industry employer of engineers in this industry. Over the decade, it recorded strong growth. In 2006, it employed just over 5,000 engineers, increasing to over 8,000 in 2016. Of the engineers working in this industry, over 75% work in engineering occupations. This industry has been historically male-dominated, with over 90% of engineers being male.

Most states have consistent growth in telecommunications engineer numbers

Figure 5.25: Compound annual growth of qualified engineers working in telecommunications services, in each jurisdiction, between census periods



There was growth in the number of these engineers nationally over the decade with 4.5% annual growth in the first half of the decade, and 5.7% annual growth in the second.

All jurisdictions except for Tasmania recorded consistent growth over the course of the decade (see Figure 5.25). The growth figures in New South Wales and Victoria are more significant, as this is where most telecommunications engineers base themselves.

80% of telecommunications engineers are in Sydney or Melbourne

Sydney and Melbourne were home to the vast majority of telecommunications engineers, with almost 80% located in these two centres. In 2016, there were over 3,400 telecommunications engineers in Sydney, which grew from 2,200 in 2006. In Melbourne, there were 3,000 engineers in 2016, growing from 1,600 in 2006.

Smaller numbers can be seen in Brisbane, Adelaide and Perth. This could be somewhat expected with the large volume of work for wired, mobile and satellite telecommunications network operation services in these large population areas.

6. Non-Core Engineering Industry Analysis

The non-core engineering industries have a percentage of engineers working in engineering occupations below the economy-wide average. In 2016, non-core industries had a 24.3% share of all the engineers that work in engineering occupations, up from 20.4% in 2011.

This section will briefly analyse the sub-industries of the non-core engineering industries. This will include outlining the number of engineers in each sub-industry in each census year, the percentage in engineering occupations and the compound annual growth between the census periods.

Transport, postal and warehousing

Table 6.1: Engineering employment in Transport, Postal and Warehousing, 2006, 2011 and 2016

Transport, Postal and Warehousing Industry	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Air and Space Transport	3563	84	4585	79	5310	75	5.2	3.0
Road Passenger Transport	907	6	1456	7	2465	7	9.9	11.1
Other Transport Support Services	651	24	1670	67	1973	55	20.7	3.4
Postal and Courier Pick-up and Delivery Services	725	18	917	13	1653	10	4.8	12.5
Airport Operations and Other Air Transport Support Services	935	80	1165	77	1464	74	4.5	4.7
Rail Passenger Transport	1089	67	1661	67	1379	66	8.8	-3.7
Road Freight Transport	1041	27	1263	30	1269	31	3.9	0.1
Water Transport Support Services	749	76	959	76	1049	76	5.1	1.8
Warehousing and Storage Services	301	40	362	28	982	29	3.8	22.1
Rail Transport, nfd	321	77	429	79	743	77	6.0	11.6
Transport, Postal and Warehousing, nfd	218	56	199	59	690	51	-1.8	28.2
Rail Freight Transport	237	77	457	79	453	70	14.0	-0.2
Water Freight Transport	356	87	484	85	363	81	6.3	-5.6
Pipeline and Other Transport	69	80	207	85	300	80	24.6	7.7
Water Transport, nfd	186	75	201	74	275	71	1.6	6.5
Scenic and Sightseeing Transport	260	74	227	75	261	63	-2.7	2.8
Water Passenger Transport	96	85	82	84	100	62	-3.1	4.1
Transport Support Services, nfd	4	0	3	0	14	0	-5.6	36.1
Road Transport, nfd	0	0	22	36	11	0	N/A	-12.9
Other Transport, nfd	0	0	0	0	0	0	N/A	N/A
Total	11708	61	16349	61	20754	53	6.9	4.9

Over the decade, the transport, postal and warehousing industry experienced strong growth in engineer numbers, partly due to urban renewal and infrastructure programs. The proportion of engineers employed in engineering occupations in this industry is just below the national average (see Section 3), and therefore just short of being classified as a core engineering industry.

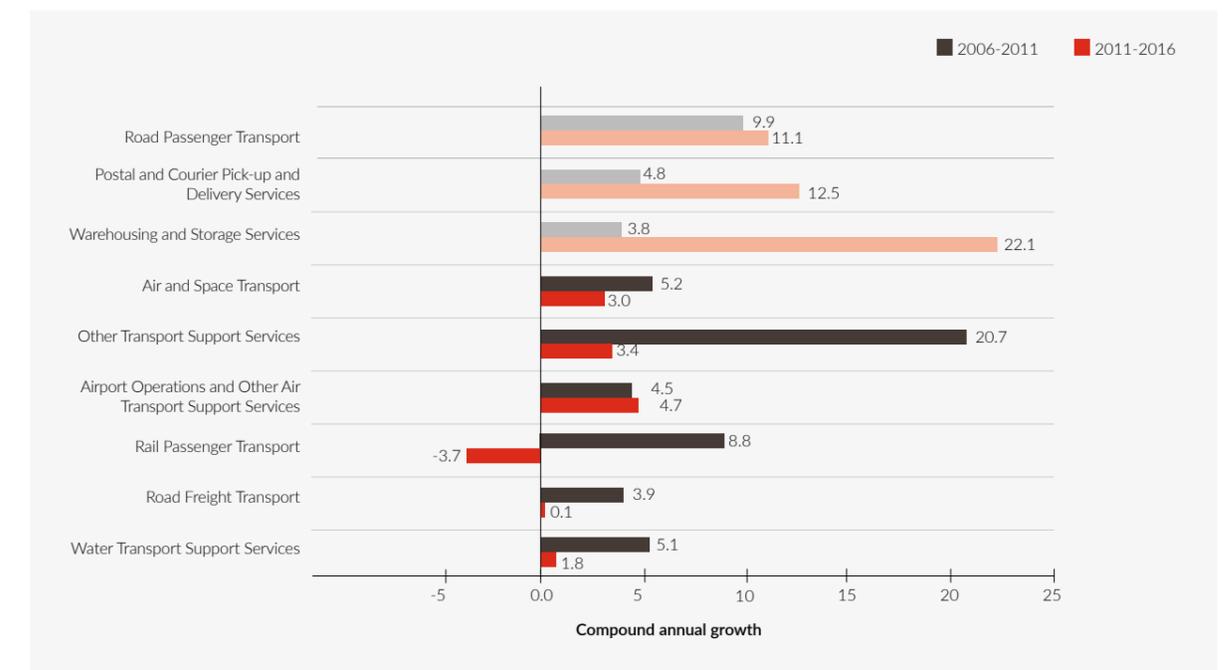
The transport, postal and warehousing industries have historically made up about 4 to 5% of the general work population and about 1 to 2% of skilled workers. This compares to 6 to 7% of engineering employment. In 2016, 5.9% of all engineers working in engineering occupations were employed in this industry.

Growth was strong over the decade for this industry, though particularly during the first half (including in the air and space transport, airport operations and rail passenger transport sub-industries). The total number of engineers working in the transport, postal and warehousing sector grew from almost 12,000 in 2006 to over 16,000 in 2011, and then to almost 21,000 in 2016.

Mostly positive growth in the major sub-industries

The mostly positive growth in engineer numbers for the major sub-industries is evident in Figure 6.1. Figure 6.1 shows the compound annual growth in the transport, postal and warehousing industries that employ more than 900 engineers. The full coloured bar graphs represent those industries that employ over 50% of engineers in engineering occupations, while the lighter bars have under 50% of engineers in engineering occupations.

Figure 6.1: Compound annual growth in qualified engineers working in the largest transport, postal and warehousing industries, between census period



The best performers are sub-industries with less than 50% in engineering roles

While there was strong growth in the number of engineers working in road passenger transport, postal and courier services and warehousing storage, these are industries where fewer than 50% of engineers work in engineering occupations. So, although these industries overall are growing, the figures suggest that the majority of growth was in non-engineering occupations. Indeed, despite growth in the numbers of engineers, the overall percentage of engineers actually working in engineering occupations dropped from 61.2% in 2011 to 53.4% in 2016.

For road passenger transport (which encompasses taxi and bus driving), as little as 7% of engineers work in engineering roles. This is despite the industry experiencing steady growth over the decade and employing almost 2,500 engineers in 2016. Similarly, there was strong growth in the number of engineers working in postal and courier pick-up and delivery services, with 1,653 engineers recorded in 2016, yet only around 10% working in engineering occupations.

These sub-industries in particular call attention to the underutilisation of engineering capability in the economy in the second half of the decade. Many engineers moved into jobs that do not make use of their engineering skills, but they have shifted to these industries for stable and consistent work.

AIR AND SPACE TRANSPORT

There is a significant number of engineers employed in air and space transport, and of the engineers that work in this industry, over 75% work in engineering occupations. This industry is also heavily male-dominated, with over 90% of the engineers being male.

Engineers working in air and space transport are primarily involved in international and domestic air travel. The statistics do not allow us to disaggregate the industries any further. Engineers working in this industry are mainly engaged in operating aircraft for the transportation of freight and passengers. Sydney is the region which employs the most air and space engineers (1,360 in 2016). However, its share of engineers has been falling since 2006.

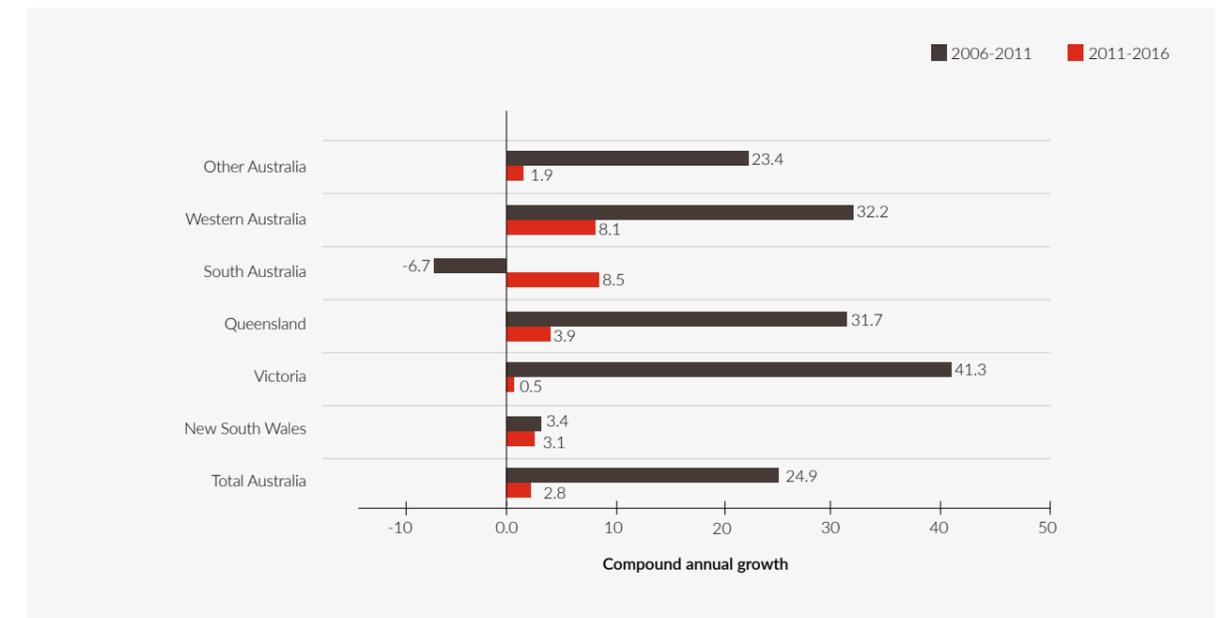
There was continuing growth in Victoria (mostly in Melbourne), Brisbane and Western Australia, with Perth doubling the number of air and space transport engineers over the decade. Although there was weak growth in regional New South Wales or Queensland, those parts of Australia still employed a significant number of air and space transport engineers. Specific regions with high concentrations of these engineers include the Southern Highlands, Newcastle and Illawarra, the Gold Coast, the Moreton Bay region and the Sunshine Coast.

OTHER TRANSPORT SERVICES

A large number of engineers classified themselves as working in 'other transport support services.' However, it is difficult to pinpoint exactly what roles might fall under this classification. Digging into the sub-categories, options include 'customs agency services and freight forwarding services', but the vast majority have selected 'other transport services not elsewhere classified'. This may include container terminal operation, road and rail terminal operation and toll bridge or road operation. Looking at the state-by-state breakdown, the majority of these engineers work in Victoria, followed by smaller numbers in Western Australia, New South Wales and Queensland.

Growth rates by jurisdiction for this industry are shown in Figure 6.2.

Figure 6.2: Compound annual growth of other transport support services engineers, in the different jurisdictions, between census periods



Numbers of engineers working in other transport services grew in all regions over the decade, other than in South Australia between 2006 and 2011 (see Figure 6.2). Although the smaller jurisdictions have been combined in Figure 6.2, the Australian Capital Territory also recorded a fall between 2011 and 2016.

The strongest growth in the number of engineers working in these industries was in the first half of the decade. Although growth continued in the second half of the decade, it slowed. Growth in South Australia and Western Australia during this time remained high. Engineering employment in these industries grew from 478 in 2006 to 1,667 in 2016. In 2006, only 24% of the engineers working in these industries were working in engineering occupations. This grew to 67% in 2011, before falling back to 55% in 2016.

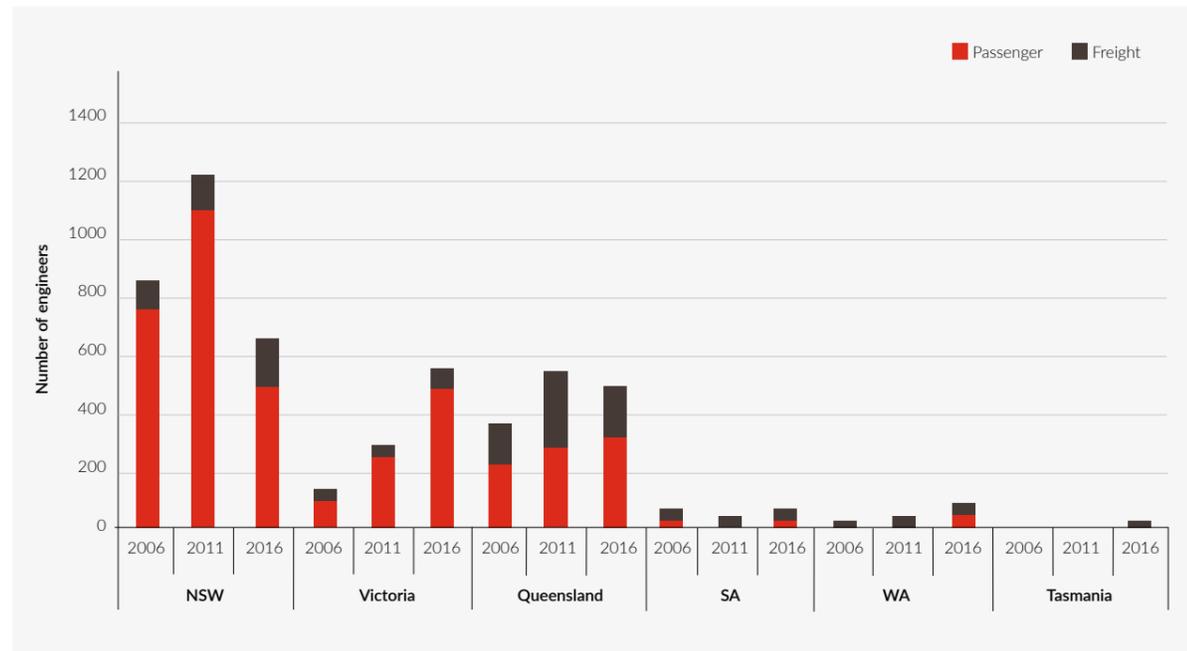
RAIL PASSENGER TRANSPORT AND RAIL FREIGHT TRANSPORT

Of the engineers working in rail passenger transport and rail freight transport, around two-thirds work in engineering occupations. Engineers have been vital to the operation of rail passenger transport and rail freight transport over the decade.

The distribution of the engineers working in these sub-industries is shown in Figure 6.3.

The strongest growth in the number of engineers working in these industries was in the first half of the decade

Figure 6.3: Compound annual growth of other transport support services engineers, in the different jurisdictions, between census periods



New South Wales, Queensland and Victoria were the regions with the largest proportions of rail transport engineers (Figure 6.3). In 2006, there were 237 engineers working in rail freight transport, climbing to 457 in 2011, and 453 in 2016. The majority were located in Queensland, and not all of these were in Brisbane. Notable numbers were recorded in the Fitzroy region and in Ipswich.

Rail passenger transport engineers experienced a fair amount of upheaval over the decade, particularly those based in New South Wales. Engineer numbers peaked in the middle of the decade. In 2006 there were 1,089 engineers working in rail passenger transport, climbing

to 1,661 in 2011 and falling back to 1,379 in 2016. As expected, the majority of these engineers were located in the major capital cities to be in close proximity with the largest passenger rail networks.

The demand for these engineers in New South Wales boomed in 2011, with over 1,100 of the engineers located there at that time, and over 1,000 of those located in Sydney. By the time of the 2016 census, this number had fallen dramatically, with just over 500 of these engineers located in New South Wales. At the same time, the number of these engineers in Victoria showed the opposite trend, growing to over 470 engineers in 2016.

Wholesale trade

Table 6.2: Engineering employment in Wholesale Trade, 2006, 2011 and 2016

Wholesale Trade Industry	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Other Machinery and Equipment Wholesaling	4797	64	6091	63	6326	66	4.9	0.8
"Specialised Industrial Machinery and Equipment Wholesaling"	619	54	847	54	1010	56	6.5	3.6
Grocery, Liquor and Tobacco Product Wholesaling	646	23	768	22	934	20	3.5	4.0
Mineral, Metal and Chemical Wholesaling	626	55	707	57	811	53	2.5	2.8
Motor Vehicle and Motor Vehicle Parts Wholesaling	368	41	485	36	657	40	5.7	6.3
Timber and Hardware Goods Wholesaling	476	42	544	36	610	38	2.7	2.3
Furniture, Floor Covering and Other Goods Wholesaling	652	24	727	24	563	25	2.2	-5.0
Wholesale Trade, nfd	535	31	522	28	464	36	-0.5	-2.3
Pharmaceutical and Toilet Goods Wholesaling	257	53	277	45	283	45	1.5	0.4
Textile, Clothing and Footwear Wholesaling	357	19	351	19	236	24	-0.3	-7.6
Agricultural Product Wholesaling	97	23	128	27	137	20	5.7	1.4
Commission-Based Wholesaling	77	27	156	54	128	55	15.2	-3.9
Machinery and Equipment Wholesaling, nfd	73	44	100	42	48	52	6.5	-13.7
Other Goods Wholesaling, nfd	16	19	17	18	9	0	1.2	-11.9
Basic Material Wholesaling, nfd	15	67	6	0	5	80	-16.7	-3.6
Total	9611	51	11726	51	12221	53	4.1	0.8

Historically, the wholesale trade industries have made up around 2 to 5% of general employment and 2 to 3% of skilled employment. This compares to around 4 to 5% of engineering employment. Numbers of engineers in these industries have increased over the decade.

Engineers who work in wholesale trade are engaged in the purchase, on-selling, commission-based buying or selling of goods, without significant transformation, to businesses.

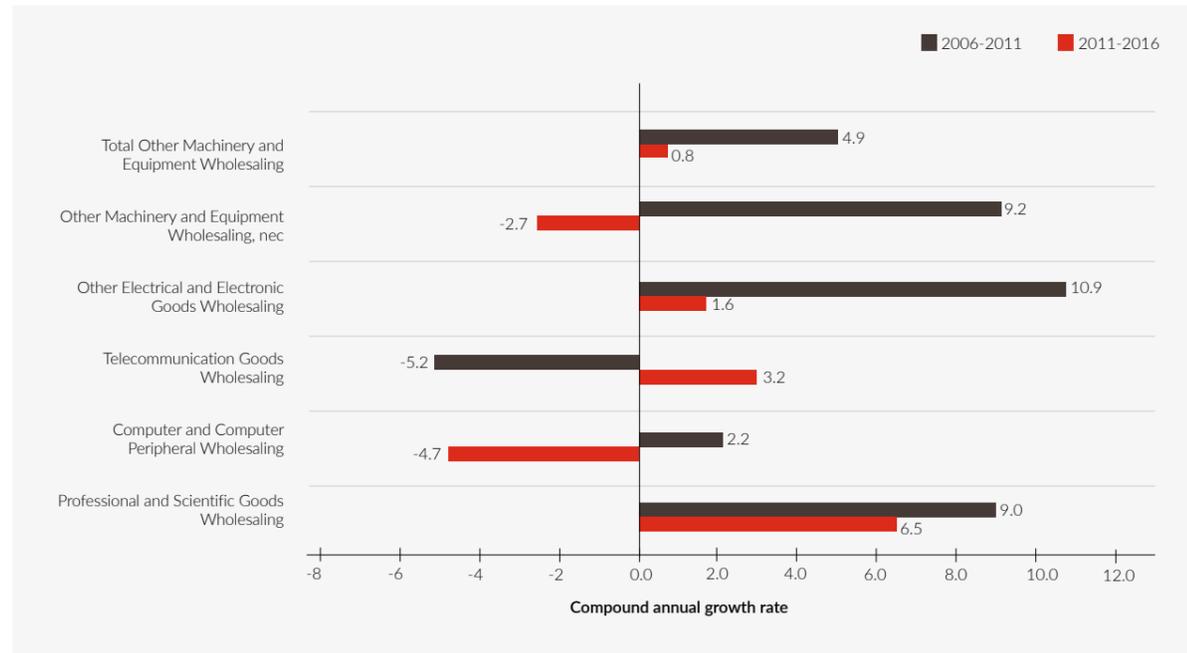
It is unsurprising that the majority of engineers work in equipment wholesaling. Over 90% of engineers in this sub-industry are male, and over 60% are employed in engineering roles. Other sub-industries that were big employers of engineers included specialised industrial machinery and equipment wholesaling, mineral, metal and chemical wholesaling, and motor vehicle and motor vehicle parts wholesaling.

While a large number of engineers work in grocery, liquor and tobacco product wholesaling, only 20% work in engineering occupations: another sign of underutilisation of engineering capability.

OTHER MACHINERY AND EQUIPMENT WHOLESALING

The largest sub-industry employer of engineers within the wholesale trade sector is 'other machinery and equipment wholesaling.' It is clear that engineers work in these industries due to their specialised knowledge of the products. This includes electrical and electronic goods, telecommunication goods, computer goods and professional and scientific goods. This industry can be disaggregated accordingly (see Figure 5.4).

Table 6.4: Compound annual growth of Other Machinery and Equipment Wholesaling engineers, between the two census periods.



Growth was mostly strong for all industries in the first half of the decade (other than for telecommunications wholesaling), but weaker in the second half. In the five years to 2016, other machinery and computer wholesaling experienced falls.

Electrical and electronic goods wholesaling was the largest employer of engineers, employing over 2,300 in 2016. This was followed by telecommunication goods, with over 1,100; and professional and scientific goods and computer wholesaling, each with just over 1,000. Most engineers working in these industries were located in New South Wales or Victoria.

Education and training

Table 6.3: Engineering employment in Education and Training, 2006, 2011 and 2016

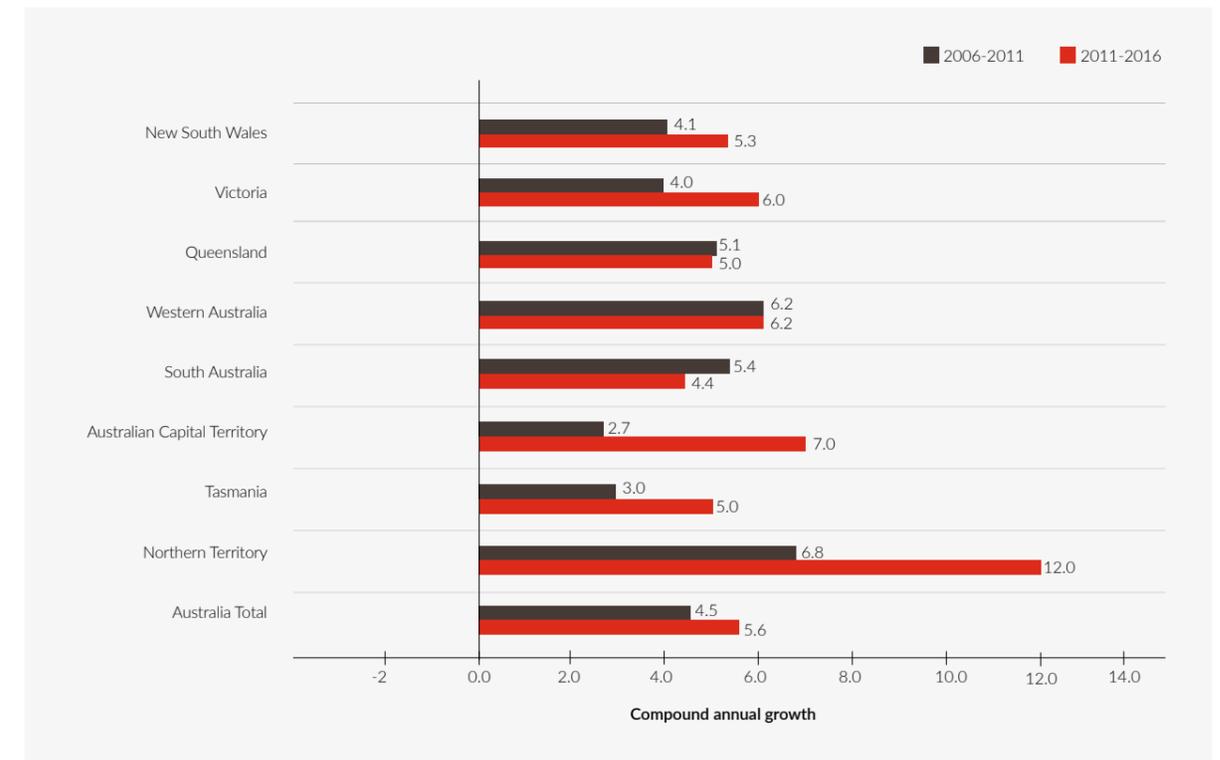
Education and training	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Education and Training								
Tertiary Education	5565	72	6935	71	9103	68	4.5	5.6
School Education	1224	9	1475	12	2411	13	3.8	10.3
Adult, Community and Other Education	889	47	1066	44	1258	36	3.7	3.4
Education and Training, nfd	238	38	226	38	305	43	-1.0	6.2
Preschool Education	27	0	36	14	111	9	5.9	25.3
Educational Support Services	19	26	33	39	48	35	11.7	7.8
Adult, Community and Other Education, nfd	15	33	3	0	17	41	-27.5	41.5
Preschool and School Education, nfd	0	0	41	15	0	0	N/A	-100.0
Total	7977	58	9815	58	13253	54	4.2	6.2

The education and training industry has historically made up a reasonable proportion of skilled employment, though this is not carried through to engineering employment. 18 to 20% of skilled employees work in the education and training sector, compared to around 7 to 9% for the general working population, and around 3 to 5% for engineering employment. More than half of the engineers employed in this sector work in tertiary education.

TERTIARY EDUCATION

Engineers working in tertiary education do so in universities, research schools, specialist institutions and business colleges, as well as technical and vocational education institutions. Around 70% of the engineers working in tertiary education were employed in engineering occupations, and over 70% were male.

Figure 6.5: Compound annual growth of qualified engineers employed in tertiary education, in each jurisdiction, between census periods



There was consistent growth across all jurisdictions over the decade in the number of engineers working in tertiary education (see Figure 6.5). In 2016, there were over 9,000 engineers employed in this industry, up from 5,500 in 2006. The largest number of tertiary education engineers worked in New South Wales, with over 30% employed in that state, followed by:

- Victoria, with just under 30%
- Queensland, with around 16%
- Western Australia, with around 10%
- All other jurisdictions, with under 10%.

Financial and insurance services

Table 6.4: Engineering employment in Financial and Insurance Services, 2006, 2011 and 2016

Financial and Insurance Services	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Depository Financial Intermediation	1261	47	2128	54	3043	60	11.0	7.4
Auxiliary Finance and Investment Services	1488	35	1686	41	1873	40	2.5	2.1
Health and General Insurance	601	48	749	46	1057	49	4.5	7.1
Central Banking	22	50	242	25	714	52	61.5	24.2
Financial Asset Investing	382	53	364	48	397	56	-1.0	1.8
Superannuation Funds	76	39	172	54	232	66	17.8	6.2
Finance, nfd	400	28	152	30	211	40	-17.6	6.8
Auxiliary Insurance Services	134	37	156	40	206	47	3.1	5.7
Life Insurance	61	56	74	46	117	62	3.9	9.6
Non-Depository Financing	59	47	118	51	105	53	14.9	-2.3
Financial and Insurance Services, nfd	105	23	39	87	55	75	-18.0	7.1
Insurance and Superannuation Funds, nfd	5	0	3	100	10	70	-9.7	27.2
Auxiliary Finance and Insurance Services, nfd	0	0	3	0	6	0	N/A	14.9
Total	4594	41	5886	47	8026	52	5.1	6.4

The largest sub-industry employers of engineers in the finance sector included depository financial intermediation, auxiliary finance and investment services, and health and general insurance. There was also strong growth in the second half of the decade in the number of engineers working in central banking, with around half in engineering occupations. Within the finance sector, the number of engineers working in engineering occupations was in the 40 to 60% range.

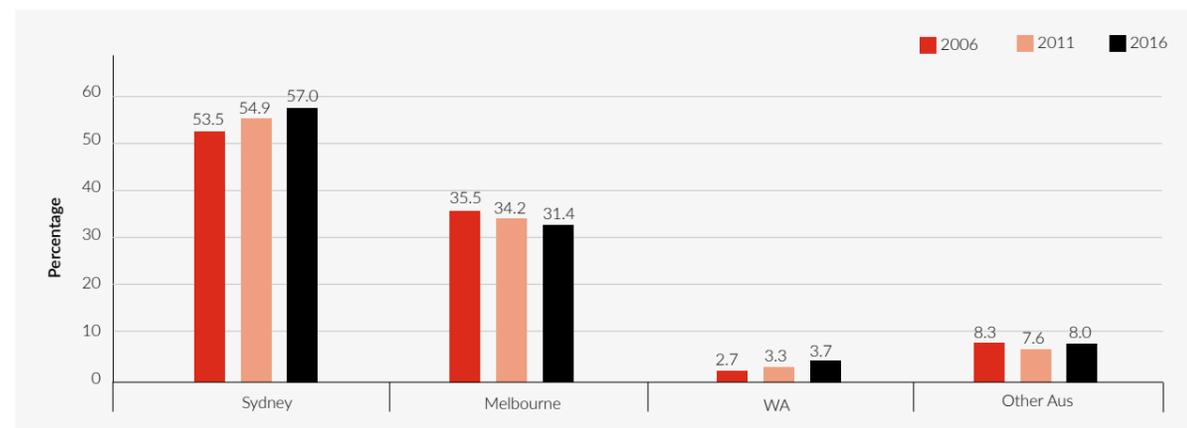
DEPOSITORY FINANCIAL INTERMEDIATION

Within the finance sector, the depository financial intermediation industry was the biggest employer of engineers, with most working in banking. There were

over 3,000 engineers employed in the depository and financial intermediation industry in 2016 (with 2,900 of those working in banking). 60% of engineers in this industry worked in engineering occupations. Engineers are adaptable, and have highly regarded mathematical and risk analysis skills, which would be highly sought after in this industry.

Almost 90% of engineers in the depository intermediation industry reside in Sydney or Melbourne, which are Australia's major banking hubs. The number residing in Sydney increased over the decade, but the number in Melbourne fell slightly. The number of engineers in other parts of Australia was low, with Western Australia and Perth having the next largest contingent.

Figure 6.6: The distribution of engineers working in Depository Financial Intermediation industries



Health care and social assistance

Table 6.5: Engineering employment in Health Care and Social Assistance, 2006, 2011 and 2016

Health Care and Social Assistance	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Hospitals	1032	37	1398	35	1944	36	6.3	6.8
Residential Care Services	393	9	764	8	1376	7	14.2	12.5
Other Social Assistance Services	373	19	536	19	853	20	7.5	9.7
Medical Services	308	43	386	40	781	34	4.6	15.1
Allied Health Services	280	13	415	11	706	12	8.2	11.2
Child Care Services	147	5	238	7	502	6	10.1	16.1
Pathology and Diagnostic Imaging Services	118	42	165	38	275	39	6.9	10.8
Other Health Care Services	107	29	151	32	168	33	7.1	2.2
Medical and Other Health Care Services, nfd	171	35	125	38	155	48	-6.1	4.4
Health Care and Social Assistance, nfd	185	39	196	28	133	35	1.2	-7.5
Social Assistance Services, nfd	197	32	167	20	129	23	-3.3	-5.0
Total	3311	28	4541	25	7022	24	6.5	9.1

Historically, the health sector has about a 10 to 12% share of all workers, and 18 to 20% of skilled workers. The percentage of engineering employment, by comparison, is much smaller, with a share of only 1 to 3% over the decade.

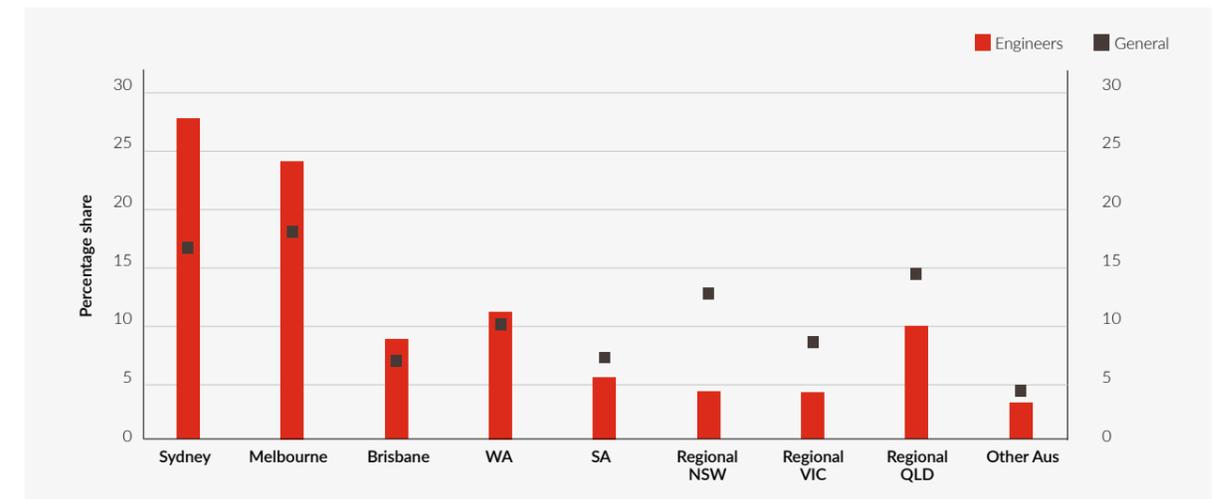
The hospital sub-industry was the largest employer of engineers in the health sector. Many of Australia's biomedical engineers would work in hospitals. Of the engineers employed in the hospital industry, 36% were employed in engineering occupations, and around 25% were female. The other notable sub-industry in this sector is residential care services. However, fewer than 10% of engineers in this sub-industry were employed in engineering occupations.

HOSPITALS

The distribution of engineers working in the hospital industry by Australian region in 2016 compared to the same distribution for general employment appears in Figure 6.7.

Engineers working in hospitals are much more likely to be working out of the larger centres of Sydney and Melbourne when compared to hospital workers generally (see Figure 6.7). It is likely that engineers working in hospitals are needed for the more specialist services located in larger Australian hospitals. This is evident from the higher percentage of general hospital workers in the regional areas of New South Wales and Queensland.

Figure 6.7: The distribution of engineering labour force and the general labour force working in hospitals, 2016



Accommodation and food services

Table 6.6: Engineering employment in Accommodation and Food Services, 2006, 2011 and 2016

Accommodation and Food Services	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Industry								
Cafes, Restaurants and Takeaway Food Services	2031	4	3025	3	5914	3	8.3	14.4
Accommodation	855	13	964	12	1345	10	2.4	6.9
Pubs, Taverns and Bars	252	4	254	4	603	5	0.2	18.9
Food and Beverage Services, nfd	66	20	73	4	251	7	2.0	28.0
Clubs (Hospitality)	117	4	122	3	202	5	0.8	10.6
Accommodation and Food Services, nfd	7	0	4	0	20	0	-10.6	38.0
Total	3328	6	4442	5	8335	4	5.9	13.4

The accommodation and food services industries are a relatively small employer of engineers, except for the large number who work in cafes, restaurants and takeaway food services. There is also a reasonable number of engineers employed in accommodation. Of the engineers in both these sub-industries, fewer than 10% work in engineering occupations: again highlighting the underutilisation of engineering capability in the Australian economy.

The strong growth in the number of engineers working in these hospitality industries, particularly in the second half of the decade, is a worrying trend. The number of engineers working in cafes, restaurants and takeaway food services had compound annual growth of 14.4% during this time. Similarly, numbers of engineers working in accommodation increased at a rate of 6.9% annually; and, for pubs, taverns and bars, at a rate of 18.9%.

Further analysis of the demographics of engineers working in these industries is in Section 8.

Retail trade

Table 6.7: Engineering employment in Retail Trade, 2006, 2011 and 2016

Retail Trade	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Industry								
Supermarket and Grocery Stores	1056	12	1508	10	3156	8	7.4	15.9
Electrical and Electronic Goods Retailing	1230	32	1346	34	1476	41	1.8	1.9
Fuel Retailing	561	25	702	28	1296	29	4.6	13.1
Pharmaceutical and Other Store-Based Retailing	591	14	708	10	1027	13	3.7	7.7
Motor Vehicle Retailing	287	8	457	8	950	11	9.8	15.8
Clothing, Footwear and Personal Accessory Retailing	445	10	616	9	938	13	6.7	8.8
Specialised Food Retailing	547	6	539	3	906	7	-0.3	11.0
Hardware, Building and Garden Supplies Retailing	354	15	460	15	707	16	5.4	9.0
Retail Trade, nfd	621	18	612	17	623	24	-0.3	0.4
Recreational Goods Retailing	443	8	494	7	609	9	2.2	4.3
Furniture, Floor Coverings, Houseware and Textile Goods Retailing	305	11	403	5	490	7	5.7	4.0
Department Stores	254	18	237	14	471	16	-1.4	14.7
Motor Vehicle Parts and Tyre Retailing	103	24	164	19	301	27	9.8	12.9
Non-Store Retailing	73	25	97	30	153	23	5.9	9.5
Food Retailing, nfd	88	9	63	11	70	11	-6.5	2.1
Other Store-Based Retailing, nfd	41	17	55	16	45	11	6.1	-3.9
Retail Commission-Based Buying and/or Selling	7	43	9	89	15	20	5.2	10.8
Motor Vehicle and Motor Vehicle Parts Retailing, nfd	3	0	4	0	8	0	5.9	14.9
Non-Store Retailing and Retail Commission-Based Buying and/or Selling, nfd	3	0	4	0	6	0	5.9	8.5
Total	7012	17	8478	16	13247	17	3.9	9.3

Historically, the retail industry has employed 10 to 12% of all workers, but only 3 to 4% of all engineers.

While fairly large numbers of engineers work in retail trade, very few work in actual engineering occupations. This suggests that many engineers moved into the sector to find secure employment when engineering work was unavailable, particularly in the second half of the decade. As an example, supermarkets and grocery stores – the biggest retail employer of engineers – employed just over 1,500 engineers in 2011, growing to over 3,100 in 2016. However, only 8% of these engineers were employed in engineering occupations.

Electrical and electronic goods retailing – the next largest employer of engineers – had a much higher rate of engineers working engineering occupations, with a rate of around 40%. In 2016, over 1,400 engineers worked in this industry. Other big engineer employers were fuel retailing, with almost 1,300 engineers in 2016; and pharmaceutical and other store-based retailing, with over 1,000 engineers. In both these industries, the number working in engineering occupations was under 30%.

Further analysis of the demographics of engineers working in these industries is in Section 8.

Administrative and support services

Table 6.8: Engineering employment in Administrative and Support Services, 2006, 2011 and 2016

Administrative and Support Services	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Industry								
Building Cleaning, Pest Control and Gardening Services	1063	8	1551	5	3095	5	7.9	14.8
Employment Services	1051	37	1226	42	1649	40	3.1	6.1
Other Administrative Services	936	53	1239	56	973	41	5.8	-4.7
Travel Agency and Tour Arrangement Services	328	38	358	43	499	29	1.8	6.9
Packaging Services	64	25	105	38	210	31	10.4	14.9
Administrative and Support Services, nfd	6	50	7	43	14	50	3.1	14.9
Administrative Services, nfd	4	0	4	0	7	0	0.0	11.8
Building Cleaning, Pest Control and Other Support Services, nfd	0	0	0	0	3	0	N/A	N/A
Total	3452	32	4490	33	6450	22	5.4	7.5

Engineering employment in administrative and support services is relatively small compared to other industries. The largest employer of engineers in this sector is building cleaning, pest control and gardening services, which boosted its engineer numbers steadily over the decade. However, only 5% of those engineers found work in engineering occupations. This again highlights the trend of movement of engineers into non-core industries, but not into engineering occupations within those industries.

Other services

The most important sub-industries for engineers in the other services group are machinery and equipment repair and maintenance, and automotive repair and maintenance. The former employed over 2,300 engineers in 2016, with around 40% in engineering occupations. Engineers in these occupations mostly work in electronic and precision equipment repair and maintenance, and repair and

Other sub-industries had higher rates employed in engineering roles, though none cracked 50%. Around 1,600 engineers working in employment services and other administrative services. In these industries, more than 80% of engineers were male.

Further analysis of the demographics of engineers working in these industries is in Section 8.

maintenance of other equipment such as agricultural, construction, electrical, engine, heavy machinery, food and forestry, and material and mining equipment not elsewhere classified.

Engineers working in these industries are spread throughout the country, with the highest numbers in Sydney, Melbourne and Perth.



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Table 6.9: Engineering employment in Other Services, 2006, 2011 and 2016

Other services	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Industry								
Machinery and Equipment Repair and Maintenance	1641	36	2306	39	2340	39	7.0	0.3
Automotive Repair and Maintenance	595	19	808	15	1654	14	6.3	15.4
Other Personal Services	340	11	344	10	620	11	0.2	12.5
Civic, Professional and Other Interest Group Services	345	54	425	58	510	45	4.3	3.7
Religious Services	317	5	301	7	378	10	-1.0	4.7
Repair and Maintenance, nfd	113	35	197	24	282	29	11.8	7.4
Personal Care Services	81	10	99	8	206	10	4.1	15.8
Other Repair and Maintenance	117	6	131	2	170	3	2.3	5.4
Funeral, Crematorium and Cemetery Services	26	12	27	22	47	34	0.8	11.7
Private Households Employing Staff and Undifferentiated Goods and Service-Producing Activities of Households for Own Use	0	0	10	50	17	18	N/A	11.2
Other Services, nfd	4	0	3	0	14	43	-5.6	36.1
Personal and Other Services, nfd	0	0	0	0	0	0	N/A	N/A
Total	3579	28	4651	30	6238	26	5.4	6.1

Rental, hiring and real estate services

Table 6.10: Engineering employment in Rental, Hiring and Real Estate Services, 2006, 2011 and 2016

Rental, Hiring and Real Estate Services	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Industry								
Real Estate Services	689	18	845	19	1562	19	4.2	13.1
Property Operators	521	39	565	37	879	38	1.6	9.2
Other Goods and Equipment Rental and Hiring	280	34	359	42	372	36	5.1	0.7
Motor Vehicle and Transport Equipment Rental and Hiring	120	28	140	25	196	23	3.1	7.0
Property Operators and Real Estate Services, nfd	87	33	71	13	185	25	-4.0	21.1
Rental and Hiring Services (except Real Estate), nfd	21	48	6	0	41	10	-22.2	46.9
Rental, Hiring and Real Estate Services, nfd	8	38	3	0	25	36	-17.8	52.8
Non-Financial Intangible Assets (except Copyrights) Leasing	8	50	13	54	7	0	10.2	-11.7
Farm Animal and Bloodstock Leasing	0	0	0	0	0	0	N/A	N/A
Total	1734	29	2002	29	3267	27	2.9	10.3

The rental, hiring and real estate industry employs only small numbers of engineers, with the largest employer being the real estate sector. Of the engineers that do work in these industries, fewer than 20% work in engineering occupations.

Agriculture, forestry and fishing

Table 6.11: Engineering employment in Agriculture, Forestry and Fishing, 2006, 2011 and 2016

Agriculture, Forestry and Fishing	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Sheep, Beef Cattle and Grain Farming	728	4	715	3	848	5	-0.4	3.5
Fruit and Tree Nut Growing	220	6	258	5	274	7	3.2	1.2
Mushroom and Vegetable Growing	83	0	146	5	234	9	12.0	9.9
Agriculture and Fishing Support Services	169	69	171	58	210	53	0.2	4.2
Agriculture, nfd	75	35	51	22	193	20	-7.4	30.5
Dairy Cattle Farming	69	4	88	15	193	26	5.0	17.0
Fishing	74	34	49	53	130	45	-7.9	21.6
Poultry Farming	48	13	62	19	128	13	5.3	15.6
Nursery and Floriculture Production	50	0	41	0	83	4	-3.9	15.2
Aquaculture	41	7	35	17	63	43	-3.1	12.5
Other Crop Growing	52	8	43	12	60	8	-3.7	6.9
Other Livestock Farming	38	0	48	6	53	0	4.8	2.0
Agriculture, Forestry and Fishing, nfd	7	57	16	63	46	43	18.0	23.5
Forestry and Logging	40	55	37	43	41	27	-1.6	2.1
Forestry Support Services	17	47	11	73	30	27	-8.3	22.2
Fishing, Hunting and Trapping, nfd	41	32	18	39	10	0	-15.2	-11.1
Hunting and Trapping	0	0	0	0	3	0	N/A	N/A
Deer Farming	3	0	5	0	0	0	10.8	-100.0
Agriculture, Forestry and Fishing Support Services, nfd	0	0	0	0	0	0	N/A	N/A
Total	1755	16	1794	15	2599	17	0.4	7.7

The numbers of engineers working in the agriculture, fishing and forestry industry is reasonably small, and very few work in engineering occupations. Engineers employed in these industries

are predominately male. The agriculture and fishing support services industry had almost 70% of engineers in engineering occupations in 2006. However, this fell to 53% in 2016.

Arts and other recreation services

Table 6.12: Engineering employment in Arts and Other Recreation Services, 2006, 2011 and 2016

Arts and Other Recreation Services	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Gambling Activities	277	28	462	27	763	34	10.8	10.6
Sports and Physical Recreation Activities	212	30	282	27	501	19	5.9	12.2
Creative and Performing Arts Activities	163	14	235	14	327	15	7.6	6.8
Amusement and Other Recreation Activities	68	31	101	26	157	20	8.2	9.2
Parks and Gardens Operations	79	46	71	68	97	44	-2.1	6.4
Museum Operation	54	28	76	45	84	33	7.1	2.0
Horse and Dog Racing Activities	29	17	30	37	52	17	0.7	11.6
Arts and Recreation Services, nfd	42	21	17	29	42	19	-16.6	19.8
Sports and Recreation Activities, nfd	4	75	8	0	21	24	14.9	21.3
Heritage Activities, nfd	3	0	0	0	4	0	-100.0	N/A
Total	931	27	1282	28	2048	26	6.6	9.8

The arts and other recreation sector employs only small numbers of engineers, with a low proportion actually working in engineering roles. The largest

employer of engineers is the gambling industry, followed by sports and physical recreation activities, and creative and performing arts activities.

Inadequately described or not stated

Table 6.13: Employed engineers classified as Inadequately Described or Not Stated, 2006, 2011 and 2016

Inadequately Described or Not Stated	2006		2011		2016		Compound annual growth	
	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	Qualified engineers	% in engineering occupations	2006-2011	2011-2016
Inadequately described	3397	59	3478	58	12618	54	0.5	29.4
Not stated	1001	30	1027	29	1844	26	0.5	12.4
Total	4398	53	4505	52	14462	51	0.5	26.3

The 'inadequately described' and 'not stated' options made up a much higher portion of the industry-wide share in 2016 than only five years earlier. The category of 'not stated' covers engineers who completed the census but did not complete the Industry section. 'Inadequately described' covers engineers who could not find a suitable industry category describing the work they do.

The jump in 'inadequately described' responses occurred across the board in 2016, but was particularly high amongst engineer respondents. Traditionally, the percentage of all workers who selected 'inadequately described' has been between 2.3 and 2.6%, and this was the case in the first half of the decade. However, in 2016, this jumped to 4.5%. The same occurred for skilled workers, with percentages increasing from between 1.5% and 1.3% in the first half of the decade to 2.7% in the second. And for engineers, the proportions were 2.3% in 2006, 1.8% in 2011, and then a big jump to 4.7% in 2016.

The technical issues that plagued the 2016 census offer one likely explanation for the sudden rise. The 2016 census was the first census that respondents were widely encouraged to complete online. In the event, there were technical issues on census night which may have hindered reporting. This is considered the most plausible reason for the high 'inadequately described' response compared to previous census releases, with nearly 350,000 Australians selecting this option in 2016.

There are other possible explanations for the particularly high number of 'inadequately described' responses by engineers. By 2016, engineering employment had bottomed out. The prolonged period of low job opportunities signalled a rapid fall in the demand for engineers after the resources boom. At this time, many engineers struggled to find work. Some decided to move into one-person operations, and others were forced to work in other industries not normally associated with engineering.

It is possible that these engineers chose not to describe the industry in which they worked in a form of social desirability bias. It is a well-known issue in major surveys that respondents sometimes try to make themselves look like they are in a better situation than the one they find themselves in. This might lead engineers working in 'lesser' or 'lower status' jobs outside their area of expertise to refrain from specifying the industry they work in, hence the increase in 'inadequately described' responses.

7. Engineers in the Public Sector: Industries of Work

A large proportion of engineers employed in the public sector work in government administration at each level of government. However, the public sector also harnesses the expertise of engineers for managing utilities, in the education system, in transport networks, and in telecommunications services, hospitals and scientific research.

This section offers further analysis of engineers working in public administration, including by delving into the sub-industries that public sector engineers work in.

Distribution of engineers across public and private sectors

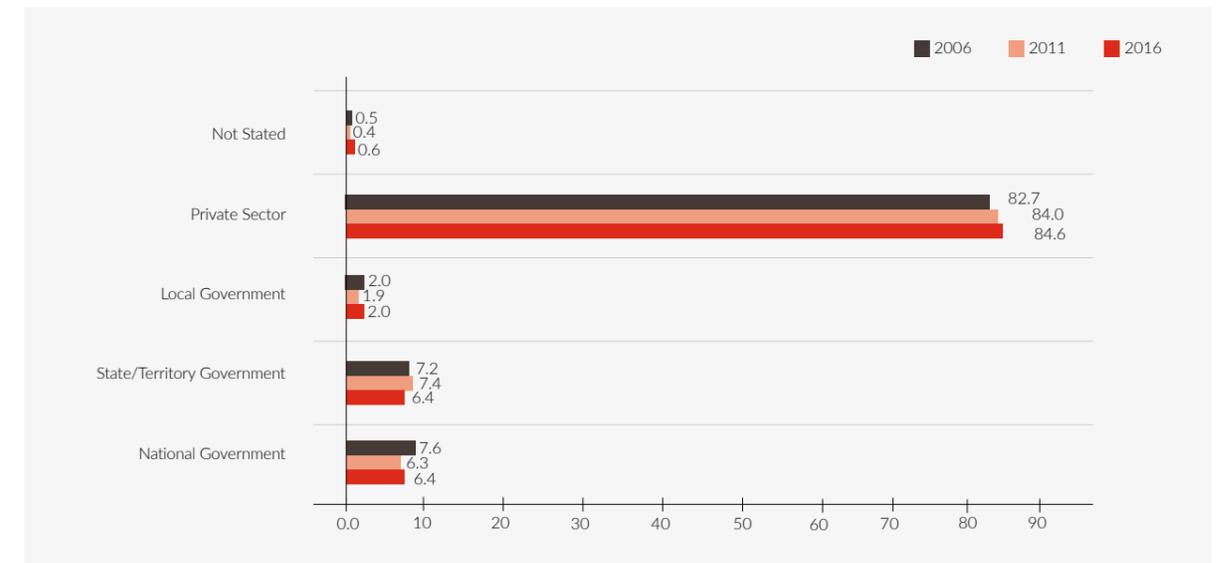
The distribution of engineers across public and private sectors appears in Figure 7.1.

Over the decade, the number of employed engineers increased in Australia, with both the public and private sectors experiencing gains. The vast majority of engineers worked in the private sector (see Figure 7.1). Although numbers working in the public sector increased, the sector did not grow at the same rate as the private sector. This means that the public sector's numbers went up while its share of all engineers went down. In particular, the state and national government

sectors ended the decade with a smaller share than they started with.

In 2016, over 84% of engineers were employed by the private sector, up from 82.7% in 2006. For the public sector, 6.4% were employed by the national government in 2016, down from 7.6% in 2006; 6.4% were employed by state or territory governments in 2016, down from 7.2% in 2006; and there was 2.0% employed in local government, which was the same as a decade ago. 0.6% of engineers did not state their sector of employment in 2016.

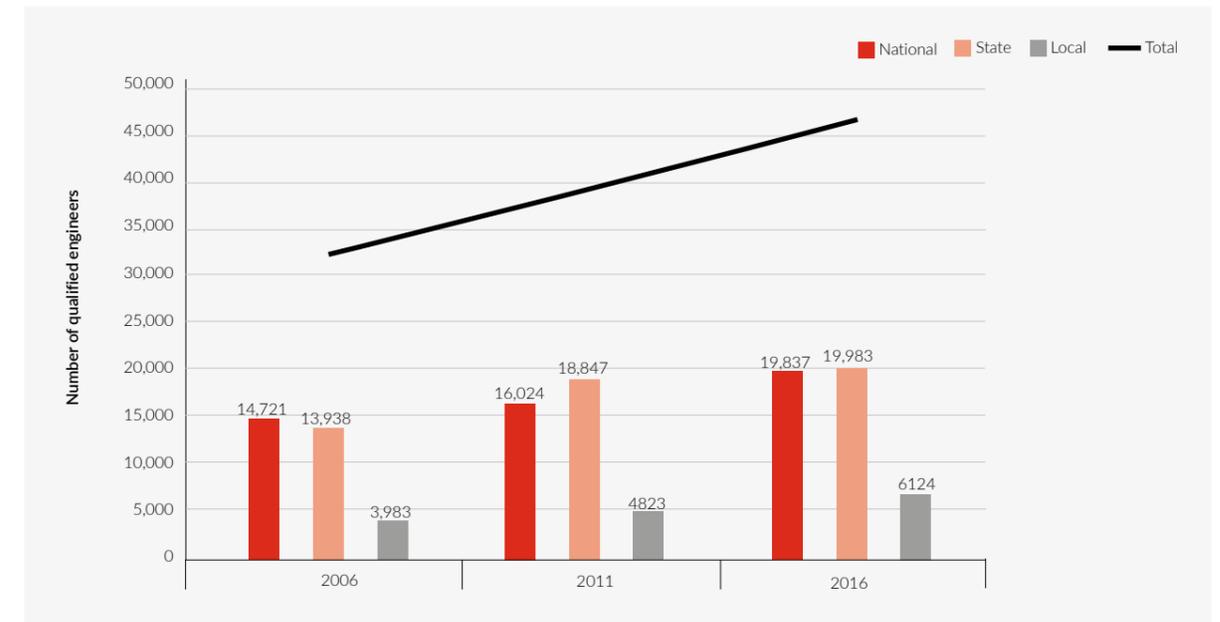
Figure 7.1: The employment of engineers in Australia by sector, 2016



Engineer numbers in each level of government

The numbers of engineers employed in each of the three levels of government appear in Figure 7.2.

Figure 7.2: The total number of qualified engineers working in public sector levels, 2006 - 2016



Growth steady across all levels of government

Engineer numbers in all three levels of government increased over the decade. In 2006, there were 32,600 engineers in the public sector, growing to 39,700 in 2011 and then to 46,000 in 2016.

Growth has been steady. In the first half of the decade, there was annual growth of 4%, while in the second half, annual growth was 3%. This was slightly better than growth for general employment in the public sector, which grew 3.6% in the first half of the decade, and 0.4% in the second.

Almost equal numbers work for state versus federal government

State and territory governments were the biggest public employers of engineers, though only just. In the first half of the decade, the number of engineers working for state governments grew at an annual rate of 6.2%. In the following five years, this growth slowed to 1.2%. By the end of the decade, there were 19,983 engineers working for state governments.

Similar numbers worked for the Commonwealth public sector with 19,837 engineers recorded in 2016. Annual growth in the first half of the decade was 1.7%, compared to growth of 4.4% in the second.

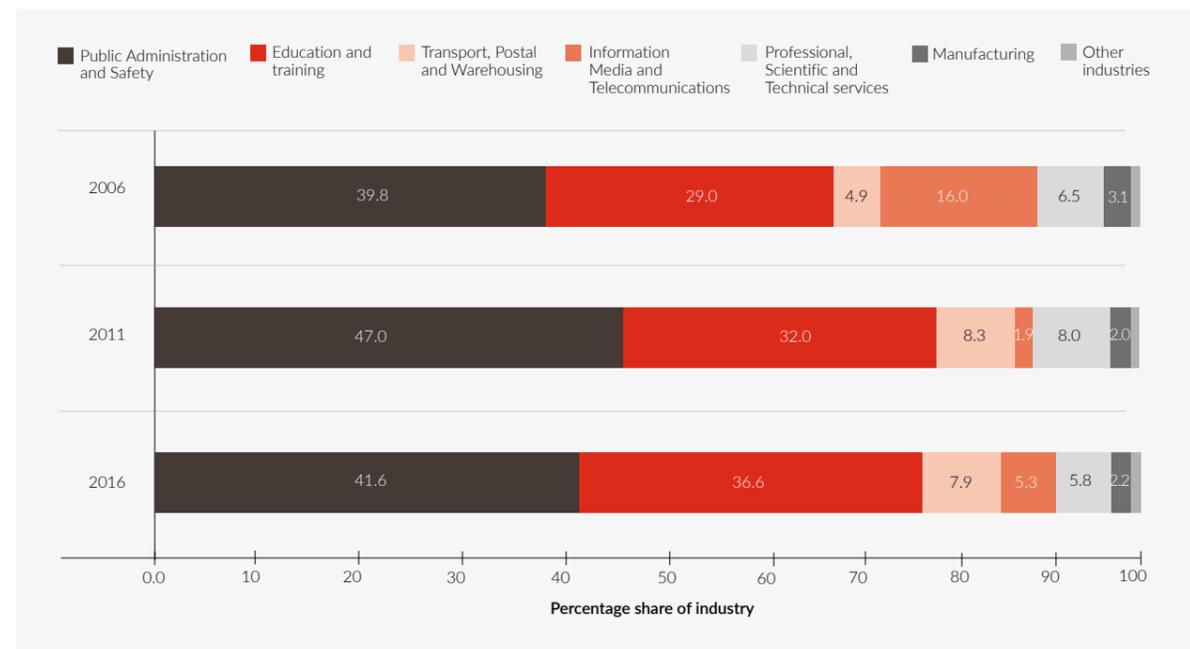
The number of engineers working for local government is much lower than for state and federal. In 2016, there were 6,124 engineers recorded. In the first half of the decade, annual growth was 3.9%, increasing to 4.9% in the second.

Industries of Commonwealth government engineers

The industry distribution of engineers employed in the Commonwealth public sector appears in Figure 7.3.

The largest industries for Commonwealth government engineers are public administration and safety, education and training, transport, telecommunications and professional services.

Figure 7.3: The industry distribution of qualified engineers employed in the commonwealth government public sector, 2006 - 2016



Tertiary education and defence sub-industries were big employers

For those working in public administration, large numbers were employed in the sub-industries of defence and central government administration. At the end of the decade, 5,782 engineers were employed in defence, and 2,166 in central government administration. For engineers working in education and training, the overwhelming majority worked in the sub-industry of tertiary education, with over 7,200 employed in 2016.

Engineers working in telecommunications probably involved in NBN roll-out

Most Commonwealth government engineers working in transport, postal and warehousing were employed in postal and courier pick-up and delivery services, with over 500 engineers employed in this industry by the end of the decade. Engineers in the information

media and telecommunications industry predominantly worked in telecommunications services, with over 800 employed in this industry in 2016. It is probable that a segment of these engineers are involved in the roll-out of the National Broadband Network.

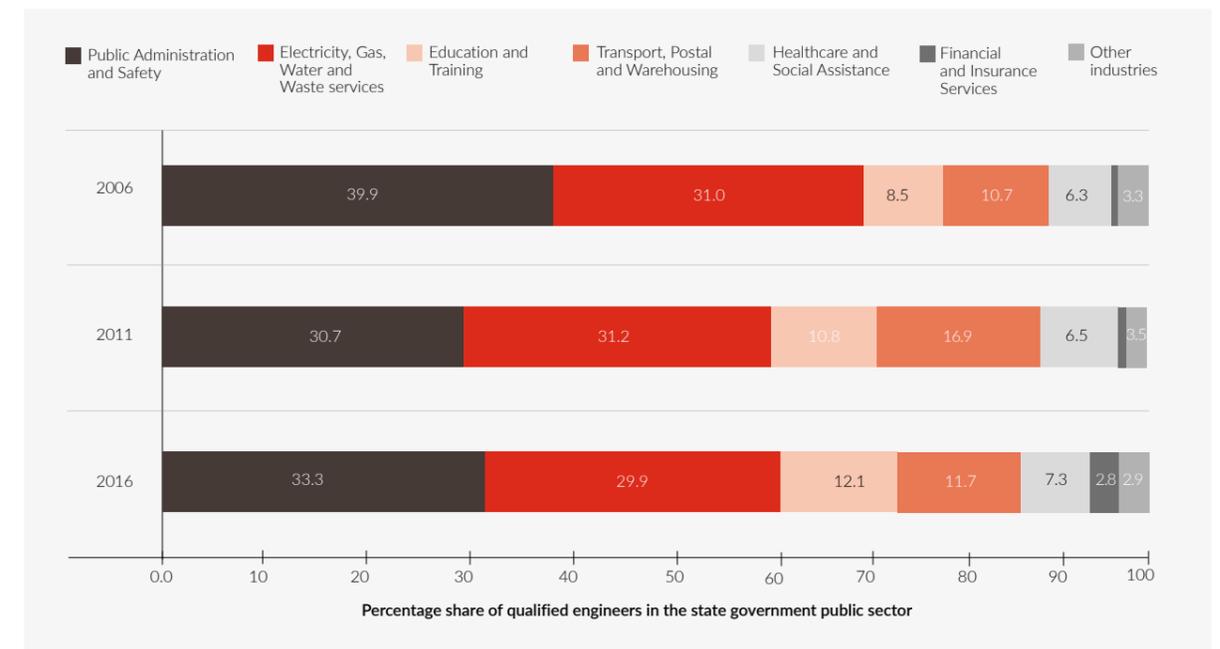
There was also growth in the number of engineers working in scientific research services, which would include federal government agencies such as CSIRO.

Industries of state government engineers

The industry distribution of engineers employed in the state public sector appears in Figure 7.4.

The largest industries for state government engineers are public administration and safety, utilities, education and training, transport and healthcare and social assistance.

Figure 7.4: The industry distribution of qualified engineers employed in the state government public sector, 2006 - 2016



Most state government engineers work in state admin or the utilities

The overwhelming majority of engineers working in public administration worked in the sub-industry of state government administration, with almost 4,400 recorded in 2016. Engineers working in the utilities were spread over the different utility services. At the end of the decade, almost 2,800 worked in water supply, sewerage and drainage services; 2,000 in electricity distribution, 570 in electricity transmission and 500 in electricity generation.

For state government engineers working in education, there was a split between the two levels of education. In 2016, there were 1,400 employed in tertiary

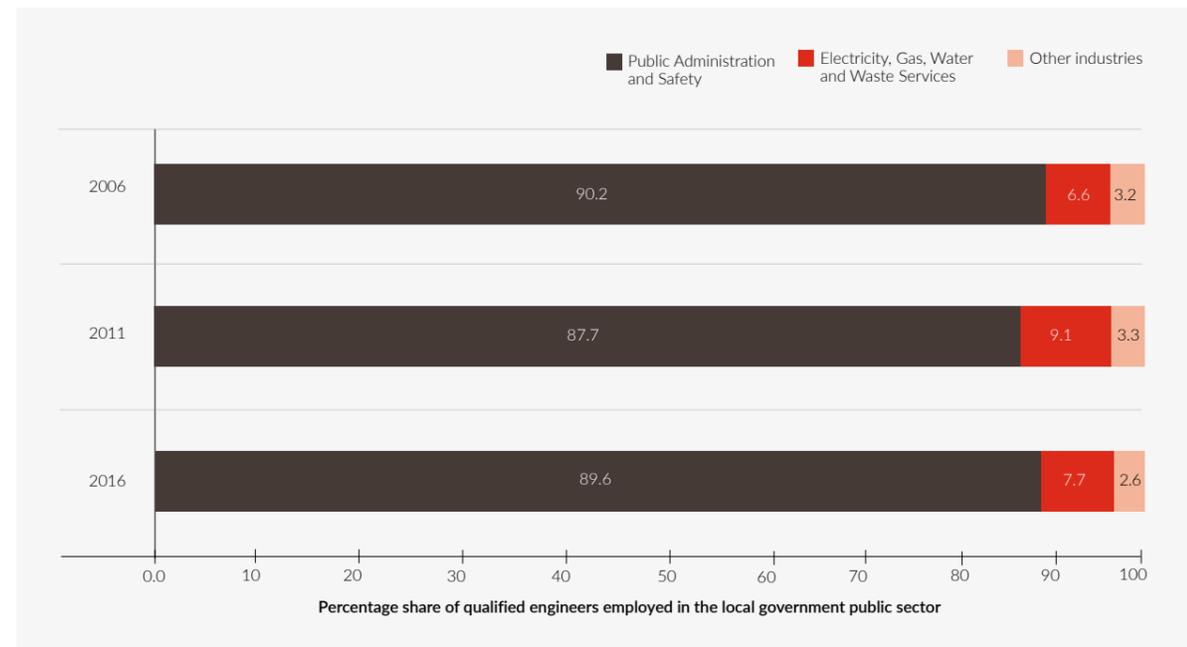
education and 950 employed in school education. For engineers working in transport, the largest cohort were employed in rail passenger transport, with almost 1,000 recorded in 2016; followed by other transport support services, with almost 900 employed.

The largest healthcare employer of engineers was hospitals, with almost 1,300 recorded in 2016.

Industries of local government engineers

The industry distribution of engineers employed in the local government public sector appears in Figure 7.5.

Figure 7.5: The industry distribution of qualified engineers employed in the local government public sector, 2006 - 2016



The overwhelming majority of local government public sector engineers work in public administration, with a much smaller proportion in the utilities and other industries (see Figure 7.5).

Of the engineers working in public administration and safety, all worked in local government administration. In 2016, almost 5,500 engineers worked in this sub-industry. This is by far the largest local government industry.

For engineers working in the utilities in 2016, 250 worked in water supply, sewerage and drainage services, and a further 200 worked in electricity distribution. There were only small numbers of local government public sector engineers working in other industries.

8.

Engineer Diversity, Age and Salaries: Industry Comparisons

This section examines characteristics of the engineering profession by demographic factors including age, gender and salaries. While there are comparable levels of male and female engineers in core industries and the top three sub-industries, we see disparity emerging for remaining sub-industries.

Analysis of Australian-born and overseas-born engineers showed that non-core industries have bigger proportions of migrant engineers.

When we examined age statistics, we found that most engineers in their 30s, 40s and 50s worked in core engineering industries. However, this figure fell below 50% for engineers below 30 or over 60.

Analysis of salary data showed that engineers working in core industries tended to have earnings in the top income brackets.

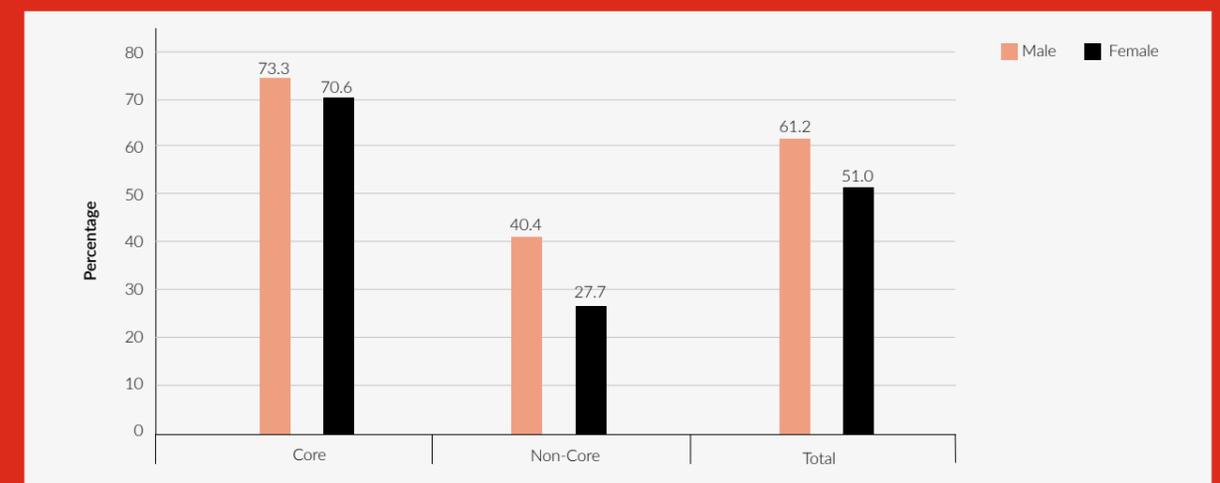
Engineer gender diversity by industry

The engineering profession is skewed towards men, but analysis of the industries of highest employment paints a picture of differences in job prospects for male and female engineers. 63.2% of male engineers work in the core engineering industries. This compares to just 54.3% of female engineers.

PROPORTIONS OF MALE AND FEMALE ENGINEERS WORKING IN ENGINEERING ROLES

The percentage of male and female engineers working in engineering occupations appears in Figure 8.1.

Figure 8.1: The percentage of qualified engineers working in engineering occupations, in the core and non-core engineering industries 2016



Men and women in core industries are more likely to work in engineering roles

Both male and female engineers in core industries are much more likely to be working in engineering occupations. A large proportion of male and female engineers work in engineering occupations if they work in the core industries. In core engineering industries, 73.3% of male engineers work in engineering occupations, compared to 70.6% for female engineers.

In non-core industries, men are much more likely to land engineering roles

The biggest difference comes in the non-core industries. 40.4% of male engineers working in these industries work in engineering occupations, compared to only 27.7% of female engineers.

The industries with the biggest differentiation along gender lines are all non-core industry groups:

- 58.4% of male engineers working in education and training work in engineering occupations, compared to 37.2% of female engineers.

- 29.9% of male engineers working in healthcare and social services work in engineering occupations, compared to only 10.9% of female engineers.

However, in the core industries, female engineers are slightly more likely to work in engineering occupations than male engineers, if they work in mining, construction or the utilities industries.

TOP INDUSTRIES THAT EMPLOY FEMALE ENGINEERS AND MALE ENGINEERS

To further establish the differences by gender, sub-industry groups have been analysed. The top industries that employed female engineers in 2016 are shown in Figure 8.2. Figure 8.3 shows the same for male engineers.

Figure 8.2: The top industries that employ female engineers, and the number of those employed in engineering occupations, 2016

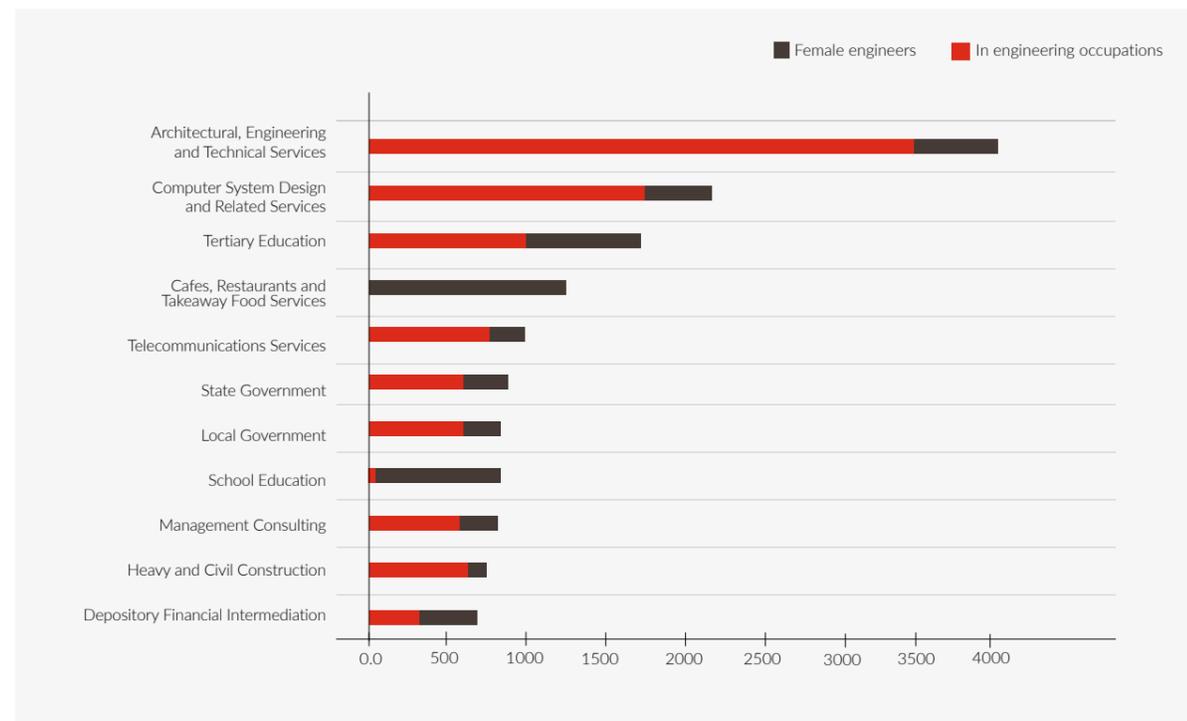
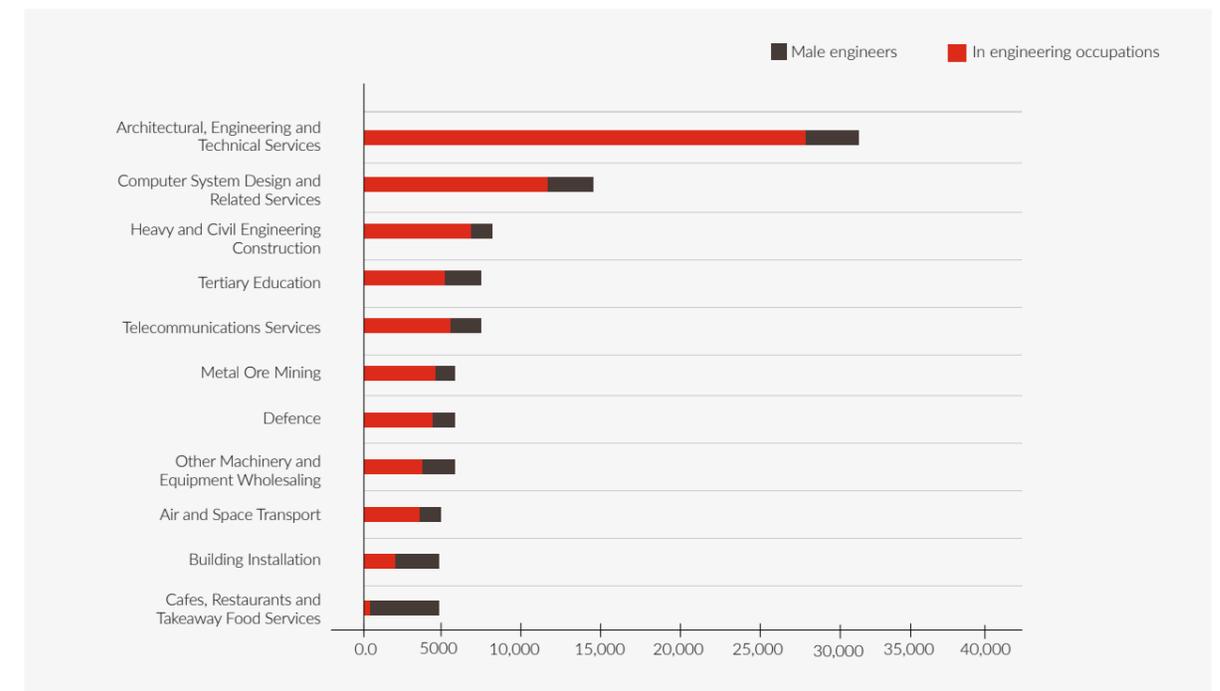


Figure 8.3: The top industries which employ male engineers, and the number of those employed in engineering occupations, 2016



In 2016, the top industries for men and women were similar (see Figures 8.2 and 8.3). Although there are much larger numbers of male engineers, much of the industry distribution is the same. Overall, there are much higher numbers of male engineers compared to female engineers employed in Australia. In 2016, there were just under 270,000 male engineers compared to just under 41,000 female engineers.

Top industries similar for male and female engineers

Architectural, engineering and technical services was the largest sub-industry for both male and female engineers, and over 85% of these engineers are employed in engineering occupations. This sub-industry includes consulting and design engineers, so it is no surprise that it is the largest industry for both genders.

Computer system design and related services, which is a notable employer of engineers for both genders, is the second largest sub-industry, and employs over 80% of these engineers in engineering occupations. Other sub-industries which employ high numbers of engineers for both genders is heavy and civil engineering, construction and telecommunications.

The industry of tertiary education was prominent for male and female engineers, however male engineers were more likely to work in engineering occupations. Over 70% of male engineers in this industry are employed in an engineering occupation compared to 57% for female engineers.

Greater gender differentiation further down the list

The top industries for male and female engineers begin to deviate after the top three. Female engineers are more likely to be employed in state and local government, management consulting and depository financial intermediation (although only about half of finance engineers work in engineering occupations). Male engineers are more likely to be employed in metal ore mining, defence, machinery and equipment wholesaling, air transport and building installation (with only 44% of building installation engineers in engineering occupations).

Female engineers are also more likely to be employed in school education, with over 800 female engineers employed in this sector in 2016. However, only 4% worked in an engineering occupation.

Engineer oversupply pushes food services industry up the list

The oversupply of engineers at the end of the resources boom forced many engineers to find (non-engineering) work in cafes, restaurants and takeaway food services. The increase was so large that by the end of the decade it was the eleventh largest sub-industry employer of male engineers and the fourth largest of female engineers. This reveals the employment situation faced by many (mostly younger) engineers during a low point for engineering vacancies in Australia after the boom.

In the second half of the decade, there was still a steady flow of graduates and migrant engineers entering the labour market on the back of demand for engineers during the resources boom. However, by 2016, the demand for engineers had evaporated, hence the large numbers of engineers finding work in non-engineering roles and non-traditional industries. This is exemplified by engineers working in the food services industry, almost all of whom were employed in non-engineering occupations.

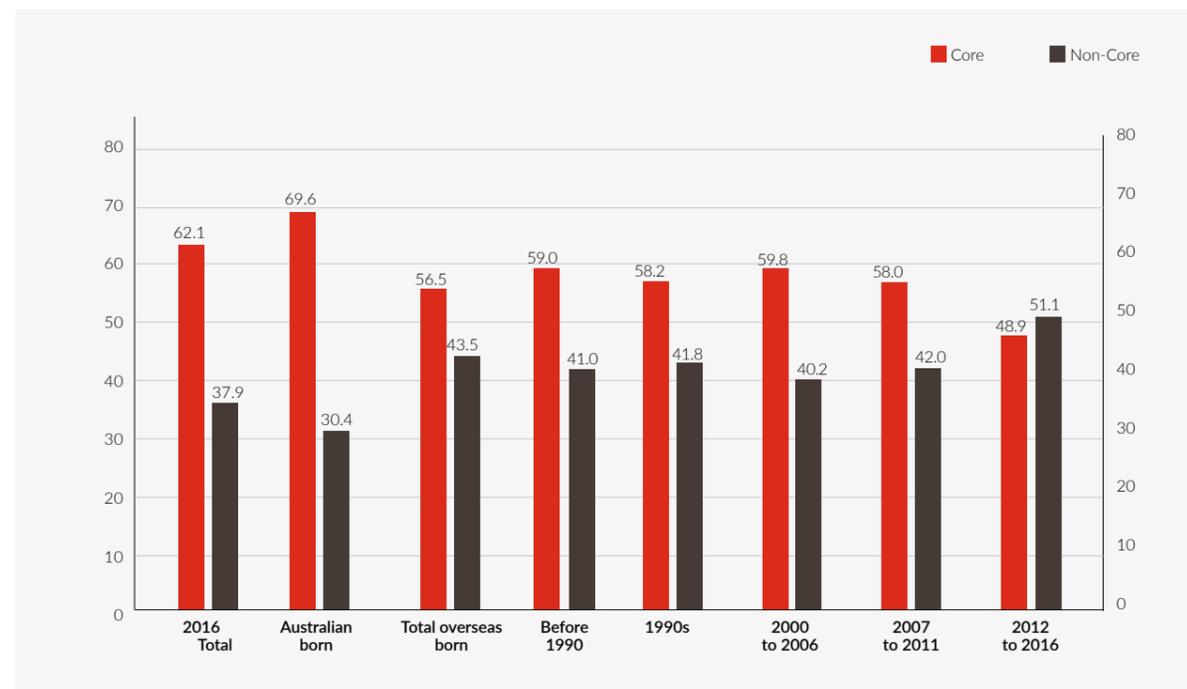
Overseas-born engineers by industry

The high demand for engineers in Australia resulted in a notable proportion of engineers migrating from overseas. Skilled migration has been established policy in Australia for decades. In the accompanying Engineers Australia report Australia's Engineering Capability: How the last ten years will influence the future, the changes to Australia's engineering labour force and the influence of migration is explained in detail. In this report, we look at the industries that Australia's migrant engineers work in, and use the same timeframes used in that report to compare notable differences.

PROPORTIONS OF AUSTRALIAN-BORN AND OVERSEAS-BORN ENGINEERS IN CORE AND NON-CORE INDUSTRIES

The percentage of Australian-born and overseas-born engineers working in core versus non-core industries is presented in Figure 8.4.

Figure 8.4: The percentage of qualified engineers working in core vs non-core industries based on Australian born, or year of arrival



Australian-born engineers were much more likely to be working in core industries compared to overseas-born engineers (see Figure 8.4). At the end of the decade, 69.6% of Australian-born engineers worked in core engineering industries, compared to 56.5% of overseas-born engineers.

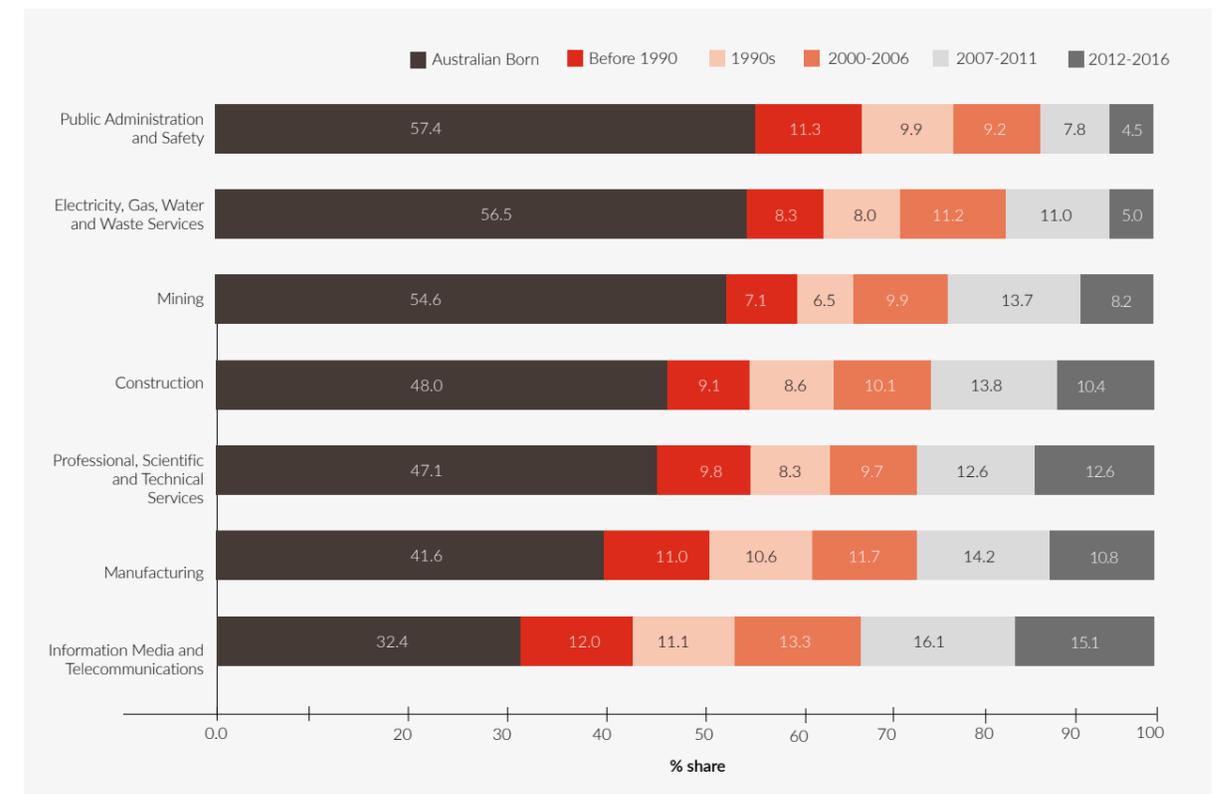
It is also clear that migrant engineers who arrived in Australia in the second half of the decade were less likely to be working in a core industry. Only 48.9% of overseas-born engineers who arrived in Australia between 2012 and 2016 worked in core industries. This is significantly less than overseas-born engineers

who arrived between 2007 to 2011 (of whom 58% worked in core industries). These figures highlight the difficulty recent migrants had in finding work in an engineering occupation.

DISTRIBUTION OF OVERSEAS-BORN ENGINEERS IN CORE INDUSTRIES

The distribution of overseas-born engineers across core industries is presented in Figure 8.5. It illustrates the different proportions of overseas-born engineers in each core industry.

Figure 8.5: The overseas migrant proportion of core engineering industries, 2016



Over half of public admin, utilities and mining engineers Australian-born

The industries of public administration, the utilities and mining all have over 50% Australian-born engineers. When looking at the migrant engineers who make up the remaining portion of engineers, the groupings for year of arrival are generally even. For public administration and the utilities, the

most recent migrant arrivals made up a very small proportion of the engineers employed in these industries, being 5% or less.

During the resources boom, there was an increase in the number of migrant engineers employed in mining industries. In 2016, over 2,100 engineers who arrived between 2007 and 2011 worked in the industry, a proportion of 13.7% of all mining engineers.

Telecommunications, manufacturing and professional services biggest employers of migrant engineers

At the other end of the scale, the core engineering industries with the highest proportions of overseas-born engineers were telecommunications, manufacturing and professional services.

Professional services is the largest industry employer of engineers throughout the economy. The breakdown of professional services engineers according to arrival period closely mirrors of the overall proportions of migrant engineers in each arrival period.

Manufacturing was the second largest industry employer of engineers, and the proportion of overseas-born engineers in this industry was 58.4%. The time of arrival for these migrant engineers was fairly evenly spread over the different arrival periods.

The total number of engineers working in telecommunications was much smaller than the

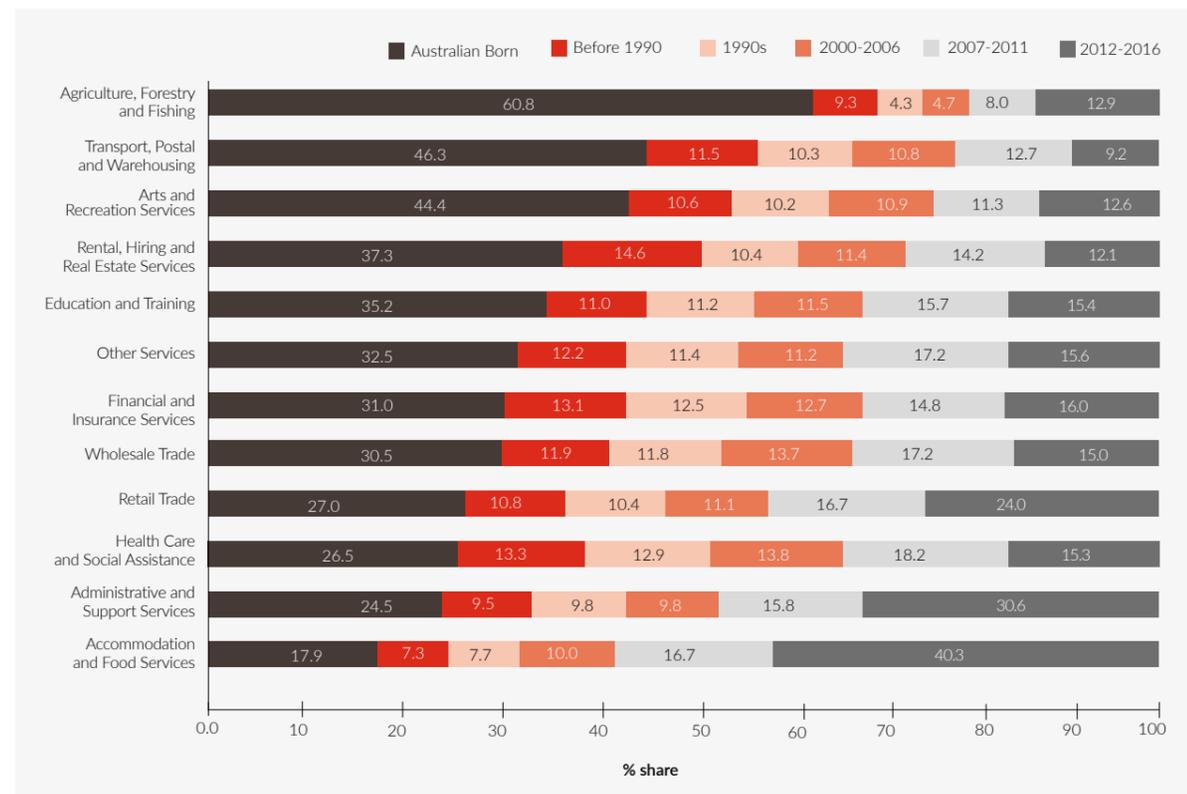
number working in professional services and manufacturing, but the proportion of migrant engineers in this industry is larger. 67.6% of the engineers who work in telecommunications were born overseas. Over 30% of the engineers employed in this industry arrived between 2007 and 2016. This amounts to around 3,500 engineers.

This may seem like a large number due to the proportion size. However, when compared to the number in professional services (15,700) and manufacturing (9,700), the number is not so significant. Even though the proportions of overseas-born engineers in these industries are smaller, the sheer numbers of engineers mean professional services and manufacturing are important industries to both Australian-born and overseas-born engineers.

DISTRIBUTION OF OVERSEAS-BORN ENGINEERS IN NON-CORE INDUSTRIES

The distribution of overseas-born engineers across non-core industries is set out in Figure 8.6.

Figure 8.6: The overseas migrant proportion of non-core engineering industries, 2016



The non-core industries with the lowest proportion of overseas-born engineers were agriculture, transport, and arts and recreation services. Of engineers working in agriculture, only 39.2% were born overseas. This industry is an obvious standout in the non-core industries. However, the number of engineers working in this industry is low (see Section 6).

Non-core industries have bigger proportions of migrant engineers

When compared to the core industries (and to Figure 8.5), the non-core industry breakdown shows a noticeable trend of larger proportions of overseas-born engineers. In the core industries, 52.3% of the engineers were overseas-born, compared to 65.8% in non-core industries.

Certain industries have a large share of recently arrived migrants

Another trend is the unusually high proportion of more recently arrived migrant engineers in certain non-core industries. In these industries, time of arrival offers a greater point of differentiation. This departs from the distribution of migrant engineers in the core industries, where the proportion sizes are more evenly distributed between arrival years.

The industries of accommodation and food services, administrative and support services and retail trade all have proportions of recent migrants much higher than other industries. In all three, over 24% of engineers arrived in Australia after 2011. These are industries in which engineers predominantly work in non-engineering roles, illustrating the difficulties many recent migrants have experienced finding engineering work in Australia.

In the retail industry, the biggest employer of engineers is the supermarket and grocery stores sector. In 2016, over 1,100 migrant engineers who arrived in Australia after 2011 worked in this sub-industry, but only 4.9% were employed in engineering occupations.

Similarly, over 2,600 migrant engineers who arrived in Australia after 2011 worked in the cafes, restaurants and takeaway food industry – a sub-industry of the accommodation and food services industry. Of those, only 1.1% worked in engineering occupations.

And for administrative and support services, the largest sub-industry is building cleaning, pest control and garden services, which employed over 1,200 migrant engineers who arrived after 2011. Only 1.7% of these engineers worked in engineering occupations.

Age of engineers by industry

The distribution of age groups of engineers between the different industries gives us an insight to how the economy is changing, as well as where older engineers and recent graduate engineers might be working.

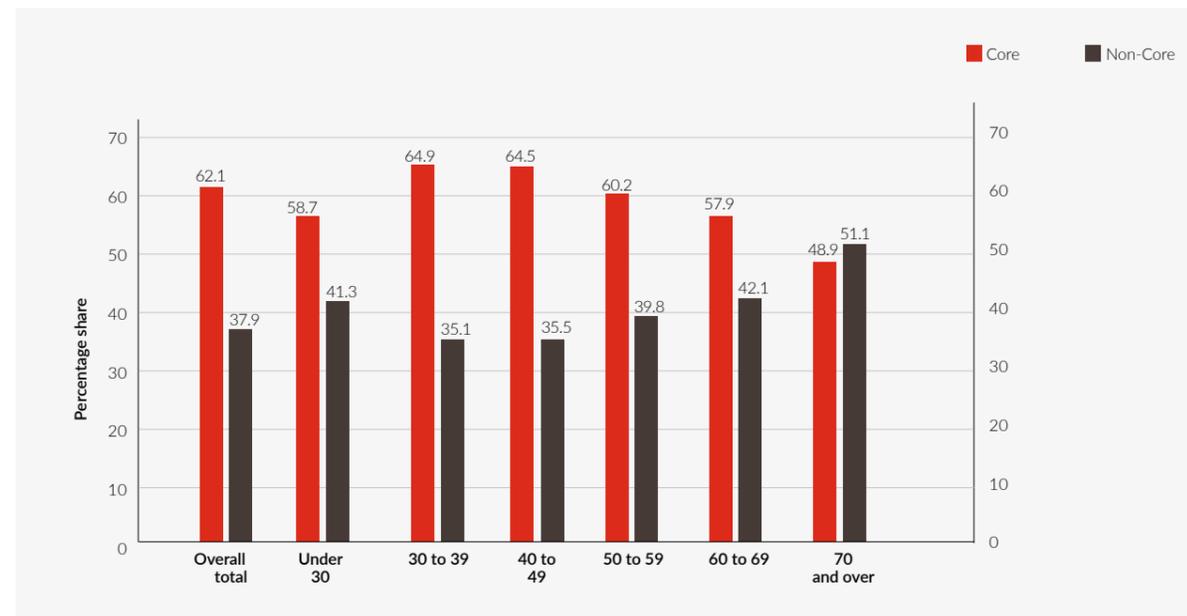
DISTRIBUTION OF ENGINEERS IN CORE AND NON-CORE INDUSTRIES BY AGE

The distribution of engineers working in core and non-core industries by age is set out in Figure 8.7.

More than 60% of engineers in their 30s, 40s and 50s worked in core engineering industries. This more or less echoed the overall proportion of engineers working in core industries. However, fewer than 60% of engineers under 30 or over 60 worked in core industries. For the age bracket of 70 years and over, this drops to below 50%.

The biggest age group in terms of numbers of engineers was the 30 to 39 group – over 93,000 engineers fell into this bracket. This was followed by 40 to 49, with over 75,000 engineers. The over 70 age bracket comprised almost 4,400 engineers; and, while notable, was the smallest age bracket.

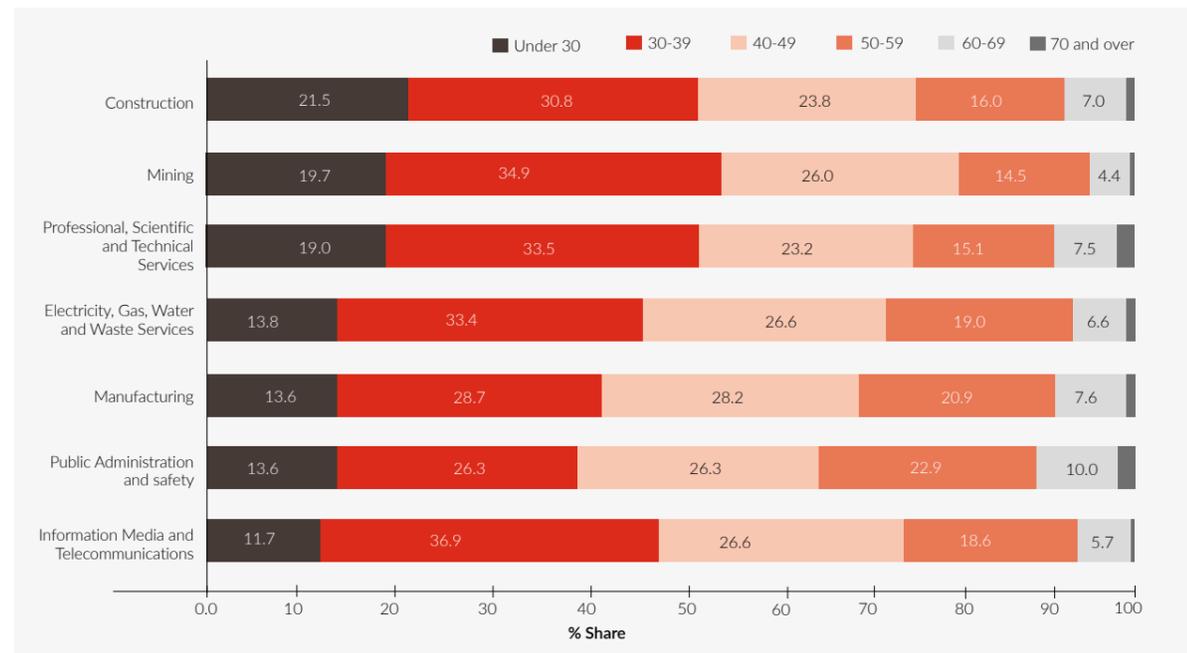
Figure 8.7: The percentage of qualified engineers working in core vs non-core industries based on age brackets, 2016



DISTRIBUTION OF ENGINEERS IN CORE INDUSTRIES BY AGE

The distribution of engineers in core industries by age is set out in Figure 8.8.

Figure 8.8: The age structure of core engineering industries, 2016



There were slight variations in the breakdown of core industries according to engineer age, remembering that the 30 to 39 and 40 to 49 brackets contained the largest numbers of engineers.

More than half of professional services, mining and construction engineers are under 40

In the professional services industry, 52.5% of engineers were under 40 in 2016. The industry's biggest age group was the 30 to 39 bracket, with over 21,000 engineers in their 30s working in the industry in 2016. The professional services industry is the largest employer of engineers. For that reason, it also employs the largest number of engineers in the older age brackets, despite having a smaller share in these age brackets.

The construction and mining industries also had higher proportions of younger engineers. Of those engineers working in mining, 54.6% (8,578 engineers) were under 40, suggesting the appeal of this industry to younger engineers. In construction,

the proportion was 52.3% (15,086 engineers). These are the only core industries where over half of the engineers are under 40.

Manufacturing and public admin have larger share of older engineers

The manufacturing and public administration sectors have higher proportions of older engineers:

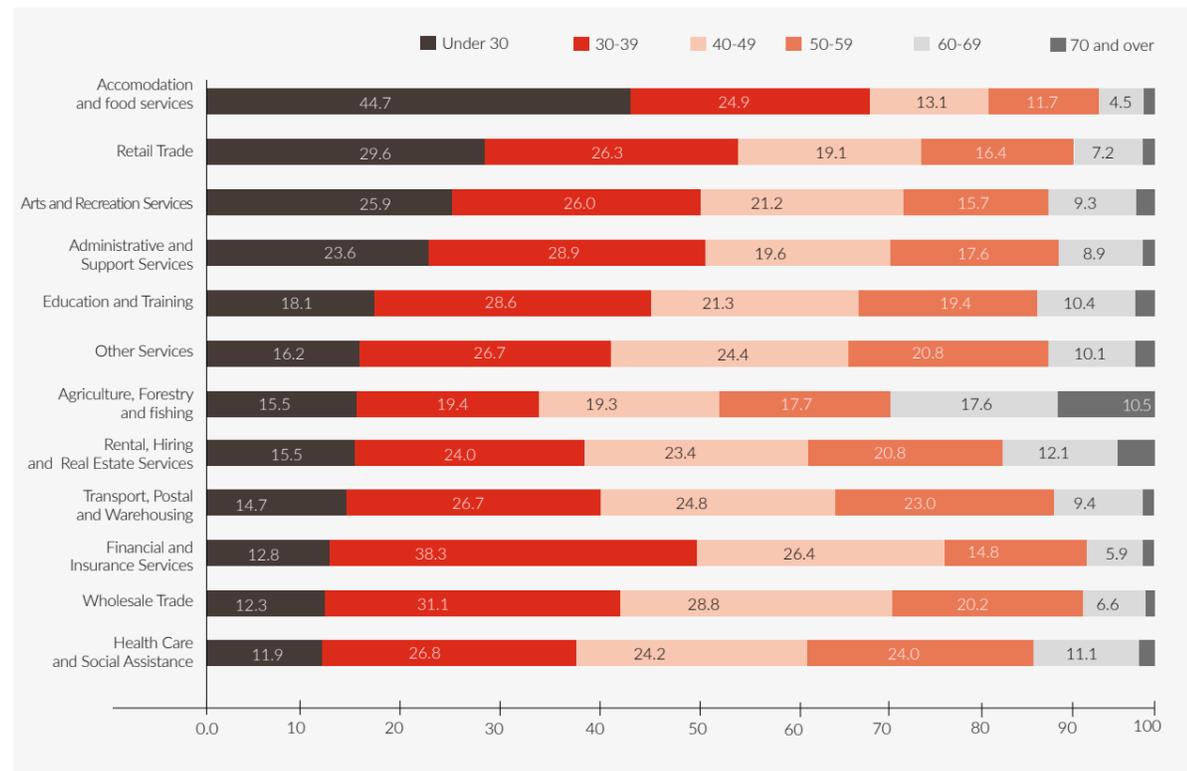
- 29.5% (11,459) of engineers working in manufacturing industries were 50 or over.
- 33.8% (7,740) of engineers working in public administration were 50 or over.

In contrast, only 19.4% (3,043) of engineers working in mining were 50 or over.

DISTRIBUTION OF ENGINEERS IN NON-CORE INDUSTRIES BY AGE

The distribution of engineers in non-core industries by age is set out in Figure 8.9.

Figure 8.9: The age structure of non-core engineering industries, 2016



There was a larger variance in the proportions of the different age brackets for the non-core industries

(see Figure 8.9). Due to the large numbers of engineers in their 30s and 40s, the 30 to 39 and 40 to 49 age brackets tended to have the biggest shares. However, this was not always the case. As could be expected, industries with a low proportion of engineers working in engineering occupations often had more pronounced differences in age distribution.

Young engineers find work in 'engineering-lite' industries

The retail and accommodation and food services industries had large cohorts of under 30-year-olds.

Nearly a third (3,925) of engineers who worked in retail trade in 2016 were under 30. For engineers working in accommodation and food services, nearly half (3,726) are under the age of 30. These industries are not the largest employers of engineers, but do employ a sizable number.

Engineers in these industries are unlikely to be working in engineering occupations. This highlights the difficulty some younger graduate engineers have had breaking into traditional engineering occupations, particularly in the second half of the decade. It could be argued that someone under 30 is too young for their successful transition into engineering

employment to be judged. However, the results are still significant for young engineers in these two industries. They suggest that a number of the engineers in their 20s have graduated and are having difficulty moving into engineering work matching their qualifications.

The education and training, rental hiring and real estate services, and agriculture, forestry and fishing industries have slightly higher proportions of engineers over 70. In agriculture, 10.5% of engineers were over 70, a share much higher than in any other industry. Many of these would be engineers who have worked in the agriculture, forestry or fishing industries for a long time.

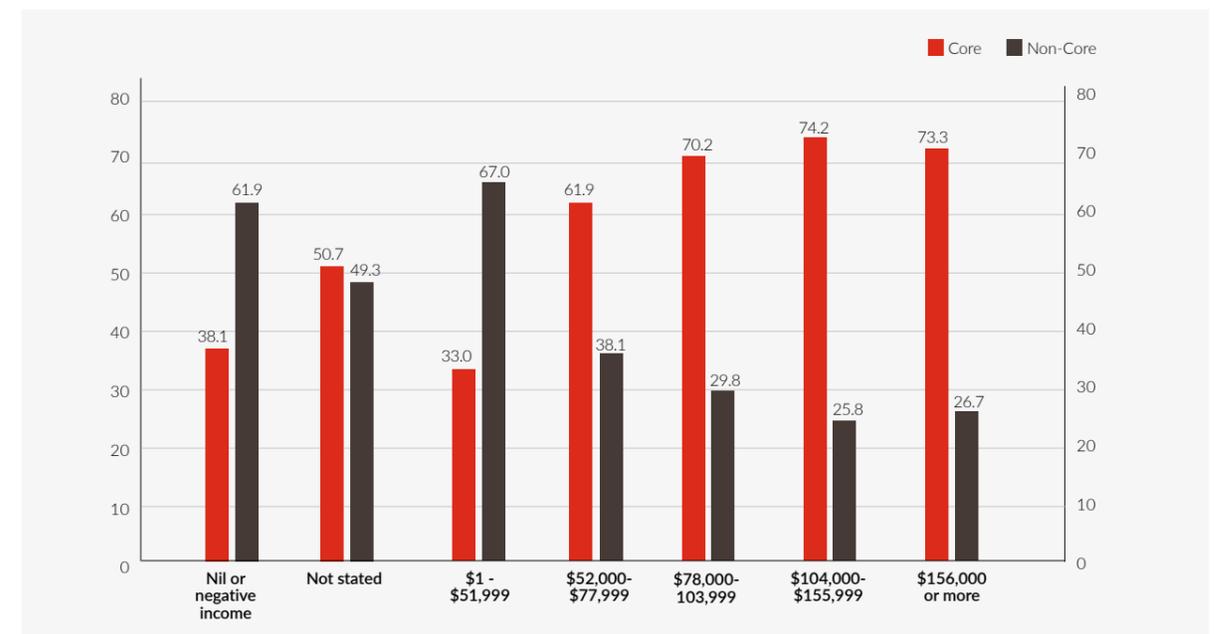
Level of salary by industry

Different industries have different earning expectations for engineers, and some industries have a higher proportion of engineers in the highest salary income brackets.

COMPARISON OF ENGINEER INCOME IN CORE AND NON-CORE INDUSTRIES

The breakdown of engineer income comparing core to non-core industries is presented in Figure 8.10.

Figure 8.10: The percentage share in each income bracket, for engineers working in core and non-core industries, 2016



Engineers working in core industries make up larger proportions of the top three income brackets. The top three income brackets are all above 70%, higher than the 62% share of engineers working in core industries. It is clear that most engineers earning in the higher income brackets are more likely to be working in core industries, where they earn upwards of \$52,000 per year.

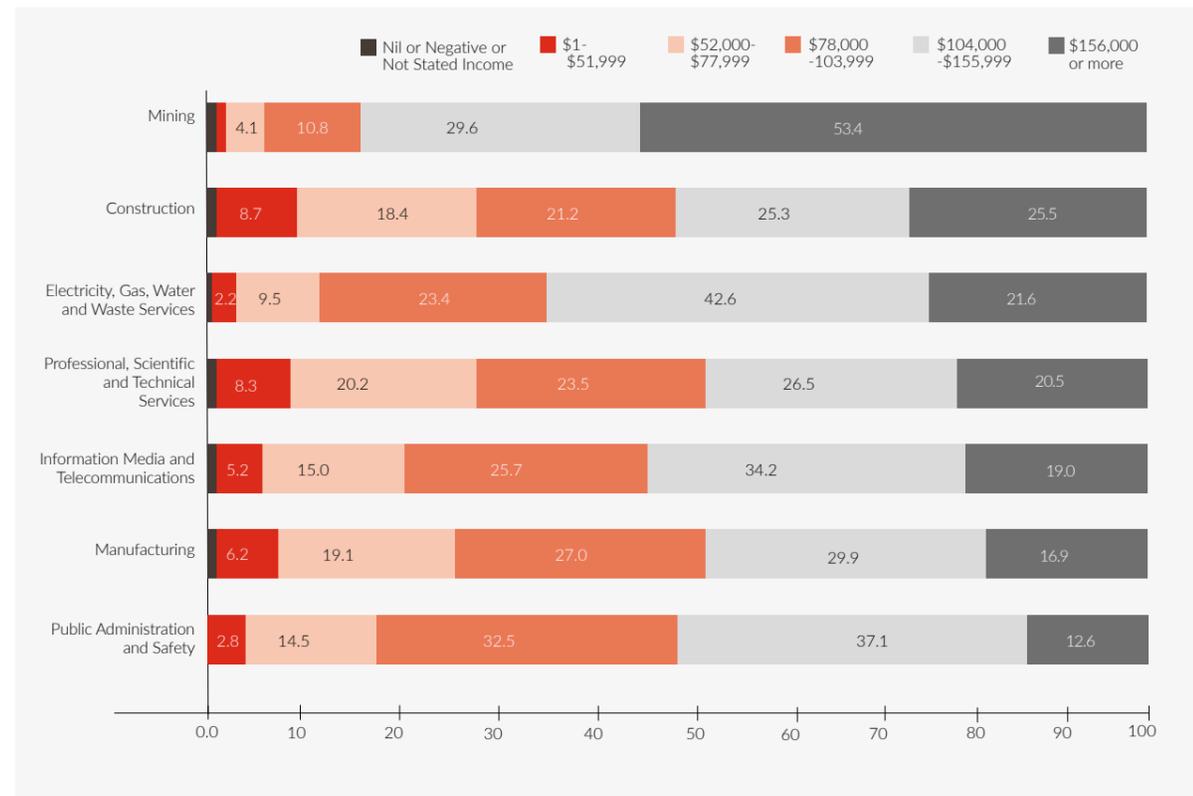
This supports the likelihood that an engineer working in one of the core industries is not only more likely to be working in an engineering occupation, but is also more likely to be getting paid in one of the higher income brackets.

Engineers with a nil or negative income, or an income between \$1 and \$51,999 per year were much more likely to be working in one of the non-core industries. As previously discussed, many of the engineers working in the non-core industries are not working in engineering occupations.

ENGINEER INCOME IN CORE INDUSTRIES

Income bracket distribution for engineers working in each of the core industries is set out in Figure 8.11.

Figure 8.11: The income distribution of qualified engineers working in engineering occupations, core engineering industries, 2016



Mining industry engineers earn the most on average

The mining industry had the largest proportion of engineers earning the top salary bracket at 53.4%. This proportion in the top bracket was the biggest of any industry, more or less double the nearest competitor. The surge in the demand for mining engineers during the resources boom would have coincided with a pay increase for many of these engineers, and this continued through to 2016.

But all core industries pay their engineers well

All core industries have a large proportion of their engineers earning in the top two income brackets. For mining industries, this made up 83%; for construction, 50.8%; for the utilities, 64.2%; for professional services, 47%; for telecommunications, 53.2%; for manufacturing, 46.8%; and for public administration, 49.7%. Public administration had the lowest proportion of engineers in the top bracket of the core industries.

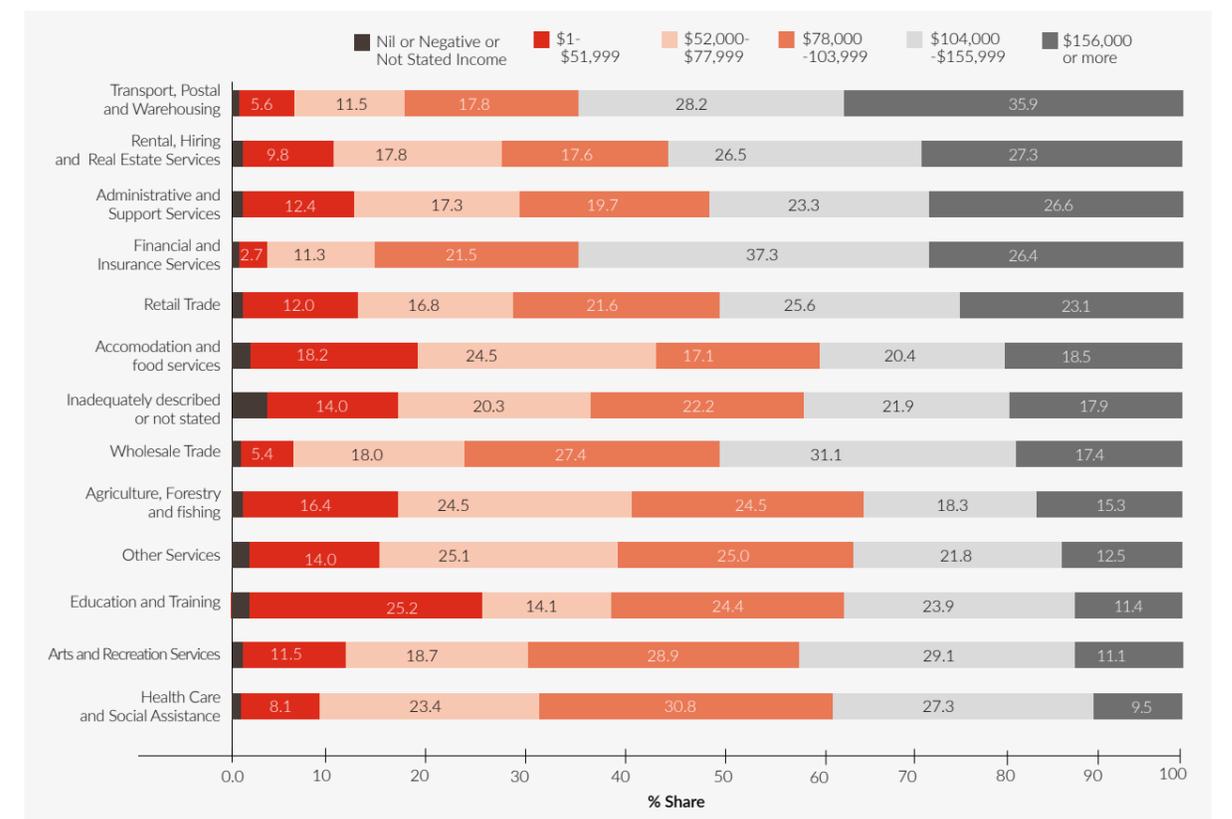
Additionally, core industries had a higher proportion of their engineers earning salaries in the top two income brackets when compared to the general population in the same industry. For the general population, only 13.1% in manufacturing earn in the top two income brackets, while only 13.3% do in construction.

In the core industries, working in an engineering occupation made a difference to income. For each core industry, a slightly higher proportion of engineers working in engineering occupations were in the top two income brackets, compared to engineers generally.

ENGINEER INCOME IN NON-CORE INDUSTRIES

Income bracket distribution for engineers working in each of the non-core engineering industries is set out in Figure 8.12.

Figure 8.12: The income distribution of qualified engineers working in engineering occupations, in non-core industries, 2016



A number of the non-core engineering industries have engineers earning a salary in the top two income brackets (see Figure 8.12).

This includes the transport and warehousing industry, with 64.1% of its engineers in the top two brackets; the financial and insurance services industry, with 63.7%; the rental, hiring and real estate services industry, with 53.8%; and wholesale trade, with 48.5%.

Correlation between proportion in engineering jobs and proportion in top income brackets

The transport, postal and warehousing, and financial and insurance services industries had both a reasonable proportion of engineers working in engineering occupations and the highest number of engineers in the top income bracket. This suggests a correlation between income level and work in an engineering occupation, whereby the larger proportions working in engineering occupations push up the proportions in the top income brackets.

This is borne out by trends in the other non-core industries. There are large differences in the proportions working in accommodation and food services (38.8% in engineering occupations with an

income in the top two brackets, compared to 3.9% in non-engineering occupations) and in retail trade (48.7% in engineering occupations with an income in the top two brackets, compared to 13.6% in non-engineering occupations).

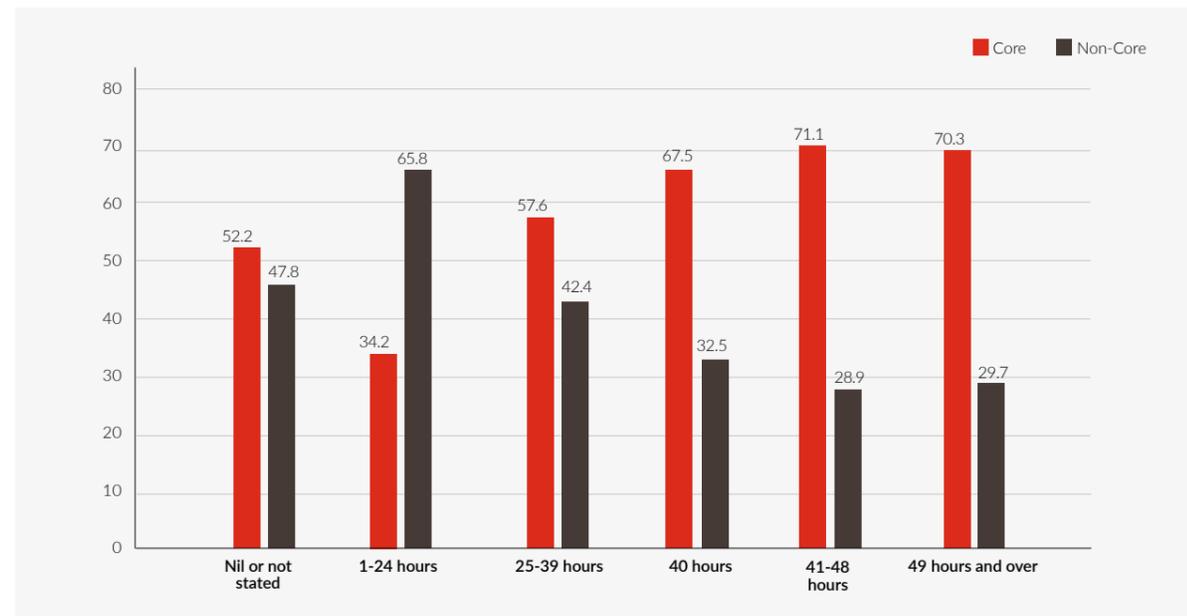
Industries that employ engineers with higher proportions in the lower salary ranges include education and training, accommodation and food services, administrative and support services, and agriculture, forestry and fishing. Some of these industries have a high proportion of engineers working in non-engineering occupations, or even working part-time hours.

Hours of work per week by industry

The salary range for engineers in the various industries could also be related to the average number of hours engineers work in each industry.

The percentage share of hours of work for engineers working in core and non-core industries is set out in Figure 8.13.

Figure 8.13: The percentage share in each hours of work bracket per week, for engineers working in core and non-core industries, 2016



Engineers working in the core engineering industries are more likely to be working longer hours, compared to engineers working in non-core industries (see Figure 8.13). For 40 hours and over, this is above the 62% range of the percentage of engineers who work in core industries.

The majority of engineers working part-time (1-24 hours a week) were employed in non-core industries. Engineers in the non-core industries have a higher likelihood of being in non-engineering occupations. Moreover, many of these industries would have a notable proportion working part-time hours due to the nature of the work.

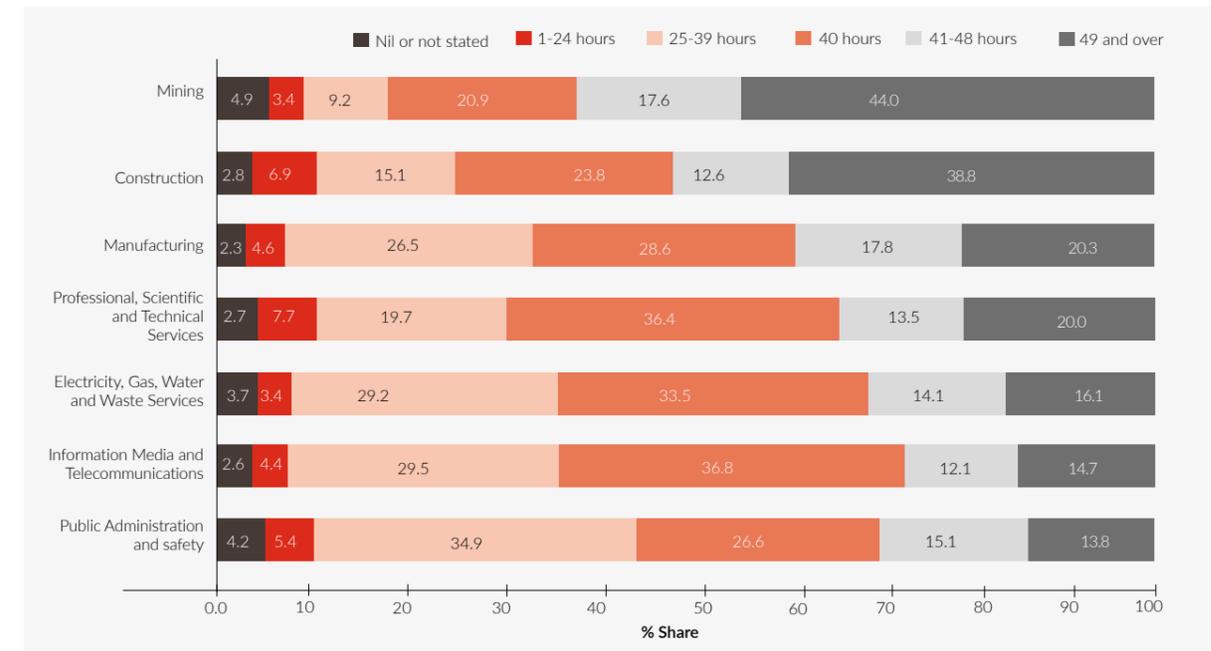
For engineers working the longest hours, the largest proportions were in core engineering industries.

Engineers in the core industries have a higher chance of working in engineering occupations. This indicates that engineers working in engineering occupations are more likely to work longer hours. This could suggest that there is either not much flexibility in working hours associated with engineering roles, or that those who work in engineering roles have the desire to work longer hours.

HOURS OF WORK IN CORE INDUSTRIES

The distribution in the hours of work for engineers split according to core industry is presented in Figure 8.14.

Figure 8.14: The distribution of hours of work, for qualified engineers in core industries, 2016



Core engineering industries have high proportions of engineers working long hours, notably hours of above 40 hours per week.

Mining and construction engineers more likely to work long hours

The mining and construction industries had the biggest share of their engineers working longer hours. Over 61.6% of the engineers working in mining industries worked more than 40 hours a week, and this was 51.4% for construction. This compares to only 30.2% in the utilities industries, 28.9% in public administration, and 26.8% in telecommunications.

While the mining industries have the highest proportion of engineers in the top hours of work bracket, they do not have the highest number of engineers in those brackets. Over 12,000 engineers in the professional services industry, and over 11,000 in the construction industry worked 49 hours and

over a week. This compares to just under 7,000 in the mining industries. Even still, engineers in mining and construction are more likely to work long hours.

High remuneration appears to line up with long hours of work

There is a loose pattern forming between Figure 8.11 and Figure 8.14 with the mining and construction industries having large proportions of engineers in the top income brackets, but also having a large proportion working long hours. This could indicate that engineers in these industries work longer hours but receive high remuneration in return.

HOURS OF WORK IN NON-CORE INDUSTRIES

The distribution in the hours of work for engineers split according to non-core industry is set out in Figure 8.15.

Engineers working in the non-core industries have varied proportions in hours of work, depending on the industry (see Figure 8.15).

Engineers working in agriculture, forestry and fishing, rental, hiring and real estate services, transport, postal and warehousing, and wholesale trade are more likely to be working longer hours. There are over 6,500 engineers working more than 40 hours in the industry of transport, postal and warehousing, and around 3,900 working more than 30 hours in wholesale trade.

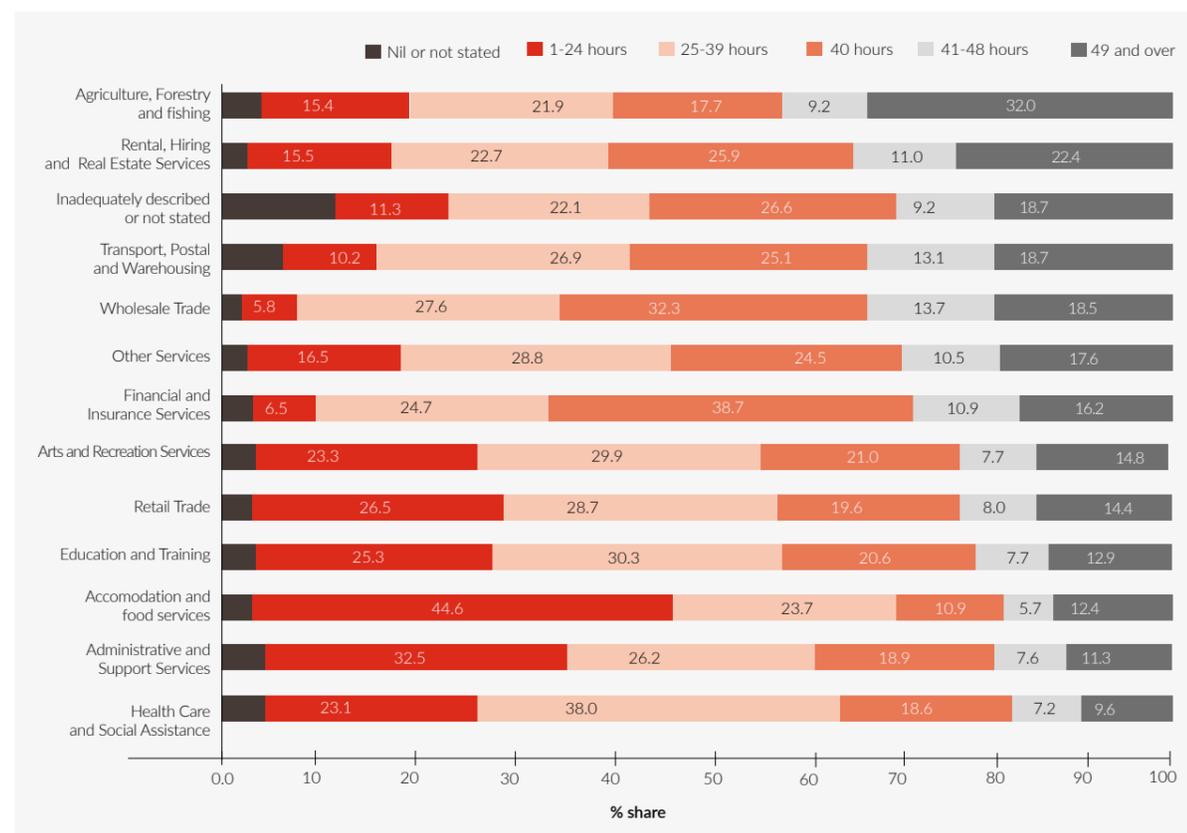
Non-engineering occupations correlate with higher rates of part-time work

The accommodation and food services, administrative and support services, education and training, and retail trade industries have a high proportion of their engineers working part-time hours. In the 24

hours and under bracket, there were almost 4,000 engineers in accommodation and food services, around 3,900 in retail trade and almost 3,800 in education and training. This would be consistent with many of the non-engineering occupations in these industries, which require only part-time work.

This is also consistent with some of the previous findings for younger engineers, and even recent migrant engineers. Many of these engineers seeking work in non-core industries may only have the option of part-time work. Some might also choose part-time work while they try to break into one of the more traditional industries associated with their engineering qualification.

Figure 8.15: The distribution of hours of work, of qualified engineers in non-core industries, 2016



9.

Conclusions

There has been a pronounced change in the engineering profession over the course of the decade. The ten years to 2016 can be split into two five-year periods, each with a distinct character and growth pattern for engineering employment.

2006 to 2011

During the first five years from 2006 to 2011, there was strong growth in the number of engineers working in core industries. This was echoed by equally strong growth in the number of engineers in these industries finding work in actual engineering occupations. At the height of the resources boom, demand for engineers was high.

Core industries that grew in the first half of the decade included the professional services (consulting, design and computer software), construction, public administration, utilities, mining and telecommunications industries. Even manufacturing saw a growth in engineer numbers during this time, despite a fall in overall manufacturing employment.

2011 to 2016

In the second five-year period from 2011 to 2016, the trend changed and growth in the core industries slowed dramatically. The subsequent redistribution of engineers in the economy pushed many into non-core industries, even though those industries did not have the same engineering-specific employment opportunities. While significant numbers continued to work in core industries like construction, mining, telecommunications and the utilities, growth in the

largest industry – professional services – stalled, and the numbers in manufacturing fell. This resulted in large numbers of engineers moving into non-engineering occupations.

Core vs non-core industries

Although there was some growth in the number of engineers finding work in engineering occupations in non-core industries, many were forced to work in non-engineering roles. For example, growth in numbers of engineers working in retail trade and food services meant that a sizeable proportion of engineers moving into those industries moved into roles with very little connection to engineering.

Higher proportions of younger engineers and recent graduates were working in non-core industries.

Higher proportions of female engineers were also working in non-core industries and non-engineering occupations, when compared to male engineers.

Engineers who had recently migrated to Australia were more likely to work in non-core industries, and thus in non-engineering occupations. For overseas arrivals who arrived between 2012 and 2016, more were employed in non-core industries compared to core industries.

There are significant benefits to working in a core industry, and even more so if it is in an engineering occupation. Larger proportions of engineers working in core industries are earning the top salary brackets, and those in engineering occupations are even more likely to be in these higher income brackets. However, engineers working in core industries and those in engineering occupations were also more likely to work long hours. Contrary to this, significantly higher proportions of those employed in non-core industries were working part-time hours.

Along with differential growth across the various industries, there was differential growth across geographical regions. There has been solid growth in the number of engineers working in Australia's capital cities, mostly due to the large numbers of urban-based engineers working in construction, professional services, wholesale trade, financial services and even mining. Although mining is considered a regional profession, much of the engineering work can be done remotely in capital cities.

At the same time, there was some regional growth in engineer numbers, and this is due to growth in smaller subsets of some of the major core industries such as the utilities and certain manufacturing sub-industries. The utilities require the engineers to work onsite, most likely due to the requirements of power stations or distribution and transmission infrastructure. However, growth in regional areas was dwarfed by growth in the capital cities.

Policy implications

This report highlights the significant changes seen in the engineering workforce over the decade. The pronounced changes in the second half of the decade point to key challenges for younger engineers and migrants finding work in core industries, and in engineering roles. Engineers are expected to play a vital role in the continued transition to a technically proficient, innovative economy; and Australia will need to continue to produce and import STEM graduates who can facilitate this transition. However, policy makers must look at policies which avoid creating a boom-bust engineering labour force scenario. Looking at the decade to 2016 can help us to understand changes in the economy and guide how current policy shapes the future.





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