Renewable Energy Jobs in Australia: Stage One

Prepared for Clean Energy Council
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Disclaimer

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Executive Summary

This study presents the findings from the first large-scale survey of renewable energy employment in Australia[1].

The renewable industry is an important source of employment in Australia. The industry has reported skill shortages but found a lack of data on renewable energy employment an impediment to workforce planning. Consequently, the Clean Energy Council commissioned the Institute for Sustainable Futures, University of Technology to undertake a survey of employment in renewable energy. Surveys were undertaken for large-scale solar PV and wind power, distributed solar PV, hydro generation and pumped hydro, battery storage, and the associated supply chains.

Using employment factors derived from these surveys, estimates of renewable energy jobs from 2020 to 2035 have been produced using three energy market scenarios and other inputs from the Australian Energy Market Operator's (AEMO) Integrated System Plan (AEMO 2020)[2] for the eastern states:

- **Central Scenario**: growth is determined by market forces under current federal and state government policies (i.e. business-as-usual with no additional policy).
- **Step Change**: strong policy commitments occur with 'aggressive de-carbonisation' and growth in renewable energy.
- **High Distributed Energy Resource (DER)**: higher growth in rooftop solar and battery storage relative to large-scale renewable energy.

Equivalent scenarios were developed for Western Australia using the WA Whole of System Plan or AEMO data where possible, supplemented by publicly available data on proposed projects in WA.

Using AEMO scenarios, our study estimates average employment in renewable energy between 2020 and 2035 to be 34,400 in the Step Change scenario, compared to 33,900 in the High DER scenario and 21,000 in the Central Scenario. Based on AEMO scenarios (pre-Covid 19), around 26,000 renewable energy jobs were projected for 2020.[3]

It is important to note this is not a comprehensive estimate of renewable energy employment as it is only the first stage of a two-stage project. The study does not include jobs in the construction of electricity networks to connect renewable generation in regional areas to the rest of the country. Nor does it include bioenergy, professional services,[4] renewable hydrogen, the growth in mining inputs for renewable energy (e.g. nickel, lithium) or recycling and disposal of renewable energy equipment. Looking more broadly, it does not include the potential for renewable energy to create comparative advantage in energy-intensive industries such as aluminium and steel in a low-carbon global economy (Garnaut 2020; Grattan Institute 2020).

[1] The Australian Bureau of Statistics (ABS) publishes an annual estimate of renewable employment, but it is based on secondary sources without an industry survey.
[2] Note the survey and AEMO's scenarios were undertaken before Covid-19 and the downturn in the Australian economy and its impacts on electricity markets.
[3] Note that these estimates do not include all renewable energy jobs. While Covid-19 is likely to affect the energy scenarios, the Clean Energy Council has also projected that up to 50,000 jobs could be created if the government implemented Covid-19 stimulus measures aimed at supporting renewable energy.
[4] The ABS (2020) estimates there were 2700 employees in bioenergy and government /not-for-profit organisations (around 10 per cent of current employment). There are no current estimates for the other listed sectors that are outside the scope of the survey.

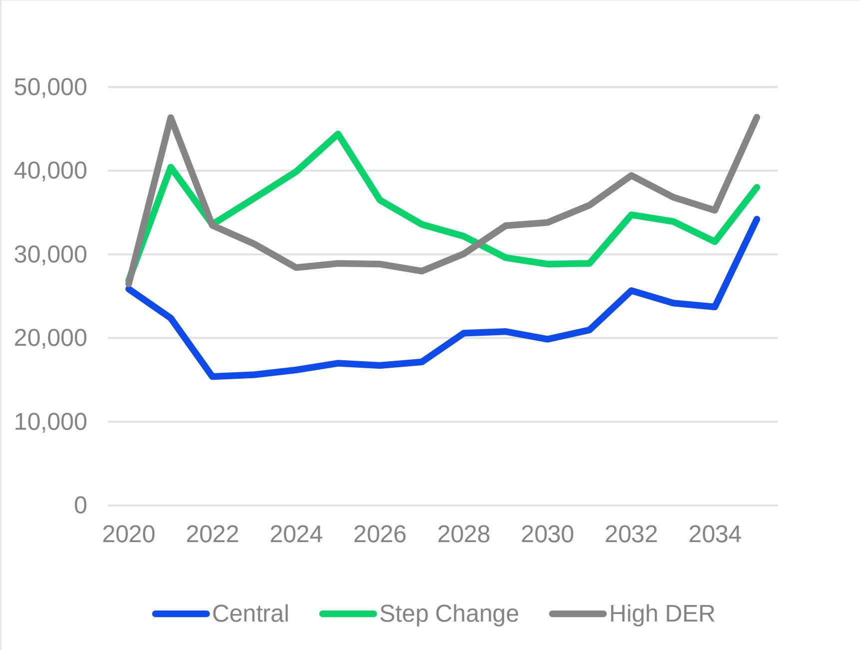
There are seven key findings from the study:

1. Renewable energy will be a major source of jobs in the medium-term - but there are quite different short-term trajectories for renewable energy jobs under AEMO scenarios. In the Step Change and High DER scenarios (the 'growth scenarios'), renewable energy jobs peak around 45,000 and there is an average of 34,000 jobs annually to 2035. By contrast, under the Central Scenario, a slowdown in renewable energy investment leads to the loss of around 11,000 jobs by 2022 before steady employment growth resumes – highlighting the importance of including renewable energy in Covid-19 recovery funding.
2. Renewable energy creates employment across a diverse range of occupations, led by trades and technicians, labourers and professionals.
3. Under all scenarios, job growth is strongest in rooftop solar and wind. Most jobs are in construction and installation but over time an increasing proportion of jobs would be on-going operations and maintenance roles.
4. Renewable energy currently employs more people than in the domestic coal sector and will continue to do so under all scenarios. In the growth scenarios, renewable energy employment is comparable to current employment across all coal mining.
5. Renewable energy will create employment across regional Australia including coal regions. The occupational mix and location of renewable energy jobs indicates the sector can play a meaningful role in creating alternative employment as the global transition out of coal accelerates - but only within comprehensive industry plans and investment to diversify these regional economies
6. Renewable energy experienced significant skill shortages and recruitment difficulties in 2018-19, reducing local employment and increasing costs.
7. There are significant opportunities for better coordination, planning and investment to improve employment outcomes, notably through the Renewable Energy Zones.

1. Renewable energy will be a major source of jobs in the medium-term – but there are different short-term trajectories for employment under AEMO scenarios.

Based on AEMO's scenarios, there are very different trajectories possible for renewable energy jobs in the short-term (noting that these scenarios pre-date Covid-19). Average employment in the Step Change scenario is 34,400, and 33,900 in the High DER scenario. Employment peaks around 45,000, an increase of approximately 19,000 from today's level.

Figure 1 Australian renewable energy jobs, 2020 - 2035



The Central Scenario is AEMO's projection of the current state of play or business-as-usual including current Federal and State policies. In this scenario, the number of jobs in renewable energy would fall from about 26,000 jobs now to 15,000 in the mid 2020s – reflecting the downturn in renewable energy investment expected by AEMO even before Covid-19. Growth in renewable energy resumes from the mid-2020s but employment

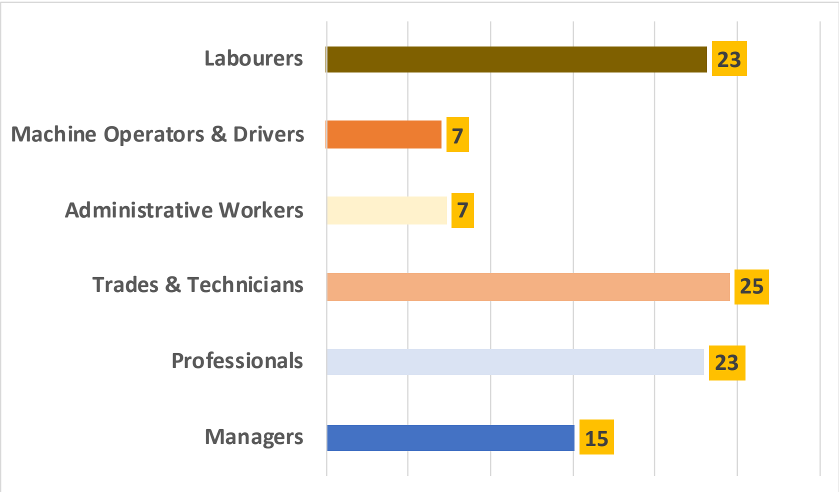
levels do not recover until the early 2030s. In the next eight years the Step Change scenario has an average of 20,000 more renewable jobs than the Central scenario, highlighting the risks under current policy settings and the importance of stimulating investment in Covid-19 recovery packages.

2. Renewable energy creates employment across a diverse range of occupations, led by trades and technicians, labourers and professionals.

When people think of jobs in renewable energy, they often think of an installer on a roof putting in solar panels – but renewable energy creates employment for a diverse range of occupations. The leading groups are trades and technicians, labourers and professionals (Figure 2). Under the Step Change scenario, over 8500 jobs would be created on average per annum for trades and technicians, and over 8000 jobs for labourers and professionals. In this scenario, employment peaks at over 11,000 for trades & technicians and over 10,000 for professionals and labourers (see Appendix 3).

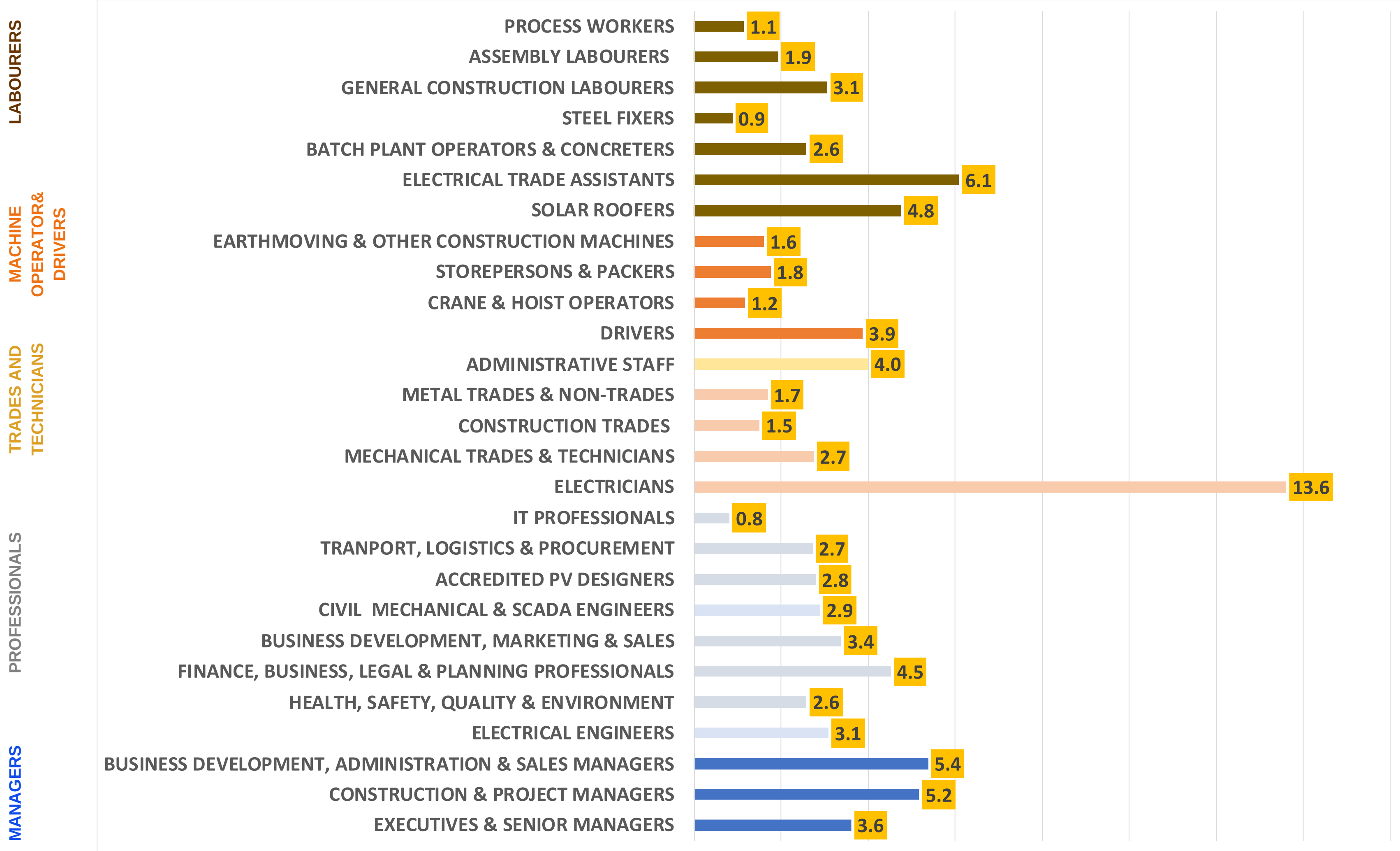
Looking at specific occupations illustrates the diversity of jobs in renewable energy (Figure 3). Around one-in-five renewable energy workers is an electrician or electrical trade assistant (up to a peak of 9,500). Other major types of workers include roofers and installers (rooftop solar), concreters and construction labourers, drivers, mechanical trades, engineers and a range of skilled professionals and managers

Figure 2 Renewable energy jobs by occupation (%), Step Change, 2020 - 2035



Photograph courtesy of Craig Sillitoe Photography

Figure 3 Renewable energy jobs by detailed occupation (%), Step Change scenario, 2020 - 2035

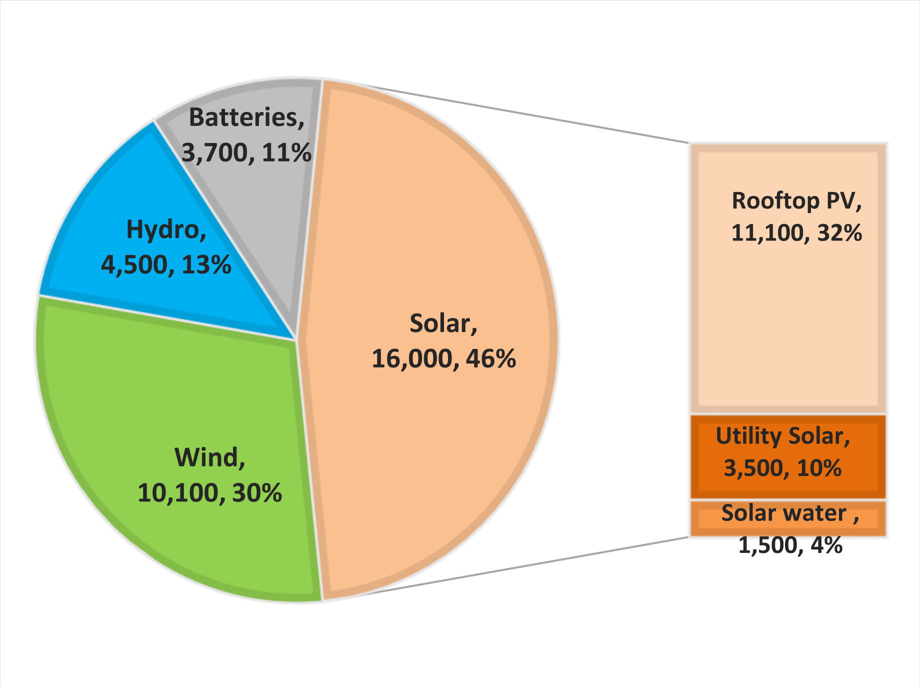


3. Renewable energy could create around 45,000 jobs led by rooftop solar and wind farms. An increasing proportion of these jobs would be on-going employment, primarily in regional areas.

AEMO's growth scenarios highlight the opportunity for renewable energy to create significant employment. On average, there are more than 10,000 more jobs under both the Step Change and High DER scenarios. Under these scenarios, the low point of renewable employment is around 25,000 jobs, with peaks of over 45,000, compared to the low of 15,000 jobs under the business-as-usual scenario and slow growth in the years afterwards.

What sectors drive the growth of new renewable energy jobs? Rooftop solar and wind farms are the major sources of employment (Figure 4). Under the Step Change scenario, solar averages more than 16,000 jobs and accounts for nearly half of renewable energy jobs. Consequently, renewable energy will increasingly provide stable employment.

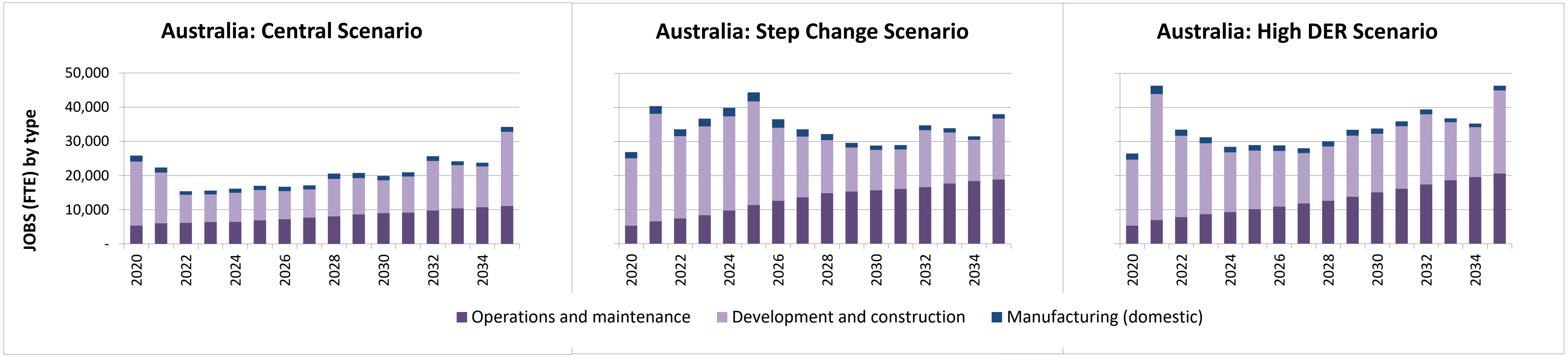
Figure 4 Average RE jobs by technology, Step Change scenario 2020-2035



Photograph courtesy of Neoen

The construction phase is a major source of employment but over time, as more renewable energy generation is built, operations and maintenance (O&M) jobs increase. Just over half of all jobs in the Step Change scenario, 45 per cent in the High DER scenario and one-in-three in the Central Scenario are projected to be O&M jobs (Figure 5). The higher proportion of O&M jobs in the Step Change scenario reflects the higher volume of installed capacity. The trend towards higher O&M employment is driven by wind farms and rooftop PV

Figure 5 Share of operation and maintenance jobs, all technologies, 2020-2035



4. Renewable energy creates more jobs than current employment in the domestic coal sector - and under growth scenarios renewable energy employment is comparable to current employment in all coal mining

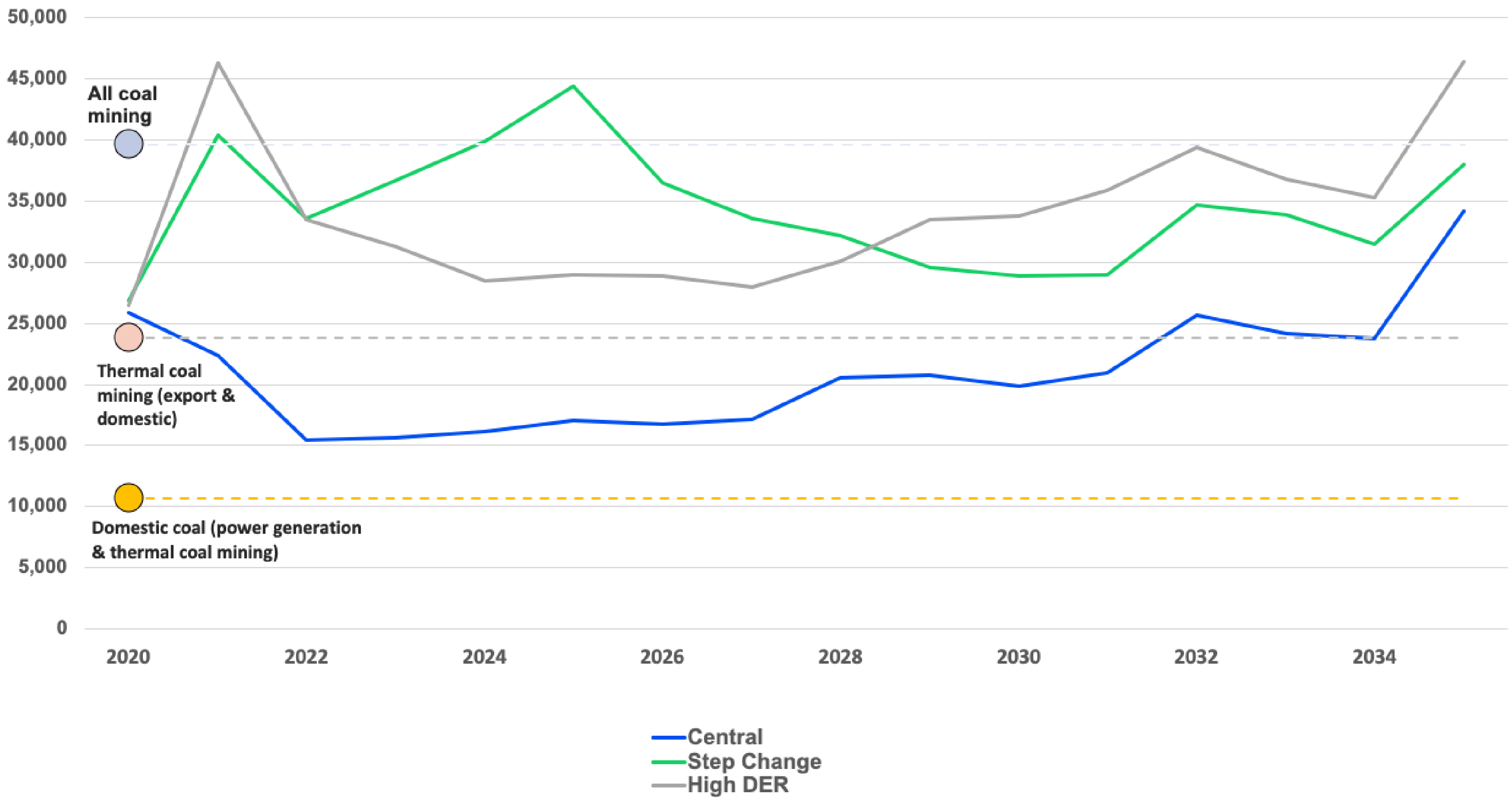
Under the Step Change scenario, renewable energy jobs would grow strongly to around 45,000 by the mid-2020s, and then gradually fall back to about 30,000 before rising again from around 2030. The fall in jobs reflects a projected slowdown in construction of new renewable energy before coal power station retirements. If coal power stations retire earlier than the late 2020s, growth in employment would also occur earlier. By contrast, under the high DER scenario, employment increases sharply to over 45,000, declines until the late 2020s and then increases back to over 45,000.

How does this compare to coal sector employment? As illustrated in Figure 6, under all scenarios, renewable energy jobs are higher than the current domestic coal sector workforce (power stations and thermal coal mining supply). The growth in renewable energy will displace some of the jobs in the domestic coal sector, but 75 per cent of coal is produced for export and therefore the majority of coal jobs depend on overseas market demand – they are not affected by the growth of renewable energy in Australia.

Renewable energy employment under the Step Change and High DER scenarios is higher than current employment in thermal coal mining (export and domestic). Renewable energy employment is sometimes higher, sometimes lower than current employment in all coal mining (thermal and metallurgical). AEMO projects sharp growth from 2035 onwards so if transition were to occur more quickly renewable energy employment would be higher across this period.

Photograph courtesy of the Clean Energy Council

Figure 6 Renewable energy jobs compared to coal sector jobs, 2020 – 2035



Note: the coal employment figure is not a forecast – it is the level of employment based on latest figures to enable comparison between renewable energy job projections and the current coal sector workforce.

Sources: Total coal mining: ABS, Labour Account (2019). There is another ABS series, Labour Quarterly, under which total coal mining employment averaged just over 50,000 for 2018-19 – but the ABS describe Labour Account as more accurate (see ABC 2019). Data from the Department of Resources and Energy (2019) is used to calculate share by export/domestic and thermal/metallurgical based on production volumes. Labour intensity is assumed to be the same for thermal & metallurgical employment. Fossil fuel power stations: the Australian Census (ABS 2016). Employment was apportioned based on the share of installed capacity in coal and gas power generation in 2016. Note the figure pre-dates the closure of Hazelwood power station.

5. Renewable energy will create employment across regional areas including coal regions – it can play a meaningful role creating alternative jobs as the global transition out of coal occurs but only within comprehensive industry plans to diversify regional economies

Our study examined the location and types of jobs that would be generated by renewable energy and how they compare to the coal sector.

Around two-thirds of renewable energy jobs could be created in regional areas. Renewable energy jobs are distributed more widely across regional areas than the coal sector, which concentrates jobs in a handful of regions. The two states with the biggest share of the renewable energy jobs under all scenarios are the leading coal mining states – NSW and Queensland. The Australian Energy Market Operator has identified Renewable Energy Zones (REZs) where it forecasts most of the large-scale renewable energy will be located. In Queensland, some of the REZs overlap with the coal workforce. In NSW, the Central West REZ to the west of the Hunter Valley and the North-West REZ in the Moree region are leading sources of employment. In general, though, many of the renewable energy jobs will be located in other regions and the capital cities.

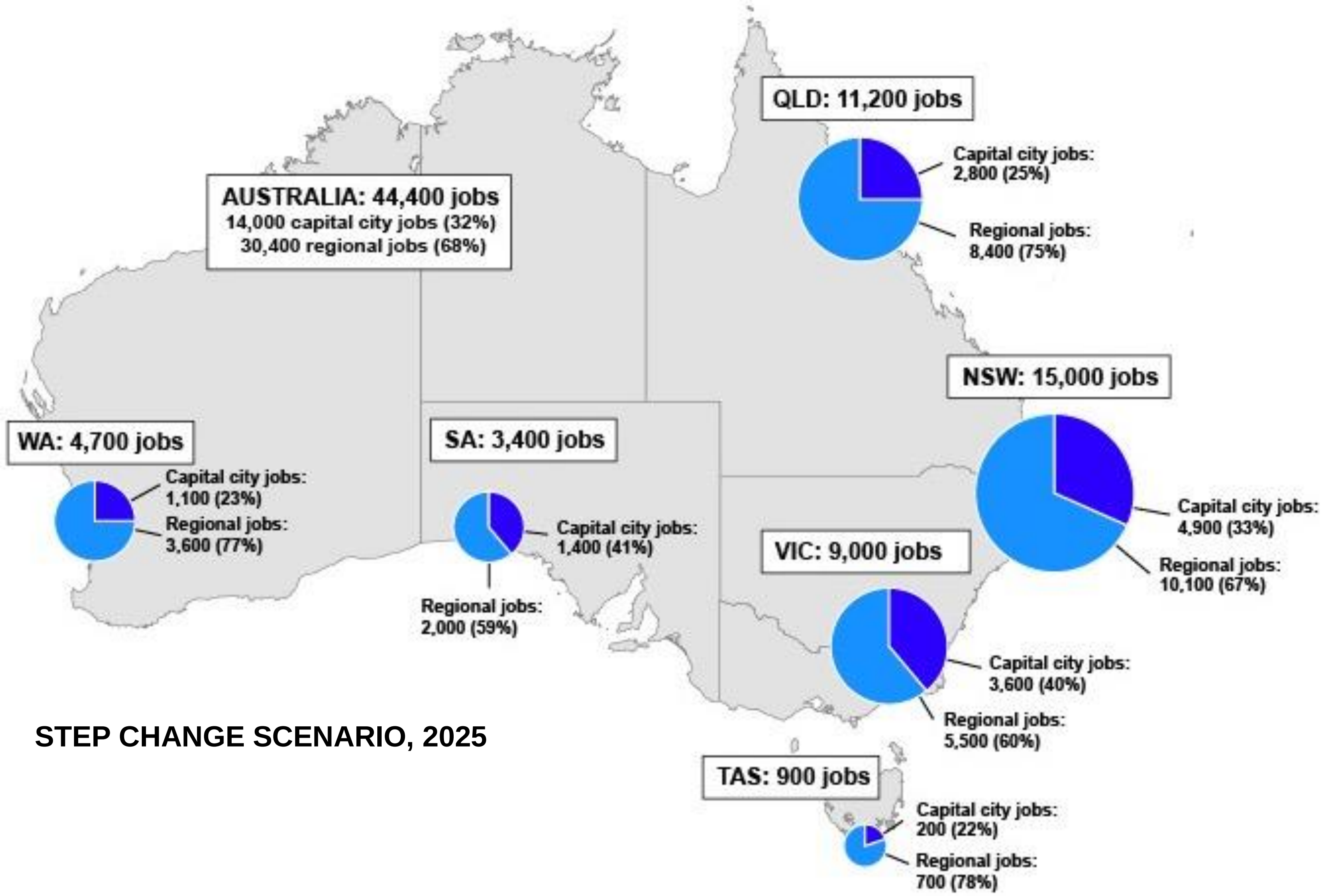
In terms of occupations, there is overlap between a range of professionals, trades and labourers within renewable energy and the coal sector – such as construction and project managers, engineers, electricians, mechanical trades, office managers and contract administrators, and drivers (see Figure 7, p.12). The number of jobs is often comparable or higher than in the domestic coal sector.

The timing and location of these jobs will influence the extent to which they can be a source of alternative jobs for coal mining. Re-training would also be required if there was to be a transfer between the sectors. Importantly, there is no direct correspondence between renewable energy jobs and the largest category of coal mining jobs (drillers, miners and shot fixers) (see Figure 7). While drillers are needed for pumped hydro construction, and there was qualitative reporting of competition with the resources sector for drillers, there is no match for much of the core mining workforce of semi-skilled machine operators.

Recent studies have highlighted the role renewable energy can play in supporting employment growth in heavy industries. As the global transition to renewable energy proceeds, Australia's high-quality renewable energy resources will be a source of comparative advantage for energy-intensive industries. There is the opportunity to create tens of thousands of jobs in areas such as 'green steel' and alumina (Grattan Institute 2020). Together, the opportunity for jobs creation in renewable energy and using renewable energy in other industries highlights renewable energy can play a meaningful role creating alternative employment as the world transitions out of coal.

Photograph courtesy of AGL

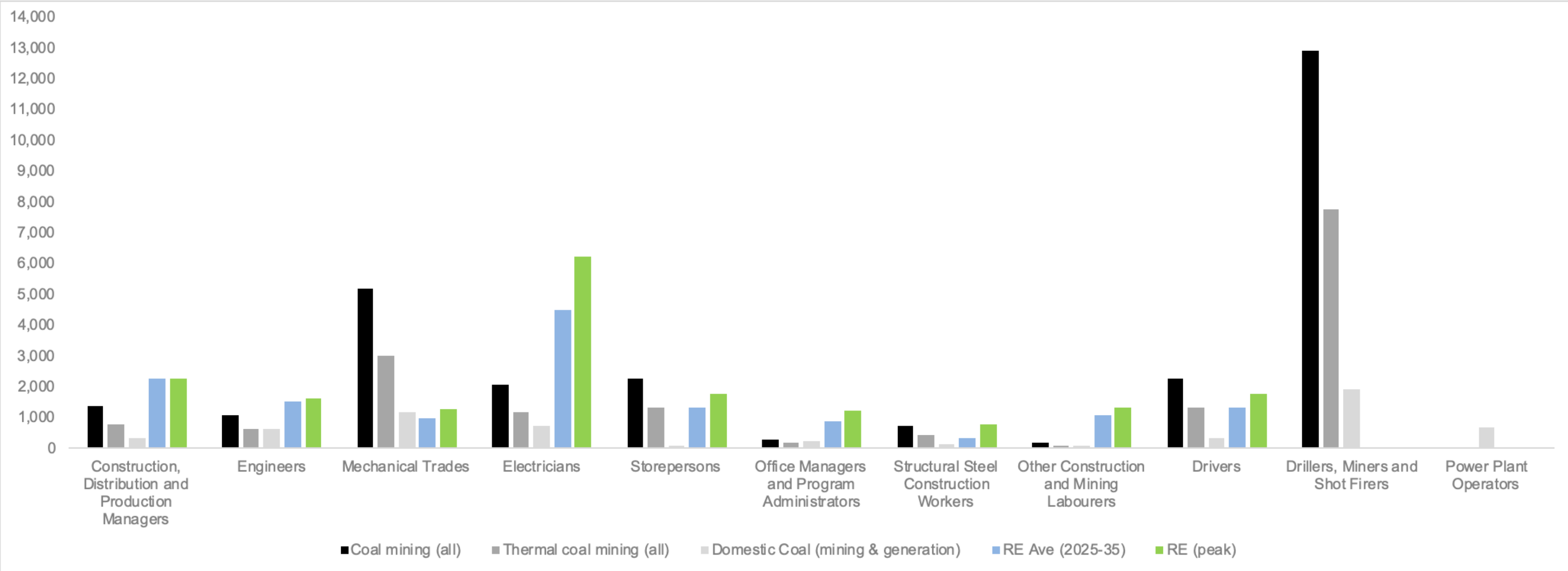
Figure 7 Renewable energy jobs, capital cities and regions (Step Change Scenario, 2025)



The fact that renewable energy will create more jobs than the local coal sector should not be taken as evidence that these job losses don't matter or that renewable jobs will simply provide replacement work for the sector. Without planning and investment, the social and economic consequences within coal regions are likely to be severe as their economies are heavily dependent on the commodity – especially when the coal export sector declines as this is the larger source of income and employment.

It takes time to develop new industries and businesses. Economic diversification and workforce planning over time is essential to avoid collapse in these regions at some point in the future when global demand for coal exports falls. Renewable energy can play a role in providing employment opportunities for workers in the coal sector - but only within comprehensive regional industry development plans which diversify coal region economies into other sectors.

Figure 8 Workforce numbers by occupation, mining sector and renewable energy sector



Note: the source for coal mining occupations is the 2016 census (ABS 2016)

6. Renewable energy experienced significant skill shortages and recruitment difficulties in 2018-19, reducing local employment and increasing costs

Industry respondents were asked about their recruitment experiences during 2018-19 and asked to rate the level of difficulty based on the ‘low’, ‘medium’ and ‘high’ ratings used by the Department of Employment, Skills, Small and Family Business. The survey covered a boom period (2018-19) so it should be a useful guide to the pressure points that emerge as the industry grows.

The major recruitment difficulties in large-scale renewable energy were for electrical and grid engineers and construction managers. There were other occupations which do not need large numbers of workers, but created bottlenecks when they were hard to recruit. For example, high crane operators, truck drivers specialising in wind farm transportation and operation and maintenance technicians (especially wind blade technicians) were critical occupations. Very few companies had difficulties sourcing construction trades and labourers. The hydro sector is mobilising after no construction projects for many years and there were already reports of difficulties sourcing skilled drillers.

For distributed solar, almost one-in-two respondents who had recruited in the past year reported ‘high difficulty’ sourcing electricians, especially in regional areas. In what appears to reflect the strains of a booming market, there were few businesses reporting low difficulty for core occupations such as PV designers and solar roofers. Software engineers and designers with energy knowledge were also hard to source for the emerging control equipment and data analytics sector.

Across both large-scale and small-scale renewable energy, the key cause for the difficulty was finding candidates that had experience in renewable energy. Large-scale renewable energy also reported pay competition for some occupations, especially with the resources sector. Regional locations were a barrier for around one-quarter of businesses.

Issues with the training system were identified. In both large and small-scale renewable energy, the apprenticeship system was not considered to work well as on the one hand apprentices do not get a sufficiently broad experience, but the industry is struggling to source workers with sufficient renewable energy understanding. There was a high number of electrical trade assistants in distributed solar which appears to be a pathway into the industry, while large-scale renewable energy makes use of coping strategies such as importing skilled workers, especially in construction, but also operations and maintenance.

7. Better coordination, planning and investment is needed to improve employment outcomes

The primary focus of this project was on estimating job numbers and identifying skill shortages and pressures rather than an analysis of solutions. However, a number of opportunities to increase local employment and labour supply for the industry were identified.

Photograph courtesy of AGL

Increasing the supply and retention of skilled labour

In some cases, there is a shortage of supply (e.g. grid engineers) but problems with the interaction between the training system and the industry lay behind a number of the skill shortages. Alternative training arrangements, such as short training courses and group training schemes (sharing apprentices between a group of employers and across industries), were suggested as an option that could be investigated. A group of wind farms had investigated using a group training scheme for technicians but the initial costs of pre-qualifications have proved a barrier. Employee retention is also an issue, especially where there is competition from the resources sector, and the industry could consider measures to improve retention (e.g. worker transfer, portability of entitlements).

Local content requirements and policy certainty

It is very hard for the industry to invest in training and development in the context of policy uncertainty. This is especially so for the large-scale construction phase where rapid mobilisation is needed once the project secures finance to meet contractual timelines. Coping strategies are often used (e.g. importing workers) which do little to build the skill base. An investment pipeline with greater certainty is necessary to create an environment more conducive to skill development.

This is a necessary but not sufficient pre-condition for higher local content – which is low by international standards. A significant portion of the local supply chain for large-scale renewable energy is a result of the inclusion of selection criteria for local content in the Victorian Renewable energy Target auctions. Local content criteria which incentivise the use of local suppliers in renewable energy auctions have worked here and internationally – especially where there are multiple rounds of auctions. Auctions in exchange for local content and increased training could be a vehicle for increasing local jobs.

Pre-planning for pumped hydro construction

There has not been any hydro construction for some years in Australia. One project developer noted *“There is likely to be a shortage of hydro skills in Australia because it's a long time since any new hydro was built, so international recruitment is likely to be needed.”* Hydro has a higher proportion of construction labour than other renewable energy technologies and will create significant demand for local inputs (e.g. concrete). There could be significant competition for labour with other projects, for example Snowy 2.0 could overlap with the construction of new transmission lines. Hydro and pumped hydro could also create significant employment in the supply chain for concrete and steel in particular.

Coordination through the Renewable Energy Zones

The establishment of Renewable Energy Zones to coordinate and prioritise investment in network extensions to unlock regional renewable energy resources offers an ideal opportunity for better coordination and pre-planning of labour and skill requirements. Key stakeholders such as project developers and engineering, procurement and construction firms, electricity networks, governments and the regional development authority could identify labour requirements in advance to improve local content, employment and supply. The NSW Government has announced a pilot to unlock 3000 MW of renewable energy generation in the Central-West REZ which is an excellent opportunity to also pilot better workforce development arrangements (see https://energy.nsw.gov.au/renewables/renewable-energy-zones).

Regional industry development plans

The renewable energy industry should seek to play a pro-active role advocating for and participating in regional industry development plans for coal regions. Australia does not have a good history of managing structural change and there will be serious consequences unless there is major investment in diversifying regional economies ahead of the decline of the coal sector. It is the responsibility of governments and the mining industry to lead the transition, but the renewable energy industry can contribute via collaboration to retrain and employ workers in affected regions. Effective support for a ‘just transition’ in coal regions is needed both on the grounds of fairness and because anxiety, fear and division over the future of coal region communities is a serious barrier to clean energy transition.

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1. Introduction

Jobs in renewable energy have emerged as a key issue for energy transition. For the renewable energy industry, skill and labour shortages have been a recurrent problem as the industry has swung through ‘boom-bust’ cycles; local workforce gaps lead companies to use ‘coping strategies’ (e.g. offshore recruitment which reduces local employment) and increases project costs from competition for specialists. For local communities, there are questions about how many jobs renewable energy will create as traditional energy sources decline, the types of jobs and where they will be located. In particular, regions which rely upon coal mining and power generation are rightly anxious about whether existing jobs will be adequately replaced.

Currently, there is limited information on the volume, location and type of jobs in renewable energy in Australia. The international classification frameworks, used by the Australian Bureau of Statistics (ABS) and other national statistical agencies, measure employment within coal mining and fossil fuel power generation but not renewable energy (which is grouped as ‘other electricity generation’).[5] The ABS publishes an annual estimate of employment in renewable energy based on secondary sources (e.g. a literature review of employment factors) but does not collect survey data on renewable energy jobs. Consequently, there is an absence of robust Australian data on jobs in renewable energy.

The Clean Energy Council has commissioned the Institute for Sustainable Futures, University of Technology to undertake the first large-scale survey of employment in renewable energy in Australia. The objectives of the project are to:

- **Estimate total renewable energy jobs** from 2020 – 2035;
- **Profile the renewable energy workforce:** estimate jobs by occupation (electricians, engineers etc.) and location;
- **Support workforce planning** through employment projections and surveying the industry on **recruitment issues and skill shortages** to understand pressure points;
- **Assist in transition planning for regional areas** by comparing the volume and location of renewable energy and coal mining and generation jobs.

Photograph courtesy of ACCIONA Energy

[5] See Australian Bureau of Statistics (2017), *Employment in Renewable Energy Activities – Explanatory Notes*, for a summary. http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4631.0Explanatory+Notes12015-16. Accessed September 16 2018.

Scope of this study

This is the first stage of a two-stage project to estimate the number of jobs in renewable energy in Australia. It is not therefore a comprehensive estimate of all the renewable energy jobs in Australia.

Stage One includes solar and wind farms, distributed solar PV, hydro generation and pumped hydro and battery storage. Figure 9 shows the scope of the study.

The areas which were out of scope were:

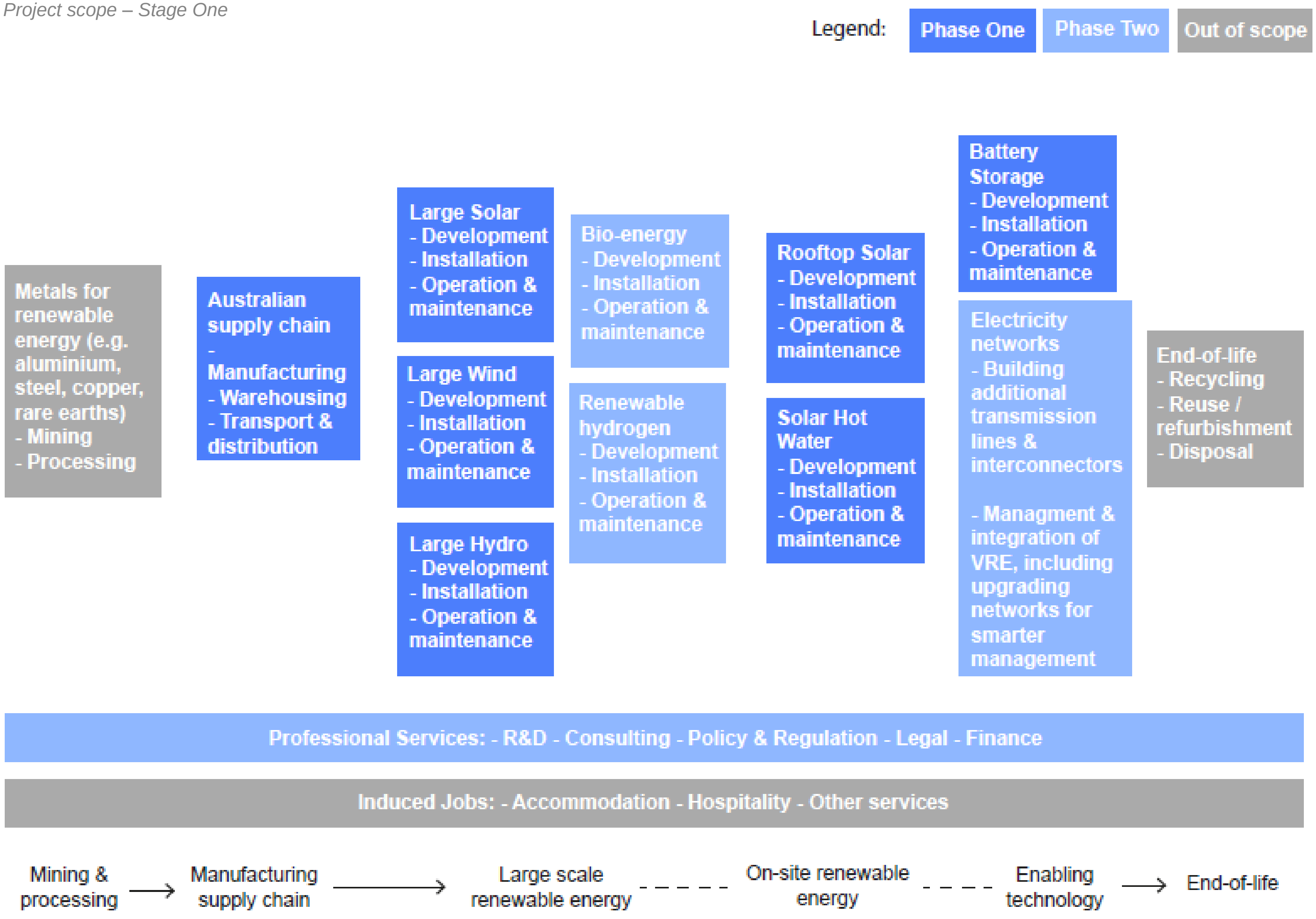
- **Mining for renewable energy** – the growth of renewables in Australia and overseas will drive demand for minerals such as lithium, nickel and rare earths.
- **Bio-energy** – bio-mass generation and waste-to-energy;
- **Renewable hydrogen –** a future potential export sector;
- **Professional services** outside the renewable energy businesses such as regulators, government offices and consultants;
- **Electricity network businesses** (e.g. building new infrastructure to connect and integrate renewable energy in regional areas);
- **End of lifecycle** – re-use, recycling and disposal

Within the sectors covered by Stage One, the scope of jobs is defined as follows:

- **direct jobs** (development, construction & installation and operation and maintenance);
- the **indirect jobs** within the supply chain which were surveyed for each of the technologies (local manufacturing, wholesalers and retailers, transport).
- **'induced jobs'** are not included (e.g. jobs created by the expenditure of construction workers in regional areas).

Photograph courtesy of AGL

Figure 9 Project scope – Stage One



2. Methodology overview: how were the job numbers calculated?

The methodology undertaken in this study is consistent with the standard techniques used to estimate renewable energy internationally. Simply put, an employment factor (full-time equivalent jobs/megawatt of installed capacity) is derived from industry surveys and applied to the level of installed capacity (MW) to estimate total employment. The employment factor is reduced over time to reflect productivity improvements.

There are five key steps used to estimate renewable energy employment and identify skill shortages or recruitment issues.

- **Step One: Industry surveys** to derive employment factors.
- **Step Two: Calculate employment factors** from the survey data, supplemented by literature review where required.
- **Step Three: Collate scenarios for renewable energy capacities** for the study period, based on the AEMO draft 2020 Integrated System Plan for the National Electricity Market, and Whole of System Plan supplemented by additional research for Western Australia.
- **Step four: Calculate employment projections** for each technology and region based on the capacity projections and the employment factors using an excel model.
- **Step Five: Calculate the occupational composition** of employment using survey data and the volume of employment from the total employment projections, and identify skill shortages from the surveys.

The calculation of employment for each of the renewable energy technologies (Step Four) was calculated using an excel model, with the calculation summarised in Figure 10. The calculation itself is simple. However, the robustness of the results is entirely dependent on the accuracy of the employment factor. For the occupational job estimates, survey data was used to estimate the proportion of total employment accounted for by each of the identified occupations, as illustrated in Figure 11.

Figure 10 Employment calculations - overview

Manufacturing employment for year	=	MW installed per year	x	Manufacturing employment factor for that year	x	% onshore manufacturing
Construction employment for year	=	MW installed per year	x	Construction employment factor for that year	/	Average construction time
Operation and Maintenance jobs	=	Cumulative capacity	x	O&M employment factor for that year		
Employment factor for year	=	2018/19 employment factor	x	Technology decline factor for relevant year		

Figure 11 Occupational calculations - overview

Manufacturing employment for year	=	MW installed per year	x	Manufacturing employment factor for that year	x	% onshore manufacturing
Construction employment for year	=	MW installed per year	x	Construction employment factor for that year	/	Average construction time
Operation and Maintenance jobs	=	Cumulative capacity	x	O&M employment factor for that year		
Employment factor for year	=	2018/19 employment factor	x	Technology decline factor for relevant year		

An overview of the key project steps is provided beneath, with a full description is provided in a separate methodology report (Rutovitz et al, 2020).

Step One: Industry surveys

Detailed industry surveys were used to collect data for each sector[6]. Each survey was piloted with a cross-section of business types and then distributed by the Clean Energy Council (and the Australian Industry Group in the case of the supply chain survey) to their members. For large scale solar, wind, hydro, utility batteries, and the supply chain most of the surveys were completed via interviews to improve data quality.

Table 1 summarises the numbers of respondents, the capacity coverage, and the proportion of the Australian industry represented.

The surveys collected data on:

- **Workforce numbers:** including the breakdown between employees and contractors;
- **Typical project data:** including size and occupational breakdown;
- **Business characteristics:** activities, scale of portfolio and technologies;
- **Skill shortages and recruitment issues:** level of difficulty recruiting for job types during 2018-19 and the causes for recruitment issues.
- **Other skill information:** use of apprentices and trainees, qualitative information on workforce and skills issues.

The wind, utility solar, and battery surveys achieved coverage from 20% to greater than 80% of the Australian industry, while the distributed solar survey achieved only 13%.

Table 1 Survey coverage

	No. of respondents[7]	Capacity covered	Proportion of Australian capacity
Utility solar	14	5.1 GW (development) 2.0 GW (construction) 2.7 GW (O&M)	46% (construction) 51% (O&M)
Wind	18	11.1 GW (development) 3.7 GW (construction) 6.3 GW (O&M	87% (construction) 74% (O&M)
Distributed solar	152	3.7 GW (construction) 6.3 GW (O&M)	13% (construction) 9% (O&M)
Solar water heating	8	756 systems	1% (installation)
Pumped hydro	7	2.4 GW (development) 2.2 GW (construction) 3.1 GW (O&M)	Respondents covered 80% of the existing (conventional and PHES) Australian capacity
Batteries	47	9.6 MW (construction) 35.7 MW (O&M)	**Residential data only**: Approx. 21% (installation) Approx. 24% (O&M)
Supply chain	Solar – 17 Wind - 5 Batteries - 11	6.5 GW (solar) 2.1 GW (wind) 29.7 MW (batteries)	n/a

[6] For copies of the surveys and more detail see the methodology report (Rutovitz et al, 2020).

[7] "Respondents" only counts those with sufficiently complete data to undertake analysis; of these 10 distributed solar responses and 16 batteries responses were excluded as annual installations were considered too low (less that 10 kW and less than 4 installations respectively).

Step Two: Employment factors

Table 2 summarises the employment factors. Employment factors were calculated primarily from survey data, supplemented by other data sources where necessary. Manufacturing and construction/ installation jobs are measured as full-time equivalent job-years per megawatt of installed capacity (job-years/MW) as they are for a set period of time. O&M jobs are measured in full-time equivalent (FTE) jobs per MW, as they are ongoing for the life of the renewable energy project. For example, using the factor from Table 2, a 1000 MW wind farm would create 2,800 job-years of employment; as it takes about two years for construction, this would average 1,400 jobs for two years.

Table 2 Employment factors

	Construction/ installation	Manufacturing All	Manufacturing Onshore	Operations & maintenance
	Job-years/MW			Jobs/MW
Wind	2.8 (1)	1.7 (3)	0.4	0.2 (1)
Utility Solar	2.3 (1)	4.4 (3)	0.1	0.1 (1)
Rooftop PV	5.8 (1)	4.4 (3)	0.2	0.2 (1)
Utility batteries	4.7 (1)	6.6 (1)	0.3 (4)	1.2 (1)
Distributed batteries	5.6 (1)	6.6 (1)	0.3 (4)	0.3 (1)
Hydro	7.4 (2)	3.5 (2)	0.7 (5)	0.1 (1)
Pumped hydro	11.1 (1)	3.5 (2)	0.7 (5)	0.2 (1)
	Job-years/ system			
Solar water heating	0.015	n/a	0.0021 (6)	-

Note 1: Factor derived in this study
Note 2: Factor from Rutovitz et al, 2015.
Note 3: Factor from IRENA 2017 & 2017a
Note 4: Assumed 5% occurs on shore.
Note 5: Assumed 20% occurs onshore.
Note 6: ABS, 2019

The employment factors derived for this study are higher than the factors which have been used by the ABS, but significantly lower than other international estimates (Table 3). The ABS do not include O&M employment.

Table 3 Employment factors – comparison with other work

UTILITY SOLAR	This work	ABS (2019)	Solar Foundation (2018)	IRENA (2017a)
Construction	2.3	1.8	3.3	3.9
Manufacturing	0.1	n/a		4.4
Utility solar O&M	0.1	n/a		1.2
WIND	This work	ABS (2019)	ISF (2015)	IRENA (2017b)
Construction & development	2.8	1.2	3.2	3.3
Manufacturing	0.4	0.1	0.3	0.2
O&M	0.2		4.7	1.7
DISTRIBUTED SOLAR	This work	ABS (2019)	Solar Foundation (2018)	Ernst & Young (2017)
Construction	5.8	4.7	1 - 6	21 - 38
PUMPED HYDRO	This work	ABS (2016)	ISF 2015	NREL (2016)
Construction & development	7.2	n/a	n/a	17.2
O&M	0.1	n/a	n/a	0.1

Step Three: Renewable energy scenarios

The scenarios of the energy system operators were used for the employment projections wherever possible. For the National Electricity Market (NEM)[8], two of the growth scenarios and the Business as Usual scenario from AEMO's draft 2020 Integrated System Plan (AEMO, 2019) were used to project the growth of renewable energy:[9]

- **Central scenario**: growth is determined by market forces under current federal and state government policies (i.e. no additional policy).

[8] Note the NEM includes QLD, NSW, ACT, VIC, SA, TAS

[9] There are five scenarios in total. In addition to the three used for this study, there is a 'slow change' and a 'fast change' scenario.

- **Step change**: strong policy commitments occur consistent with the Paris Climate Agreement with accelerated exits of coal generators.
- **High Distributed Energy Resource**: higher growth in rooftop solar, battery storage and demand-side flexibility relative to large-scale renewable energy generation.

The installed capacity in each scenario until 2035 is shown in Figure 12.

The net present value of the three NEM scenarios are relatively similar, with the Step Change 6% higher and the High DER 8% lower than the Central scenario (table 4). However, the emissions variation is much greater, with the Step Change scenario reducing emissions by 40% compared to the Central, while the High DER is just 2% lower. The Step Change and High DER scenarios also create more employment than the Central Scenario.

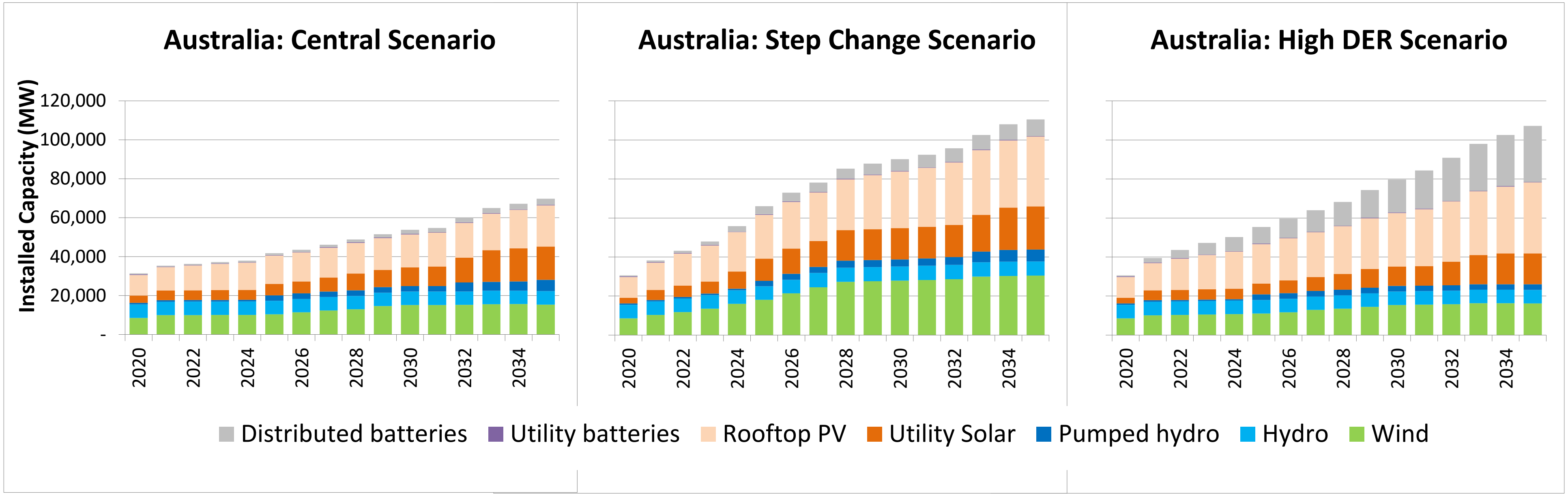
Table 4 NPV and Emissions Reductions, AEMO ISP Scenarios (NEM only)

	Central	Step Change	High DER
NPV ($ billion)	$84.9	$89.8	$78.3
Cumulative emissions to 2040 (MT)	2,041	1,227	1,991

The Western Australian Government is currently developing a Whole of System Plan (WSP) for the South West Interconnected System (SWIS). There are four scenarios:

- **Techtopia**: technological change places downward pressure on energy costs
- **Groundhog Day**: renewables thrive, but reliance on the network remains high
- **Cast Away**: leaving the grid with muted economic growth
- **Double Bubble**: booming economy with limited global action on climate change.

Figure 12 Renewable energy scenarios



The WSP modelling for distributed renewable energy has been used for this study, however, the rest of the modelling is only at draft stage so is not able to be used. In the absence of the WSP modelling for utility-scale renewable energy, assumptions have been made on the proportion of potential projects which will go ahead under each of the scenarios.[10]

Step Four: Calculating renewable energy employment

Calculating the employment from the renewable energy scenario for any year uses the basic relationships shown in Figure 10; for example, for construction, the employment for the year is:

$$\text{Employment for year} = \frac{MW\ installed\ x\ employment\ factor\ for\ year}{\text{Average construction time}}$$

The employment factors for manufacturing, development, and construction are in job-years, so the result is divided by the average construction time to find the jobs for that particular year. For operations and maintenance, the cumulative installations are multiplied by the job factor in jobs per MW.

Employment per MW tends to reduce over time, both because labour practices become more efficient and because technology changes, and the reduction in labour contributes to cost reductions (for example, the standardisation of rooftop PV systems reduces install times). This does not mean that wages are reduced, rather the amount of labour required per MW goes down. For example, as the average wind turbine size increased from 0.5 MW to 3 MW, the installation labour required per MW reduced significantly. We have not attempted to disaggregate the technology cost reductions projected for the next decade into capital and labour, but rather assume that the labour requirements will decline in line with cost reductions.

The employment factor for the year in question is the employment factor from the base year, reduced by decline in technology cost. The annual decline in technology costs have been sourced from the ISP data for each scenario except distributed solar and batteries, with the decline for those technologies calculated from the data in the CSIRO GenCost report (Graham et al, 2019). As Table 5 illustrates, the decline in cost is typically higher in the Step Change scenario, partly offsetting the higher levels of installed capacity.

For the occupational job calculation, survey data was used to derive the proportion of total employment accounted for by each of the occupations for each technology.

For solar and wind farms, occupational shares were calculated for each phase - development, construction, O&M and manufacturing – and then weighted based on the share of the phase in the overall employment factor.

In the case of distributed solar, occupational shares of employment were calculated for commercial and residential solar and then weighted based on their relative market shares (residential 73%, commercial 27%).

Table 5 Renewable Energy Cost Reductions, 2020-2035

	2035 cost as proportion of 2020 cost		
	Central	Step Change	High DER
Wind	87%	74%	87%
Utility Solar	38%	37%	44%
Rooftop PV	41%	41%	41%
Utility batteries	51%	54%	66%
Distributed batteries	46%	46%	46%
Pumped hydro	98%	96%	99%
Wind repowering	87%	74%	87%
Solar repowering	38%	37%	44%

The table shows the 2035 cost as a proportion of the 2020 cost; for example, the 2035 wind cost is 87% of the 2020 wind cost in the Central scenario, and 74% in the Step Change scenario. See the methodology report (Rutovitz et al, 2020) for details of how the reductions were calculated.

[10] For more detail on the WA scenarios, including the list of identified projects, see the methodology report (Rutovitz et all, 2020).

Step Five: Skill shortages

The skill shortage analysis is based on data from the surveys on recruitment issues and skill shortages, combined with the occupational employment mix projections. The questions on recruitment were aligned with the classification system used by the Department of Education, Skills and Employment (Department of Employment 2017) to inform its assessment of skill shortages.

Respondents were asked to classify the level of difficulty for recruiting occupations over the past 12 months into one of the three ratings:

- **Low Difficulty:** Able to find the workers needed in Australia within 4 weeks or less
- **Medium Difficulty:** Able to find the workers needed in Australia within 5 - 8 weeks
- **High Difficulty:** Unable to find workers needed in Australia within 2 months
- For occupations where medium or high difficulty had been experienced, the respondent was asked to classify the cause(s) based on 6 categories (multiple responses were permitted):
- Not enough candidates with the right qualifications / licenses;
- Not enough candidates with general experience;
- Not enough candidates with specific experience in renewable energy projects;
- Suitable candidates but they wanted higher pay;
- Difficulty attracting suitable candidates for projects in regional or remote locations;
- Suitable candidates but they wanted longer-term employment.

Respondents were also asked to identify any other workforce, skills or recruitment issues and if they engaged apprentices and trainees.

Photograph courtesy of ACCIONA Energy

3. Renewable Energy Jobs in Australia

Renewable energy boomed in Australia in the period ahead of the survey. Records were set during both 2017 and 2018 in large-scale renewable energy and distributed solar.

During 2018, there were 27 large-scale solar and wind projects commissioned with an investment of $10 billion and 17 projects went into construction. Renewable energy accounted for just over one-fifth of electricity generation. AEMO generator information reports show over 49,000 MW of large solar and wind are currently proposed or committed (AEMO 2020).

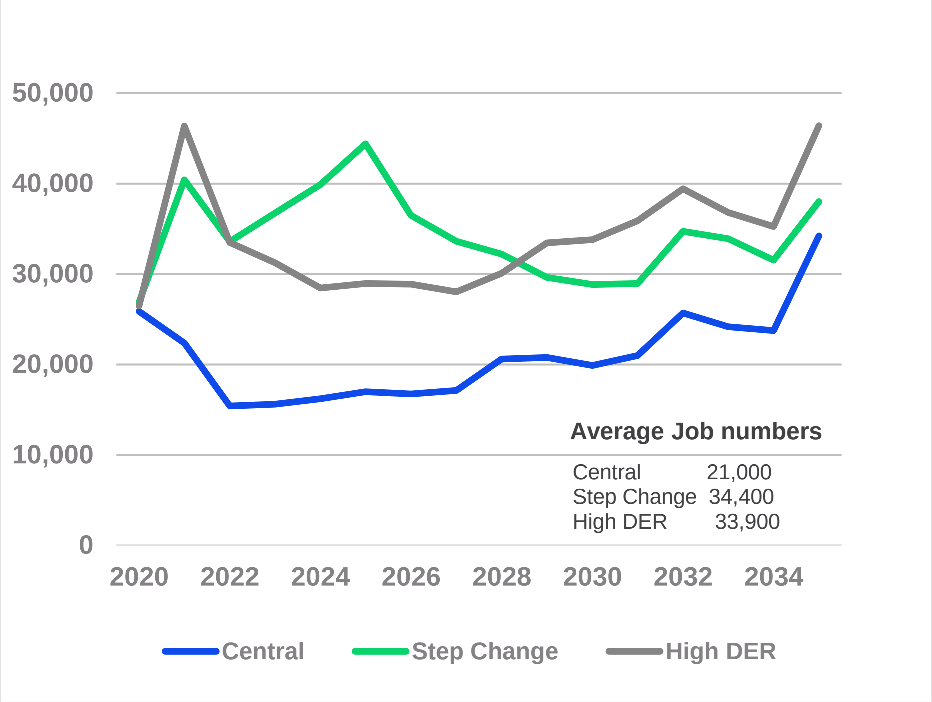
This context should be kept in mind when considering the results. The projections use employment factors derived from 2018-19 and apply them to renewable energy growth scenarios starting in 2020. Typically, labour intensity falls during a boom period, so it is possible this will underestimate the amount of jobs created. Also, whilst the industry is currently in a slow-down, the survey results provide an insight as to where the skill shortages and pressure points could emerge in future upswings.

How many Jobs will be created by Renewable Energy?

Figure 13 shows the overall number of renewable energy jobs over the study period in each scenario. Compared to about 26,000 jobs in 2020, there are 34,400 jobs on average in the Step Change scenario, 8,400 more than today, and in the High DER there are on average 7,900 more than today. However, in the Central, or Business as Usual, scenario average job numbers are nearly 5,000 lower than now.

In both the Step Change and the High DER scenario, renewable energy jobs increase steeply in the immediate future, after which, in the High DER scenario, they return to current levels until about 2027. In the Step Change scenario renewable energy jobs stay above 33,000 until 2027, after which they fall until coal retirements increase in the early 2030s. Renewable energy jobs in the Central scenario fall by about 11,000 by 2022 and then flatline for five years, corresponding to a hiatus in the industry while there is very little new capacity installed (see Figure 11), after which they start increasing again.

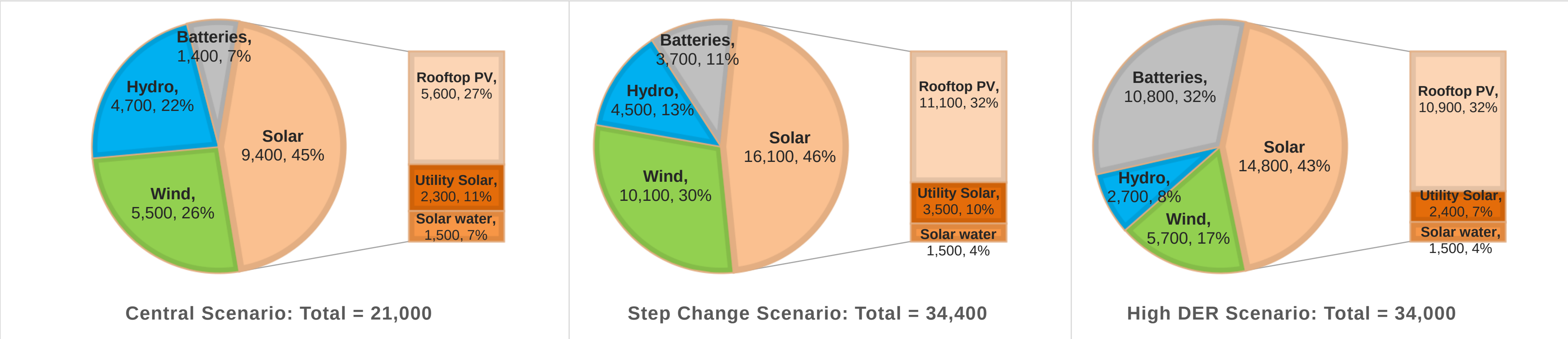
Figure 13 Renewable energy jobs in Australia, 2020-2035 (all scenarios)



The average proportion of jobs by technology in each scenario is shown in Figure 14. Solar creates the highest proportion of jobs in all scenarios, and is responsible for more than 40 per cent of renewable jobs in each one, with distributed solar responsible for most of that. The actual numbers vary considerably from one to another, with distributed PV creating an average of about 11,000 jobs in both the Step Change and the High DER scenario, compared to only 6,900 in the Central scenario.

The next biggest job creator is wind in both the Step Change and the Central scenarios, creating an average of 10,000 and 5,000 respectively. In the High DER scenario, the next largest job creator is batteries, with more than 10,000 jobs, compared to only 5,600 in the Central scenario.

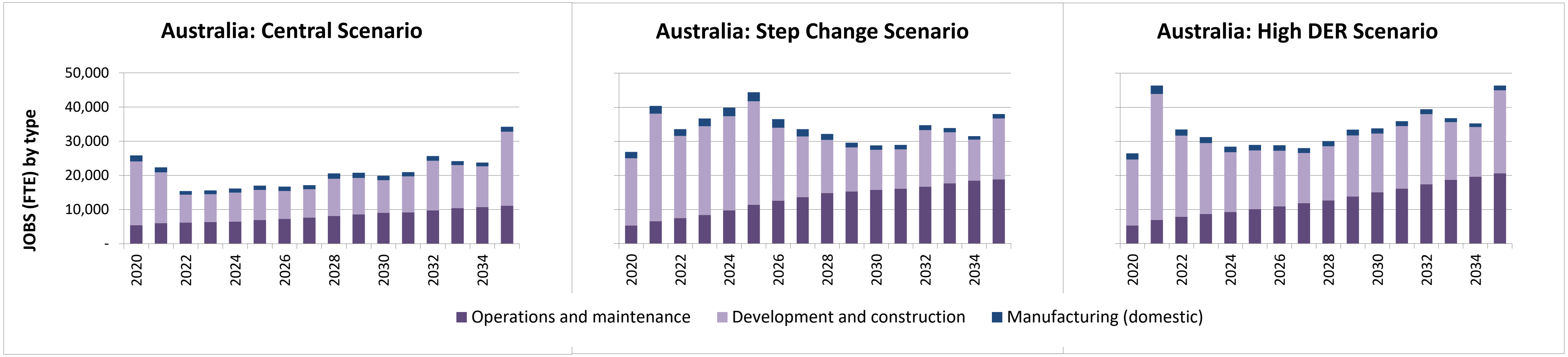
Figure 14 Average Renewable energy jobs by technology 2020 – 2035, all scenarios



Note: Appendix 1 gives an annual breakdown of jobs by technology for each scenario.

Most jobs in renewable energy are currently in construction but over time this changes significantly. Figure 13 shows the breakdown of jobs by scenario into operations and maintenance, development and construction, and manufacturing (noting that this is only onshore manufacturing). By 2035, O&M jobs could be half the renewable energy jobs. This trend is driven by wind farms, creating permanent, good quality blue-collar jobs, which are very likely to be in regional areas. The Step Change scenario performs best: by 2035 O&M jobs are 50% of RE jobs, compared to 45% in the High DER and only 32% in the Central scenario.

Figure 15 RE jobs by project stage 2020 – 2035, all scenarios

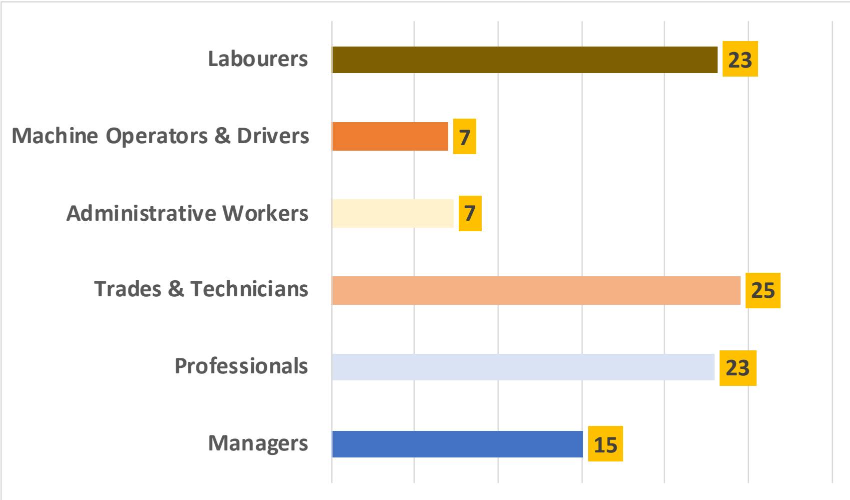


What type of Jobs will be created by Renewable Energy

The surveys collected detailed information on occupational employment across each of the renewable energy technologies and then calculated the occupational mix across the industry.

The major types of occupation are trades and technicians, labourers and professionals which together account for almost three-quarters of employment. For trades and technicians, over 8500 jobs could be created on average per annum and over 8000 for labourers and professionals. Employment peaks at over 11,000 for trades & technicians and over 10,000 for professionals and labourers (see Appendix 3).

Figure 16 Renewable Energy jobs, Occupational Composition, 1-Digit (%)



Note 1: these figures are an average from 2020-2035 under the Step Change scenario.

Note 2: The label 'managers' is frequently applied to professional jobs, even if they are not managing staff. Whilst efforts were made to adjust for this by defining managers as only those who had staff to manage (and inform respondents of the definition), it is highly likely the proportion of managers is over-stated and the proportion of professionals is under-stated.

Photograph courtesy of ACCIONA Energy

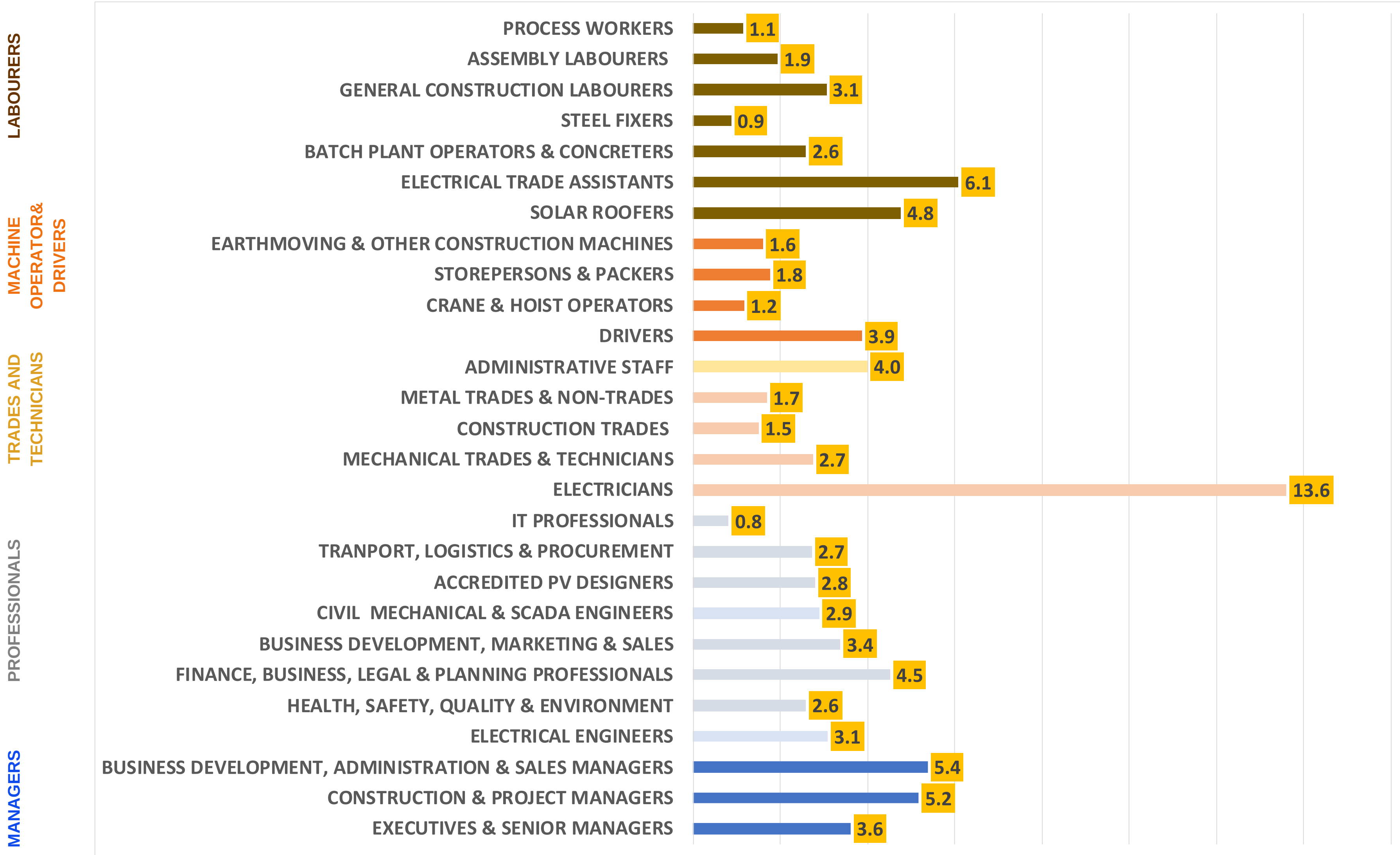
The results for these high-level occupation groupings aggregate data for specific occupations. In the Australian New Zealand Standard Classification of Occupations, occupations are gradually disaggregated into more specific job types from 1-digit (e.g. trade and technician) to the 4-digit level (e.g. electrician). In this study, a decision was made to use labels and jobs that best resembled industry practice – tested through pilot surveys – instead of asking respondents for answers based on job labels in the hierarchy. The job types are either 2, 3 and 4-digit categories depending on the volume of work – and therefore described as ‘composite’.

Almost one-fifth of the workforce is an electrician or an electrical trade assistant, but beyond this group there is a diverse range of occupations employed by the renewable energy industry:

- Amongst the trades and technicians, the next largest group is mechanical technicians (especially in O&M) and smaller demand for construction trades and metal trades (in the wind supply chain)
- The most common labourer is a roofer for solar PV but there is also a range of construction labourers and some process workers (in the wind supply chain)
- Amongst machine operators and drivers, the largest group is drivers (large-scale project truck drivers, specialist construction drivers and deliveries) followed by store persons and packers (mostly for imported solar technology) and crane operators (especially in wind farms)
- Amongst the administrative staff, there are on-site administrators for large-scale renewable energy, office and contract managers and executive assistants and clerical staff
- There is a range of reasonably equally sized professional occupations including finance and business professionals, business development, marketing and sales, electrical engineers and PV designers.
- There is a smaller but emerging group of systems and software engineers associated with solar data analytic firms
- Amongst the managers, business development managers and construction and project managers are the largest groups.

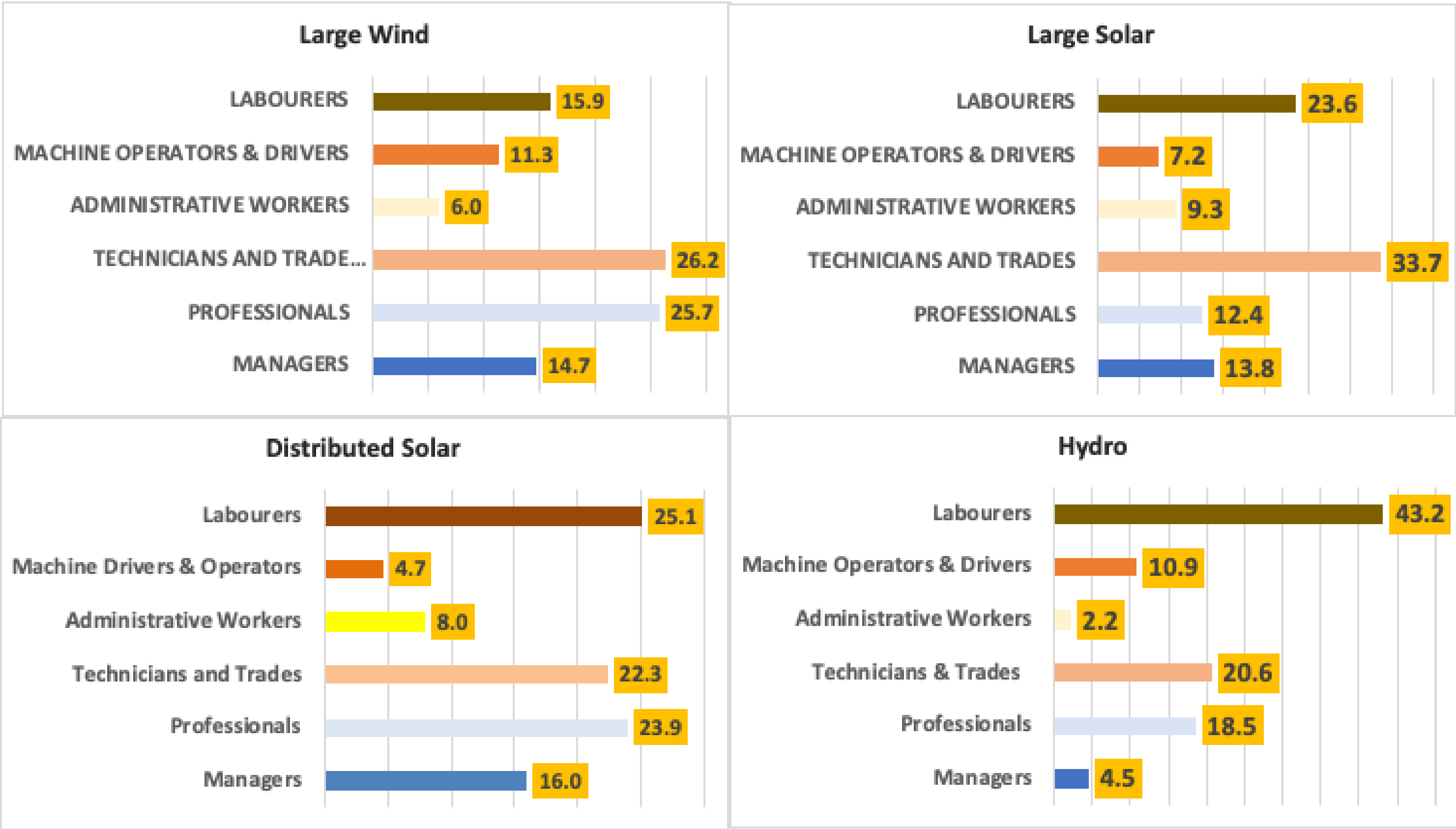
Photograph courtesy of the Clean Energy Council

Figure 17 Renewable energy, occupational composition, composite (%)



Note: these figures are an average from 2020-2035 under the Step Change scenario.

Figure 18 Renewable energy technologies: occupational composition (1-digit) (%)



There are some significant differences between the technologies (Figure 18):

- Hydro and Pumped hydro have a higher proportion of labourers and trades and technicians, reflecting the scale of construction required;
- Large wind has a more even spread across occupations and higher proportion of professionals and managers, reflecting a more complex and diverse workforce;
- Large solar has a simpler workforce structure with a greater use of trades and technicians relative to professionals;
- Distributed solar is the closest to the industry average with labourers, professionals and technicians accounting for almost three-quarters of the workforce.

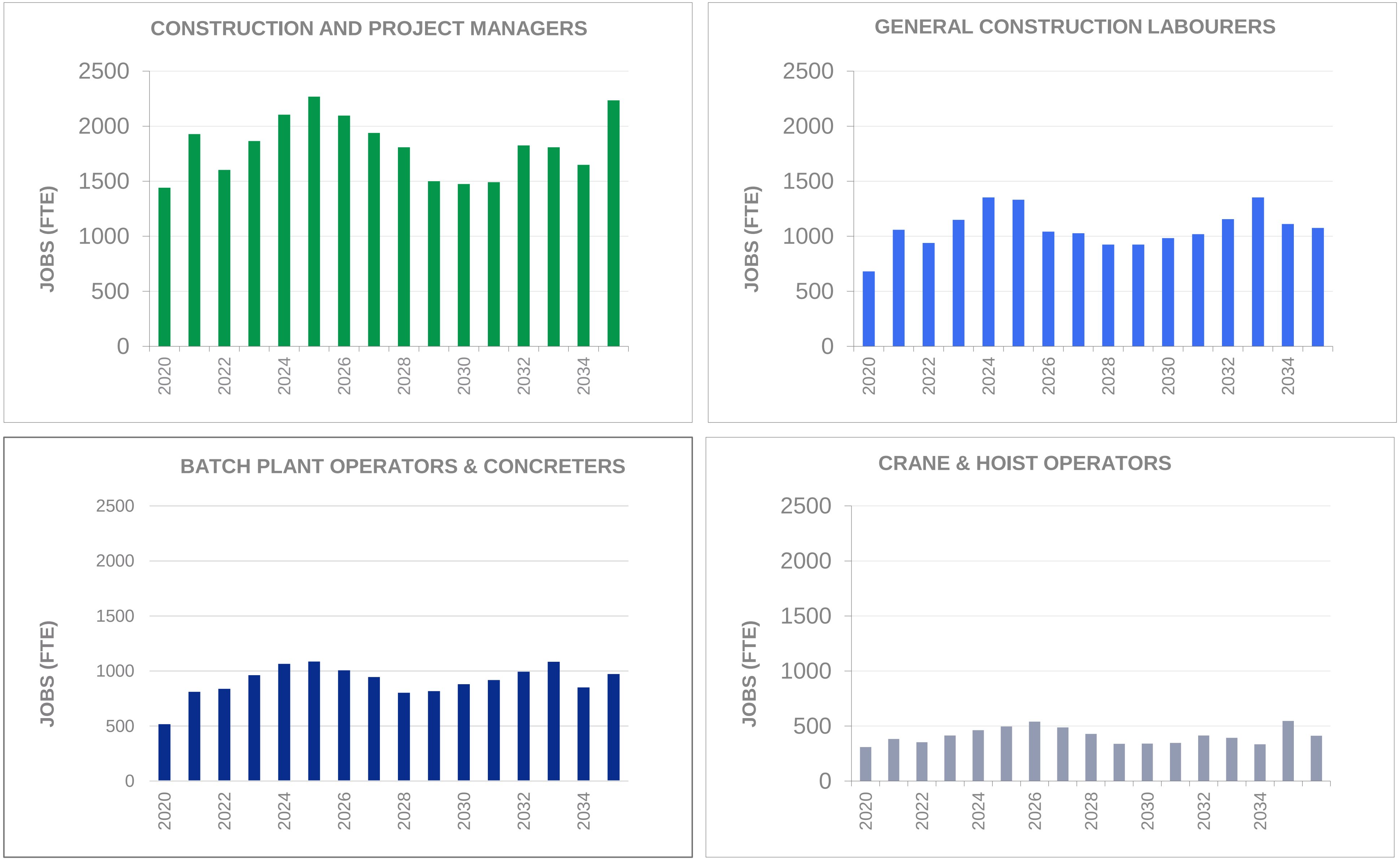
Figure 19 illustrates the level of job creation for some of the leading occupations over time:

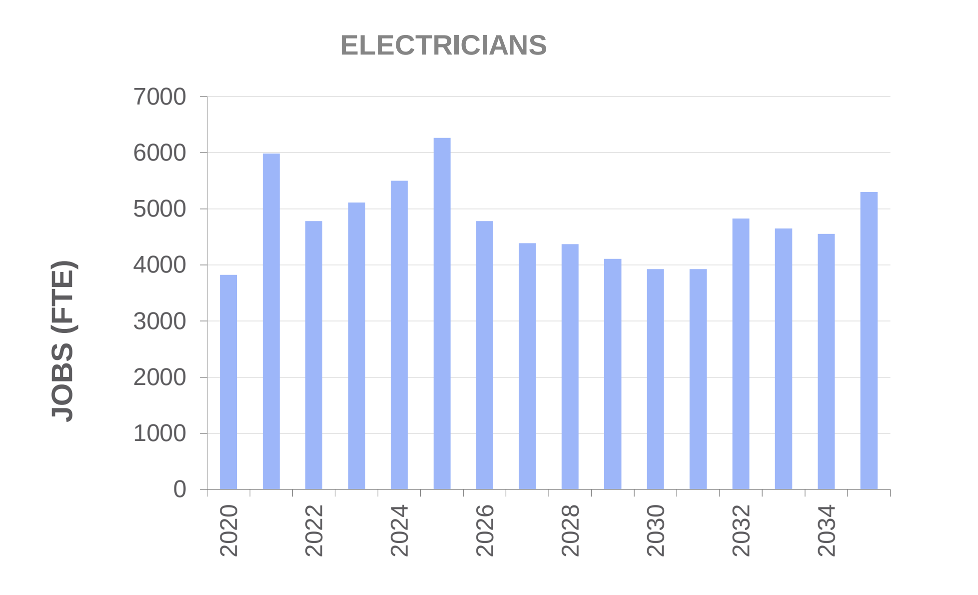
- Electricians are the leading occupation, peaking at over 6000 jobs, with a further 2000-3000 electrical trade assistants;
- Generally, there is over 2000 engineers (with a mix of electrical, civil, mechanical and scada engineers);
- There are around 1000-2000 solar roofers employed annually;
- Construction managers are an important part of the renewable energy workforce;

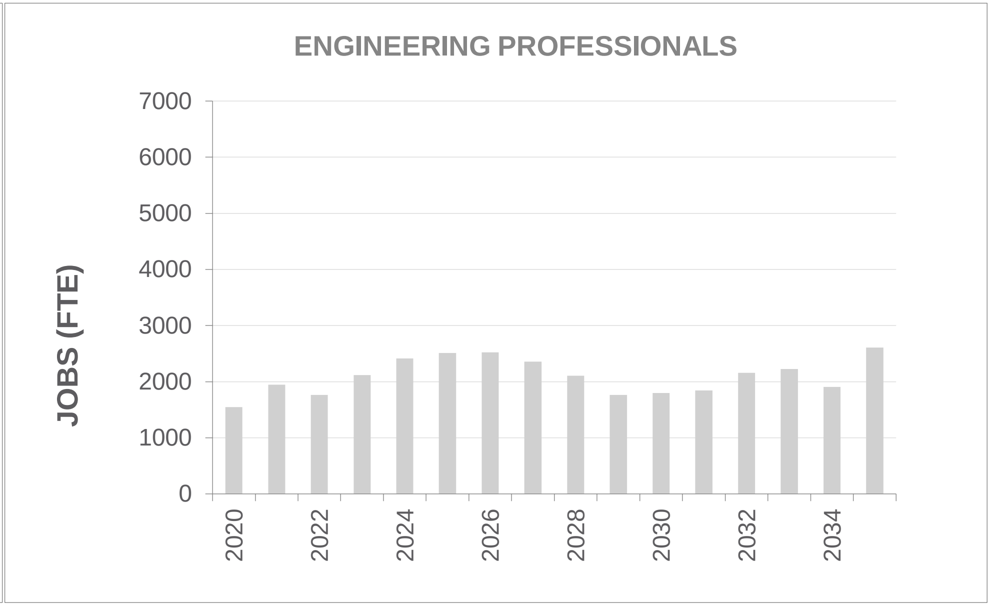
General construction labourers (not including module assemblers on solar farms) fluctuates around 1000 -1500 workers, concreters around 1000 and crane and hoist operators are less common around 500 annually (but very important for wind farms).

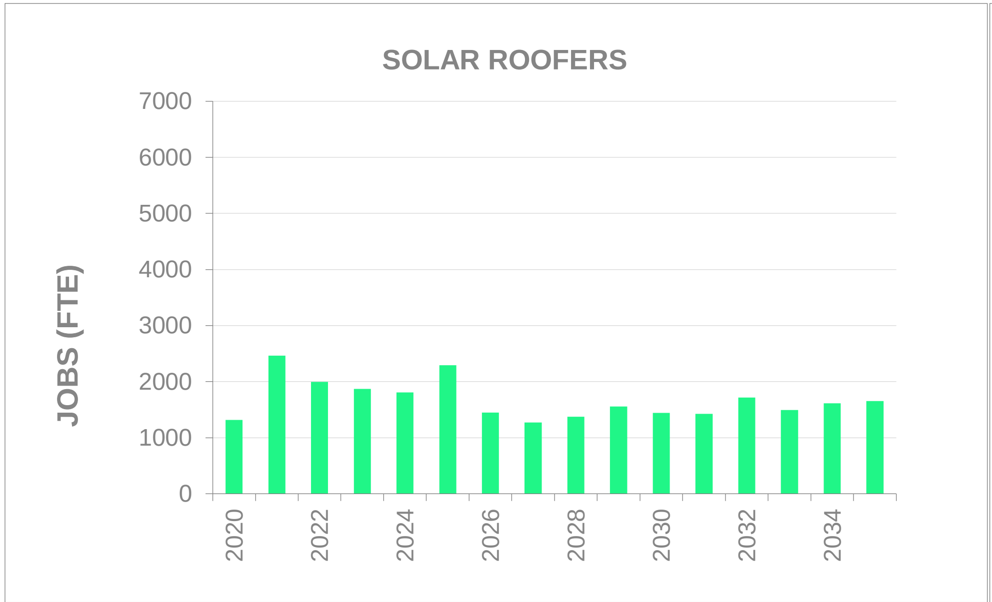
Photograph courtesy of the Clean Energy Council

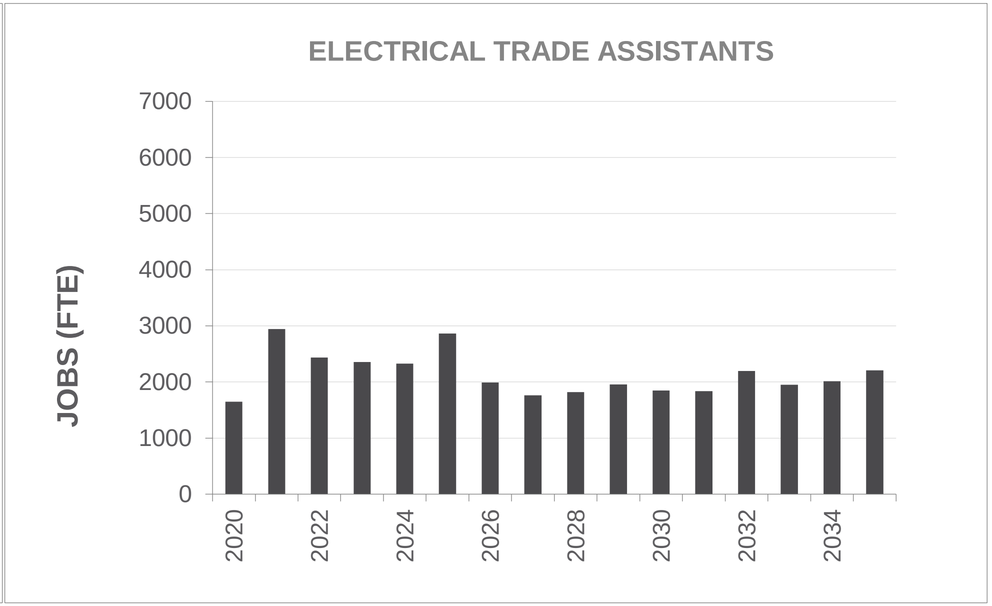
Figure 19 Renewable energy: employment for selected occupations, all technologies (Step Change scenario)




ELECTRICIANS
JOBS (FTE)
7000
6000
5000
4000
3000
2000
1000
0
2020
2022
2024
2026
2028
2030
2032
2034


ENGINEERING PROFESSIONALS
JOBS (FTE)
7000
6000
5000
4000
3000
2000
1000
0
2020
2022
2024
2026
2028
2030
2032
2034


SOLAR ROOFERS
JOBS (FTE)
7000
6000
5000
4000
3000
2000
1000
0
2020
2022
2024
2026
2028
2030
2032
2034


ELECTRICAL TRADE ASSISTANTS
JOBS (FTE)
7000
6000
5000
4000
3000
2000
1000
0
2020
2022
2024
2026
2028
2030
2032
2034

Where are the Renewable Energy jobs?

Jobs are highest in NSW in all scenarios, which averages between 5,900 jobs per year (Central scenario) to 9,500 (High DER scenario). Queensland has the next highest level of job creation, averaging between 5,000 jobs (Central scenario) and 8,300 jobs (Step Change scenario). Much of the growth in renewable capacity is driven by State government policy, so the distribution of new jobs by state is of interest.[11] The Central Scenario includes current state Government policies but new State Government policies could change the distribution of jobs between states.

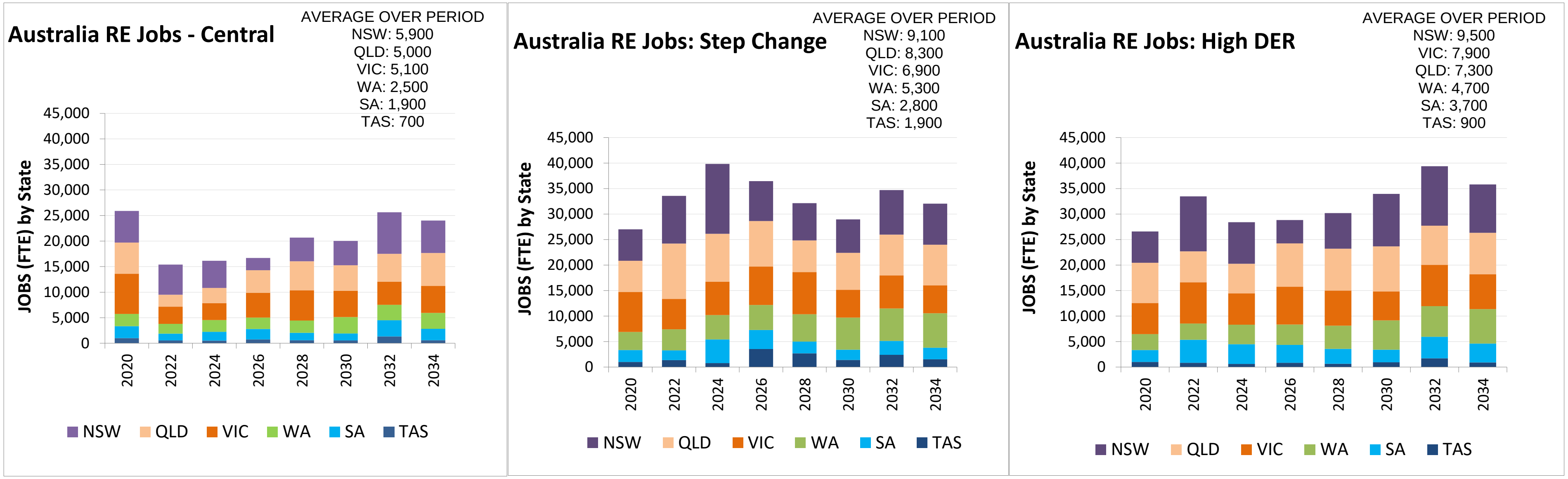
One of the key questions relating to renewable energy jobs is the extent to which they will create regional and local jobs. Estimating the jobs at a local level is complex because large-scale renewable energy projects source labour at different scales:

International: specialist skills that are in shortage in Australia (e.g. grid engineers)

- **National:** recruitment for professionals and sometimes trades and technicians – almost all companies interviewed for the project did not see any significant variations in recruitment and skill shortages between states
- **Regional:** workers are sourced from major towns or capital cities and then move from project to project (e.g. Newcastle-based wind firm with engineers, electricians etc)
- **Local:** jobs sourced local to the project site significantly varies depending on location – but generally labourers, some trades & technicians, some construction managers and site administrators

Approaches could also change over time if, for example, there are initiatives to build local and regional workforce capabilities.

Figure 20 Renewable energy jobs by state, all scenarios 2020-2035



11 See https://bit.ly/REjobsAu for detailed results by state.

In the survey for large-scale renewable energy, companies were asked to estimate the proportion of jobs that were sourced ‘local’ to the project (defined as within 100 kilometres). For the job estimates, our interest was on the portion of jobs that could be locally or regionally located for future projects. For distributed solar, it was assumed that all the installation and maintenance jobs could be local and regional. Based on the survey and discussions with companies, estimates were produced on the percentage of each occupation that could be local or regional for solar and wind farms, that is, outside capital cities (Table 6).

The equivalent proportions from the hydro survey were 84 per cent of construction employment and 93 per cent of operations and maintenance employment in regional areas. We have conservatively assumed that manufacturing is split equally between the capital cities and regions for all technologies (in practice our expectation is a higher proportion of manufacturing is located in regional areas).

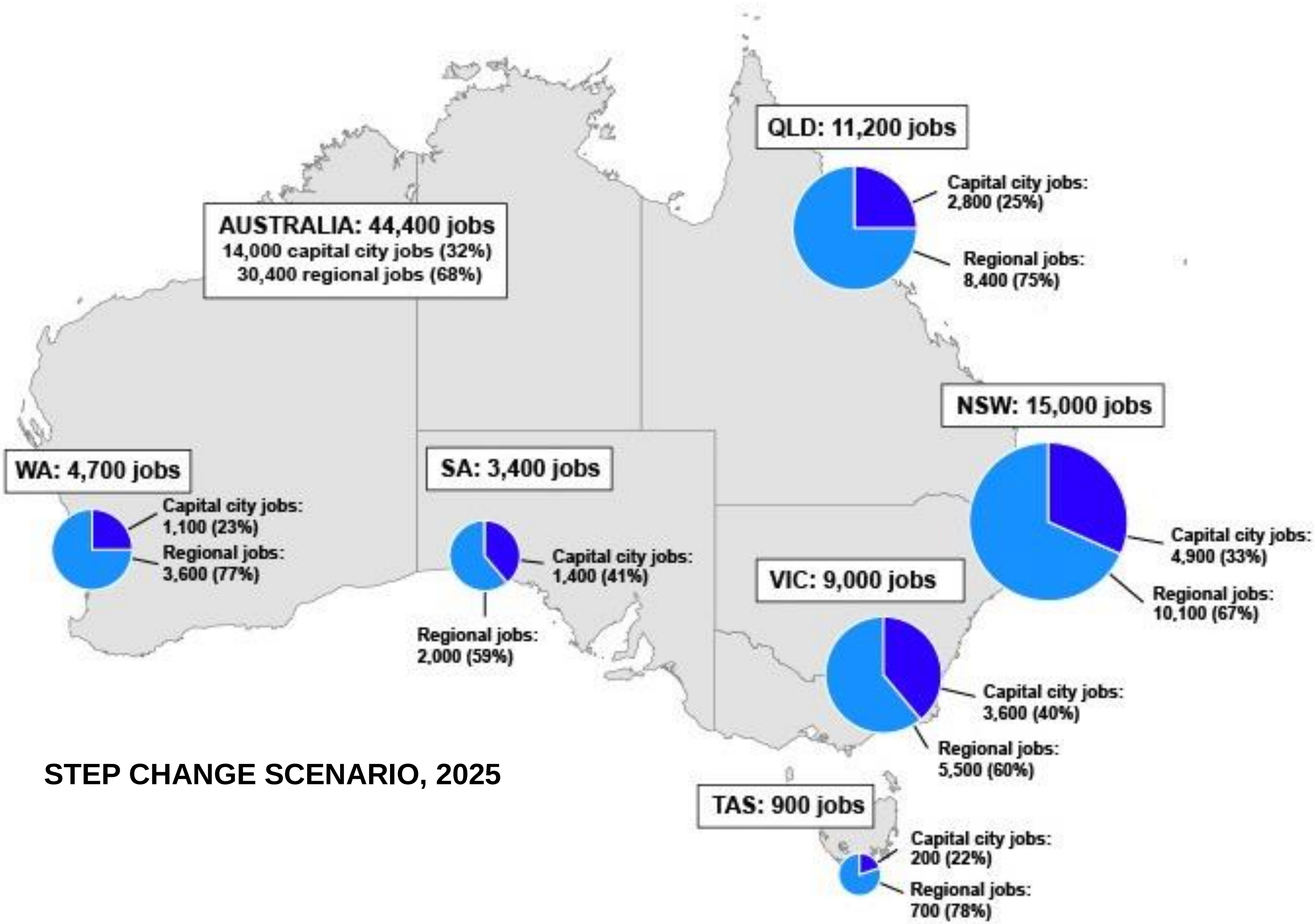
We found that about two-thirds of jobs could be located in regional areas – with some variation between states depending on the technology mix. The actual proportion of local and regional jobs will depend on government and industry approaches, and could for example be improved by policies requiring local content or training.

Table 6 Proportion of regional jobs for large wind and solar

	Regional job %	**Wind farms**		**Solar farms**	
		% of total jobs	Regional job %	% of total	Regional %
Development phase	0%	n/a	n/a	n/a	n/a
Construction managers	70%	8%	6%	7%	5%
Electrical engineers	40%	6%	2%	2%	1%
Civil & mechanical engineers	40%	5%	2%	3%	1%
Health Quality Safety Environment	50%	4%	2%	1%	1%
Logistics	90%	10%	9%	17%	15%
Other professionals and managers	0	0	0	0	0
Site administrators	100%	3%	3%	2%	2%
Trades & technicians	90%	10%	9%	17%	15%
Drivers, Machine Operators & Labourers	100%	28%	28%	30%	30%
Overall regional proportion		73%	60%	79%	70%

Note: the assumed regional proportion has been applied to the composite split for that development phase to arrive at the overall regional % for each technology. The percentages are independent of the AEMO scenarios.

Figure 21 Renewable energy jobs, capital cities and regions (Step Change scenario, 2025)



> People over-estimate the number of mining jobs – they don't see renewable energy as creating real jobs; they think of someone installing solar panels and ask, what comes next?

Rebecca Huntley, Social Researcher
Vox Populi Research

Photograph courtesy of ACCIONA Energy

What is the role for renewable energy jobs in transition for coal regions?

As the transition to renewable energy accelerates in Australia and globally, the future for workers and communities in coal regions has become a major concern. Coal mining and generation is concentrated in the La Trobe Valley (Victoria), Hunter Valley (NSW) and the Bowen Basin (Queensland). Investment and planning to diversify these regional economies are essential to avoid major economic and social hardship.

To understand the role renewable energy can play in supporting economic development and jobs creation for coal regions, three dimensions considered are here:

- the aggregate employment for the coal sector and renewable energy;
- the match between occupational employment in coal and renewable energy;
- the location of the renewable energy projects and jobs.

The short answer is this; renewable energy cannot replace the loss of jobs in coal mining - but the sector can play a meaningful role in creating alternative employment within a wider regional industry development strategy that builds a range of industries as the coal sector declines.

Aggregate employment in coal and renewable energy

There are a number of benchmarks used here for comparing coal industry employment with renewable energy:

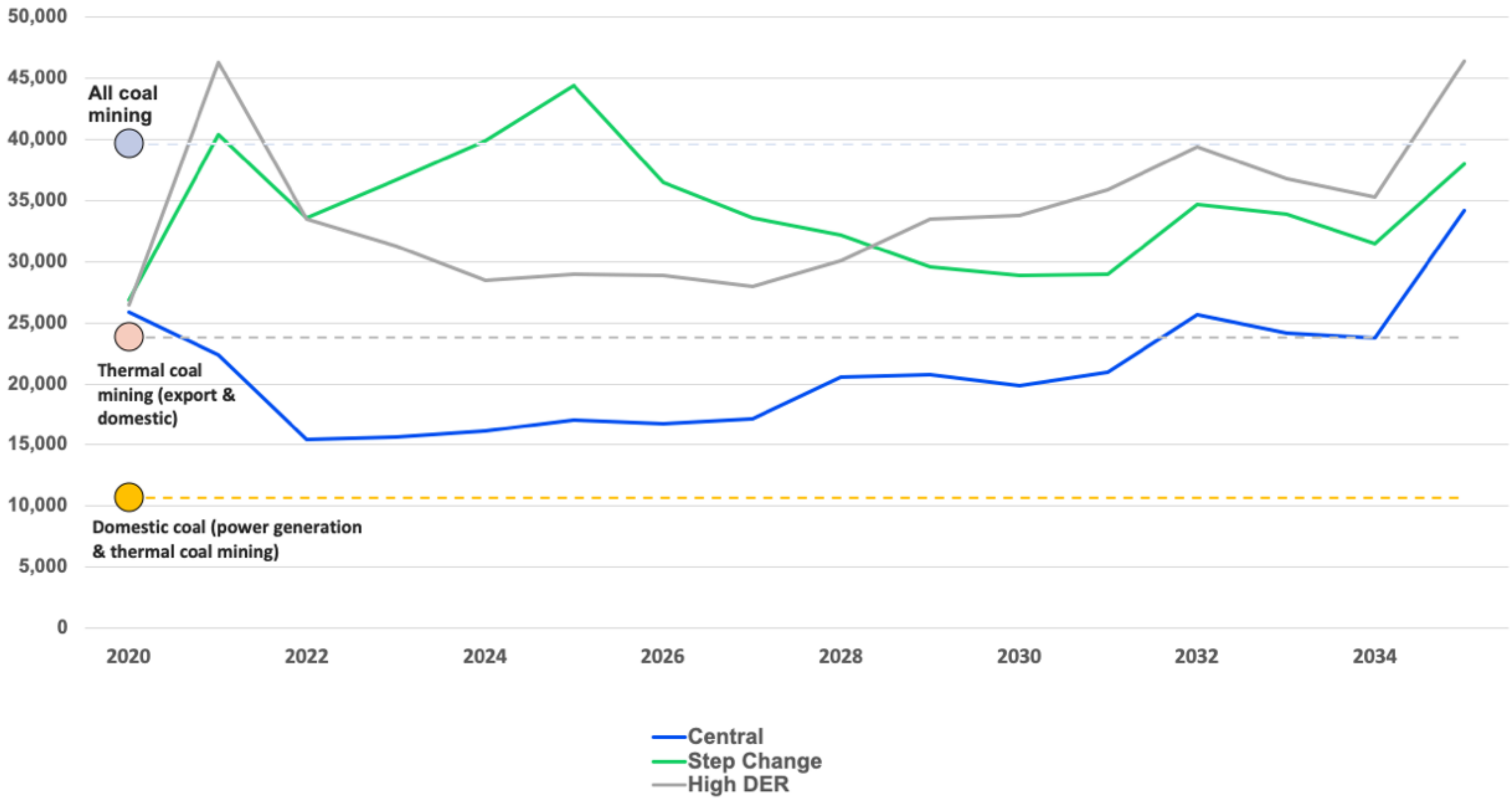
- **Domestic coal sector**: the local power stations and thermal coal mining for generation;
- **Thermal coal mining**: around 75 per cent of mined coal is exported. The future of the export coal sector depends fundamentally on international demand – and different forecasts from major agencies contain very different futures from incremental growth to abrupt decline.[12]
- **All coal mining**: this includes metallurgical coal mining as well as thermal coal mining, export and domestic. Metallurgical coal for steel production is less vulnerable than thermal coal mining but the growth of ‘green steel’ technologies and electric arc furnaces in South-East Asia could reduce demand over time.

Our study did not forecast the future of coal employment. Comparisons were made between projections of renewable energy employment and current coal employment (see overleaf).

Photograph courtesy of Craig Sillitoe Photography

[12] The International Energy Agency has three scenarios – stated policies, new policies and sustainable development. Under the first two scenarios, Australian coal exports are projected to grow modestly but under the sustainable development scenario there would be a sharp decline as coal falls from 40 per cent to 5 per cent of global electricity generation.

Figure 22 Employment in renewable energy and coal



The key points to note:

1. Renewable energy employs significantly more people across all scenarios than current employment in the domestic coal sector, which is around 11,000. The growth of renewable energy displaces jobs in the domestic sector – not the export sector.

2. Under the growth scenarios (i.e. Step Change and High DER), renewable energy employment is greater than current employment in thermal coal mining

3. Under the growth scenarios, the level of renewable energy employment fluctuates relative to employment in all coal mining – sometimes higher, generally somewhat lower. The study period finishes in 2035 but AEMO projects strong growth reflected in the upturn in renewable energy employment in the 2030s. If transition occurs earlier, the employment in renewable energy would be significantly higher

Sources: Total coal mining: ABS, Labour Account (2019). There is another ABS series, Labour Quarterly, under which total coal mining employment averaged just over 50,000 for 2018-19 – but the ABS describe Labour Account as more accurate (see ABC 2019). Data from the Department of Resources and Energy (2019) is used to calculate share by export/domestic and thermal/ metallurgical based on production volumes. Labour intensity is assumed to be the same for thermal & metallurgical mining. The Australian Census (ABS 2016) has data on fossil fuel power stations. Employment was apportioned based on the share of installed capacity in coal and gas power generation in 2016. Note the figure pre-dates the closure of Hazelwood power station.

Occupational employment in renewable energy and coal

There are some notable matches and mis-matches at a 1-digit level between renewable energy occupations and coal mining (Figure 23):

- In relation to the domestic coal sector, renewable energy averages more jobs for all occupations (except machinery operators and drivers).
- almost one-in-two coal mining workers is a machinery operator or driver and the sector employs many more workers in this category than renewable energy
- Across most other occupational categories, renewable energy employs more workers than coal mining. The exception is technicians and trades but renewable energy still employs significant numbers of workers in this category.

At a more disaggregated level, there are matches between a range of occupations for renewable energy and the coal sector at different skill levels - but not the core workforce which are semi-skilled machine operators:

- Renewable energy creates more employment across a range of occupations than the domestic coal sector, with the exception of power plant operators.
- Likewise, there is a range of occupations - such as construction and project managers, engineers, electricians, mechanical trades, office managers and contract administrators and drivers - where renewable energy is greater than coal mining or sufficient to suggest it can be a source of alternative employment.
- However, in the largest category of coal mining jobs (drillers, miners and shot firers) there is no direct correspondence. Drillers are needed for pumped hydro construction - there was qualitative reporting of competition with the resources sector for drillers - and old mining sites can be used for pumped hydro generation. But there is no occupational match for much of the core mining workforce.

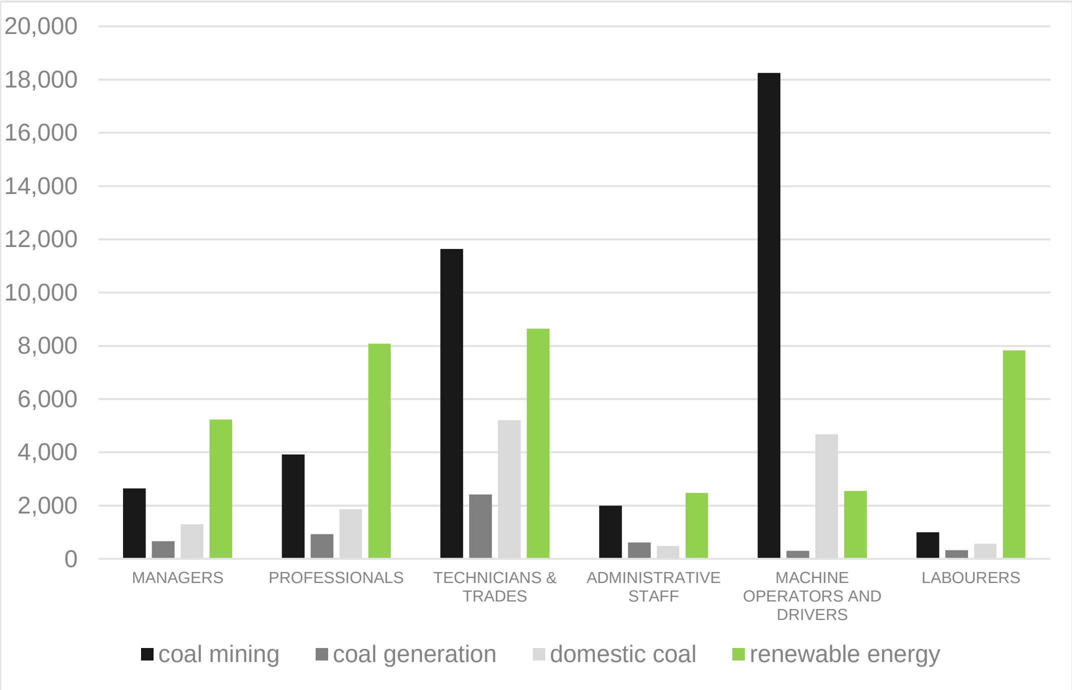
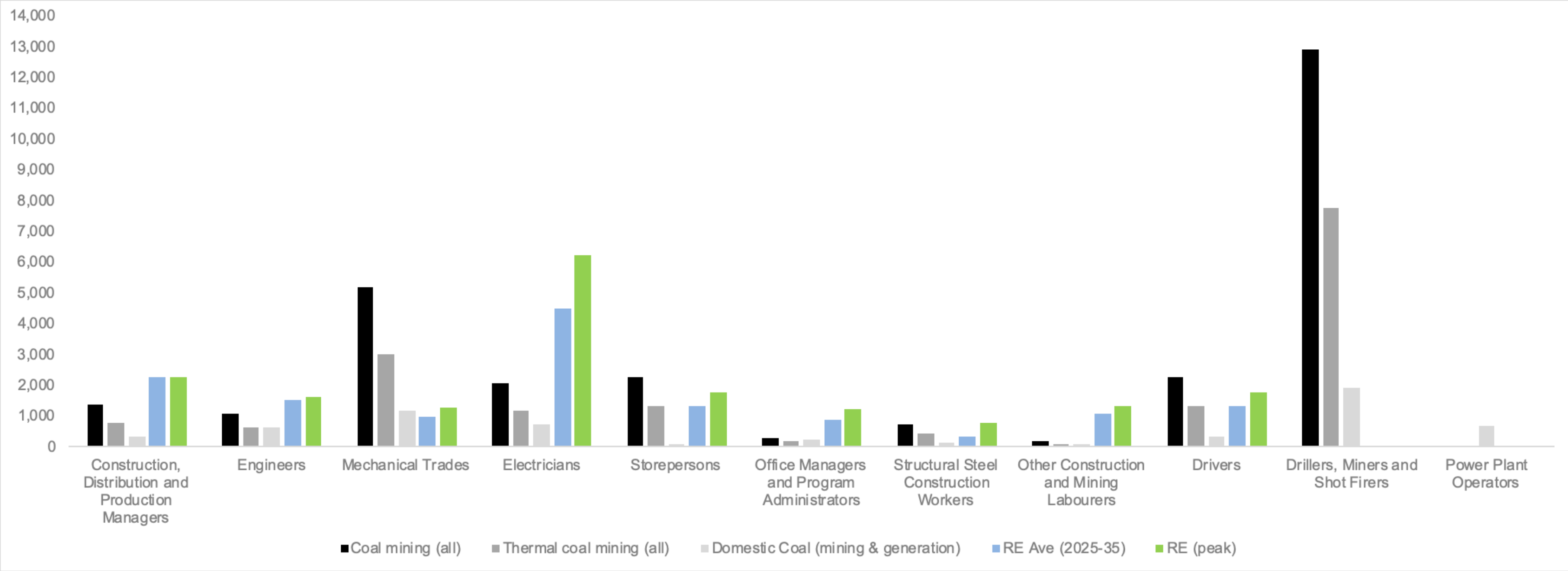


Figure 23 Renewable energy and coal employment, by occupation (1-digit)

Note: the renewable energy employment is the average for the Step Change scenario 2025–2035. The coal employment is the current level of employment using the sources listed under Figure 20.

Figure 24 Renewable energy and coal employment, by occupation (composite)



Note: the renewable energy employment is the average for the Step Change scenario 2025-2035. The coal employment is the current level of employment using the sources listed under Figure 20.

These figures should also not be used to suggest there is an easy switchover for workers in these occupations. Experience in renewable energy was nominated as a major issue by the industry in sourcing workers in 2018-19. A more detailed assessment of compatibility would be needed and different levels of retraining for worker redeployment. Nonetheless, there is an overlap between a spread of occupations in the coal sector and renewable energy.

The location of employment in renewable energy and coal

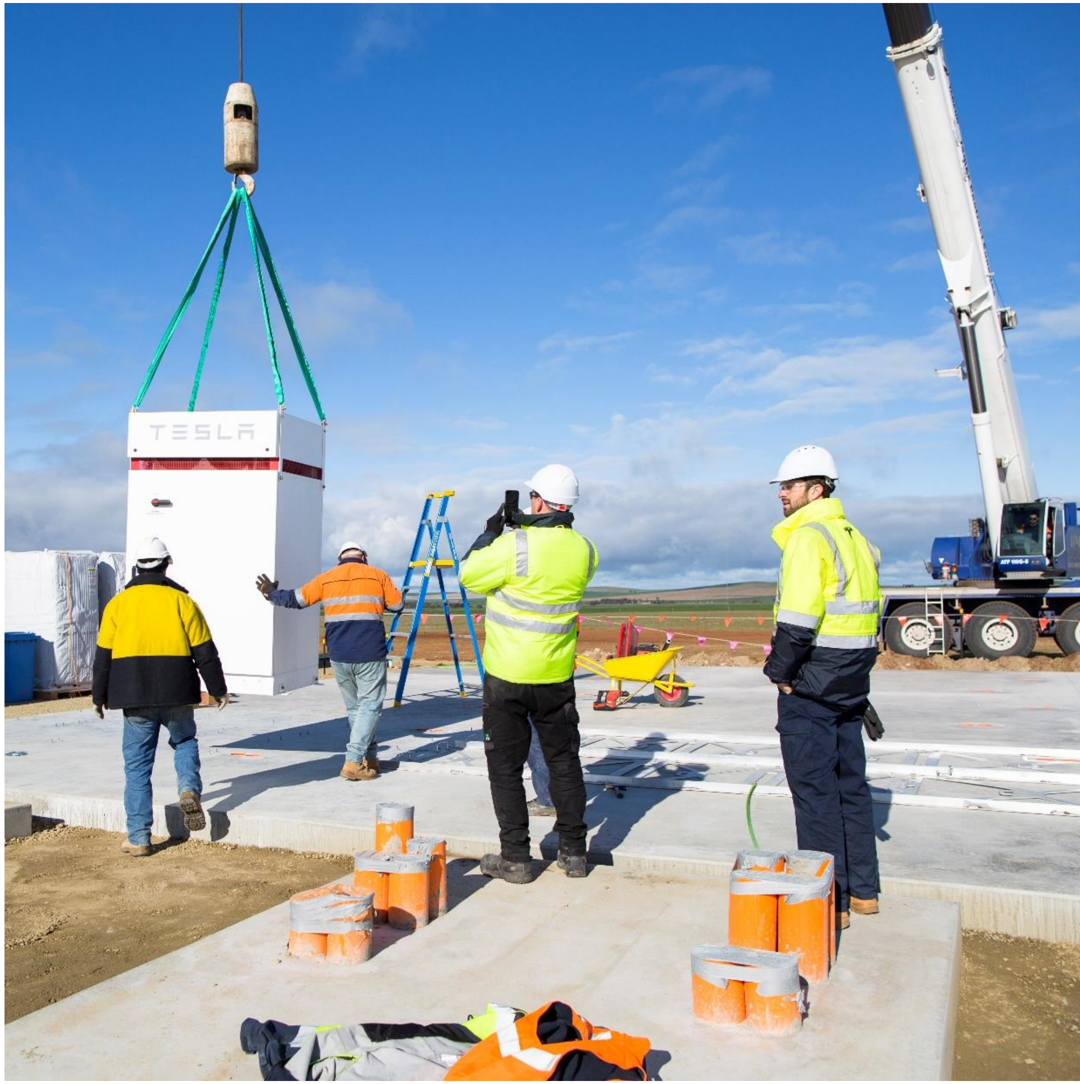
Employment in renewable energy is more dispersed than coal mining. This is a positive feature in general as it means employment will be created across a range of regional areas but raises a further question: how many of these renewable energy jobs will be created in coal regions?

The Australian census has data on the location of coal mining and fossil fuels generation employment by Local Government Area. For renewable energy, AEMO has earmarked a series of Renewable Energy Zones (REZs) through regional areas and undertaken modelling to estimate how much renewable energy will be constructed in each of these areas. It's important to note that there is a high level of uncertainty over the location and timing of renewable energy generation: decisions by investors and Governments on the location of transmission network extensions could significantly change the outcomes. Nonetheless, these results are based on current AEMO projections.

In the case of **Queensland**, there is co-location between some of the REZs and coal mining employment – especially Isaac (Q4) and Fitzroy (Q5). AEMO's modelling currently projects there will be jobs growth in these two areas - but most of the project development will occur further north and in the southern areas of Queensland. It is worth noting that significant grid investment would be required to unlock renewable energy in north Queensland or the development would occur in other areas. The highest job growth is in Brisbane.

In the case of **NSW**, the North-West REZ (N1) overlays with some mining employment in the north of the state and the Central West REZ (N3) is to the west of the mining employment in the Hunter Valley. The Southern Tablelands (N4) is adjacent to metallurgical coal mining and steel production.

AEMO's modelling currently forecasts large-scale project development and jobs growth for the Tumut REZ (N8) driven by Snowy 2.0, Central West (N3) and North West (N1) REZ.



Photograph courtesy of Neoen

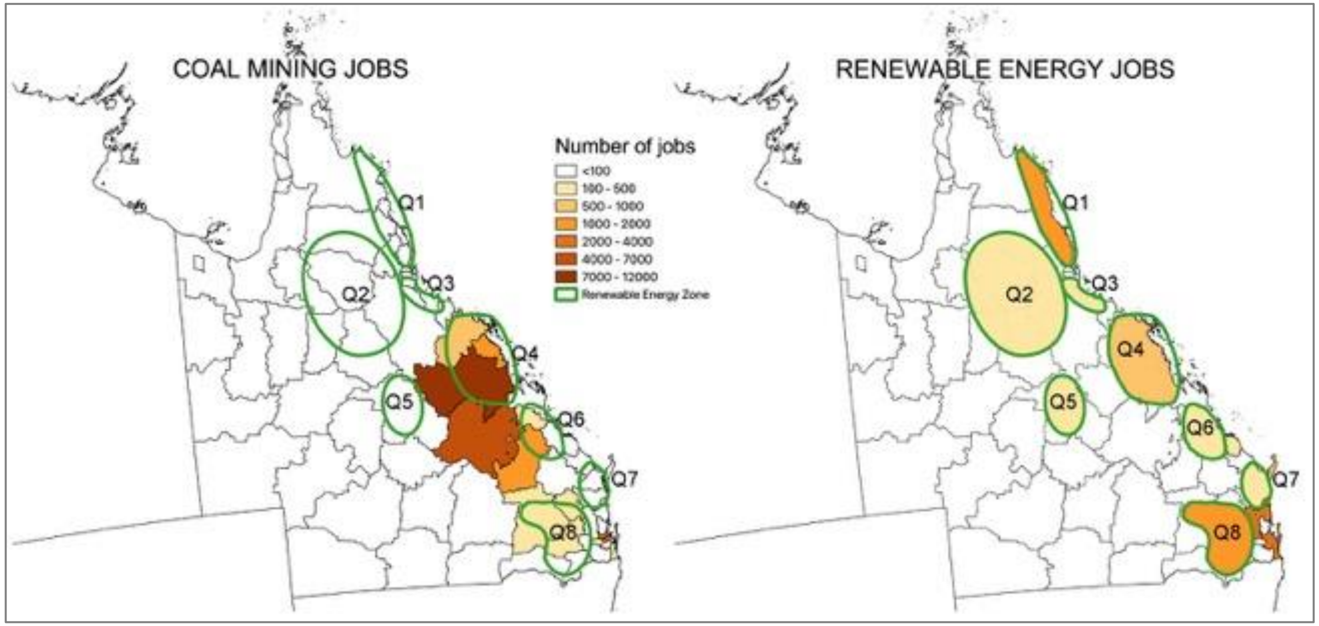


Figure 25 Renewable Energy Zones and coal mining employment, Queensland

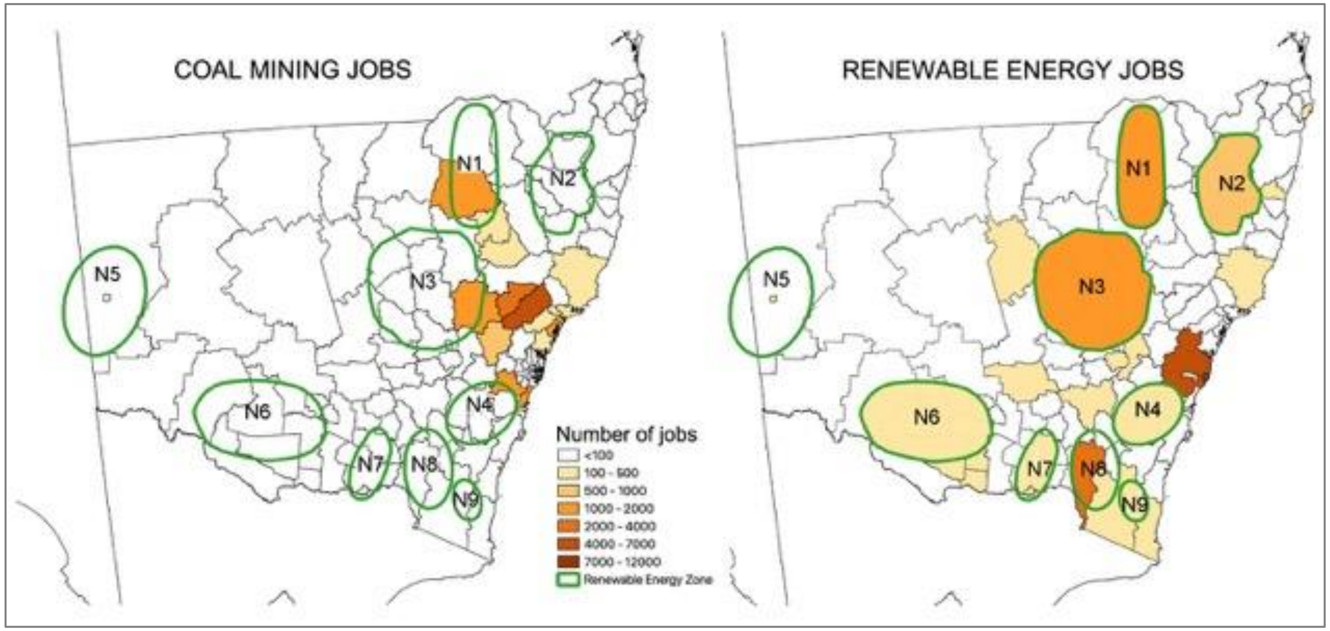
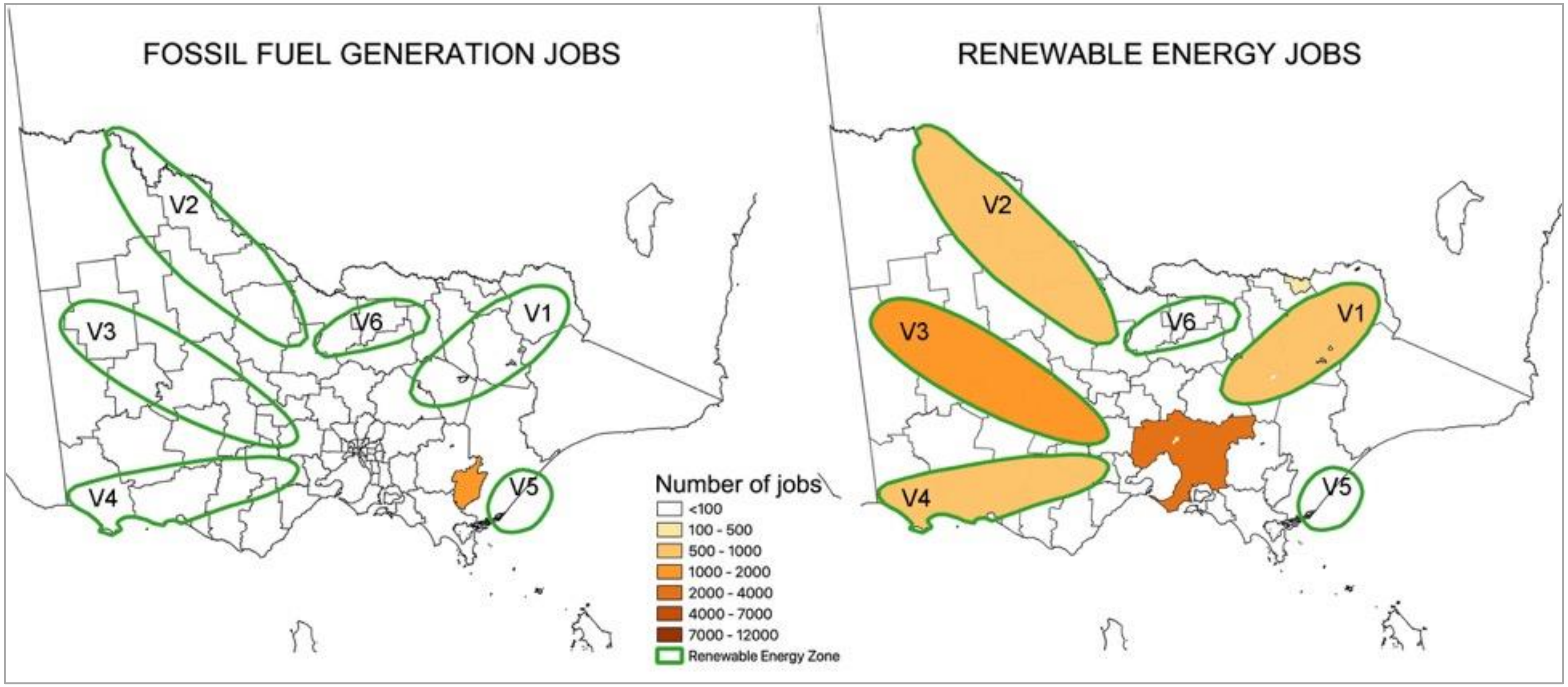


Figure 26 Renewable Energy Zones and coal mining employment, New South Wales

Figure 27 Renewable Energy Zones and fossil fuel power station employment, Victoria



In the case of **Victoria**, renewable energy creates more employment in regional areas than fossil fuel power stations, but the jobs are created in western and northern parts of the state and the greater Melbourne area away from the La Trobe Valley. Supply chain jobs are not included on these maps but Victoria does have significant employment (e.g. wind tower manufacturing).

Conclusion

Renewable energy already employs more people than the domestic coal sector. Under the Step Change and High DER scenarios from AEMO, renewable energy employment in the sector is comparable to all coal mining. Renewable energy cannot replace the jobs of coal mining – but the comparisons of occupations and location of jobs does suggest it can play a meaningful role in a wider regional industry development plan that creates jobs across a range of sectors.

4: Technology Profiles: Employment and Skill Shortages

Employment in Large-Scale Solar and Wind Energy: Key findings

- Wind power accounts for the second largest share of renewable energy jobs (after distributed solar) in the Step Change and Central Scenarios; in the Step Change scenario wind energy employment never falls below 6,700. Far less wind power is installed in the High DER scenario, which relies much more heavily on distributed solar.
- Operations and maintenance become an increasingly important feature of both wind and solar energy employment, reaching 50 per cent by 2035 (Step Change scenario).
- Skill shortages created bottlenecks in wind farm construction, there were missed opportunities for local employment and there is some competition for some occupations with the resources industry.

Employment in large scale wind and solar fluctuates in all three scenarios – albeit less in the Step Change scenario where the minimum employment is considerably higher - reflecting different construction forecasts for new projects in the AEMO scenarios. Figure 26 shows the renewable job creation for large scale wind and solar in all scenarios, while Figure 27 shows the operations and maintenance jobs in the Step Change scenario.

Figure 29 Operations and maintenance jobs in large scale wind and solar

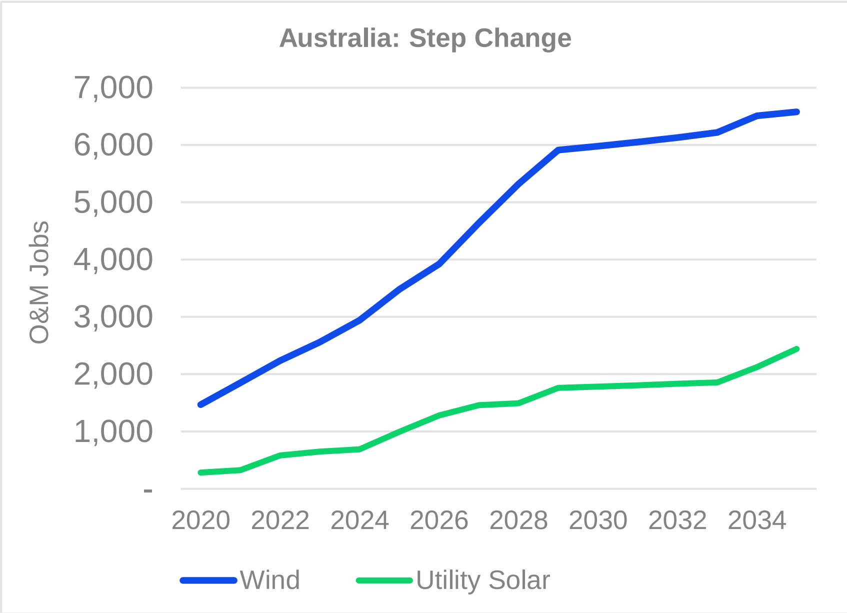
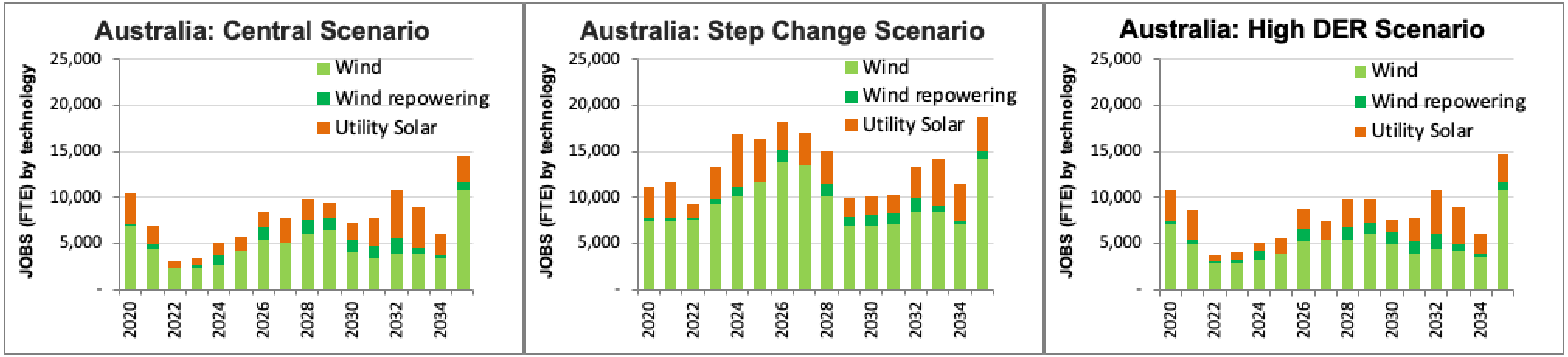


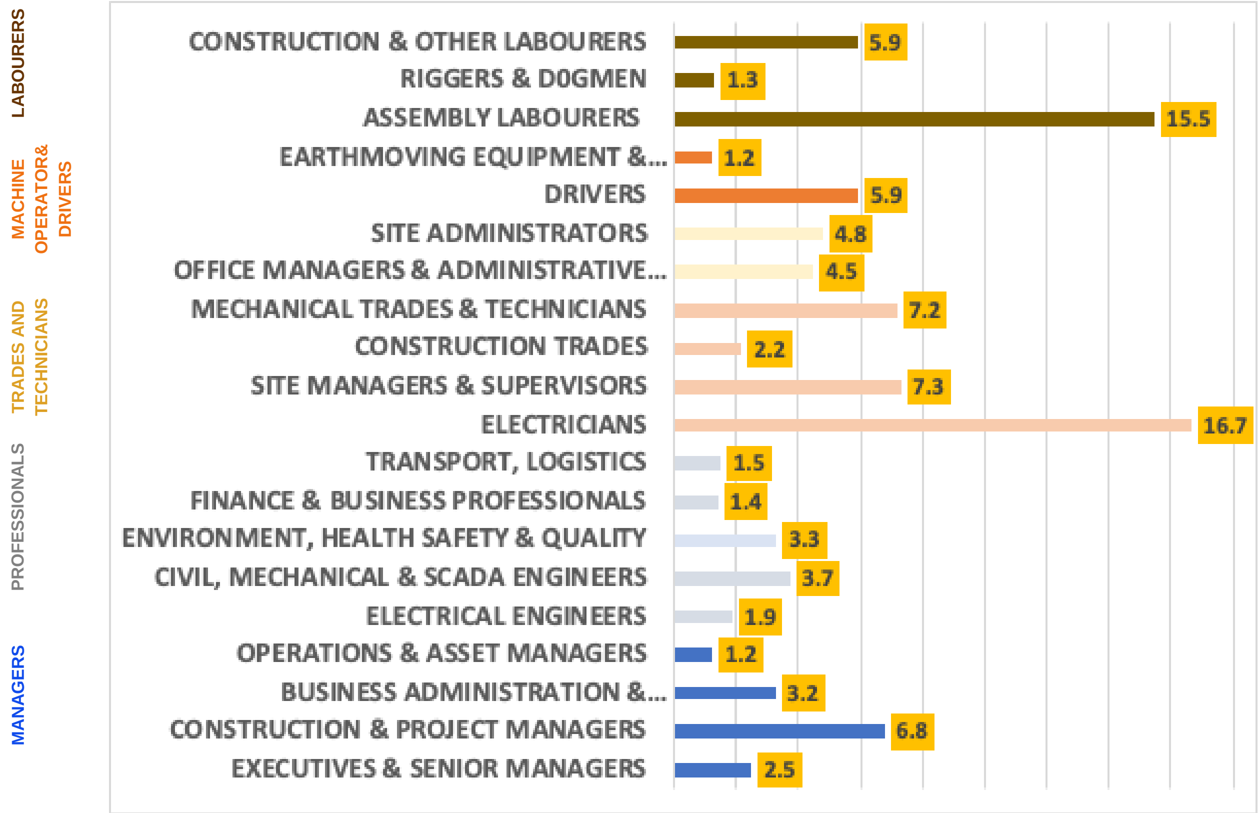
Figure 28 Employment in large scale wind and solar



Wind and Solar Farms: Occupational Employment

The employment structure of wind farms is more complex and diverse than solar farms. These differences are illustrated by a more disaggregated breakdown of occupations (Figures 30 & 31).

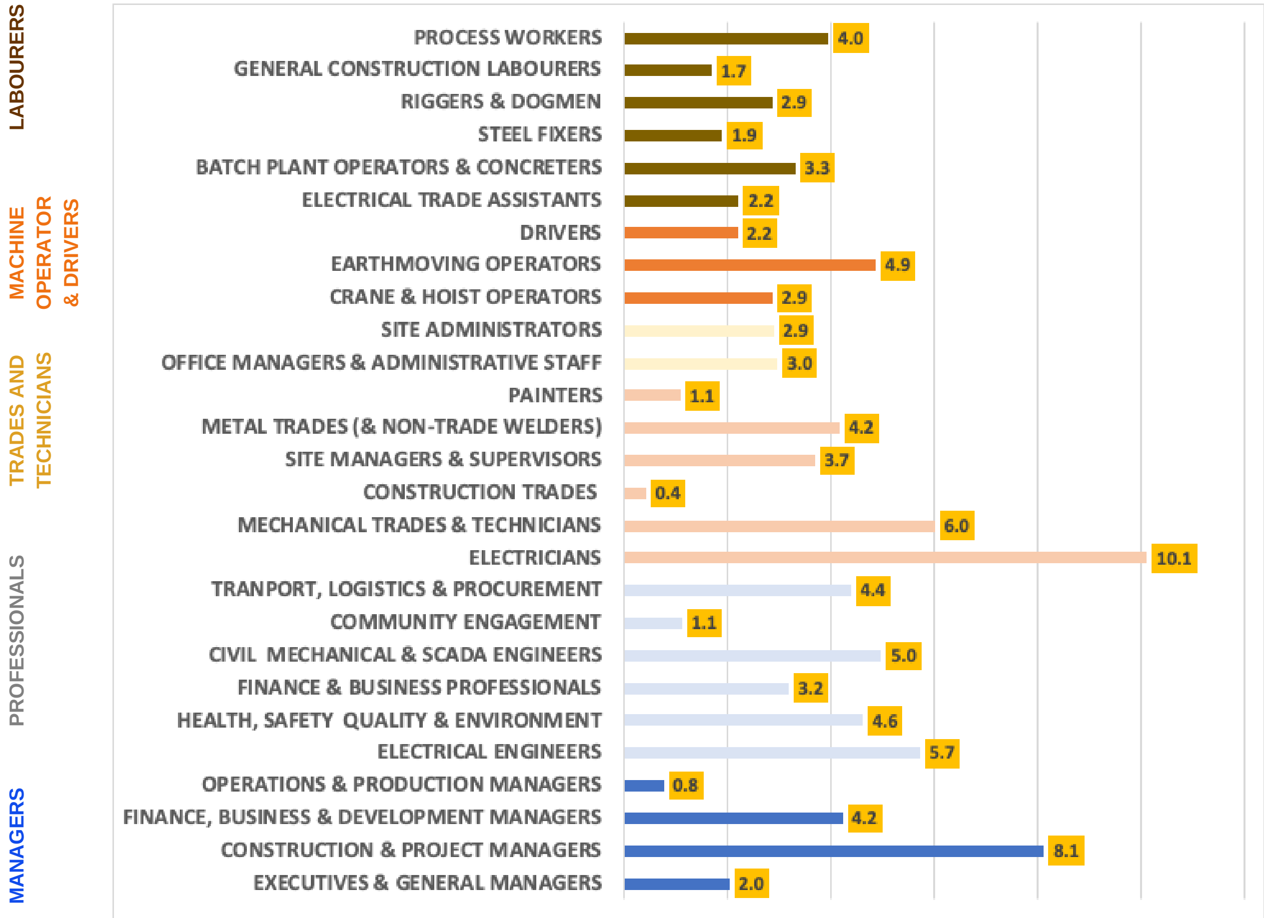
Figure 30 Solar Farms, occupational composition (%)



Solar farms have a greater concentration of employment in trades and technicians and labourers.

- Around one-in-three workers on a solar farm is either an electrician or assembly labourer (e.g. assembling solar arrays and modules).
- Other prominent occupations are construction and project managers, construction labourers, mechanical trades & technicians, engineers & health, safety, quality and environment professionals

Figure 31 Wind Farms, occupational composition (%)



Some of the notable differences for wind farms relative to solar farms include:

- a higher level of professionals such as electrical engineers, transport and logistics and community engagement;
- higher levels of operational and maintenance employment (especially mechanical and electrical technicians which account for one-in-two jobs for wind farm O&M);
- some specialised occupations that are not found on a solar farm (e.g. crane and hoist operators);
- greater levels of local supply chain manufacturing (e.g. tower manufacturing, assembly, gearbox repair).

Large-Scale Solar and Wind: Recruitment and Skill Shortages

Survey data was collected on recruitment experiences and skill shortages for both solar and wind farms. However, there was little observable differences between the experiences across solar and wind farms – and firms commonly now do both – so the data is presented here for large-scale renewable energy. No variations were also reported across states (with the exception of a couple of firms that observed greater pay competition with resource companies in Western Australia). Where there were some variations these are noted but one of the striking features was the universality of recruitment experiences across technologies and states.

There are two sets of results from the surveys used to assess recruitment difficulty and skill shortages:

- *Results for each occupation amongst businesses that recruited for the position*: this measures the difficulty for businesses that were in the market for the occupation (Figure 32)
- *Results for each occupation amongst all businesses*: this measures the significance of the occupation. It may be, for example, an occupation was hard to recruit for but not many businesses were trying to recruit so it is of less significance (Figure 33).

The key occupations for which difficulties were most commonly recruited by firms that attempted to do so in 2018-19 were:

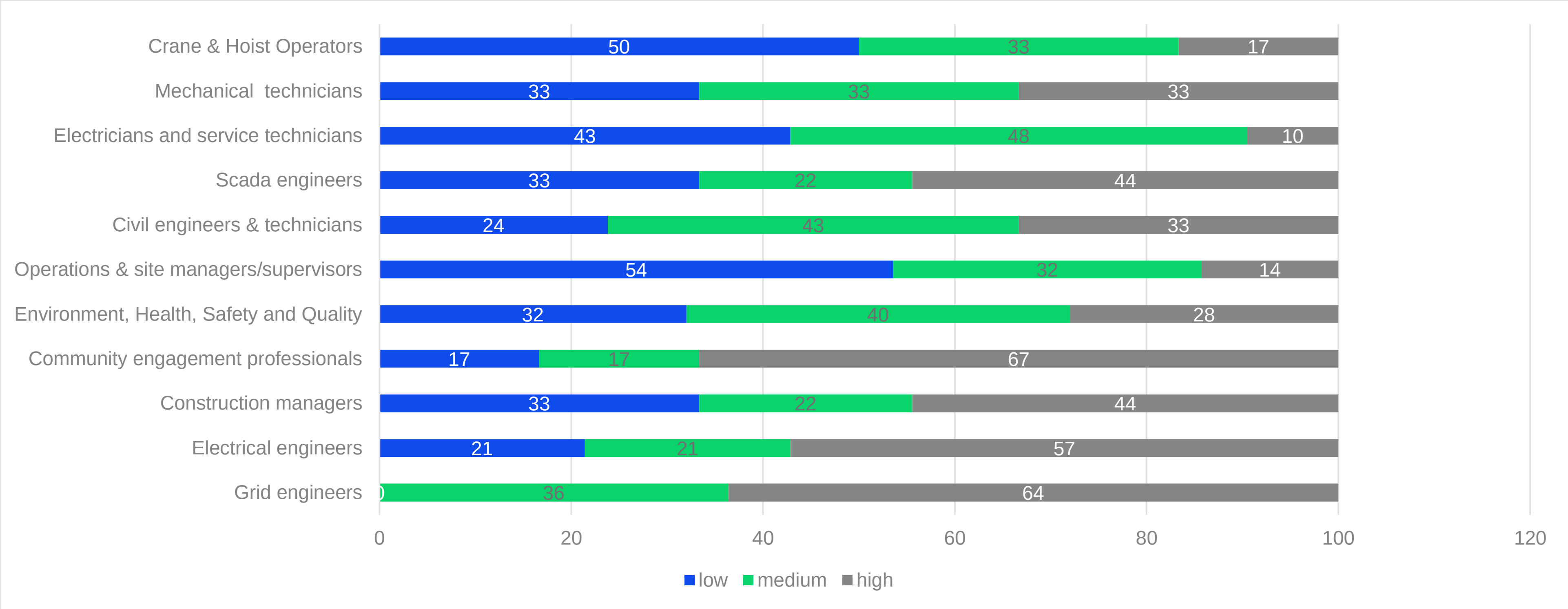
- **Grid or power system engineers**: no firm reported these were easy to recruit and a number noted there were systemic shortages in supply that led to overseas recruitment;
- **Electrical engineers**: electrical engineers in general were difficult to recruit;
- **Construction and project managers**: a very high number of firms had recruited for construction and project managers and almost two-thirds experienced high or medium difficulty;
- **Electrical and mechanical trades and technicians**: A majority of firms experienced difficulties recruiting electricians and mechanical technicians but overall the number of firms recruiting in these positions was lower.

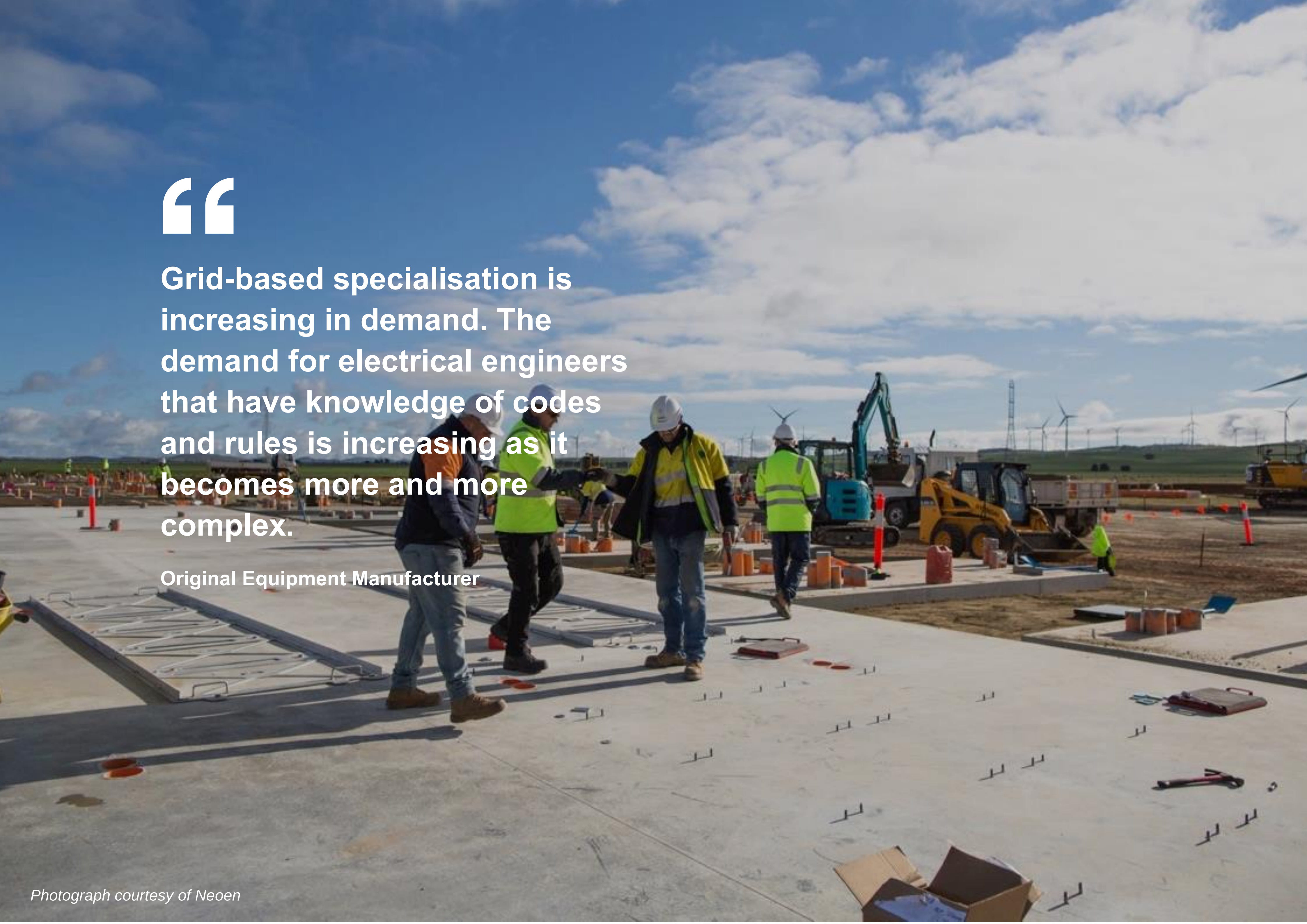
However, including the survey results from firms who did not recruit in 2018-19 gives a modified picture for some of the occupations:

- **Community engagement professionals**: a high portion experienced difficulty – but it was a relatively small number of firms that recruited for these positions;
- **Quality, health, safety and environment professionals, civil engineers and scada engineers**: for each of these professions around two-thirds reported high or medium difficulties but the number of firms recruiting was also lower than some of the key occupations;
- **Electrical/grid engineers & construction managers**: the high levels of responses underline the significance of difficulties for these two occupations.

Photograph courtesy of Canadian Solar (Normanton Solar Farm)

Figure 32 Recruitment experiences, solar and wind farms, selected occupations (%)





> **Grid-based specialisation is increasing in demand. The demand for electrical engineers that have knowledge of codes and rules is increasing as it becomes more and more complex.**
>
> **Original Equipment Manufacturer**

Photograph courtesy of Neoen

There were some shortages which weren't highly reported across the industry that became major bottlenecks or issues for projects which experienced them:

- **Crane drivers**: the growing need for high cranes and skilled operators with experience in wind farms became a major issue for some projects.

  There might have been four of those cranes operating in Australia a few years ago and now it's twenty. With each of these cranes there's probably a dozen people so it's a 5-fold increase. We have people with the right quals but they don't have experience with renewable energy and it takes 6 to 9 months to get up to speed … it's been a bit of a bottleneck (Wind Original Equipment Manufacturer)

- ***Wind O&M technicians****:* most O&M operators highlighted issues with sourcing electrical and mechanical technicians for wind farms, especially blade technicians. Blade maintenance can be a significant cost. They are recruited from a range of backgrounds (fitters & turners, farms etc) but operators cited a range of issues:

  – Wind O&M contractors highlighted the lack of short training courses to transfer technicians from other sectors and the cost of pre-requisite qualification courses

  – Traditional apprenticeships were agreed not to work well – workers don't get the breadth of experience and could end up doing menial tasks;

  – Workers can be recruited from other industries (e.g. fitters and turners, agricultural workers with a mechanical background) but there are expensive pre-requisite qualifications (e.g. Rope Access, Working and Rescue at Heights) which makes it an expensive exercise;

  – No targeted courses for developing wind turbine technicians.

  Consequently, operators use a range of 'coping' strategies including importing blade technicians. Wind technicians are good quality blue-collar jobs on base salaries of $90,000-plus so this is a missed opportunity for regional employment.

  We have to try and get people from other industries and train them ourselves on the job and put them through the basic safety courses which is time consuming and expensive. There's nothing at all for blade technicians … if there were basic courses tailored for the wind industry it would make it easier to employ local people. We could take people who have a background in composites and repair and do a short course and get them on-board … there are more technicians coming out to Australia every year to do blade technicians tasks than there are locals. There's opportunity for much more local jobs here (O&M contractor).

- ***Truck drivers****:* an operator that specialises in wind farm transportation highlighted that it takes up to 2 years to train new workers into challenging, specialised roles to move large wind farm components. Loss of workers to better paid resource industry jobs was a major challenge.

- ***Specialist trades in the supply chain***: there were also shortages for some trades for wind supply chain operators, such as blasters and painters.

For operators who had experienced a medium or high difficulty in recruitment, the major issue was lack of experience in renewable energy projects.

Photograph courtesy of Neoen

Figure 33 Recruitment experiences, solar and wind farms, all responses (%)

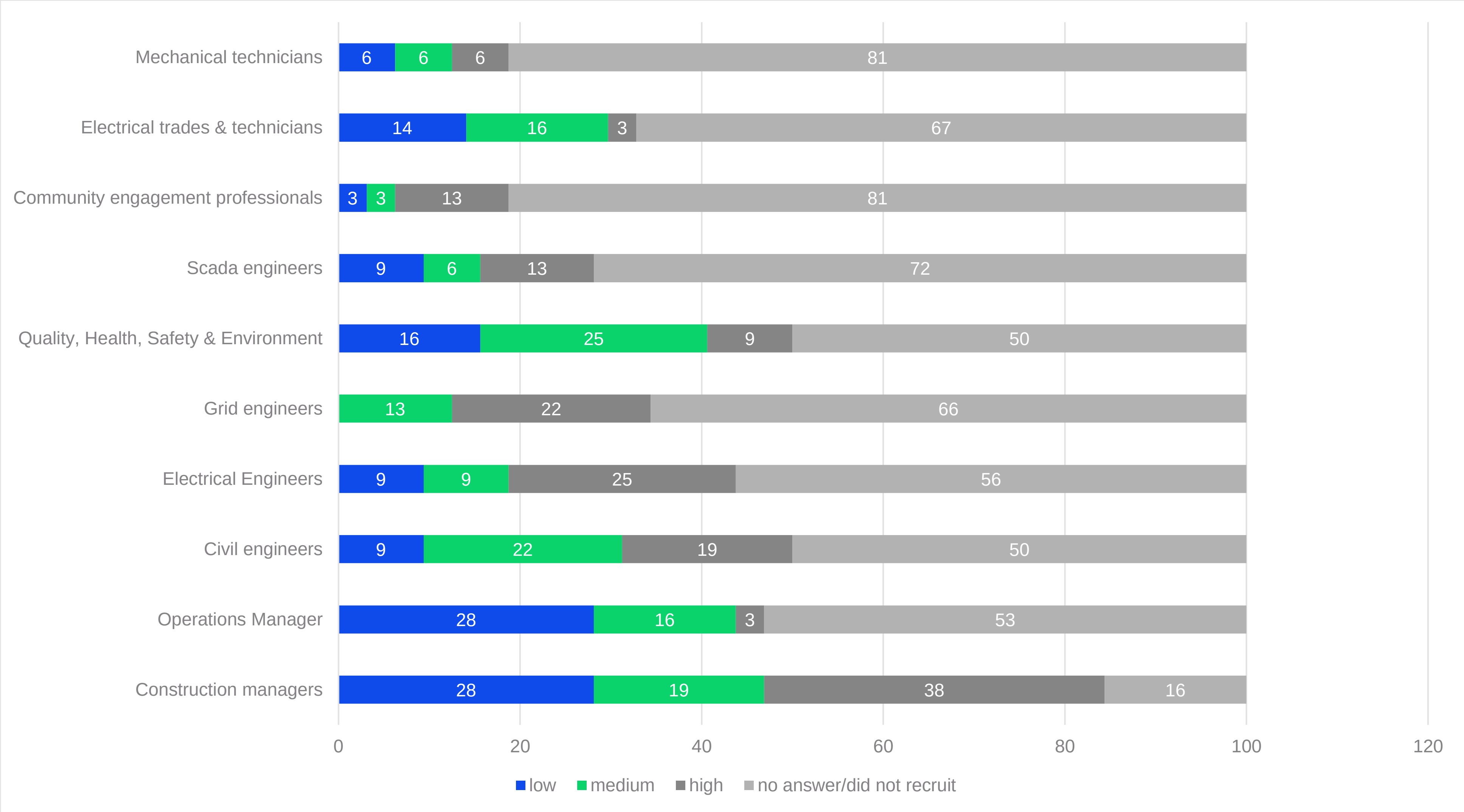
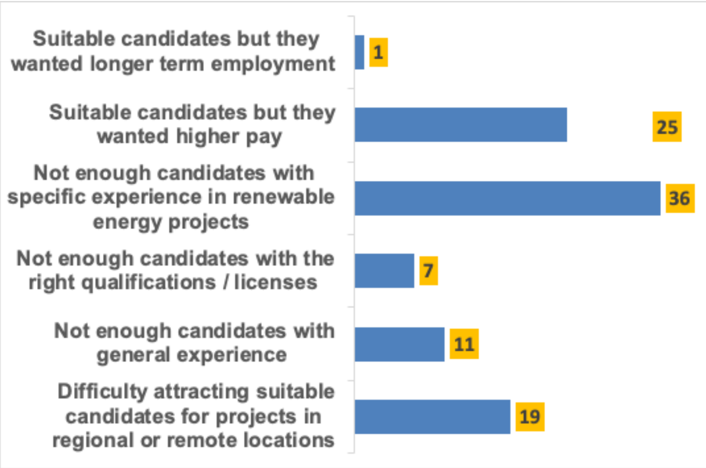


Figure 34 Cause of recruitment difficulties (%)



Over 1/3 of recruitment difficulties stemmed from difficulties finding candidates with experience in renewable energy. The next major issue was pay competition, generally with the resource sector. Difficulties attracting or finding candidates in remote locations was an issue in around 1-in-five cases. General qualifications or employment tenure was rarely considered an issue.

There are a number of dynamics which underpin recruitment and skills difficulties:

- It is hard for construction projects to invest in training: there are short lead-times once a power purchase agreement is finalised, there is high policy uncertainty over the future of the industry and stop-start project development.
- There is limited interaction with training system: the number of apprentices is low and a number of respondents noted there was poor fit as apprentices don't get sufficient breadth of experience
- Industry uses coping strategies to address skill shortages (e.g. importing workers, poaching) – but these have costs (e.g. recruitment and turnover, delays, wage inflation, reputational)
- There are challenges retaining workers that develop skills on-the-job – stop-start work as projects start and finish, loss of workers to resource and construction (better pay)
- There are some supply issues that can be resolved by government (e.g. supply of grid/power system engineers) – but biggest issue is industry experience. This reflects growth of new industry but the sector also needs to improve retention

Photograph courtesy of Neoen

> “The peaky nature of construction makes it hard to retain staff when there are lows. Project construction is so busy that training doesn’t happen during the peak and then everyone leaves. They go away with great experience and what they’ve learnt but not formal training.

Original Equipment Manufacturer

Photograph courtesy of Verve Energy

Employment in Distributed Solar PV

Key findings

- Distributed solar is by far the largest contributor to renewable employment, and in most years is the largest employer across all technologies in the three scenarios.
- There were a wide variety of business types installing PV, including many electrical contractors and installers who are sole traders. Micro businesses (<5 employees) support nearly double the jobs per MW for residential installed PV than large businesses (>20 employees).
- The majority of jobs are in the installation phase, although O&M is growing. Jobs are dominated by electrical trades and technicians, electrical trade assistants and solar roofers.
- Recruitment difficulties were experienced across a wide range of key occupations in a boom market - including electricians, PV designers, solar roofers. The emerging data analytics/control equipment sector also experienced challenges recruiting IT staff with energy knowledge (e.g. software designers) and retaining them due to competition from higher-wage segments.

Growth of Distributed PV Employment

Australia is a world leader in rooftop PV with one of highest uptakes of residential solar. In 2018/19 financial year, there was just under 2000 MW of distributed solar systems installed in Australia (APVI 2020). Our survey covered 254MW of installations (13% of the industry).

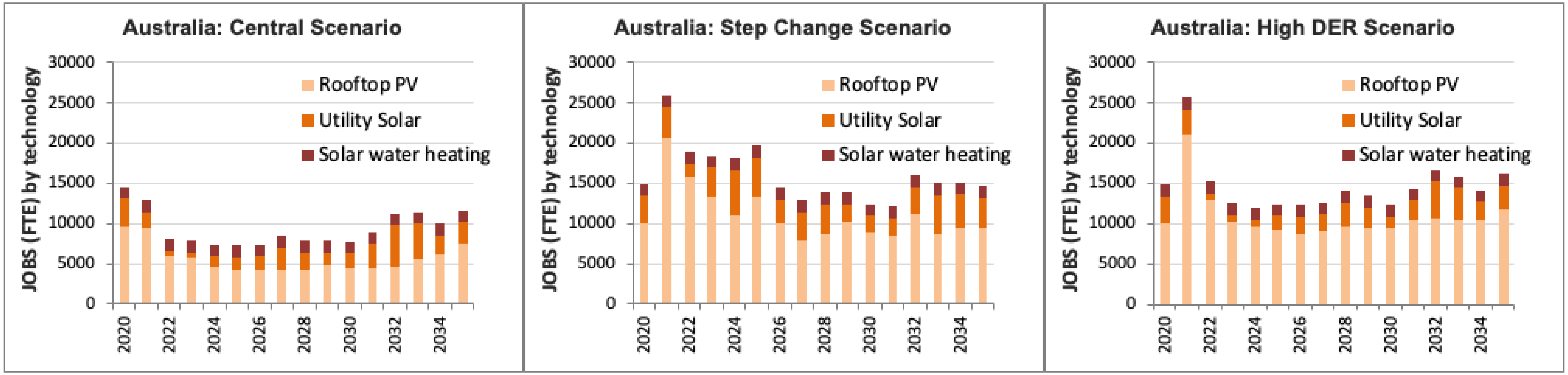
Under all scenarios, rooftop PV is the major source of employment:

- The Central Scenario projects a fall in the level of rooftop PV installations from 2021 (notwithstanding the very strong growth currently occurring) and therefore a fall in employment from current levels to approximately 5,000 throughout the 2020s.
- Under the Step Change scenario, there would be a surge in employment to a little over 25,000 before employment levels out to between 15,000 - 20,000 throughout the 2020s.
- The High DER scenario also has a surge before employment levels out between 10,000 – 15,000 through the 2020s.

Solar water heating is a small but steady contributor to jobs employing just over 1500 persons.

For more detail on the survey responses, see the methodology report (Rutovitz et al, 2020).

Figure 35 Distributed Solar PV: employment results



Distributed Solar PV: Occupational Employment

The occupational structure of employment in distributed solar PV is more concentrated than some other technologies:

- At a 1-digit level, the major occupational groups are Labourers, Professionals and Trades and Technicians.
- For the composite groupings, electricians and electrical trade assistants are just under 30 per cent and solar roofers account for a further 10 per cent – three occupations cover 40 per cent of the workforce.
- Other leading occupations include accredited PV designers, marketing and sales professionals and senior managers and executives.

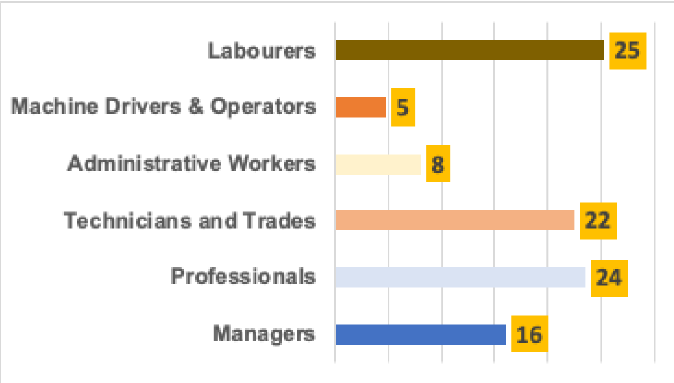
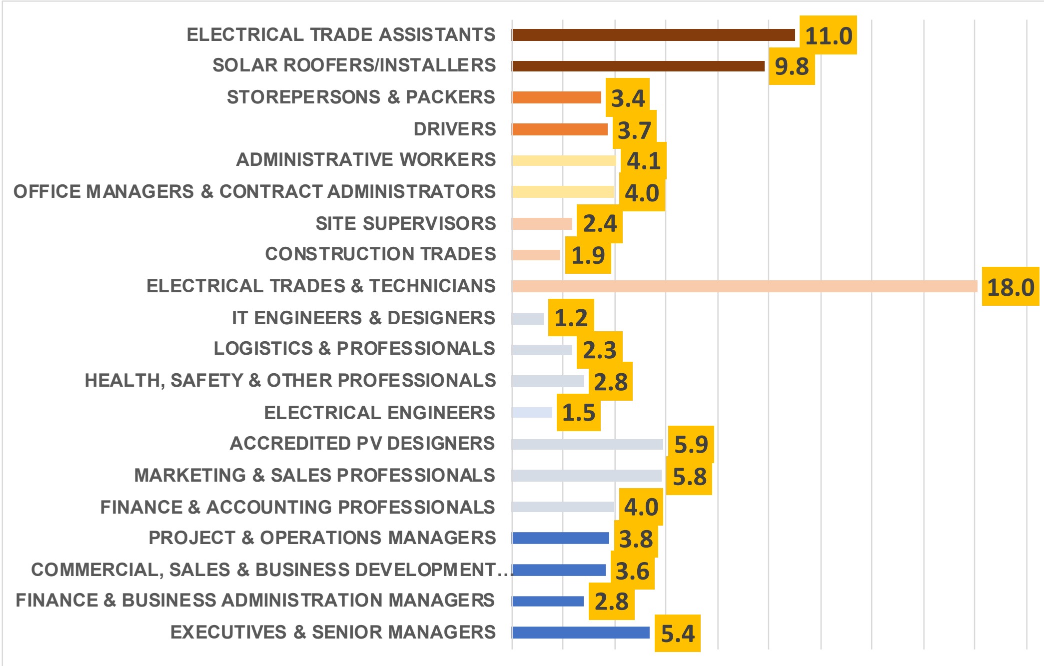


Figure 36 Distributed Solar PV: occupational composition, composite (%)

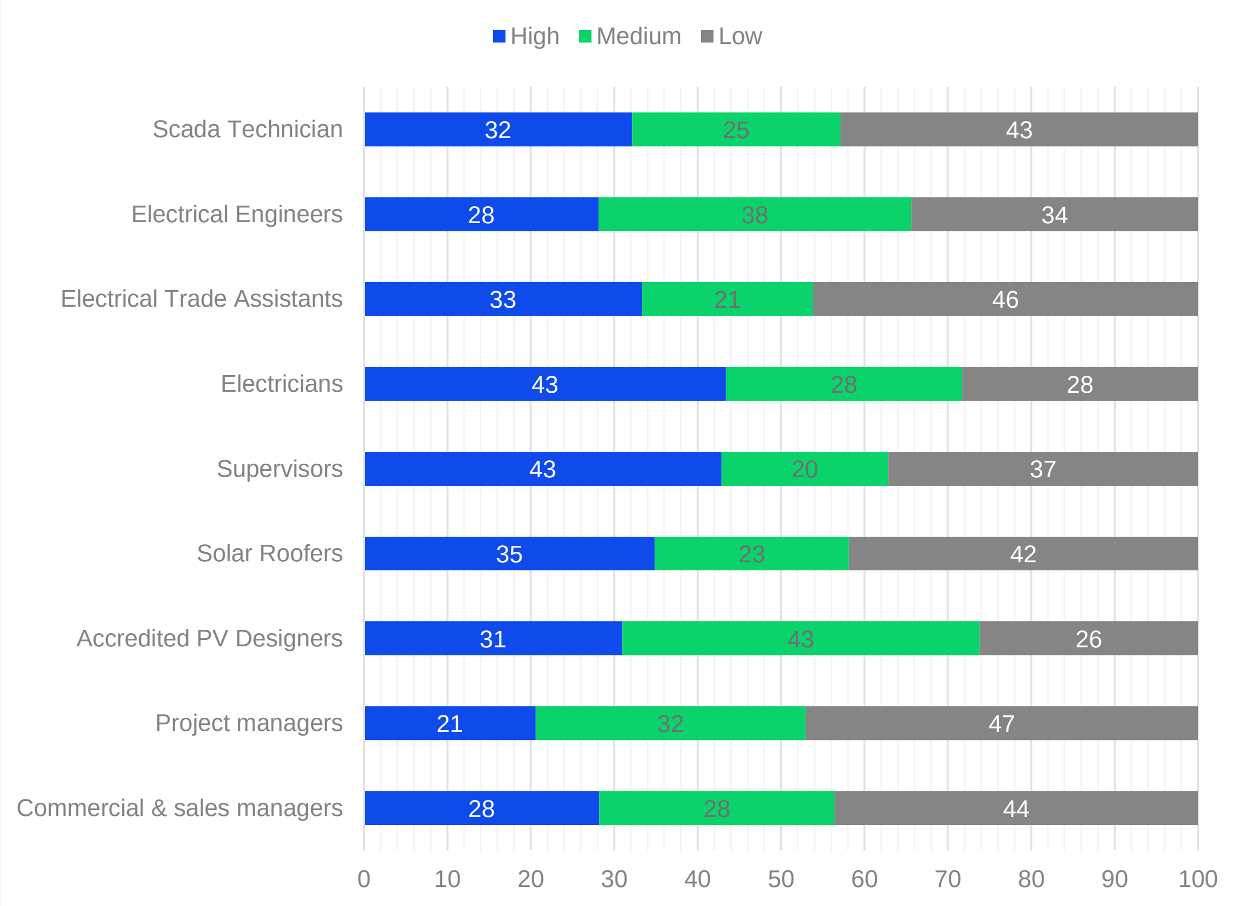


Distributed Solar PV: Recruitment and Skill Shortages

As with large-scale renewable energy, survey data was collected on recruitment experiences and skill shortages for distributed solar PV. Recruitment difficulties were experienced across key occupations in a booming market:

- **Electricians**: almost three-quarters of respondents experienced ‘high’ or ‘medium’ recruitment difficulty;
- **Accredited PV designers**: likewise, three-quarters of respondents had high or medium recruitment difficultly, although the number experiencing ‘high’ difficulty was much lower;
- **Electrical trade assistants & solar roofers**: around 2/3 had ‘high’ or ‘medium’ difficulties;
- **Commercial and sales managers**: over 1/2 had high or medium difficulty in recruitment.

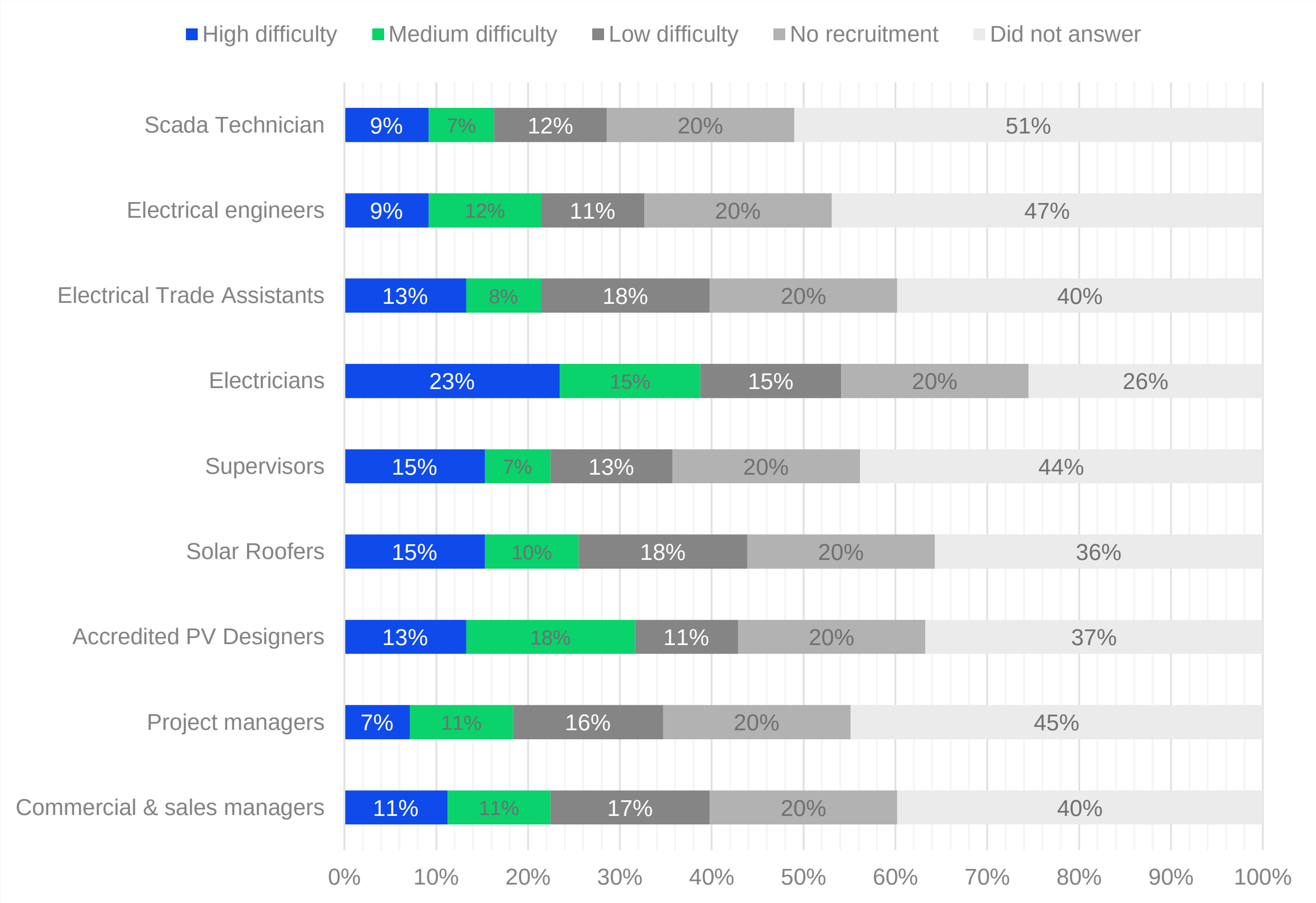
Figure 38 Recruitment experiences, distributed solar PV, selected occupations (%)



Adding in the respondents who did not recruit and did not answer provides some perspective on these results. One-in-five respondents did not recruit at all and varying numbers for each of the occupations. The proportion of all results that experienced high and medium difficulty is:

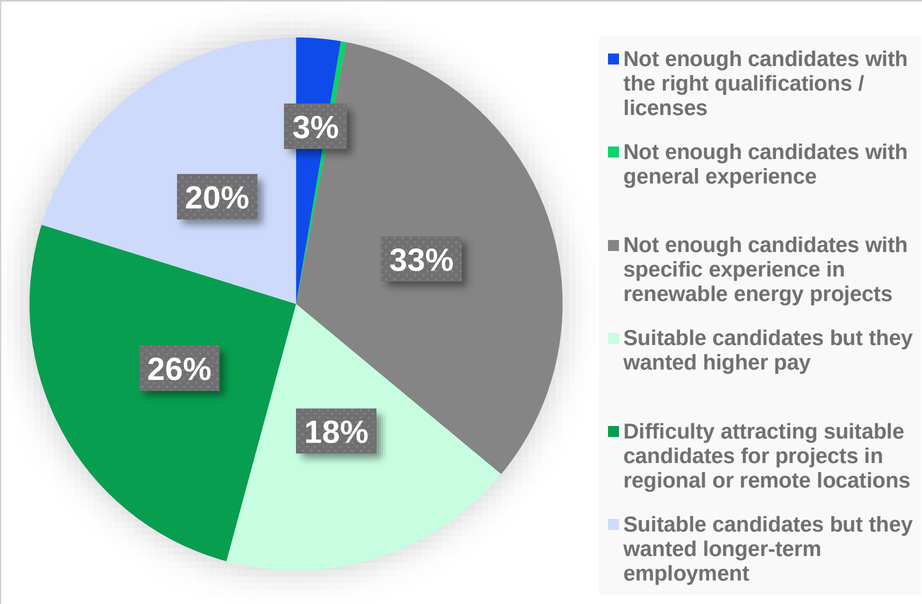
- 40 per cent for electricians;
- 30 per cent for accredited PV designers;
- 25 per cent for solar roofers
- 20 per cent for electrical trade assistants

Figure 39 Recruitment experiences, distributed solar PV, selected occupations, all respondents (%)



The primary cause of recruitment difficulties across the distributed PV sector was lack of candidates with experience in renewable energy.

Figure 40 Cause of recruitment difficulties, distributed solar PV (%)



Note: results include responses from all businesses for occupations where they experienced 'high' and 'medium' recruitment difficulties. Multiple responses were permitted.

One-in-three nominated not enough candidates with experience in renewable energy projects as a cause. This is similar to large-scale renewable energy. One-in-four nominated difficulty attracting candidates in regional locations (and there were a number of responses in comment boxes noting challenges finding electricians in regional areas) and around one-in-five nominated candidates seeking longer-term employment and pay as a source of recruitment difficulties.

In general, however, the pipeline for solar PV appears healthier than large-scale renewable energy. Electrical trade assistants are a significant portion of the workforce. Almost half of survey respondents said they had employed an apprentice in the year prior – overwhelmingly electricians – although there are issues with the quality of candidates and ability to access apprentices (see p.51). Maintaining supply of trained personnel in key occupations is likely to remain a challenge whilst the industry continues to grow so strongly.

There is a further skill issue worth highlighting in the solar data analytics and control equipment businesses. Australia has a dynamic emerging sector with rapidly growing start-up businesses in the context of very high penetrations of rooftop PV. It may be an area of competitive advantage with technology export opportunities. Each of these businesses reported 'high difficulties' recruiting for IT workers such as software engineers and developers and challenges finding workers with a combination of IT and energy knowledge. They also reported challenges retaining staff, primarily due to competition from higher wage businesses.

Employment in Hydro Generation and Pumped Hydro

Hydro generation already creates more than 1000 jobs, and the development of pumped hydro could provide up to 3000 jobs in the period up to 2030 across all scenarios. Construction work is the most labour intensive, and will fluctuate as new schemes are built.

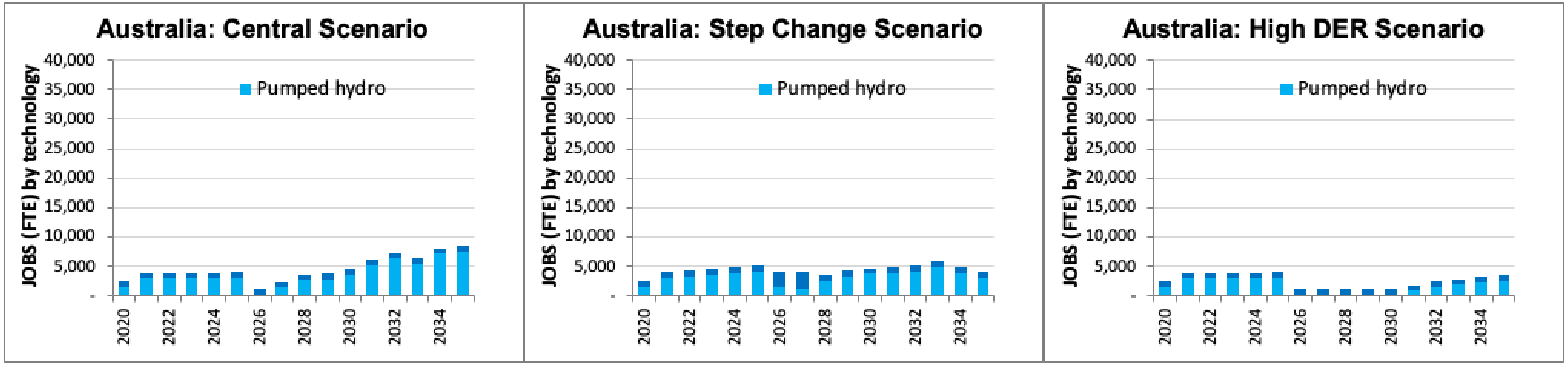
Hydro employment is close to 4,500 on average between 2020 and 2035 in both the Central and the Step Change scenario, compared to 2,700 in the High DER scenario, reflecting that the High DER scheme does not include so much centralised renewable development.

A very high proportion of hydro jobs are in regional areas, with more than 80% of construction work and more than 90% of operations and maintenance work expected to be local to the hydro scheme. Construction is expected to take close to five years.

There is a lack of hydro construction and development skills onshore because so little hydro has been built in Australia over the last decades, so recruitment may prove challenging. Some occupations are already proving a bottleneck in development, in particular drillers.

There is a very high proportion of trades & technicians and labourers required for hydro and pumped hydro construction. Supply chain jobs are not included because data was unable to be obtained but there are significant requirements for steel and concrete that is likely to provide on-shore employment.

Figure 41 Hydro and pumped hydro: employment

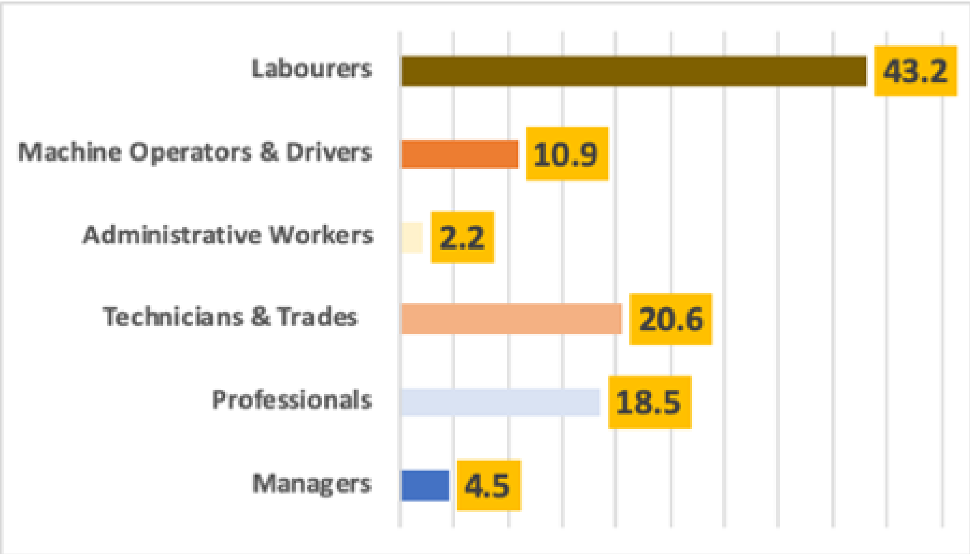


Hydro: Occupational Employment

The occupational mix of hydro and pumped hydro has a higher proportion of labourers, technicians and trades than other renewable energy technologies:

- At a 1-digit level, almost two-thirds of jobs are Labourers and Trades and Technicians.
- For the composite groupings, concreters account for almost one-in-five jobs.
- Other leading occupations include engineers (civil, mechanical, electrical and scada), civil and general labourers and drivers.

Figure 42 Hydro and pumped hydro: occupational composition, 1-digit (%)



Photograph courtesy of AGL

Figure 43 Hydro and pumped hydro: occupational composition, 1-digit (%)

Employment in Battery Storage

Employment in batteries varies considerably by scenario, with batteries creating on average 1,300 jobs in the Central scenario, just over 4,000 in the Step Change scenario, and over 10,000 jobs in the High DER scenario.

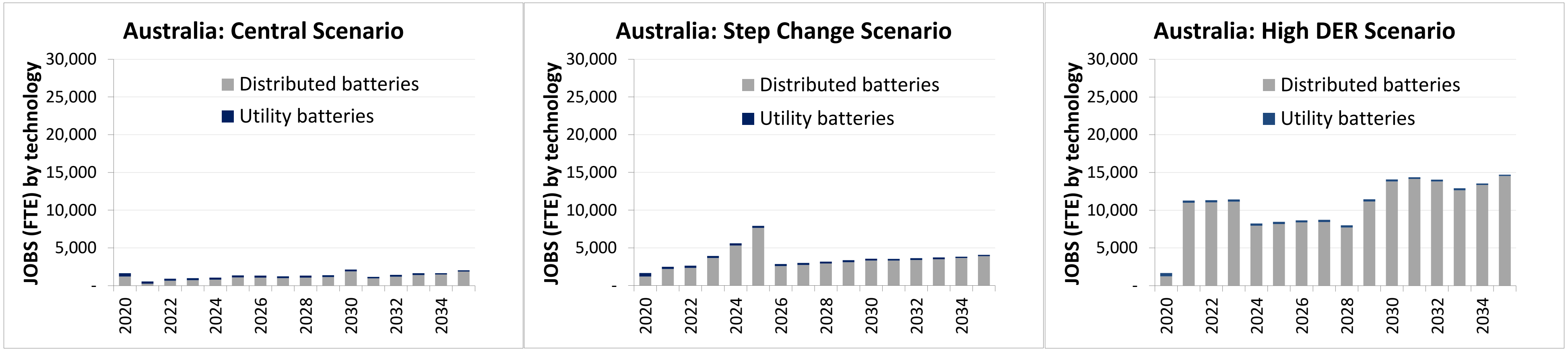
The sector includes many types of businesses, for example, manufacturers, importers (or distributors for large international manufacturers), utility scale systems providers, developers, and installers, and lastly distributed installers, who are usually solar installers.

Importers (or manufacturers) are involved in maintaining their batteries (such as maintenance and software upgrades), rather than installers. Very little manufacturing is happening in Australia, and even Australian “manufacturers” tend to import lithium-ion battery cells, although there is some assembly of battery storage systems and development of management technology.

In the Central scenario, 80% of jobs are in distributed batteries, while more than 95% are in distributed batteries in both the Step Change and the High DER scenarios. For distributed battery storage, majority of jobs are in the installation phase.

Employment per installation is currently high, reflecting the early stages of the industry. We found on average there were approximately 7 person-days per installation for distributed batteries, although this varied considerably between companies. There is likely to be considerable productivity improvements, particularly in the High DER scenario with so much installation, which might mean that employment levels in that scenario are unrealistically high.

Figure 44 Battery storage: employment



5: Job and Skill Opportunities: Improving Employment Outcomes in Renewable Energy

The primary focus of this study was to improve the quality of data on employment and skill shortages to inform the development of strategies – not on solutions or policy recommendations. However, in the course of the study, some opportunities to improve employment and skill opportunities were identified as a starting point for further analysis.

- Increasing the supply and retention of skilled labour
- Using the Renewable Energy Zones to improve coordination and planning
- Renewable energy auctions with local content and training requirements
- Pre-planning for hydro and pumped hydro
- Regional industry development

Increasing the supply and retention of skilled labour

The first response to recruitment difficulties and skill shortages is often to call for increased supply from the training system. There was one outstanding case arising from this survey (e.g. grid/power systems engineers). However, the key issue behind recruitment difficulties from industry responses was experience in renewable energy and qualitative responses highlighted other issues related to the interface with the training system (as much as the number of workers being trained).

There were other issues or opportunities for improvement highlighted by respondents:

1. **The use of short training courses:**

   Short training courses were suggested in a number of contexts, including wind technicians and solar roofers.

   "Solar roofers are often not trained. There should be an accreditation for installers who are not doing the electricals. They get no training. Training to work at heights, manual handling skills, mechanical fixing, basic retention of cabling. A 3 to 6-month course"

2. **The fit between the apprenticeship system and renewable energy**: both large-scale renewable energy and distributed solar respondents highlighted issues. For example:

   "Recruiting electricians is extremely difficult in regional Queensland. So we have tried to go down the route of employing apprentices to become electricians and solar installers. Not possible because, apparently, solar work does not provide the scope of work needed to quality for an electrical apprenticeship. Yet, if we could find qualified electricians to employ, which we can't, they are more ignorant of DC work than a trades assistant who has been working in and around solar for years who would LOVE to become an apprentice and who we would like to have as an apprentice, but can't"

   "*Apprentices tends to specialise in and out of solar – they either don't know general electricals or don't know solar"*

3. **The use of group training schemes where apprentices or trainees are shared between companies and/or industries:**

   Group training schemes can be used to share apprentices to address concerns that they are not getting a sufficiently broad grounding the trade by moving between industries. Business costs can also be reduced. Wind O&M technicians were the clearest example that combined all of these elements:

- Wind O&M contractors highlighted the lack of short training courses to transfer technicians from other sectors and the cost of pre-requisite qualification courses
- Traditional apprenticeships were agreed not to work well – workers don't get the breadth of experience and could end up doing menial tasks;
- Workers can be recruited from other industries (e.g. fitters and turners, agricultural workers with a mechanical background) but there are expensive pre-requisite qualifications (e.g. Rope Access, Working and Rescue at Heights) which makes it an expensive exercise;
- No targeted courses for developing wind turbine technicians.

One O&M company exploring Group Training scheme found a major barrier in up-front training costs:

"I have had some ad-hoc discussions with other companies regarding this model. A company I was with hired full time electrical apprentices but it became a disaster due to them being used as menial labour and so specialised in the wind industry they couldn't transfer their skills over to other electrical fields. A group scheme apprentice would at least get trained in multiple fields such as domestic and light industrial during different secondments. The big issue is the initial cost of getting them the basic training to climb a turbine. If this was subsidised by the government then a pool of group scheme apprentices in the Western District (Victoria) for example would have plenty of opportunities" (O&M contractor, personal correspondence)

4. **Industry should also consider ways it can improve the retention of workers** given the importance of workers with renewable energy experience. Examples could include worker transfer arrangements between companies and industry portability of entitlements (which has been implemented in building construction and could reduce loss of staff to better paying industries).

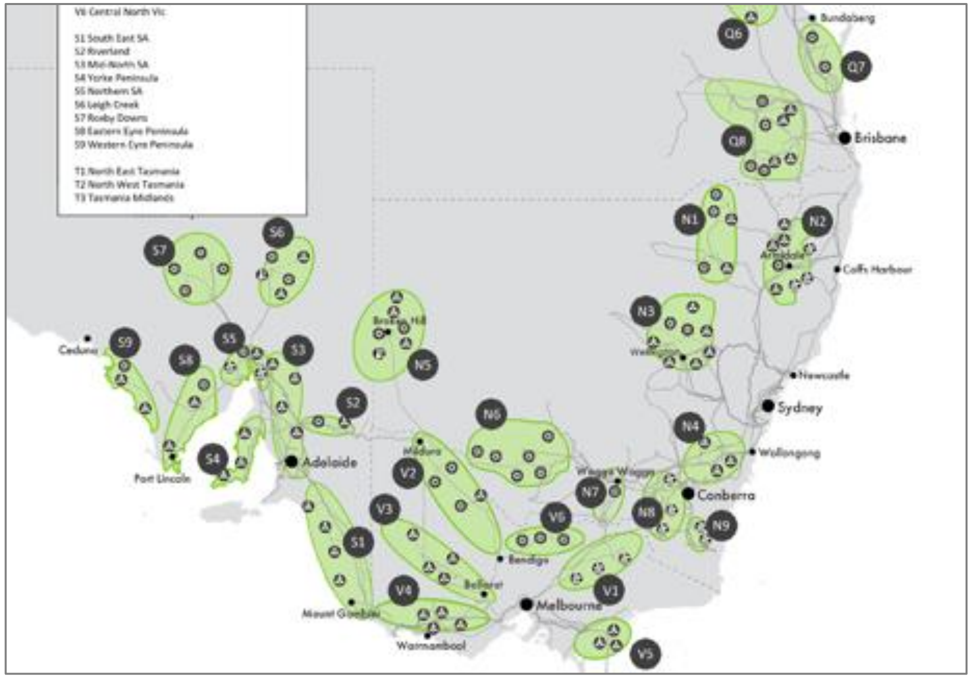
Using the Renewable Energy Zones to improve coordination and planning

In the Integrated Systems Plan, the Australian Energy Market Operator identifies a series of Renewable Energy Zones where it expects the construction of large-scale renewable energy to be concentrated. There is a large set of REZs which is still being refined by AEMO. Most of the REZs are located in regional areas well away from the cities where most of the consumption occurs. The development of REZs is intended to be used to plan for the construction of electricity transmission lines to access renewable energy and transport it to the demand centres.

The REZs also offer an opportunity for a more coordinated and place-based approach to skill and labour development (a 'skill ecosystem' approach). A coordinated approach could be developed around planning for the development of REZs with stakeholders such as the renewable energy industry, electricity networks, state governments, training authorities and Regional Development Authority. This is important to maximise local employment opportunities but also to avoid skill shortages which could occur as major project development coincides with the construction of transmission network extensions.

The Central-West REZ in NSW would appear to be an ideal candidate for trialling the use of the REZs for a more planned approach to skill development and workforce planning. The NSW Government has announced a pilot to unlock 3000 MW of renewable energy generation in the Central-West REZ (see N3 in the map). In the early stages of planning, it will include a 'REZ body that will undertake early planning to maximise benefits for local communities'.

Figure 45 Renewable Energy Zones



From AEMO (2019) *Draft 2020 Integrated System Plan*.

Renewable Energy and local content and training requirements

There are a range of businesses operating within the renewable energy supply chain in Australia:

- In the wind supply chain these include tower manufacturing, hub assembly, gearbox manufacturing and repair, transport and associated equipment manufacturing, transformer manufacturing, telecommunications and scada equipment and concrete manufacturing and electrical cabling;
- In the solar PV supply chain, these include inverter manufacturing, battery manufacturing, frames, data analytics and software equipment and warehousing and wholesale distribution.[13]

However, the level of local content and supply chain employment is low by international standards. Requiring local content could increase job numbers: for example, increasing the proportion of wind farms using Australian made towers to 75 per cent would create an average of 600 additional jobs over the period to 2035 in the Step Change scenario.[14] This is just one example: the use of local content criteria as part of auctions creates an incentive for project developers to maximise local content which can create employment in different parts of the supply chain.

A significant portion of the supply chain employment is also a function of criteria and commitments made by bidders under the Victorian Renewable Energy Target scheme.

"I'd like to be doing more internships and graduate programs … (but) we've had an off and on again market for 20 years. VRET is great but it's a bubble of work … it would be great to have an on-going program – 500 MW this year, 500 MW next year … you don't have time to build a factory, you need line of sight. You can't plan for a long-term industry if you don't have a long-term policy and plan." (Wind OEM)

It is very hard for the industry to invest in training and development in the context of policy uncertainty. This is especially so for the large-scale construction phase where rapid mobilisation is needed once the project secures finance to meet contractual timelines. Coping strategies are often used (e.g. importing workers) which do little to build the skill base. An investment pipeline with greater certainty is necessary to create an environment more conducive to skill development

Reverse auctions with local content criteria are a proven mechanism for increasing local content. In Australia, reverse auctions in both the ACT and Victoria have increased local businesses and employment. In the VRET, proponents were required to submit a Local Industry Development Plan and Major Project Skill Plan which created 900 jobs, 600 on-going jobs and 270 apprentices and trainees. Local content targets of 64 per cent were set for bidders.[15] The experience has been the same internationally, especially where there are repeat auctions as the project pipeline gives confidence for developers and businesses to invest and develop capability and competition leads to increased local content (IRENA 2019).

Pre-planning for Hydro and Pumped Hydro

Hydro and pumped hydro are forecast by AEMO to have a significant role. There is a large requirement for construction labourers, trades and engineering professionals. In addition, there is the opportunity for supply chain business due to major concrete and steel needs.

However, pre-planning will be required to maximise local employment. As one project developer said:

[13] See the Victorian directory for solar and wind supply-chain businesses: https://www.business.vic.gov.au/__data/assets/pdf_file/0007/1877542/Victorian_Wind_and_Solar_Facilities_Victorian_Business_Supply_Chain_Directory.pdf.

[14] Increasing the proportion of wind farms using Australian towers to 75% would increase the overall job-years for on-shore wind manufacturing from 0.34 job-years/MW to 0.88 job-years/MW.

[15] https://www.energy.vic.gov.au/__data/assets/pdf_file/0023/391172/VRET-auction-frequently-asked-questions.pdf

“There is likely to be a shortage of hydro skills in Australia because it's a long time since any new hydro was built, so international recruitment is likely to be needed”

Additionally, there may be competition for labour and skill shortages without advance planning. For example, Snowy 2.0 and the Hume Link transmission upgrade through the same region are both scheduled for completion in 2024-25. There is also competition with the resource sector for skilled drillers. Advance planning on skills requirements, training and workforce development and supply chain businesses is needed to maximise economic development.

Regional Industry Development

There will be major social and economic consequences in coal regions unless there is major investment in regional industry development ahead of the decline of the coal sector. Most coal mining employment is in the export sector which depends on global demand. There is a high level of uncertainty as to when the transition to renewable energy will impact on Australian coal exports will occur. There is building momentum internationally towards renewable energy, driven by factors such as the falling cost of renewable energy, climate and energy policy and actions by investors and banks to reduce exposure to fossil fuels in their portfolios.

It may be some time before this happens but structural change can be abrupt. If transition planning and investment is delayed until mass redundancies are on the horizon, labour markets will not cope with the volume of displaced workers. The closure of the Hazelwood power station in the La Trobe Valley occurred with just four months’ notice. There has been major investment of funds, programs and the establishment of a La Trobe Valley Authority – but over two years later only one-in-two workers who lost their jobs has full-time work. This experience is consistent with a large body of international cases: regional labour markets are unlikely to adjust quickly (Sheldon et. al. 2018).

The renewable energy industry should seek to play a pro-active role advocating for and participating in regional industry development plans for coal regions. It is the responsibility of governments and the mining industry to lead the transition and diversify these regional economies over time, but the renewable energy industry can contribute via collaboration to retrain and employ workers in affected regions. Effective support for a ‘just transition’ in coal regions is needed both on the grounds of fairness and to build community support for clean energy transition. Anxiety, fear and division over the future of coal region communities is a serious barrier to the rapid transition that is required. The renewable energy industry can be a part of the building coalition of parties seeking a ‘fast but fair’ transition.

Appendix 1: results by technology, all scenarios, Australia

Figure 46 Wind and solar employment, all scenarios

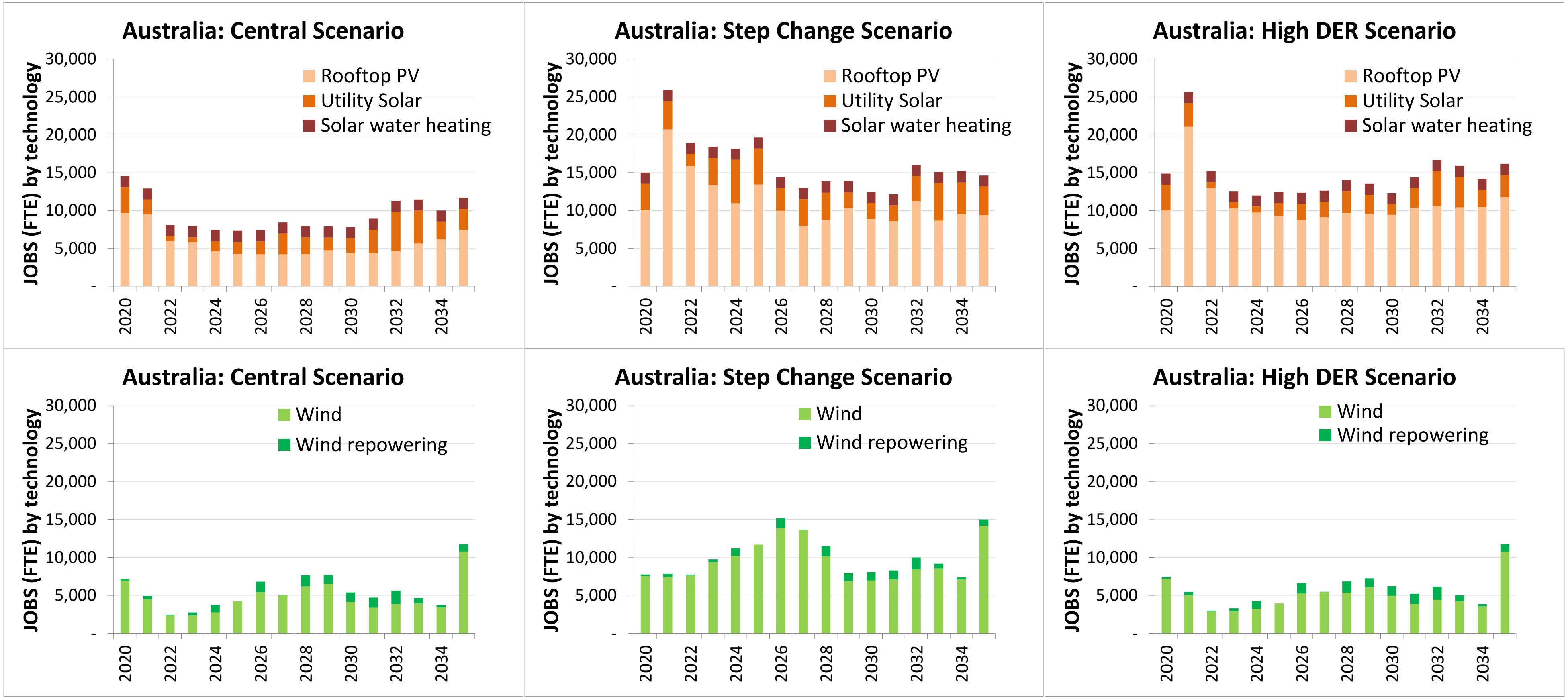
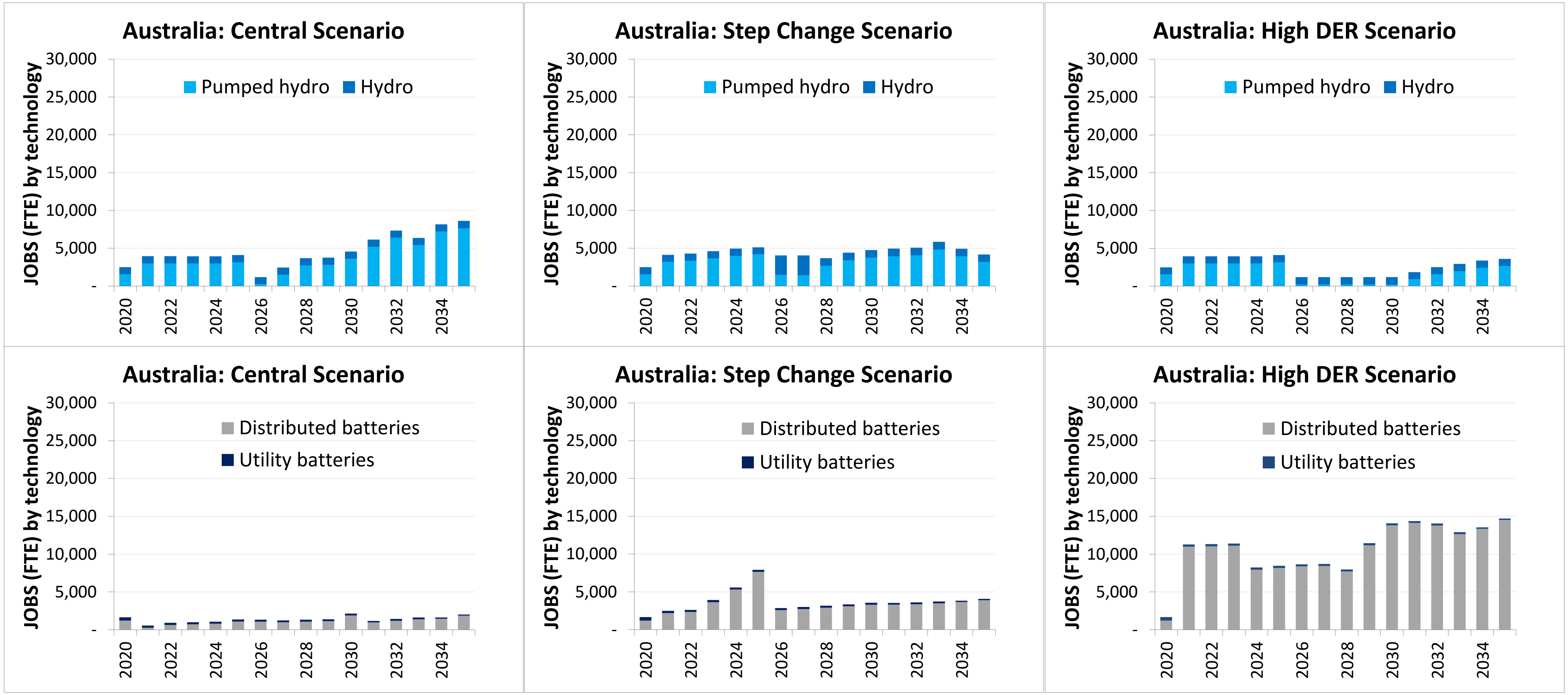


Figure 47 Hydro and batteries employment, all scenarios

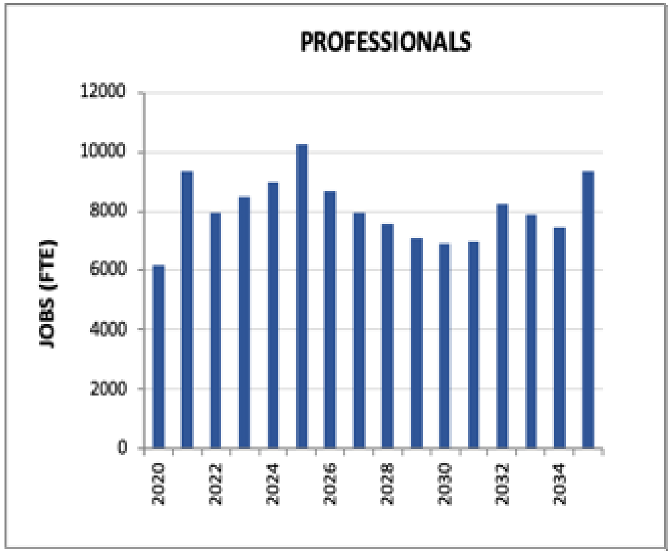


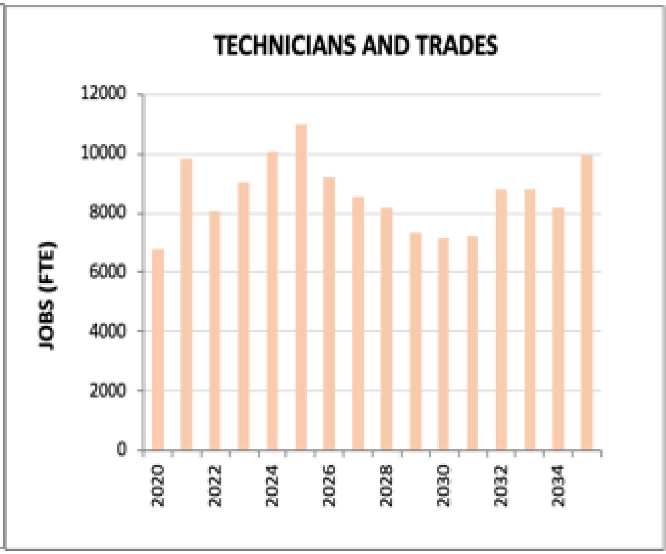
Appendix 2: Projected job numbers By Renewable Energy Zone, Step Change scenario 2025

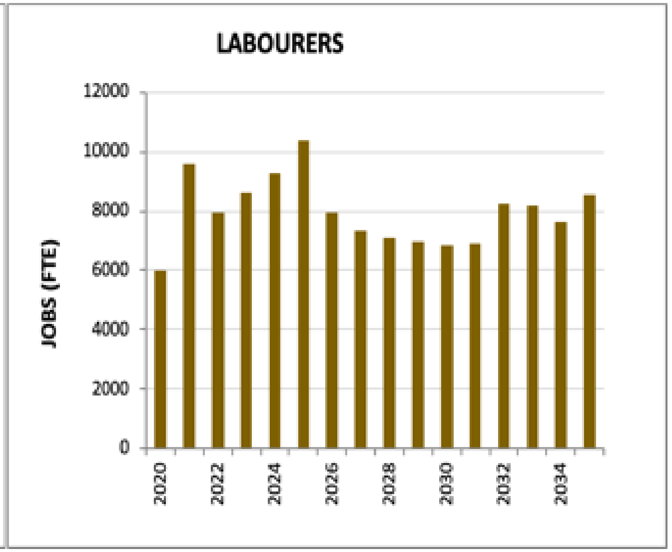
RENEWABLE ENERGY ZONE		PROJECTED JOBS AT 2025
N1	North West NSW	1,160
N2	New England	550
N3	Central West NSW	1,190
N4	Southern NSW Tablelands	240
N5	Broken Hill	130
N6	South West NSW	300
N7	Wagga Wagga	410
N8	Tumut	3,100
N9	Cooma-Monaro	-
Q1	Far North QLD	1,640
Q2	North Qld Clean Energy Hub	330
Q3	Northern Qld	150
Q4	Isaac	960
Q5	Barcaldine	230
Q6	Fitzroy	120
Q7	Wide Bay	500
Q8	Darling Downs	1,920

RENEWABLE ENERGY ZONE		PROJECTED JOBS AT 2025
V1	Ovens Murray	830
V2	Murray River	820
V3	Western Victoria	1,300
V4	South West Victoria	610
V5	Gippsland	320
V6	Central North Vic	70
S1	South East SA	250
S2	Riverland	170
S3	Mid-North SA	970
S4	Yorke Peninsula	60
S5	Northern SA	130
S8	Eastern Eyre Peninsula	120
S9	Western Eyre Peninsula	50
T1	North East Tasmania	-
T2	North West Tasmania	-
T3	Tasmania Midlands	70

Appendix 3: Projected job numbers by occupation, Step Change scenario 2020-35

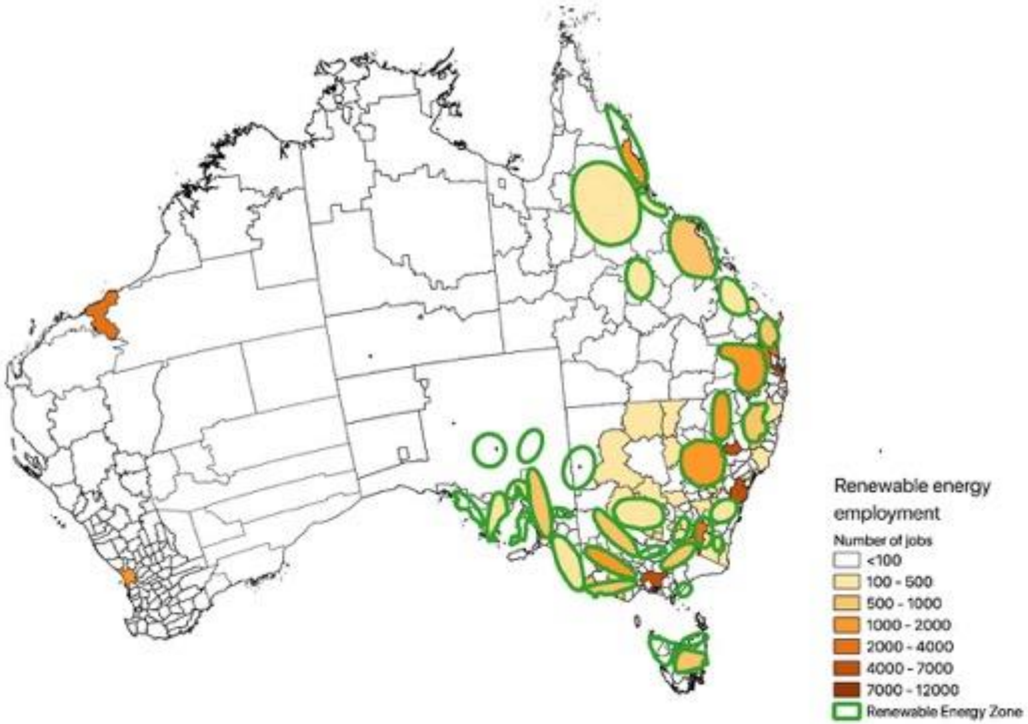






Appendix 4: Renewable and fossil fuel generation jobs – additional maps

The maps show the distribution of renewable energy jobs and fossil fuel generation jobs. Note that the scales are different, so the darkest colour on the fossil fuel generation map represents 1000-2000 jobs, while the darkest colour on the renewable energy jobs map represents between 7000 – 12000 jobs.



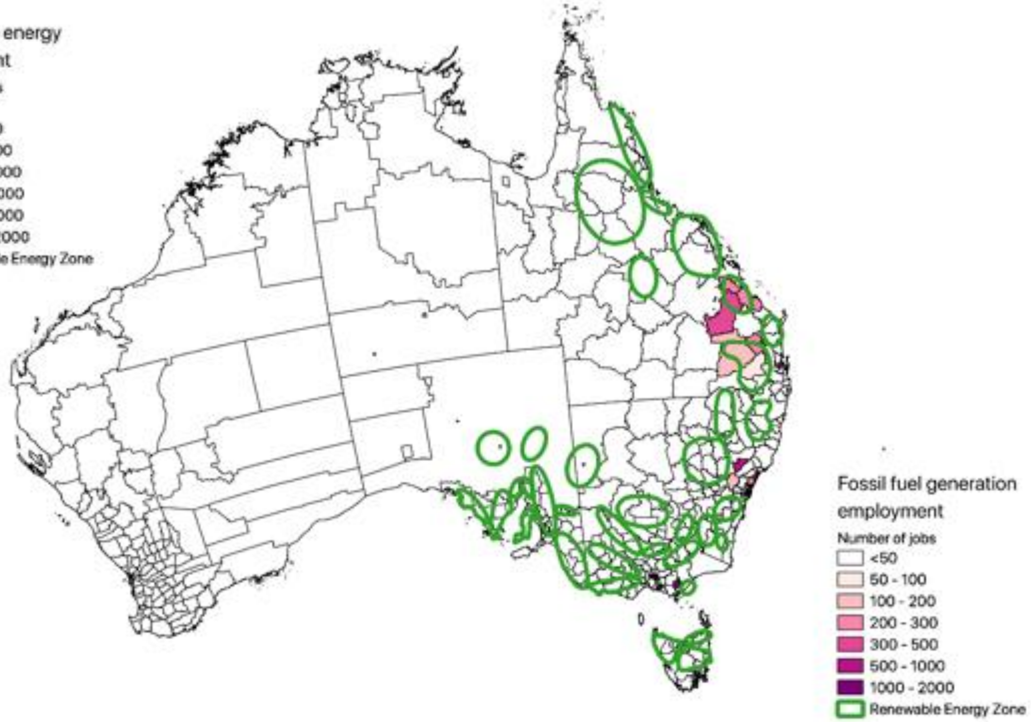
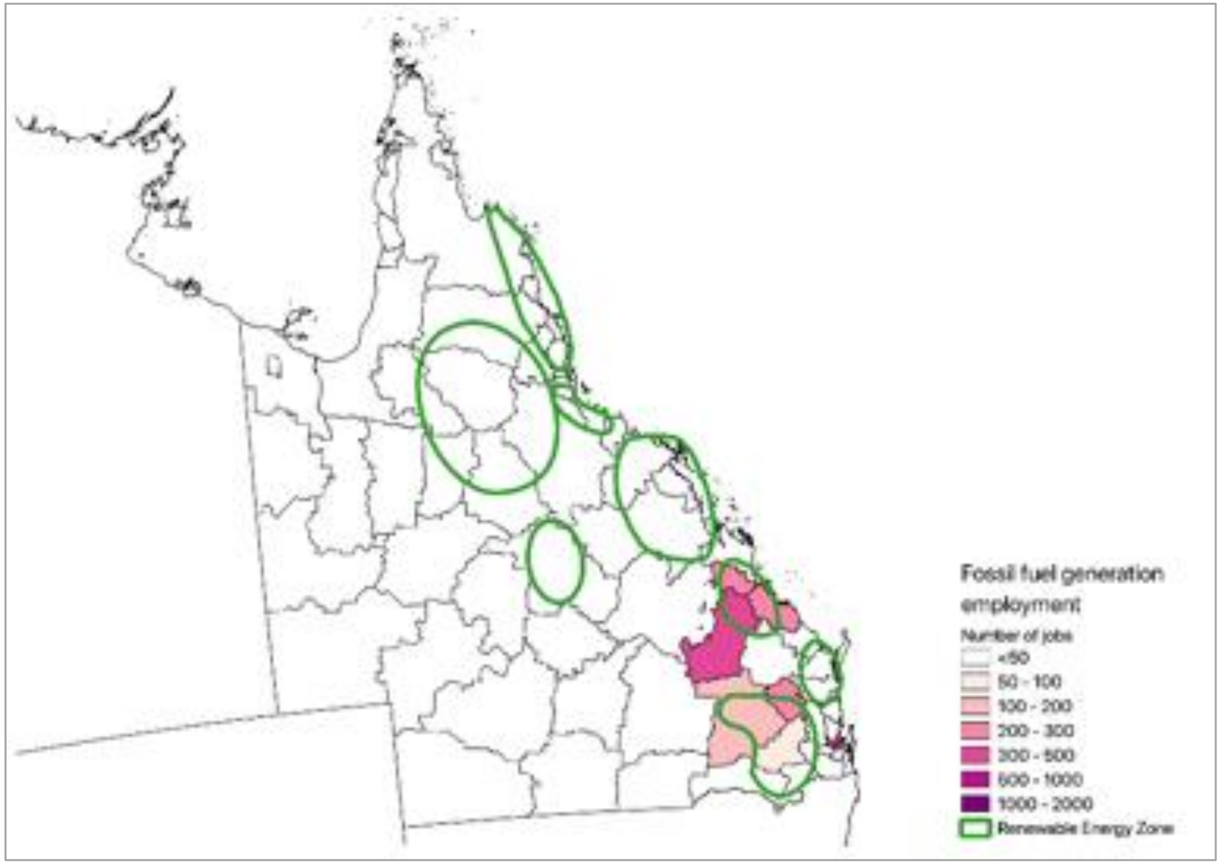


Figure 48 National renewable employment (Step Change scenario, 2025) and current fossil fuel generation jobs

Figure 49 Queensland fossil fuel generation employment (current)



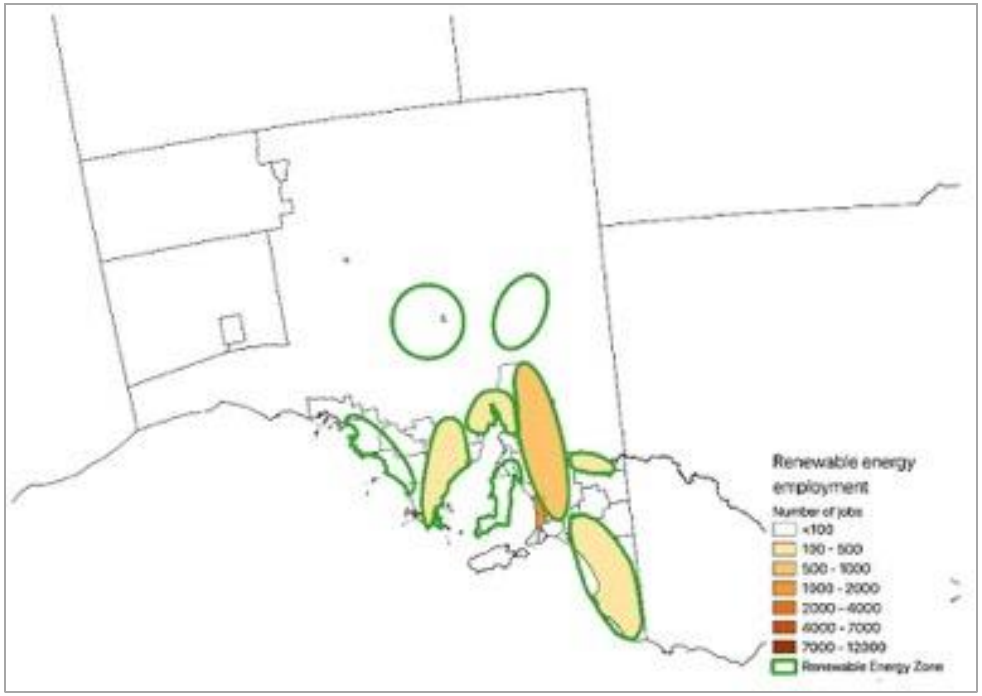


Figure 50 South Australia renewable energy employment (Step Change scenario, 2025)

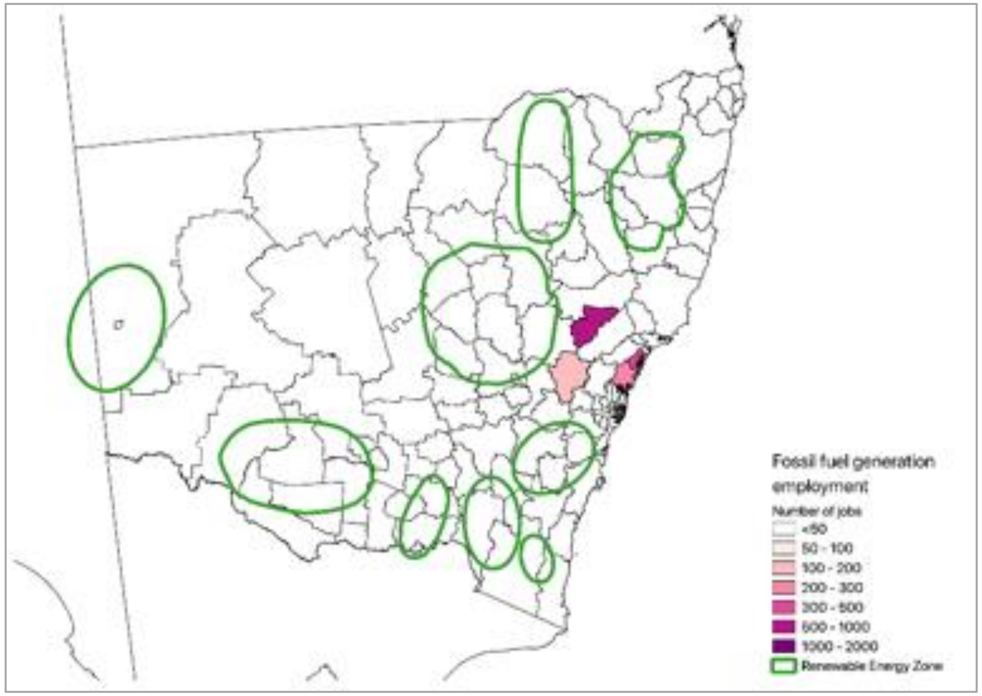


Figure 51 NSW fossil fuel generation employment (current)

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