
Australian Industry
Energy Transitions
Initiative

Foreword

The Australian Industry Energy Transitions Initiative (Australian Industry ETI) has spent the past three years undertaking an extensive program to collectively explore and address the challenges associated with decarbonising the emissions-intensive industry sector.

The Australian Industry ETI focuses on five supply chains (iron and steel, aluminium, other metals, chemicals, and liquefied natural gas (LNG)). These sectors will be critical to Australia's decarbonisation efforts due to their significant emissions, energy use, and contribution to the Australian and global economy.

When we started the Australian Industry ETI in 2020, we invited Australian businesses to come with us on a journey. Our participants - which represent more than 32 per cent of the ASX 100 market capitalisation - have collaborated to develop pathways and actions towards achieving net zero emissions in critical supply chains by 2050, consistent with limiting warming to within 1.5℃.

This report, "*Skilling Australian Industry for the Energy Transition",* was commissioned by the Australian Industry ETI to provide a deep dive into the jobs and skills that will be needed and the decision-making required to build towards a prosperous decarbonised future.

A skilled workforce - critical to an effective transition - will require investment to ensure the right skills are available, where they will be needed and at the scale required.

Change is rarely easy, and the pathway to net zero emissions is no exception.

This is a complex transition, but there is also an opportunity to ensure Australia is able to navigate the challenges and ensure the nation is well-positioned for global competitiveness in a decarbonising global economy.

Rob Kelly
Program Director
Australian Industry Energy Transitions Initiative

Australian Industry Energy Transitions Initiative

Acknowledgement and disclaimer

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Skilling Australian industry for the energy transition

February 2023

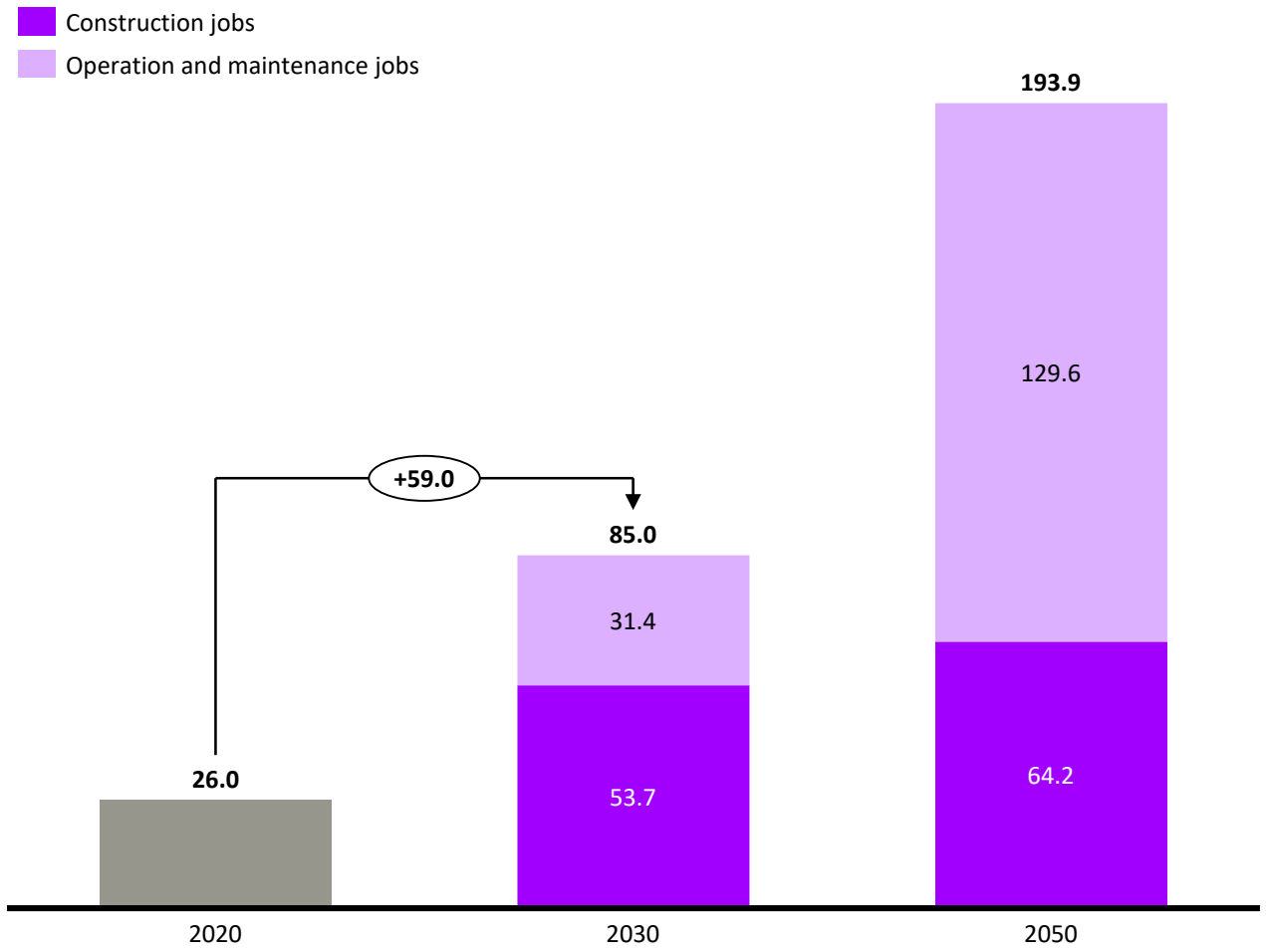
accenture

Contents

The transition to renewable energy will create jobs for ~194,000 workers by 2050 and will require an additional 59,300 workers before 2030

The renewable energy transition under the coordinated action scenario is estimated to create jobs for 193,900 workers

Number of workers (000s), 2020-2050, Australia



The renewable energy jobs story

Currently, there are approximately **26,000 workers** employed in renewable energy across solar, wind and storage across Australia.

Under the coordinated action scenario, up to **1.35 million jobs** can be supported across the Australian energy system by 2050, through investment in key renewable energy infrastructure.

This is comprised of **1.22 million construction jobs** that typically have a one-to-two-year time span. On an annual basis there is a need for at least **64,200 workers** to fill the annual construction demand.

The remaining **129,600 jobs** will support the ongoing **operations and maintenance (O&M)** of the new renewable energy infrastructure.

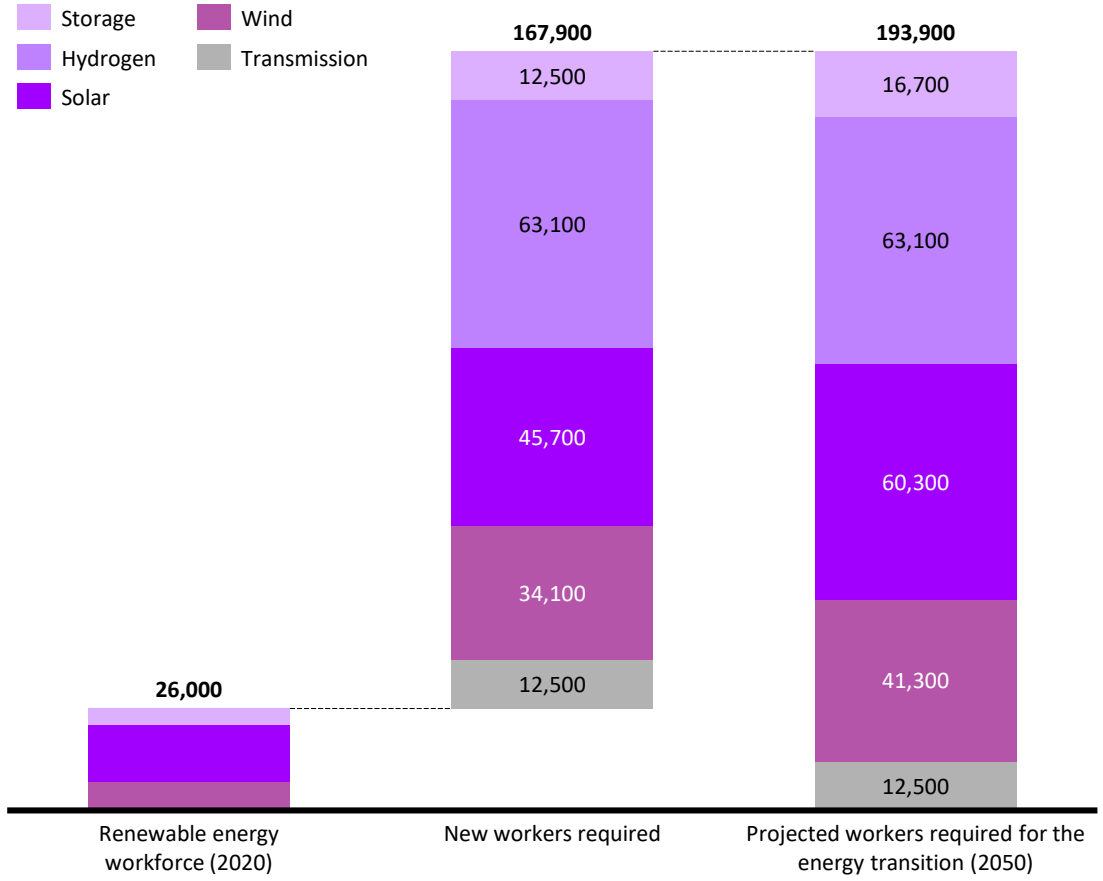
Due to large initial investments modelled through the coordinated action scenario across the Australian energy system, **85,000 workers** will be required by 2030. This means that an **additional 59,000 workers** will be required to support the construction and ongoing O&M of key renewable energy infrastructure.

Note: Numbers may not sum due to rounding
Source: ABS; Accenture Analysis of data provided by Climateworks; Clean Energy Council's Institute for Sustainable Futures

Up to ~194,000 workers will require training in new skills specific to the renewable energy industry across solar and wind energy, hydrogen and storage

To fill the 193,900 jobs required by 2050, 167,900 workers will require upskilling in renewable energy industry skills

Number of workers employed in the renewable energy industry, 2010 - 2050



These workers will likely require at least one of the following key skillsets specific to solar, wind, hydrogen and storage industries

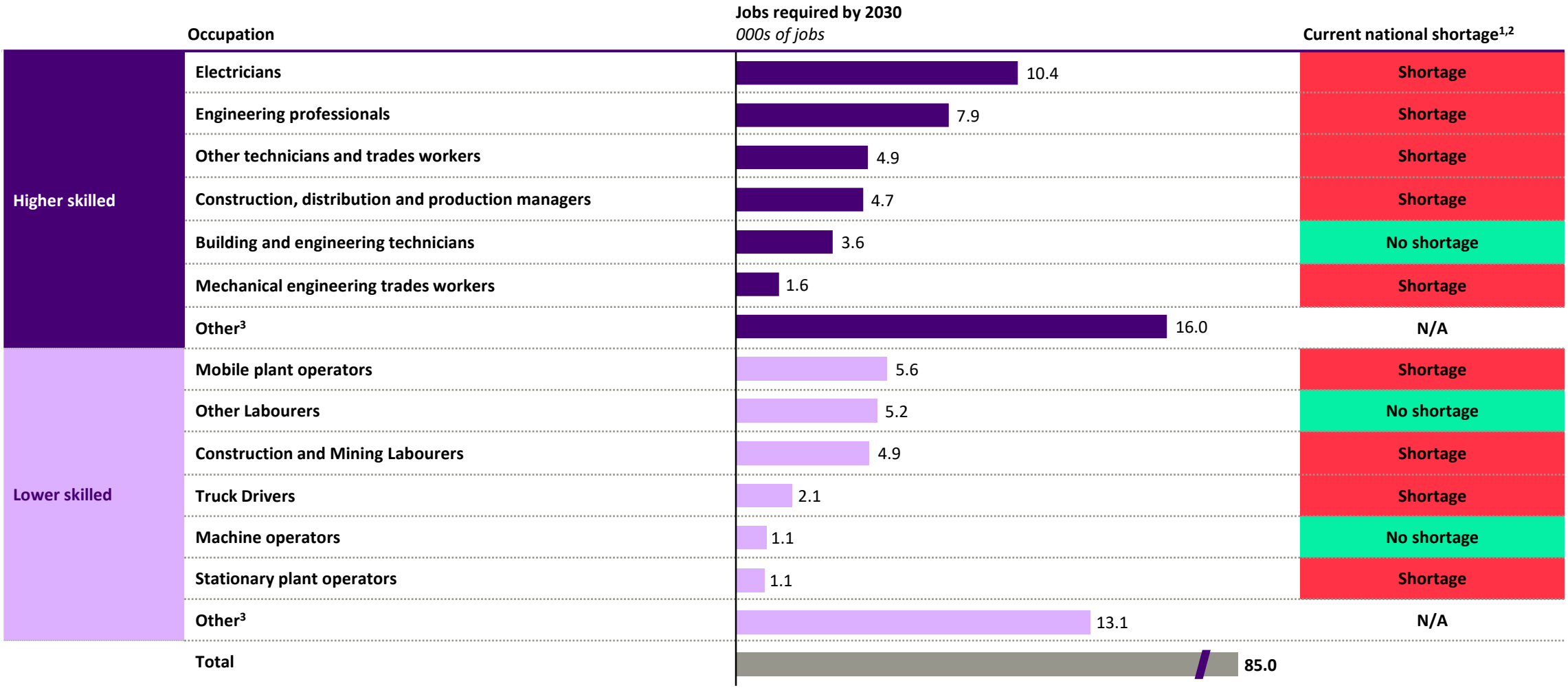
	Top 5 key skills
Solar energy	• Solar Photovoltaic Design
	• Solar Photovoltaic Engineering
	• Solar Panel Assembly
	• Solar Collector Installation
	• Solar Energy System Installation
Wind energy	• Wind Energy Engineering
	• Wind Turbine Construction
	• Wind Turbine Control System
	• Wind Farm Construction
	• Wind Farm Design
Hydrogen	• Electrolysis and Compressor Technology
	• Hydrogen electrolyser maintenance
	• Hydro-testing for transmission pipeline
	• Hydrogen Properties
	• Fuel Cell Design
Storage	• Energy Storage Systems Integration
	• Pumped Hydro Site Management
	• Battery Management Systems Analysis
	• Battery Installation and Management
	• Battery Storage System Design

Note: Numbers may not sum due to rounding

Source: Accenture analysis of data provided by Climateworks, Burning glass, ABS, Clean Energy Council's Institute for Sustainable Futures; European Battery Alliance

Meeting the short term demand for workers will be challenging, with 43,200 (51%) of the 85,000 workers required by 2030 in occupations facing a national shortage

By 2030, across the occupations key to the renewable energy transition there is currently a national workforce shortage



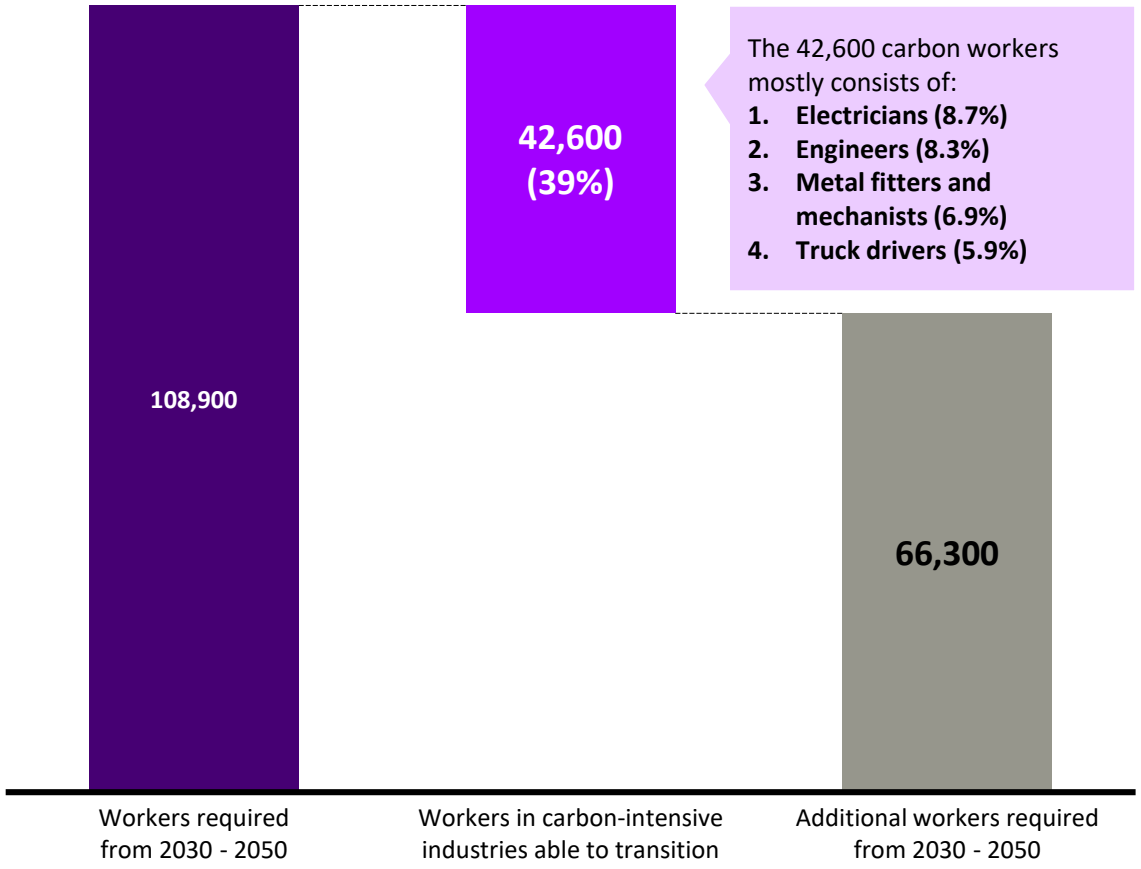
Note: 1: The 3-digit occupation is classified as a shortage if most occupations at the 4-digit level are in shortage; 3. Other category includes 89 other 4-digit occupations that comprise of 38% of the renewable energy workforce

Source: 2: 2022 Skills Priority List, *National Skills Commission* (2022); Accenture Analysis of data provided by Climateworks; ABS; Burning Glass Data; VOCSTATS; DESE Higher Education statistics

Beyond 2030, workers transitioning from carbon-intensive industries can meet 39% of the demand, but an additional 66,300 workers will need to be trained

In the medium to long term, the carbon workforce could fill 39% of the 108,900 renewable energy jobs required from 2030 - 2050

Number of workers, Australia



To upskill the additional 66,300 workers required, government and industry should consider Australian and global best practice examples

1. Examples in Australia

I. Australian Government: Joint state and territory government funding for a **$1 billion JobTrainer fund**, to offer free or low fee training in priority certifications[1]

II. Fortescue Future Industries: **The Green Skills Academy** focuses on upskilling employees in renewable energy skills, especially for hydrogen[2]

III. Queensland Government : As a part of the **$100 million Equipping TAFE for our Future initiative**, $17 million was committed to the Electro Group's Renewable Energy Training Facility, along with $10.6 million towards the Hydrogen and Renewable Energy Training Facility[3]

2. Examples of global best practice

I. Spain: **Just Transition Agreements** support displaced coal workers using multiple policy mechanisms dependent on regional needs. Agreements have measurable goals with transparent progress reporting[4]

II. United Kingdom: **The Lifetime Skills Guarantee program** has launched almost 400 fully funded qualifications to address skills gaps in construction, digital, clean energy and manufacturing[4]

III. Philippines: The **2016 Green Jobs Act** is a whole-of-government approach to identify skill needs, train and certify workers in green jobs. The package includes a 50% tax deduction on skills training[4]

Source: 1: Department of Employment and Workplace Relations; 2: Stakeholder interviews; 3: Queensland Government; 4: IEA; ABS 2021 Census Data, Accenture analysis

1 The green jobs opportunity

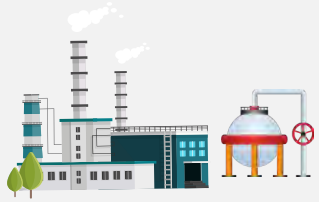
The Australian Industry Energy Transition Initiative has identified a range of carbon abatement opportunities for industry to decarbonise their supply chains by 2050

Industry could decarbonise by 2050 through a range of electrified and green hydrogen solutions

The Australian Industry Energy Transition Initiative (ETI) aims to support the **shift to net zero emissions across key industrial supply chains by 2050**, to help Australia build an economy that takes advantage of the transition.

The Australian Industry ETI has identified a range of opportunities to substantially reduce industrial emissions towards net zero emissions across key, hard to abate supply chains of **steel, aluminium, liquified natural gas, selected metals (such as copper, nickel and lithium) and chemicals (especially fertilisers and explosives):**

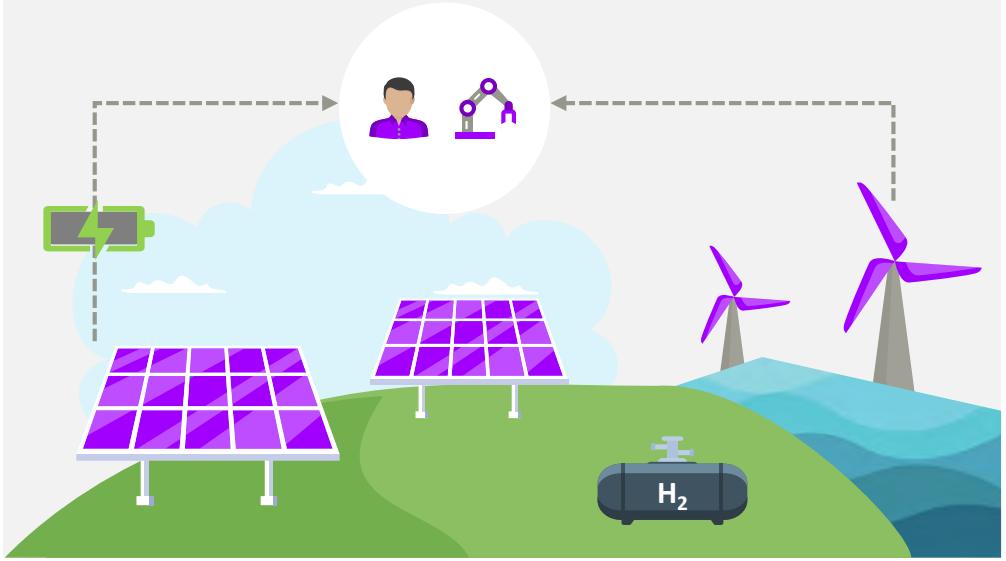
1. Switch electricity use to renewable electricity, including for iron ore mining site operations and aluminum smelting
2. Electric boilers powered by renewables
3. Electric vehicles powered by renewables
4. Green hydrogen for steel production and feedstock for ammonia and ammonium nitrate production



This will require significant investment into renewable energy generation and storage

Delivering clean energy solutions to industry requires capital and operational expenditure on green infrastructure and energy storage such as wind and PV farms, hydrogen electrolysers, and battery storage. This will require **inputs and services from a range of businesses**, such as **construction, engineering design, and installation**.

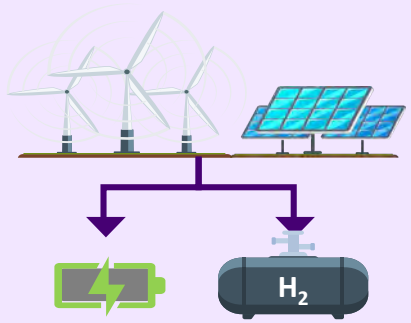
The production of these goods and services **generates direct jobs to the economy**.



Source: Setting up industrial regions for net zero: Phase 2 report, *Climateworks* (2022)

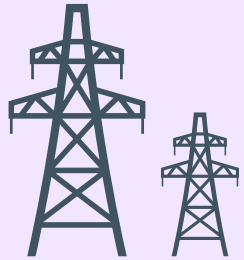
This report models the jobs created and skills required to construct and operate green generation, storage and transmission, and does not model industrial jobs

Jobs modelled



Energy generation and storage CAPEX

Ongoing operations and maintenance of the infrastructure



Electricity transmission and distribution CAPEX

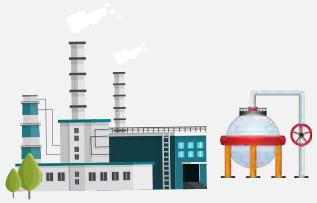
This report focuses on the job opportunities from **capital/operational & maintenance expenditures** on the energy system across Australia including:

- Wind and PV energy generation
- Battery storage
- Hydrogen electrolyser
- Ongoing operations and maintenance of the energy infrastructures
- Setting up electricity transmission and distribution networks

Other job categories

Construction of new plants and infrastructure

New industries and export capabilities



Retrofitting of existing plants and integration

Regional decarbonisation is expected to **generate additional jobs** including:

- New plants and infrastructure for new technologies (e.g. green steel)
- Catalyst to new industries and export capabilities (e.g. battery manufacturing, hydrogen export)
- Retrofitting and integration capex

If Australia pursues rapid industrial decarbonisation through coordinated action, $427B will be spent to install 221GW of clean energy capacity by 2050

Australia's pathway to decarbonisation may take many forms, from an incremental decarbonisation scenario to a coordinated action scenario that aims to pursue rapid decarbonisation.[1]

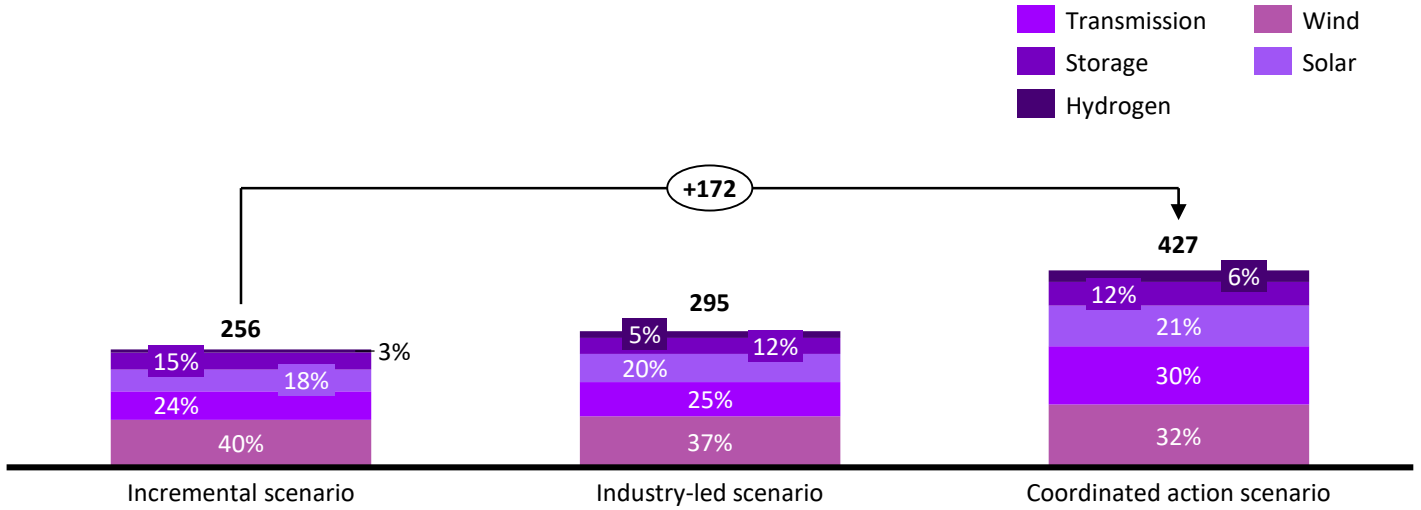
Under the coordinated action scenario, the Australian Industry ETI has identified potential for heavy industry in Australia to decarbonise while aiming to liming warming below 1.5 degrees. While possible, this transition will require a significant capital investment from industry, with up to $427B of CAPEX spend required under the coordinated action scenario from government and industry. This represents an additional $172B of CAPEX spending above an incremental (business as usual) scenario.

Under the coordinated action scenario, from 2025 to 2050 there will be 221GW of clean energy capacity created across the Australian energy system. 137GW of the total installed capacity will be created through the construction of large-scale solar and wind farms. To support the new renewable energy infrastructure, 65GW of storage capacity will be installed.

19GW of hydrogen capacity will be created across Australia by 2050 under the coordinated action scenario, supporting the demand that will be created by industrial processes, such as ammonia production, shifting to green hydrogen as an input into processes.

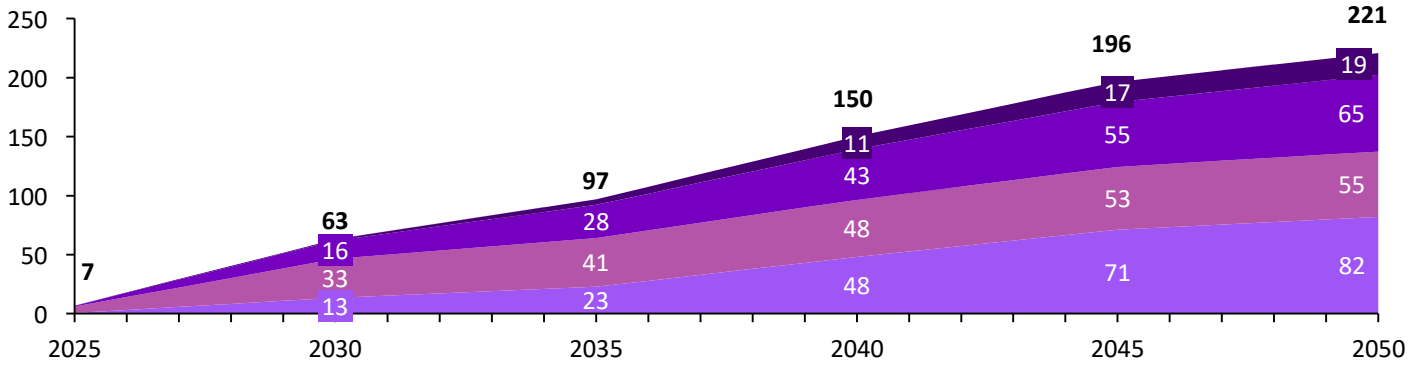
CAPEX spending across the Australia energy system by scenario

Total CAPEX spend ($M), 2025 to 2050



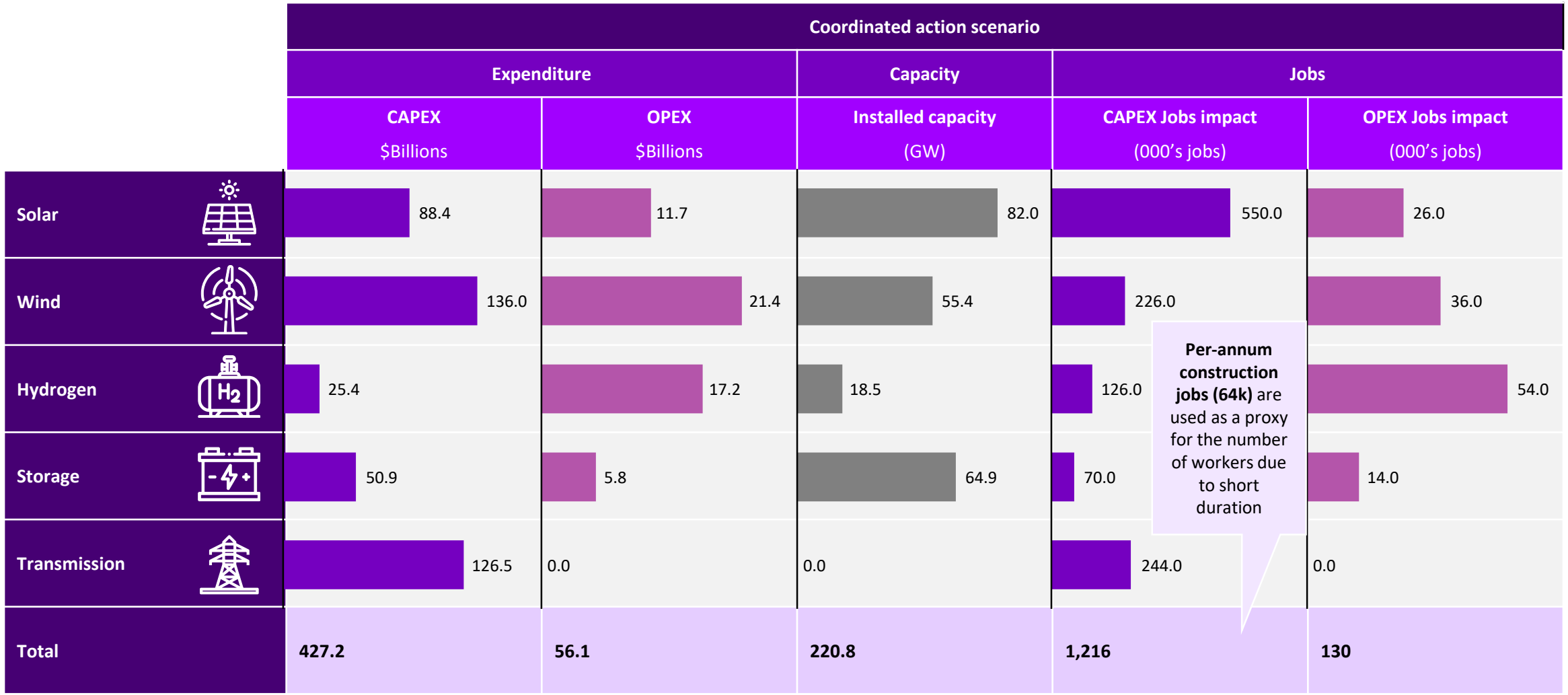
Capacity installed across the Australian energy system

Installed capacity (GW), 2025 to 2050



Note: 1. See appendix 1 for summary of Climateworks scenarios
Source: Accenture Analysis of data provided by Climateworks

The $427B of CAPEX investment could support up to 1.22 million construction jobs and 130,000 O&M jobs across Australia between 2025 to 2050



Notes: 1. Capex relates to investment in renewable energy, electrolysers, battery storage and transmission. 2. Total jobs impact is not expected to occur at the same time; 3. Numbers may not sum due to rounding; 4. See Appendix 2 for detailed methodology; 5. See Appendix 3 for detailed assumptions
Source: Accenture Analysis of data provided by Climateworks

Most construction jobs will be required before 2040, while operation and maintenance jobs will steadily rise until they peak in 2050

From 2025 to 2050, under the coordinated action scenario up to **1.35 million jobs** can be supported across the Australian energy system (excluding NT). This is comprised of **1.22 million CAPEX jobs** that are involved in the construction of wind and solar farms, energy storage facilities, hydrogen plants, and supporting transmission and distribution networks.

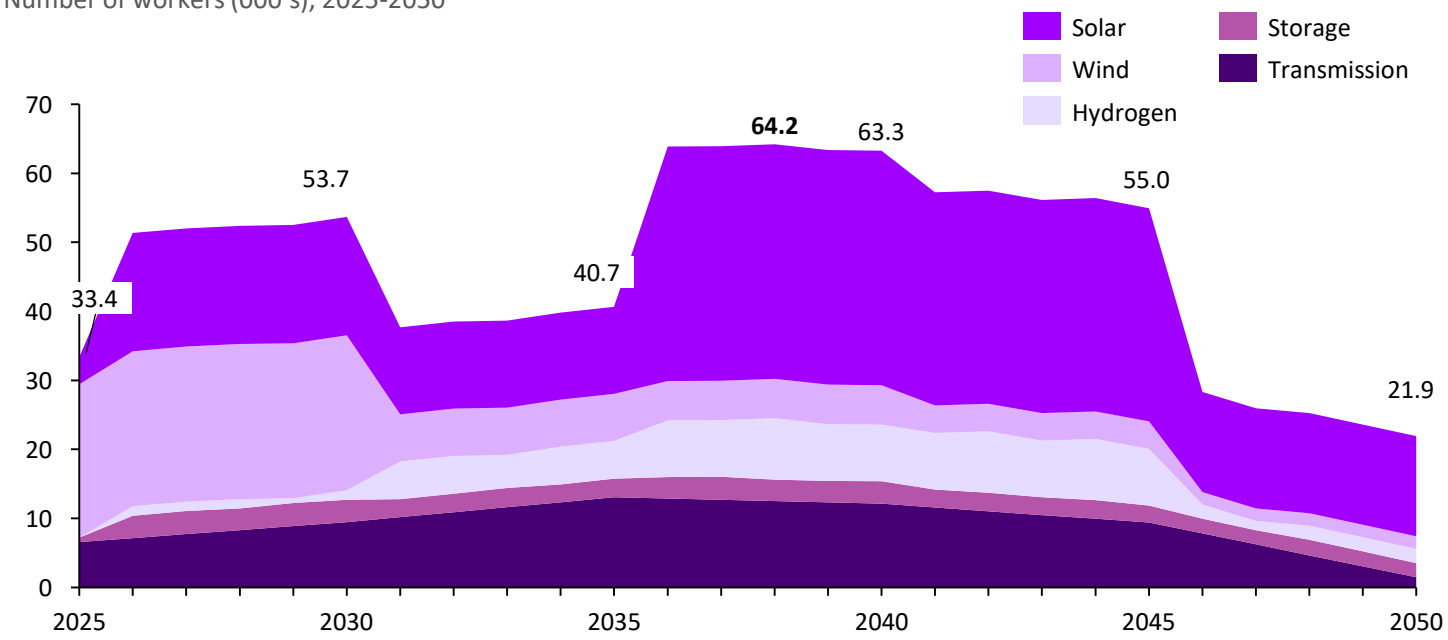
Construction jobs have a 1–2-year timeframe and as such the headline figure of 1.22 million jobs does not represent 1.22 million individuals. For example, an individual who works on constructing a solar farm in 2025 could move onto constructing another solar farm upon completion. Due to the short duration of these jobs, the best way to think about the workers that could be supported is to use a number of jobs created per annum figure.

Under the coordinated action scenario, from 2025 to 2050 there is a need for at least 64,200 workers to fill the jobs that are generated from CAPEX investments across the Australian energy system.

There are an additional **129,600 jobs** supported through the continual operations and maintenance of solar, wind, hydrogen and storage infrastructure.

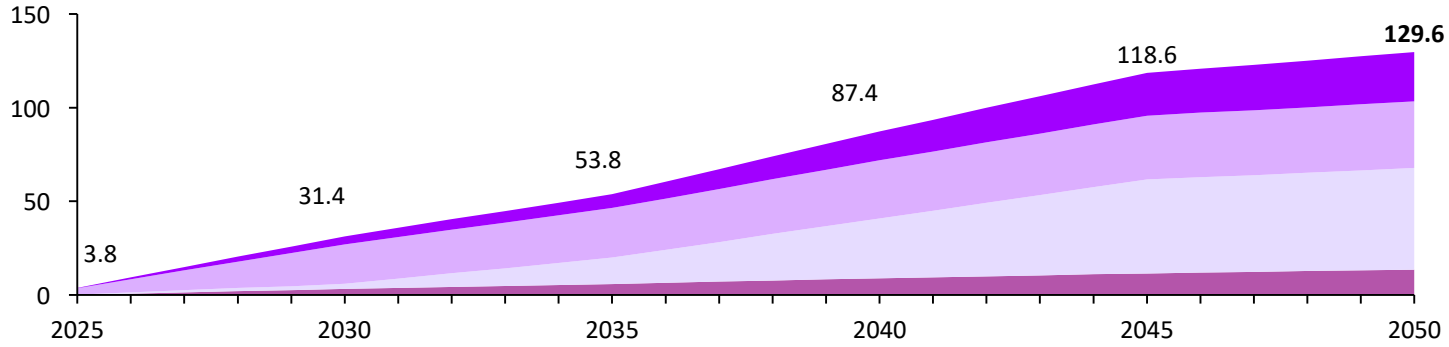
Number of construction jobs supported per year

Number of workers (000's), 2025-2050



Number of ongoing operations and maintenance jobs

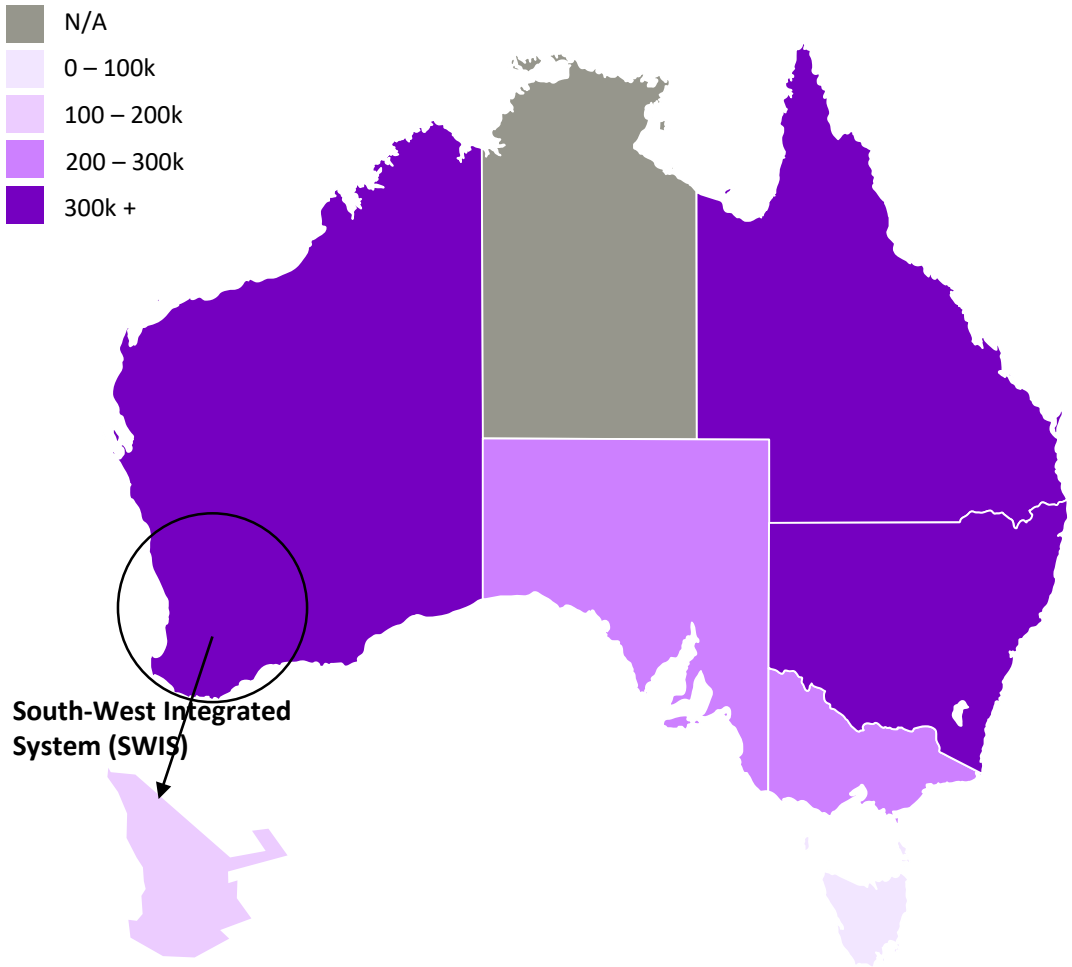
Number of workers (cumulative) (000's), 2025-2050



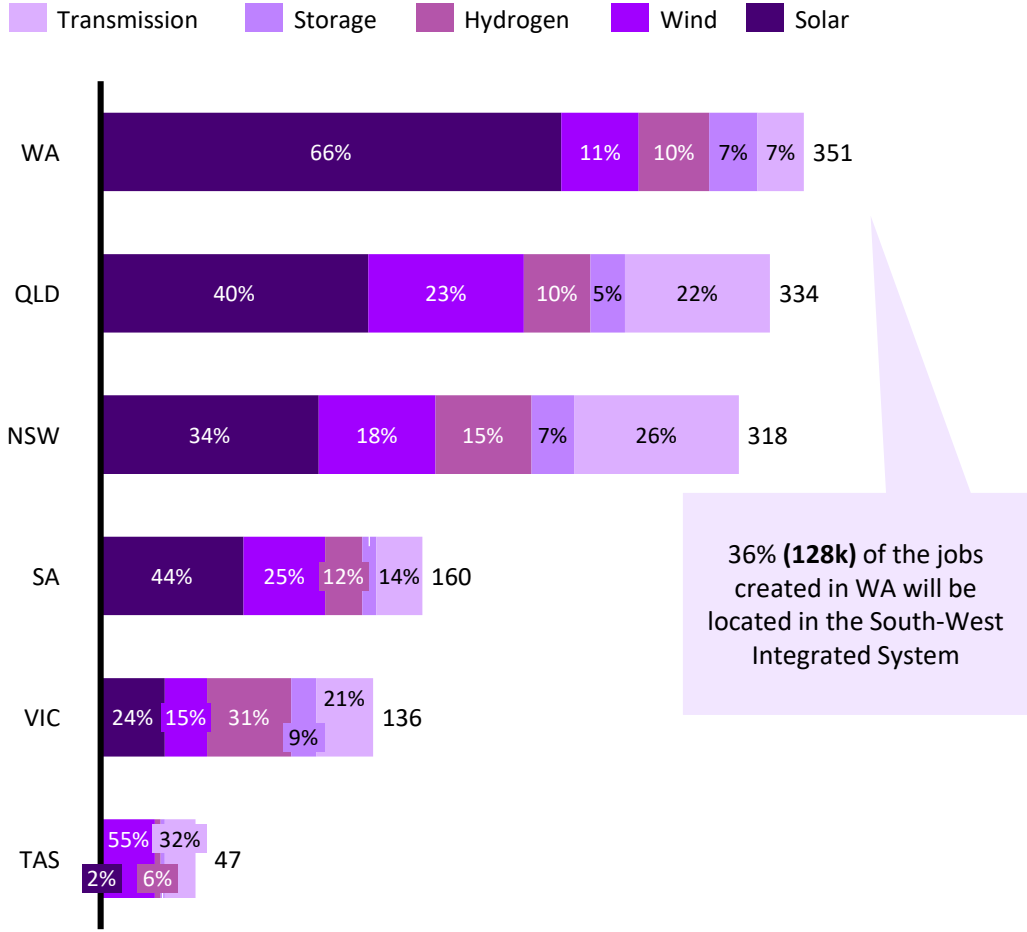
Source: Accenture Analysis of data provided by Climateworks

Queensland, NSW and WA are expected to have the largest jobs impact, with ~1 million jobs created in these regions by 2050

Total jobs supported across Australia by state
Number of jobs (000's), 2025-2050



Total jobs supported across Australia by state
Number of jobs (000's) by renewable energy industry, 2025-2050



Notes: 1. Total jobs impact is not expected to occur at the same time; 2. Numbers may not sum due to rounding
Source: Accenture Analysis of data provided by Climateworks

The green jobs opportunity will be even greater if Australia can achieve green export potential of green hydrogen and green iron

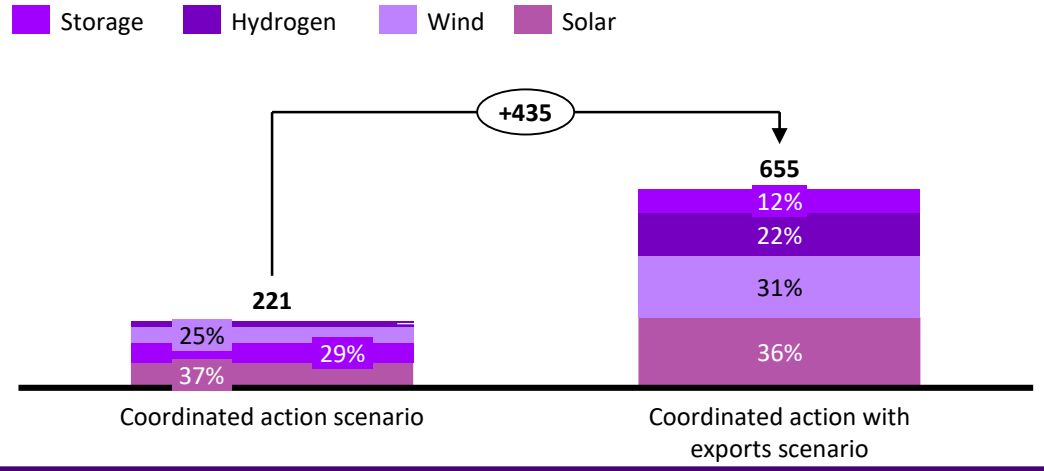
A green exports industry in Australia will require an additional $650B of investment across the energy system to support ~700Mt of export capacity

Under the coordinated action with exports scenario, the Australian industry decarbonises rapidly with substantial government incentives complementing industry leadership, driving strong abatement in all sectors in line with 1.5ºC. Zero emissions technologies are widespread, with far lower offsets needed for a 1.5ºC-compatabile budget compared to other scenarios.

The speed and scale of the transition helps Australia establish a competitive advantage in green industries, leading to new **export sectors**. Under such a scenario, it is expected that from 2025 to 2050 Australia could export up to **166Mt of green hydrogen** and **508Mt of green iron**. To support export capabilities an additional CAPEX spend of **~$650B** from 2025 to 2050 across the **energy system** on top of the coordinated action scenario is required.

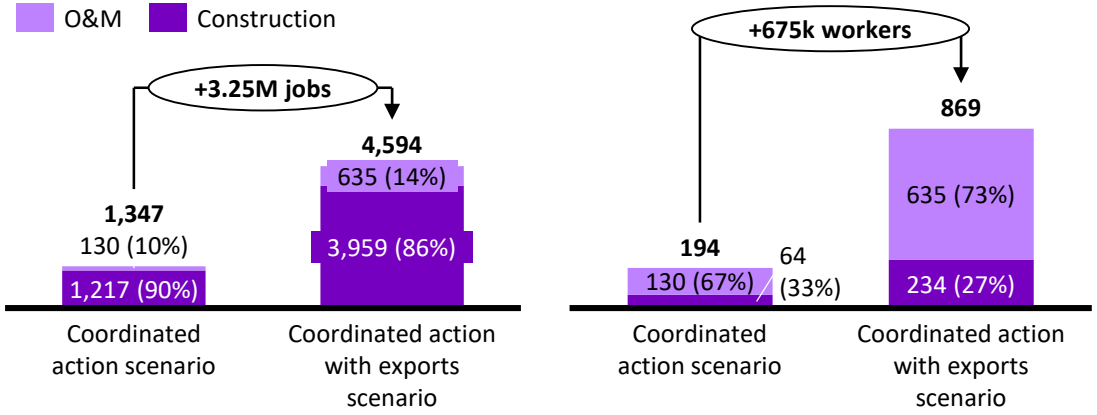
This will require an additional ~435GW of capacity

Capacity (GW) created from 2025 – 2050



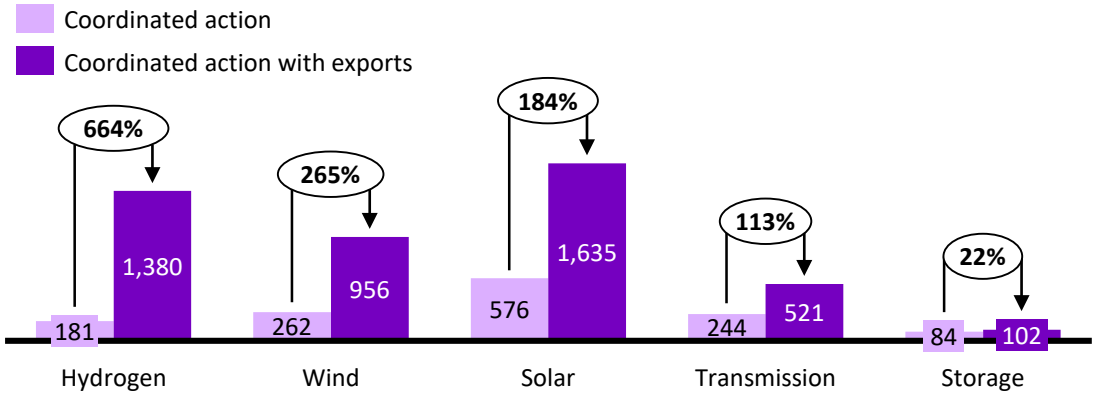
The ~435GW of capacity will create an additional 3.25 million jobs, translating to employment for 675,000 workers

Number of jobs and workers (000's), 2025-2050



These additional jobs will mainly be seen in the hydrogen industry, with a ~644% increase in jobs compared to the coordinated action scenario

Number of jobs and workers (000's) created from 2025 to 2050



Notes: 1. Total jobs impact is not expected to occur at the same time; 2. Numbers may not sum due to rounding
Source: Accenture Analysis of data provided by Climateworks; AEMO ISP 2022 Hydrogen Superpower Scenario; National Hydrogen Strategy Energy of the Future Scenario

2

The green skills challenge

Australia faces two key challenges to skill the 168,000 workers required for the energy transition by 2050

1. The renewable energy training need

Since Australia already has about 26,000 workers in renewable energy industries, an **additional ~168,000 workers trained in renewable energy skills are needed by 2050**

2. Australia's short-term skills shortage

About **51% of the workers** required by 2030 (43,200 workers) are in occupations already facing a **national shortage**, with the skills need particularly acute across **electricians** and **engineering professionals**

2a

The renewable energy training need

About 59% of the renewable energy jobs created will be higher skilled occupations, mainly consisting of technicians and trade workers

Of the total jobs supported by the energy transition in Australia from 2025 to 2050, an estimated 59.0% will be higher skilled roles such as technicians and trade workers, professionals and managers. This is mainly driven by the high number of technicians and trade workers required in the large-scale solar industries, which is expected to account for 14.4% of the total jobs created.

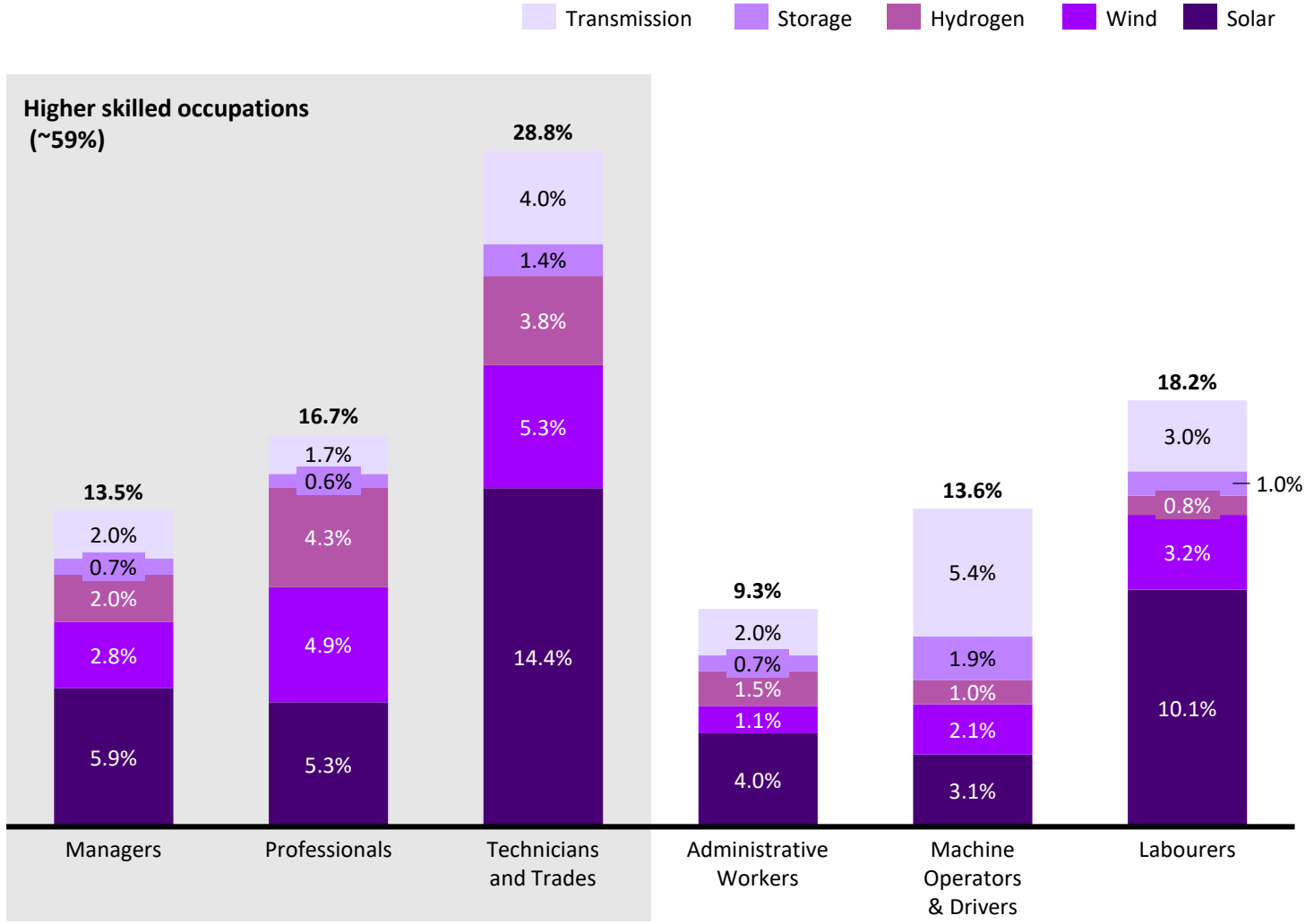
Between industries, the wind and hydrogen industries have a higher saturation of high skilled workers than the solar, transmission and storage industries. Since higher level technical skills generally have less skills transferability, these industries will likely have a greater difficulty in obtaining skilled workers.

Besides high skilled workers, labourers are expected to account for the second largest proportion of workers, contributing to 18.2% of the total jobs created from 2025 – 2050. These workers will mainly be required in the solar industry.

Many labourer jobs will likely be shorter term construction jobs. Since most constructions jobs have a short-term duration of 1-2 years, the total workforce will likely consist of a higher proportion of higher skilled workers such as managers or technician roles.

Occupations in renewable industries

Percentage of total jobs created, 2025 – 2050, Australia



Note: High skill occupation groups predominantly consist of occupations with a skill level of 1 – 3, as determined by the ABS ANZSCO classifications.
Source: Accenture Analysis of data provided by Climateworks; ABS; Burning Glass Data

Renewable energy jobs require core electrical, project management and engineering skills, with growth seen in renewable, wind and solar energy skills

An analysis of jobs advertisement data between 2019 to 2022 indicates that a significant degree of heavy equipment, electrical, and engineering skills will be required for the energy transition.

Skills related to using heavy equipment such as forklifts, power tools and welding equipment as well as core civil engineering skills will be in high demand.

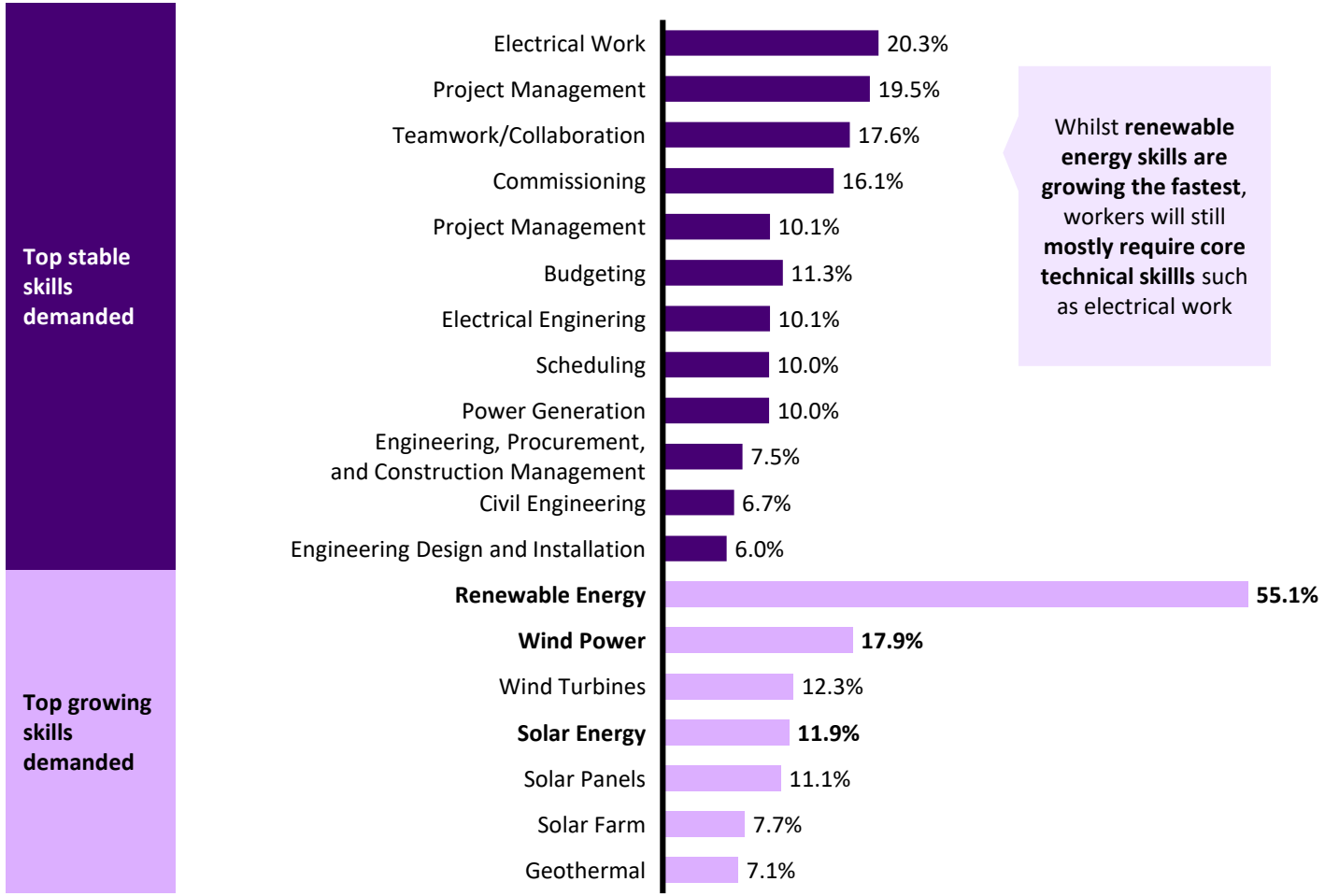
Electrical skills will also have a high-level of demand through the energy transition. Appendix 5 shows that electrical engineers will mainly require design based electrical skills, whilst electrical engineering technicians and electricians will require more labour-intensive electrical skills, such as electrical work experience, wiring, and caballing.

Skills that have been growing in demand between 2019 and 2022 cover core industry 4.0 skills such as automation, systems design and data analysis.

There has also been a growth in skills related to clean, solar and wind energy with demand for these skills only expected to rise even further as the energy transition evolves in Australia over the next 25 years.

Skills required in renewable energy jobs

% of jobs that require each skill by ANZSCO 4 digit occupation, Sep 2019 - 2022

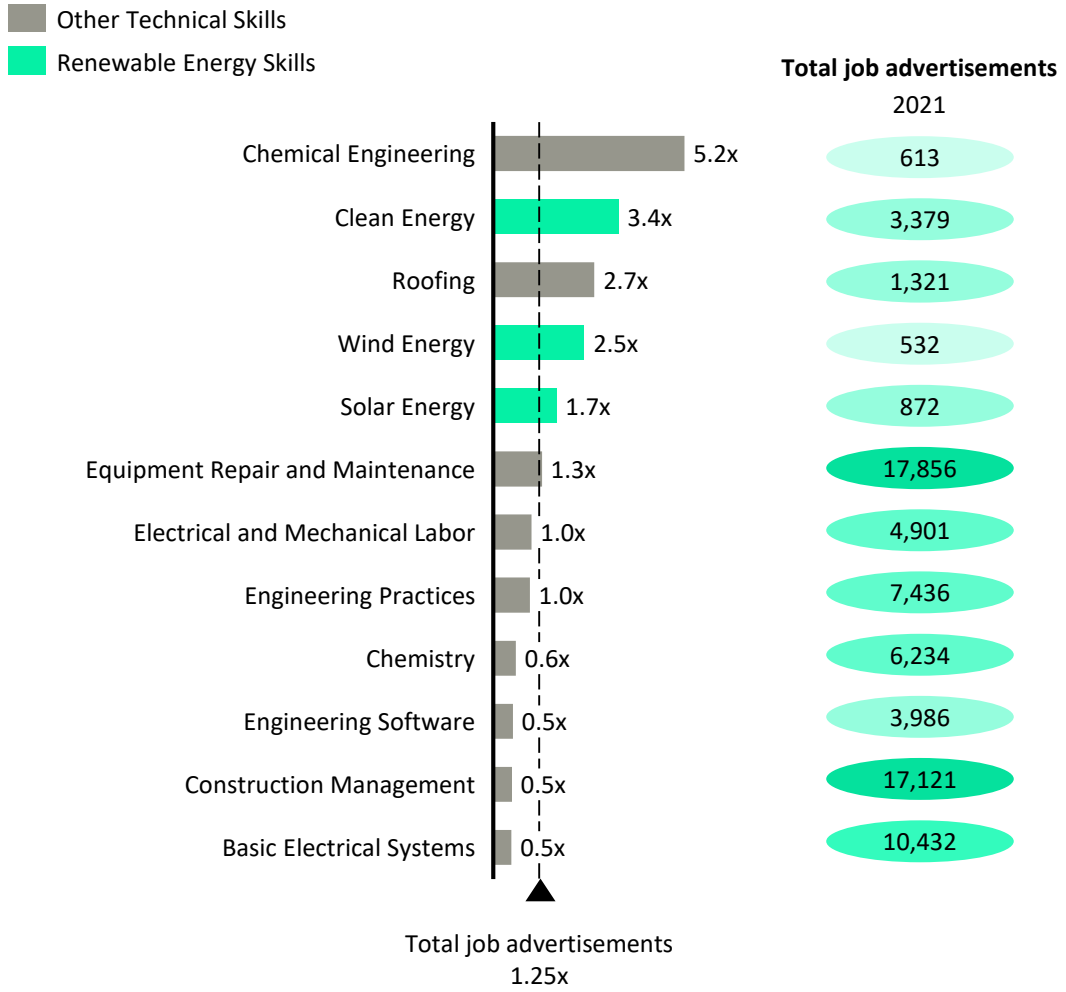


Notes: See appendix 5 for breakdown of skills by occupations and appendix 6 for skills captured under clean, solar and wind energy
Source: Burning Glass Data

Skills in solar, wind and clean energy have grown considerably over the last 10 years and are expected to continue growing as more renewable energy jobs are created

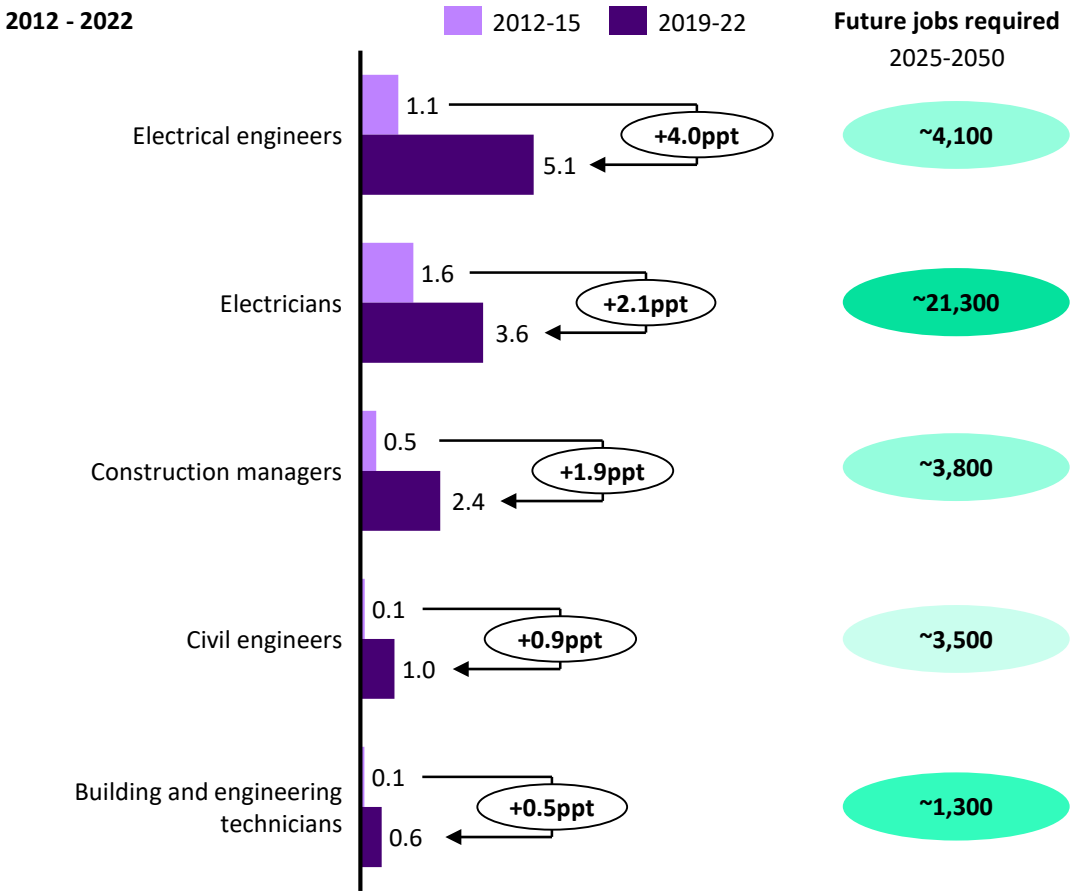
Change in demand of renewable energy technical skills

Change in demand, 2012 – 2021, Australia



Growth in solar, wind or clean energy skills across key renewable energy occupations

% of job advertisements with solar, wind or clean energy skills, Australia



Note: Skills match represents the percentage of job advertisements requiring that skill, for each occupation. Skills with an occupation match of less than 1% are excluded. See appendix 6 for skills captured under clean, wind and solar energy

Source: Accenture Analysis; Burning Glass Data

To meet the large and growing demand for renewable energy workers, up to ~168,000 workers will require training in skills specific to renewable energy industries

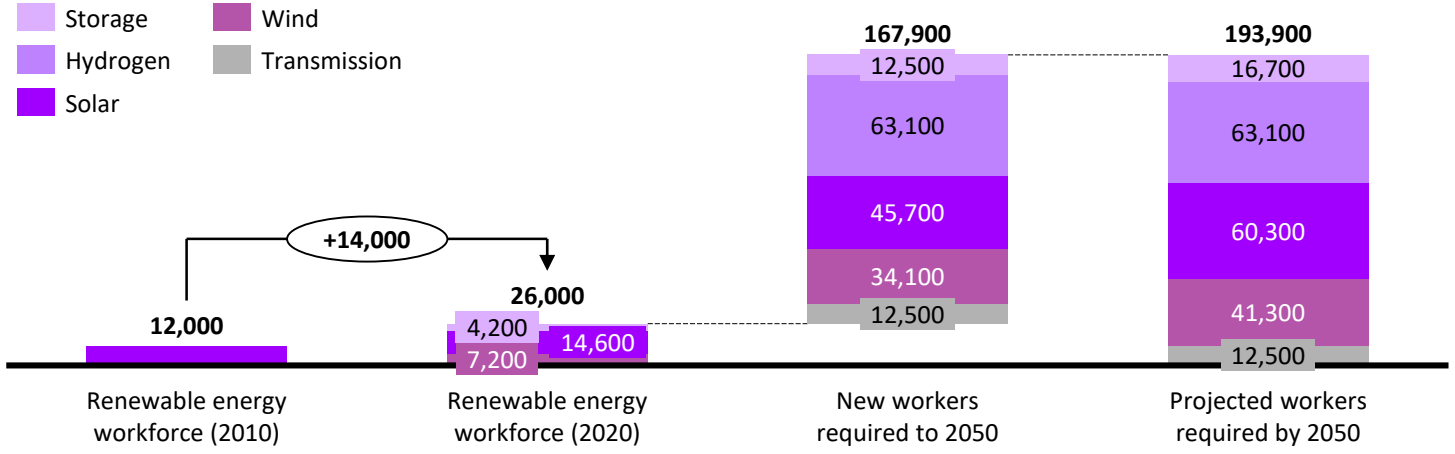
The renewable energy industry is an important and growing source of employment across Australia. The Institute for Sustainable Futures conducted found through a survey of employment in renewable energy across Australia that in 2020 there were approximately **26,000 workers** employed in renewable energy across solar, wind and storage, which has more than doubled from the **12,000 workers** employed in 2010.

Looking forward, modelling conducted in section 1 of this report suggests that across wind, solar, storage, hydrogen generation and transmission infrastructure up to **193,900 workers** will be required to support the renewable energy industries by 2050. Based on current employment in renewable energy this leaves a gap of at least **167,900 workers**.

A substantial number of the new **167,900** renewable energy workforce will need training in skills specific to solar, wind and clean energy. These skills will sit across design, engineering, manufacturing, construction and maintenance of key solar, wind, hydrogen and storage infrastructure.

Change in the renewable energy workforce from 2010 to 2050

Number of workers employed, 2010-2050, Australia



Key skills demanded through the energy transition (non-exhaustive)

Solar Energy
- Solar photovoltaic design
- Solar photovoltaic engineering
- Solar panel assembly
- Solar collector installation
- Solar energy system installation

Wind Energy
- Wind energy engineering
- Wind turbine construction
- Wind turbine control system
- Wind farm construction
- Wind farm design

Hydrogen
- Electrolysis and compressor technology
- Hydrogen electrolyser maintenance
- Hydro-testing for transmission pipeline
- Hydrogen properties
- Fuel cell design

Storage
- Energy storage systems integration
- Pumped Hydro Site Management
- Battery management systems analysis
- Battery installation and management
- Battery storage system design

Source: Accenture analysis of data provided by Climateworks, Burning glass, ABS, Clean Energy Council's Institute for Sustainable Futures; European Battery Alliance

However, current VET sector offerings in renewable energy generation and storage are not meeting industry demands with a clear need to develop battery and hydrogen specific training

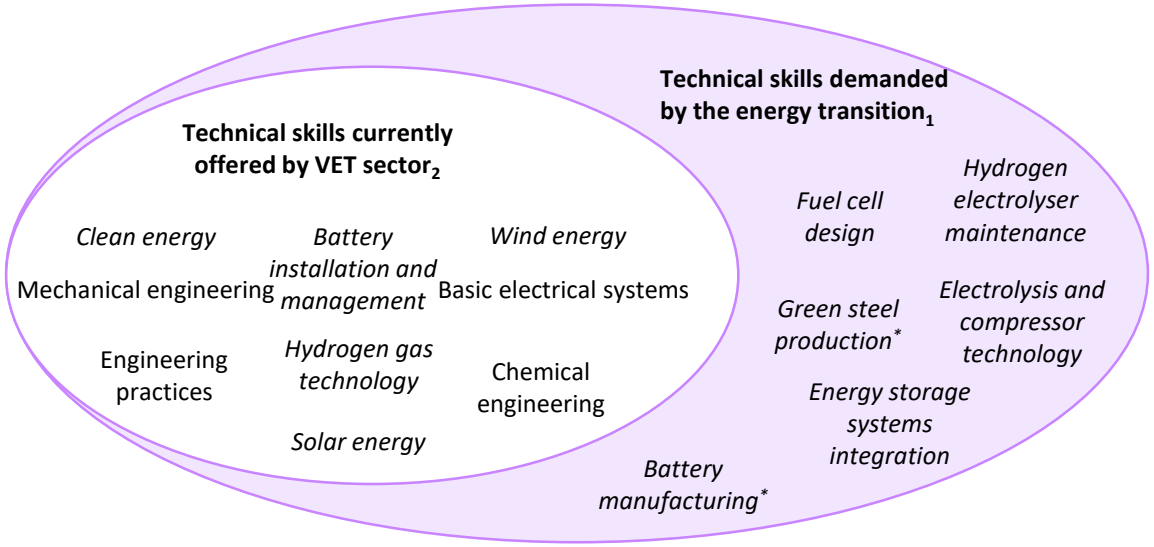
Currently, the Australian Vocational Education Training (VET) sector has developed units of competency in wind, solar, clean energy and battery instillation and management.

A recent report from the Clean Energy Council's *Clean Energy at Work* found that candidates lacking specific experience or qualifications for renewable energy was the cause for recruitment difficulties for 48 per cent of large-scale wind and solar companies.[1] Suggesting that the current offering is not designed to meet the needs of renewable energy projects.

For example, an apprentice electrician currently does not gain exposure to core units related to solar systems with opportunities only available in elective units of competency. These skills often need to be acquired as a post-trade skill set at an additional cost, discouraging workers to complete training.

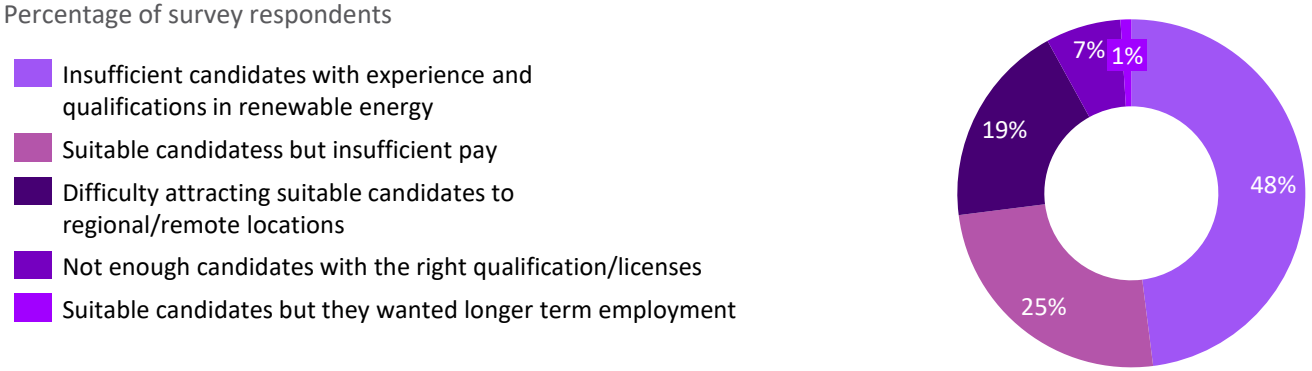
For hydrogen there is only one national training package that has successfully made revisions to include hydrogen-specific units of competency. The core base skills held by trades such as electricians can be leveraged to support the shift towards the production and storage of hydrogen. However, upskilling in hydrogen specific skills will be necessary across the sector, with targeted training opportunities needing to ensure the implementation of hydrogen systems and technologies is support adequately.[2]

Vocational education coverage of technical skills demand by the renewable energy industry



Causes of recruitment difficulties for wind and large-scale solar

Percentage of survey respondents

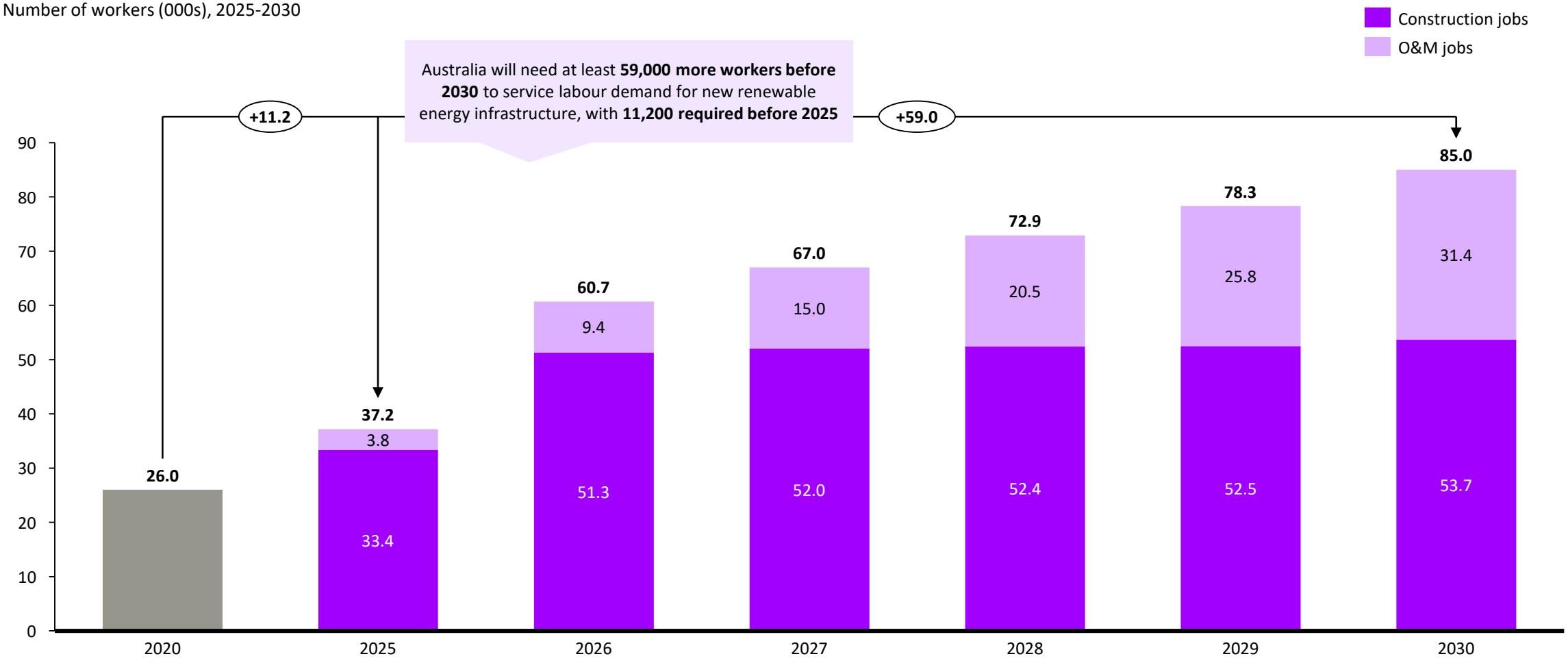


Note: *Skills that currently do not have an industry presence in Australia but will be key in the energy transition
Source: 1. Clean Energy Council, *Clean Energy at* Work; 2. Victorian Hydrogen Hub, *Hydrogen Skills Roadmap;* 3. Training.gov.au

2b Australia’s short-term skills shortage

85,000 workers will be required by 2030, representing an additional 59,000 workers to support the construction and ongoing O&M of key renewable energy infrastructure

Estimated jobs created under the coordinated action scenario
Number of workers (000s), 2025-2030



Source: ABS; Accenture Analysis of data provided by Climateworks; Clean Energy Council's Institute for Sustainable Futures

Meeting the short-term demand for workers will be challenging, with at least 43,200 (51%) of the 85,000 workers required by 2030 in national shortage occupations

Under the coordinated action scenario, an estimated **85,000 workers** willl be required to support the construction and operations and maintenance of renewable energy infrastructure. However, it will be challenging to meet this demand, as at least **51%** of these workers (**43,200 workers**) are required in national shortage occupations.[4]

Critically, **39%** of these jobs in key occupations (33,100 workers) are higher skilled occupations, which require formal education and training at TAFE or university. Since these courses generally take 3 to 4 years to complete, the benefits of new policies and programs to incentivise greater enrollment may not be realised until at least 2026.

The most concerning shortages are in electrician and engineering roles. From 2025 to 2030, an estimated **10,400 electricians** will be required, representing 12.3% of the total jobs required. **7,900 engineers** will also be required, representing 9% of the jobs created. This will mainly include electrical engineers (2.4% of the total jobs created), civil engineers (2%) and industrial, mechanical and production engineers (0.93%). These roles also have the longest estimated training time of four years.

Estimated jobs created and current national shortage

	Occupation ANZSCO 3 digit	Jobs required by 2030 000s of jobs	Current national shortage[1]	Estimated time to train[2]
Higher skilled	Electricians	10.4	Shortage	4 years
	Engineering professionals	7.9	Shortage	4 years
	Other technicians and trades workers	4.9	Shortage	3 years
	Construction, distribution and production managers	4.7	Shortage	3-4 years
	Building and engineering technicians	3.6	No shortage	3 years
	Mechanical engineering trades workers	1.6	Shortage	1-3 years
	Other[2]	16.0	N/A	N/A
Lower skilled	Mobile plant operators	5.6	Shortage	6-12 months
	Other Labourers	5.2	No shortage	0-12 months
	Construction and Mining Labourers	4.9	Shortage	0-12 months
	Truck Drivers	2.1	Shortage	1 year
	Machine operators	1.1	No shortage	0-12 months
	Stationary plant operators	1.1	Shortage	0-12 months
	Other[2]	13.1	N/A	N/A
	Total	85.0	N/A	N/A

Note: 1: The 3-digit occupation is classified as a shortage if most occupations at the 4-digit level are in shortage; 2: Estimate is based on the certifications required for occupations on the Your Career website and Burning Glass job advertisement data. The duration is then estimated based on the My Skills website and is verified by training provider websites; 3: Other category includes 89 other 4-digit occupations that comprise of 38% of the renewable energy workforce
Source: 4: 2022 Skills Priority List, *National Skills Commission* (2022); National Careers Institute; Accenture Analysis of data provided by Climateworks; ABS; Burning Glass Data

The skills shortage is partially due to the low representation of women, who account for 2-34% of workers in key occupations despite accounting for 51% of the total national workforce

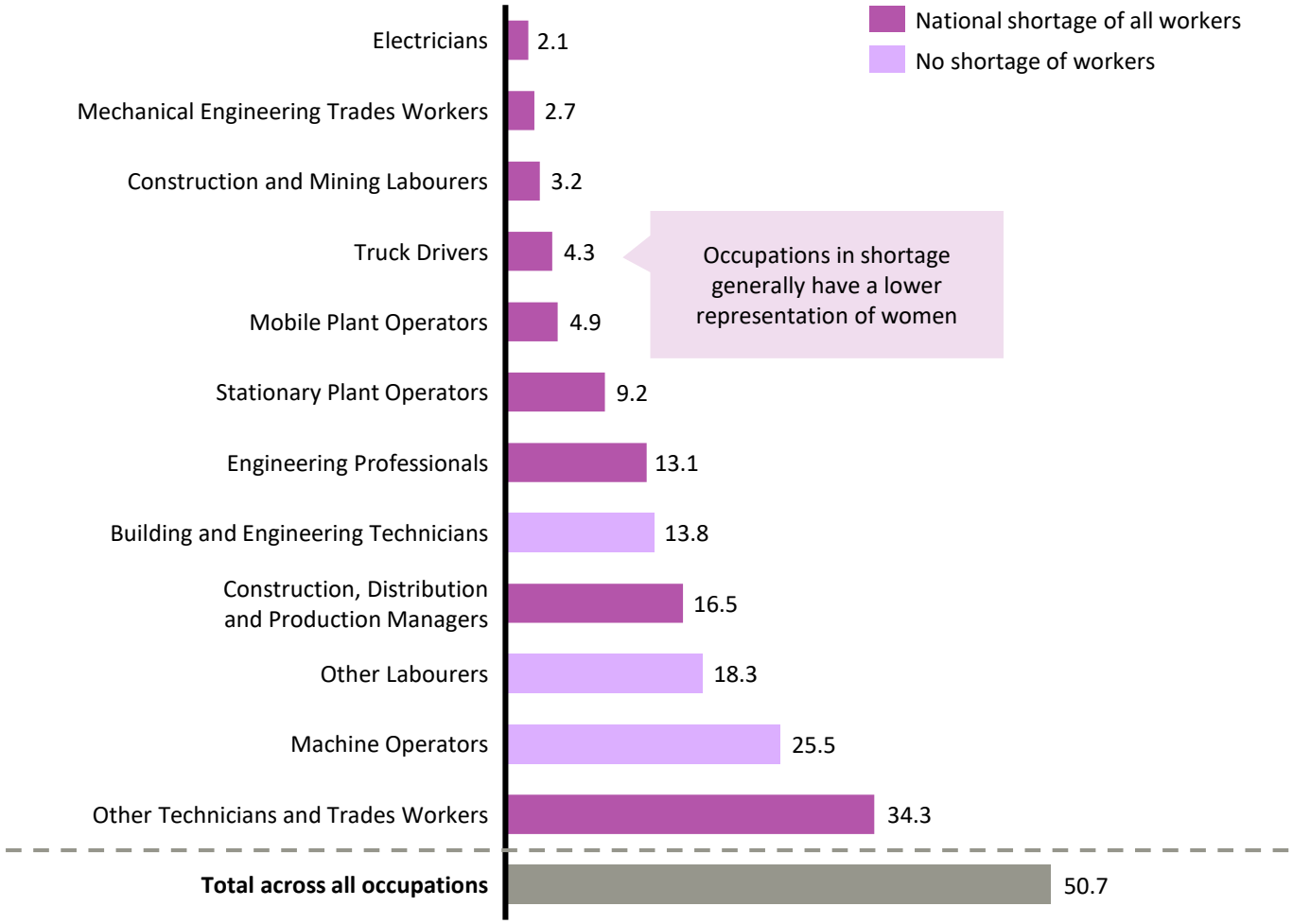
As of the 2021 Census, women accounted for 50.7% of the Australian workforce. However, the representation of women in key roles required for the energy transition is alarmingly low. For example, women accounted for just 2.1% of the electrician workforce and 13.1% of the engineering workforce.

Notably, occupations with the lowest representation women are facing a current national shortage of workers. This includes electricians, engineers, mechanical engineering trades workers, mobile plant operators, construction and mining labourers and truck drivers, all of which have a current workforce of less than 5% women.

The low representation of women will make it especially challenging to fill the 85,000 workers required for the energy transition by 2030. A key opportunity for Australian skills policy will be to promote a greater enrolment of women into key trade, engineering and management courses.

Current representation of women in key occupations required for the energy transition

Percentage (%) of women in workforce by selected ANZSCO 3 digit occupations, 2021, Australia



Source: ABS 2021 Census

Annual commencements in an electrician apprenticeship are at an 11-year high of ~17,000, but course completions over the past four years are at an 11-year low

From 2014 to 2020, there was a 26% reduction in annual commencements in electrician apprenticeships across Australia, declining from 16,600 in 2014 to 12,500 in 2020. However, the most recent data point in 2021 suggests that annual commencements are up 37% from the 2020 result to 17,100 – the highest over the past 11 years.

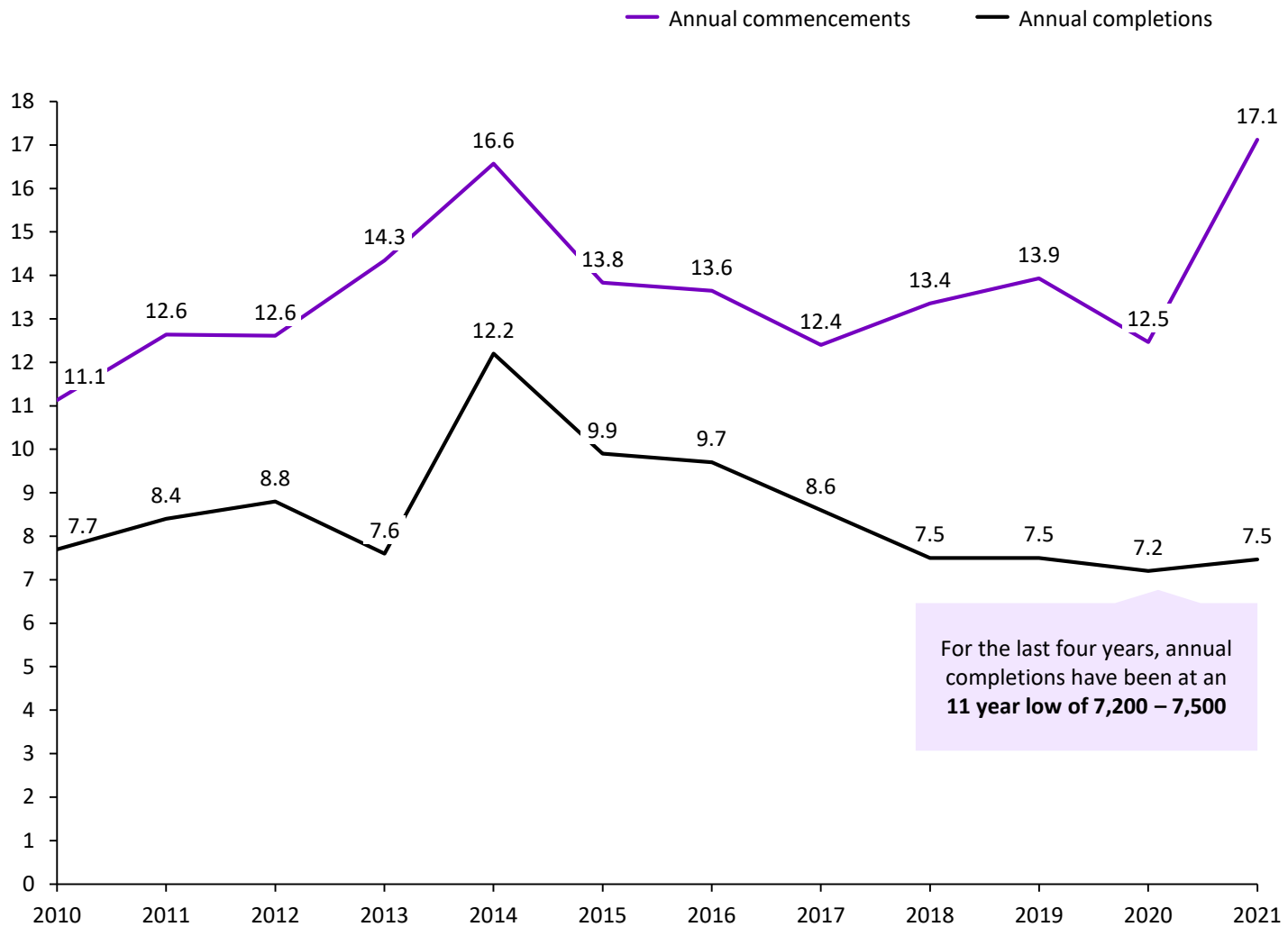
More concerning is that over the past four years the number of electricians completing their apprenticeship is at it's lowest point, with at most 7,500 apprentices completing their apprenticeship.

Current indications suggest that the low completion rate may not be improving any time soon with a recent survey conducted by the Electrical Trade Union in 2022 showing that more than 37% of electrician apprentices are considering quitting. The top reason apprentices gave for thinking about termination was wages (17%) ahead of work culture (16%) and cost of living (14%).

Although initial enrolments are high in 2021, the number of fully qualified electricians entering the workforce has been declining over the past 7 years. This suggests that unless annual commencements remain at a high level, the throughput of qualified electricians into the workforce may struggle to meet additional future demand.

Annual commencements and completions of electrician apprentices

Number of students (000's), 2010-2021, Australia



Source: NCVER VOCSTATS Data; Electrical Trades Union

Low completion rates will contribute to an estimated 9,500 electrician shortage by 2026, which will only grow as demand for electricians rises to 2050

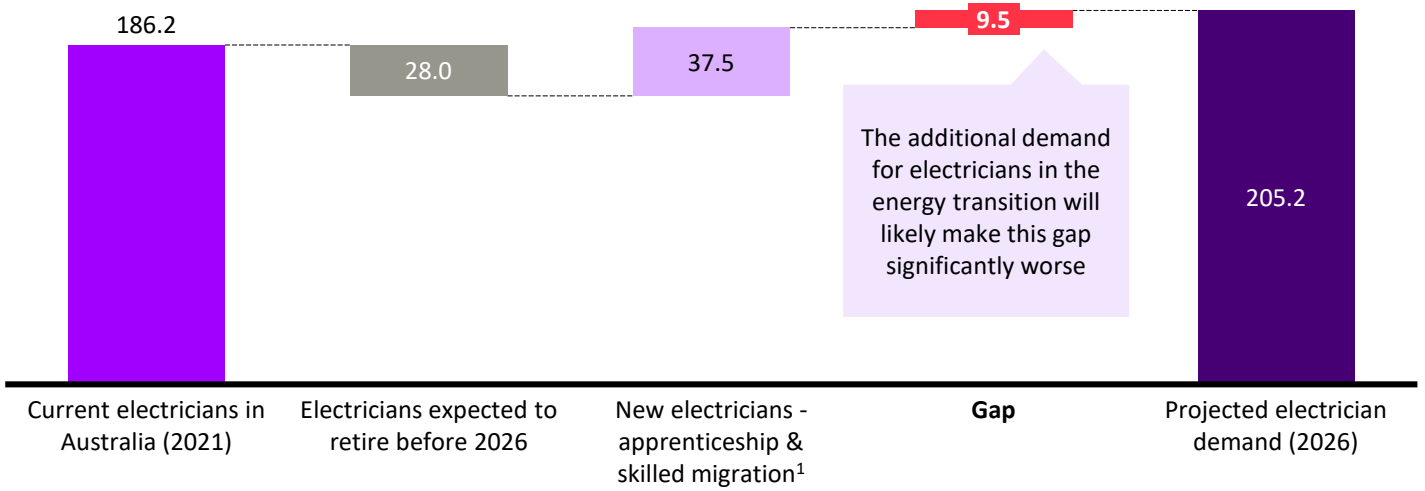
Currently across Australia there are 186,200 workers employed as accredited electricians. Forecasts from the National Skills Commission predict that demand for electricians will grow to 205,200 by 2026. Based on approximately 5,600 electricians transitioning away from the workforce each year and 7,500 electricians being added each year through apprenticeships, there will be a gap in the workforce of 9,500 electricians by 2026.

As noted on slide 18, annual commencements have increased suggesting that the gap could be reduced. However, as the energy transition takes shape across Australia, an additional 21,300 electricians will be required to support the construction and ongoing operations and maintenance of key renewable energy infrastructure by 2050.

This will create a greater level of demand for electricians that is in addition to any further growth in demand beyond 2026. The impact as detailed by key stakeholders will be that a "bidding war" will ensue for electricians, resulting in key renewable energy projects either going over budget or underdelivering due to budget constraints.

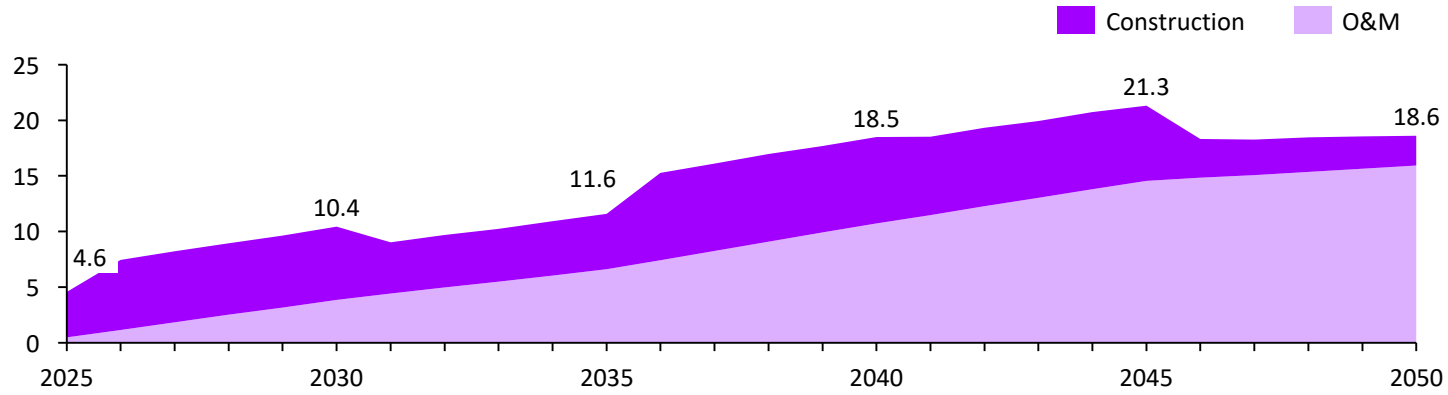
Changes in the electrician workforce by 2026

Number of workers (000's), 2021 – 2026, Australia



Number of electricians employed in renewable energy generation and storage

Number of workers (000's), 2025 – 2050, Australia



Note: Electricians entering as skilled migrants are required to complete the Australian Minimum Context Gap Training which consists of core and elective competency standard units in the Certificate III in Electrotechnology Electrician. Therefore, the number of 7,500 graduates each year captures skilled migrants

Source: Accenture analysis; Climateworks Centre, ABS; VOCSTATS; Interviews with representatives from Rio Tinto, Fortescue Future Industries and Orica

Since 2015, there has also been a 0.5% decline in engineering enrollments despite a 2.6% growth in total university enrollment

From 2015 to 2020, enrolments in tertiary education grew across most disciples, growing 2.6% nationally. However, enrolment in engineering and related technologies degrees experienced a **0.5% decline** in enrolment. This has contributed to a growing shortage of engineers across Australia

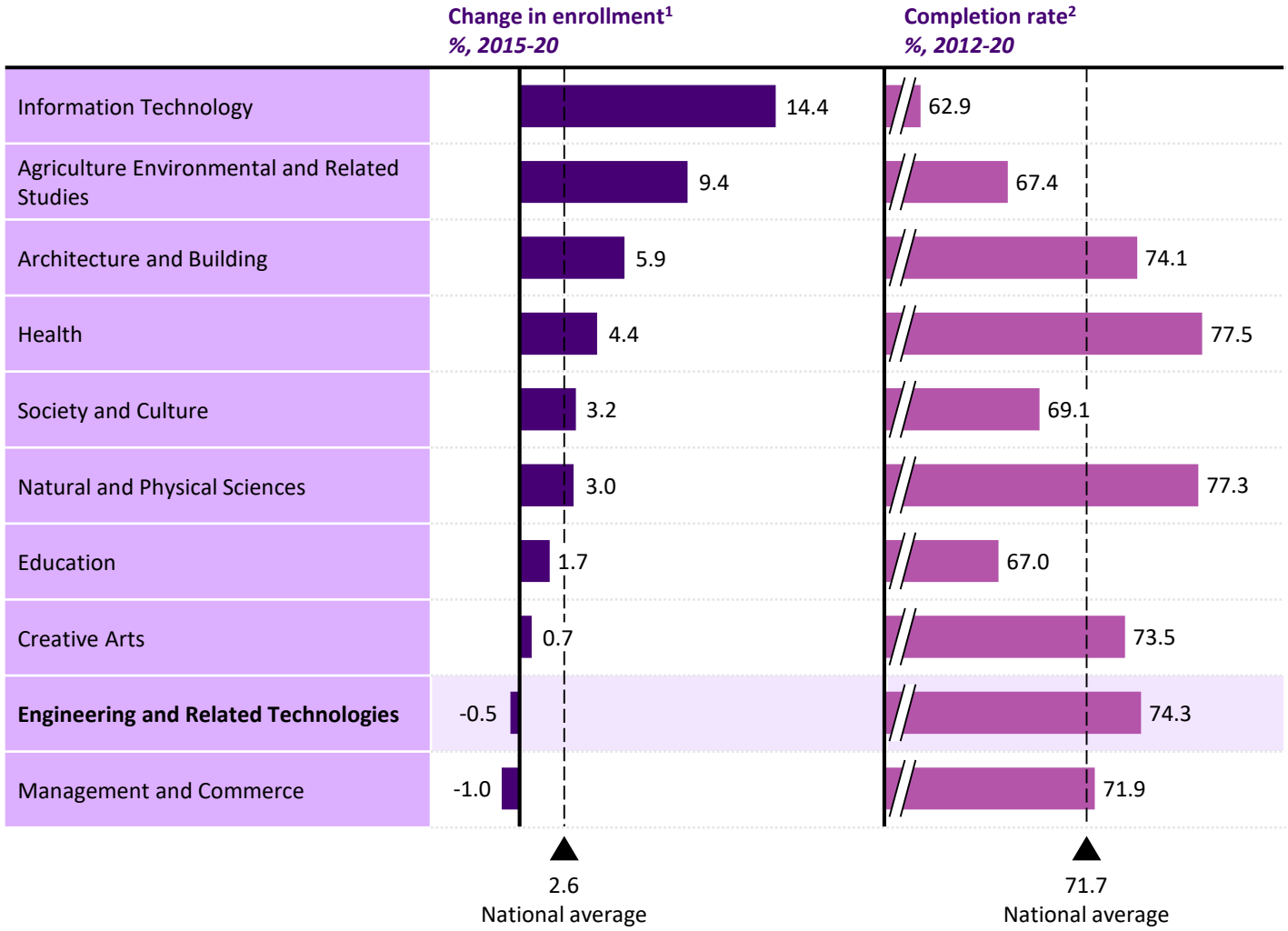
Positively, engineering and related technologies degrees had a an above average completion rate. Between 2012 and 2020, 74.3% of engineering and related technologies students finished their degrees, compared to a national average rate of 71.7%.

Whilst this indicates that increasing enrolments is key to resolving the weakening pipeline of engineers, continuing to provide engaging and quality education to maintain high completion rates is also essential. For example, despite information technology (IT) having the highest growth in enrolment of 14.4%, IT had the lowest completion rate of 62.9%.

Notably, 2020 enrolments rates have been significantly impacted by a reduction in immigration during COVID-19 lockdowns. Combined with the introduction of the Job-ready Graduates Package at the end of 2020 reducing the fees for STEM related courses,[3] enrolments from 2021 are expected to grow. However, considering the extent of the current skilled workforce shortage, further incentives may be required to prevent an even greater worker shortage as the energy transition creates more jobs.

Enrolment and completion of tertiary education degrees by field

Australia



Notes: 1: Only includes commencing students; 2: Includes Table A and Table B institutions commencing domestic bachelor students
Source: 3: Department of Education

Low enrollment rates will contribute to an estimated 12,500 engineering shortage by 2026, which will only grow as demand for engineers rises to 2050

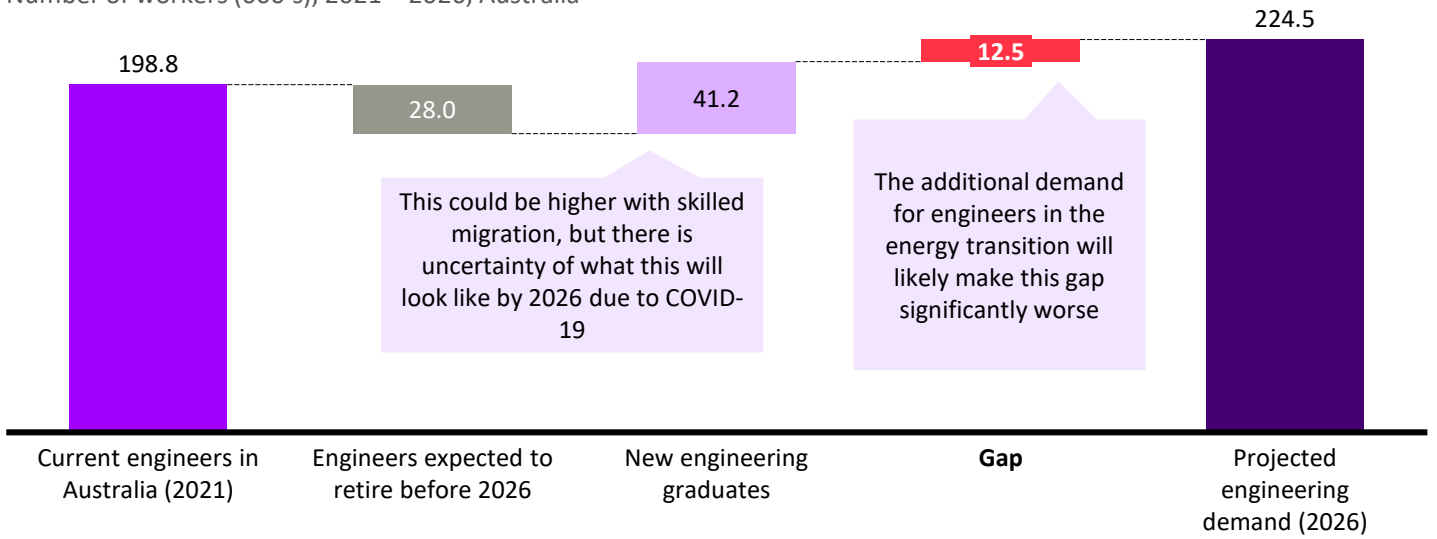
Currently across Australia there are 198,800 engineering professionals. Forecasts from the National Skills Commission predict that the demand for engineers will grow to 224,500 by 2026. Based on approximately 5,600 engineers transitioning away from the workforce each year and a 8,200 engineers being added each year through university degrees, there will be a gap in the workforce of 12.500 engineers by 2026.

Historically, over 58% of Australia's engineering workforce are born overseas. The impact of COVID-19 has meant that the number of skilled migrants seeking employment in Australia has reduced. Pre-COVID there were up to 4,000 skilled migrant engineers entering the workforce. If skilled migration is able to get back to pre-COVID levels it could help reduce the gap that the engineering workforce is currently facing.

This is even more important when considering that the transition workforce that will require at least 16,100 additional engineers to support the construction and ongoing operations and maintenance of key renewable energy infrastructure. This will create a greater level of demand for engineers that is in addition to any further growth in demand beyond 2026.

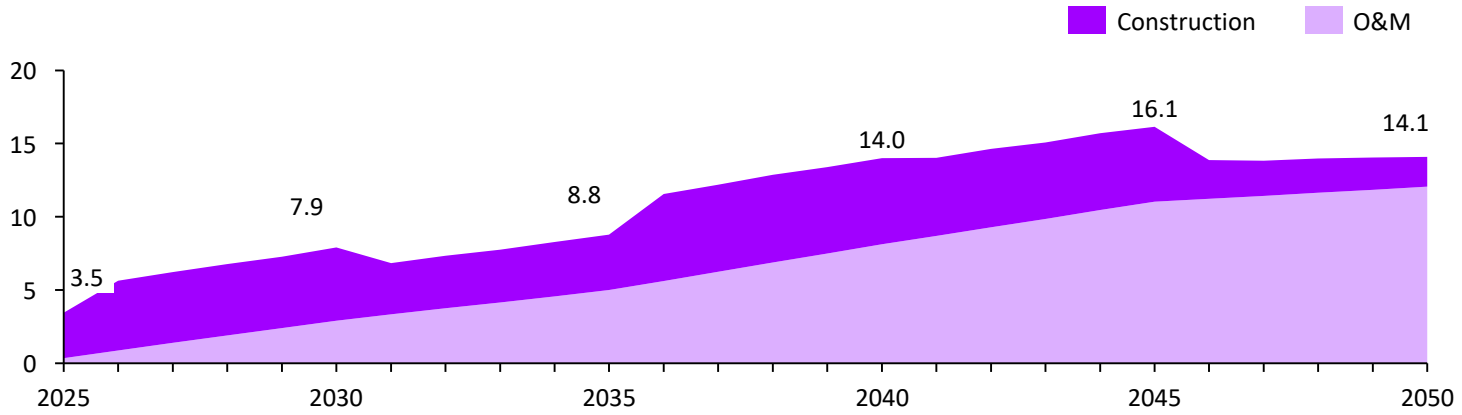
Changes in the engineering workforce by 2026

Number of workers (000's), 2021 – 2026, Australia



Number of engineers employed in renewable energy generation and storage

Number of workers (000's), 2025 – 2050, Australia



Source: Accenture analysis, Climateworks Centre, ABS, DESE

3

The transition of the carbon workforce

According to 2021 census data, there are about 91,500 workers employed in carbon intensive industries that will likely be impacted by the energy transition

Whilst the energy transition could create renewable energy jobs for up to 180,000 workers by 2050, the reduced demand for fossil fuels will eventually impact Australia's most carbon intensive industries and the workers within them.

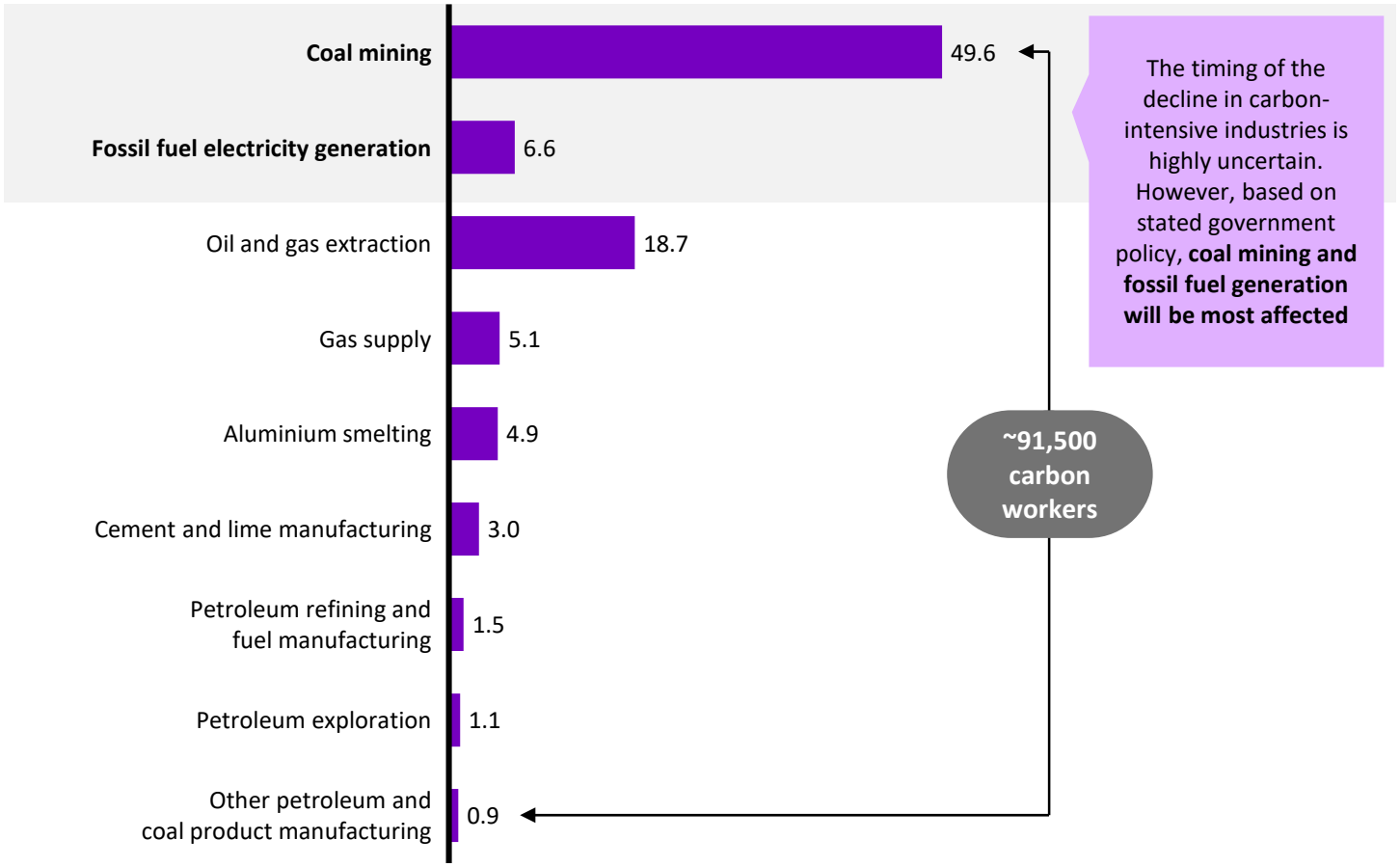
In accordance with the Grattan Institute's classification of carbon-intensive industries, this report uses the term 'carbon worker' to identify workers most likely affected by Australia's energy transition in the medium to long term.

According to the 2021 census, there are about 91,500 workers employed in carbon-intensive industries across Australia. Of those workers, about 56,200 (61%) are employed in coal mining and fossil fuel electricity generation. Another 23,800 (26%) workers are employed in oil and gas extraction or gas supply.

Importantly, these carbon-intensive industries are not expected to decline in the short term, and the timing and magnitude of the medium to long term impact is highly uncertain. However, based on the current global political environment, coal mining and fossil fuel generation will likely be the most affected by the energy transition in the medium to long term.

Australia's carbon workf'orce

Number of workers (000s) in carbon-intensive industries, 2021, Australia



Notes: 1: Carbon intensive industries is consistent with the Grattan Institute definition in the Start with Steel report. See appendix 4 for a breakdown of carbon-industries, ETI industries and critical mineral mining industries
Source: ABS Census Data 2021; Grattan Institute

Almost half (48%) of the carbon workforce is concentrated to six key regional and rural areas in Central Queensland, NSW, the Pilbara and Kwinana

Australia's carbon workforce

Number of workers by place of work (ANZSIC SA4 region), 2021

Pilbara region

~2,100

workers predominately employed across:

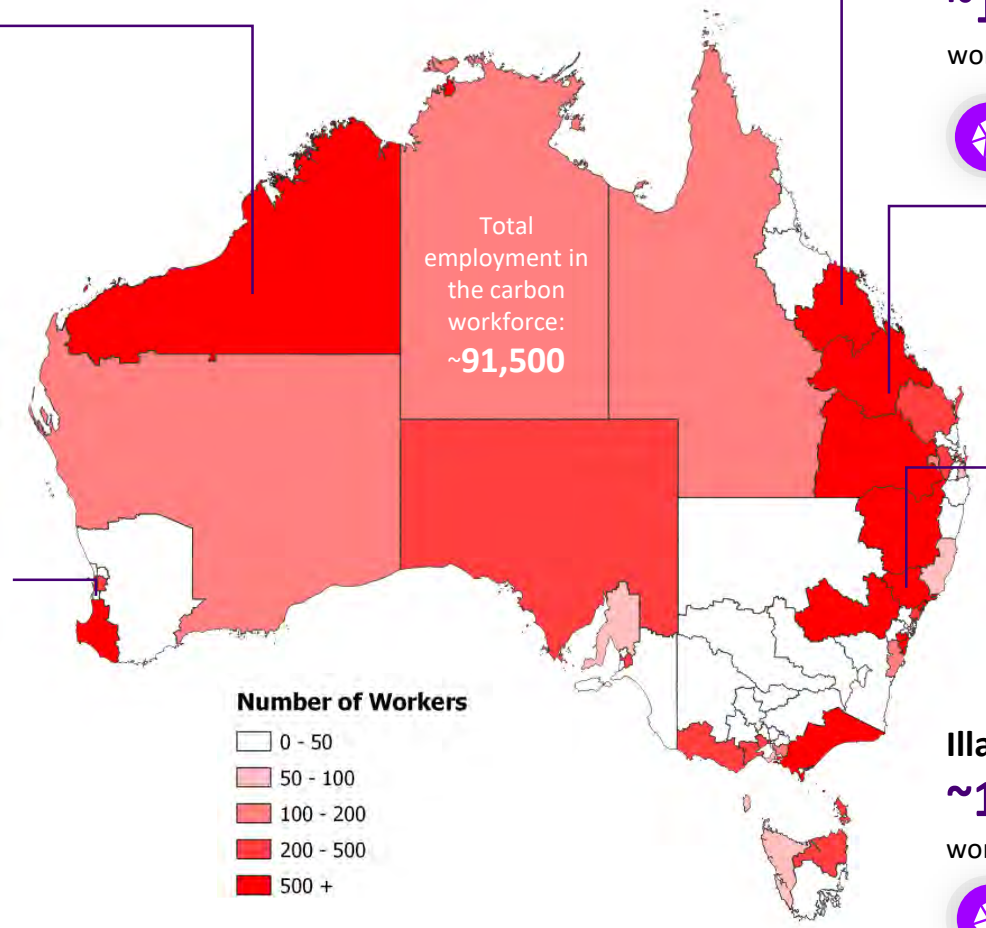
- Oil and gas extraction – **75%**

Kwinana & South West Perth

~1,300

workers predominately employed across:

- Gas supply – **36%**
- Oil and gas extraction – **18%**



Mackay, Isaac, Whitsunday

~15,100

workers predominately employed across:

- Coal mining – **88%**

Central Queensland

~10,400

workers predominately employed across:

- Coal mining – **70%**
- Aluminium smelting – **16%**

Hunter region

~13,800

workers predominately employed across:

- Coal mining – **88%**

Illawarra

~1,500

workers predominately employed across:

- Coal mining – **88%**

Notes: 1: Pilbara region refers to Western Australia – Outback (North); 2: Hunter region includes Hunter Valley and Newcastle and Lake Macquarie
Source: ABS Census 2021

While 40% carbon workers are in lower skilled occupations, 60% are in higher skilled occupations such as technicians and trade workers

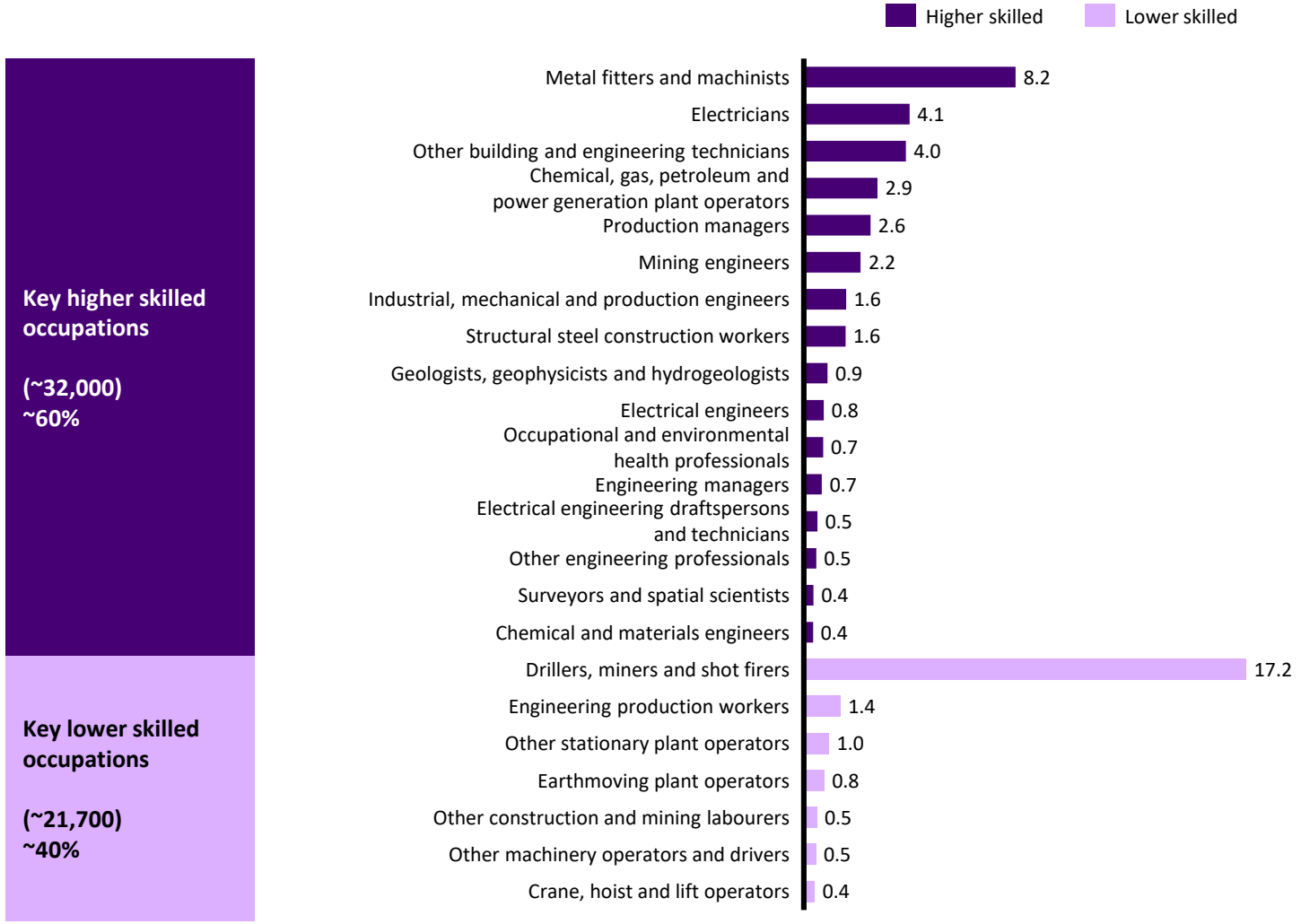
Across Australia there are approximately 92,000 workers employed in carbon intensive industries. Key occupations that exist within these industries were identified by isolating occupations by where at least 2% of individuals employed in an occupation were in carbon intensive industries.

Of the 54,000 workers employed in key occupations across carbon intensive industries, an estimated 60% have higher skilled roles such as metal fitters and machinists, electricians, various engineering roles and technicians and trades workers.

40% of workers employed in key carbon worker occupations have lower skilled jobs. Of the 20,300 workers employed in such occupations, 17,200 (80%) are employed as a driller, miner and shot firers. Almost all of the drillers (16,000 of the 17,200), miners and shot firers in carbon intensive industries are employed within the coal mining industry.

Key occupation mix across the carbon workforce

Number of workers in selected occupations (000's), 2021



Notes: Occupations used have at least 2% of the total number of people employed in each occupation employed across all carbon intensive industries
Source: ABS Census Data 2021

Carbon workers have strong capabilities in key engineering, electrical system and management skills

Top technical skills demanded in carbon-intensive industries

Percentage of jobs advertised, by ANZSCO 4 digit occupation, 2018 - 2022

0-10% | 10-20% | 20-30% | 30-40% | 40%+

Occupation	Number of individuals employed (000's)	Top skills demanded by emplpoyers				
Drillers, Miners and Shotfirers	17.2	Oil Drilling	**Geotechnical Engineering**	**Project Management**	Mining Operations	Mining Equipment
Metal Fitters and Machinsts	8.2	**Equipment Repair and Maintenance**	Welding	Forklift Operation	**Facility Management and Maintenance**	Machine Operations
Electricians	4.1	**Basic Electrical Systems**	**Facility Management and Maintenance**	**Commissioning**	**Industrial Electrical Experience**	**Industrial Engineering Industry Knowledge**
Other building and engineering technicians	4.0	**Enterprise Resource Planning**	**Facility Management and Maintenance**	**Equipment Repair and Maintenance**	**Project Management Software**	Appliance Repair and Maintenance
Chemical, Gas, Petroleum and Power Generation Plant Operators	2.9	Oil and Ammonia Sampling	Data entry	Data Analysis	Repair	**Teamwork/ Collaboration**
Production Managers	2.6	**Operations Management**	**Budget Maintenance**	Forklift Operation	Material Handling	**Facility Management and Maintenance**
Mining Engineers	2.2	**Mechanical Engineering**	**Project Management**	**Engineering Design and Instillation**	**Engineering Design**	**Engineering Support**
Industrial, Mechanical and Production Engineers	1.6	**Mechanical Engineering**	**Process Engineering**	**Chemical Engineering**	**Drafting and Engineering Design**	**Project Management**
Geologists, Geophysicists and Hydrogelogists	0.9	Earth and Space Science	**Drafting and Engineering Design**	Data Techniques	Environmental Geology	**Data Management**

Source: Accenture Analysis; Burning Glass Data

These management, electrical and engineering skills are highly applicable to the renewable energy jobs required for the energy transition

Carbon worker skills match with renewable energy jobs

% of job advertisements, by ANZSCO 4 digit occupation, Sep 2019 - 2022

Top occupations in renewable energy jobs			Top core skills required									
Skill level	% of jobs created	Occupation	Welding	Project management	Enterprise resource planning	Electrical work	Forklift operation	Boiler making	Predictive/ preventative maintenance	Engineering design and installation	Hydraulics	Machine operation
1	2.4%	Electrical engineer		18%	4%	2%				14%		
	2.2%	Construction manager		70%	2%					2%		
	2.0%	Civil engineer		26%	1%					10%	2%	
2	0.8%	Other building and engineering technicians	3%	7%	11%	3%	5%		15%			
	0.7%	Electrical Engineering Draftspersons and Technicians		4%	5%	12%	5%		6%			
3	12.3%	Electricians	1%	1%	4%	100%	6%		14%			
	1.8%	Metal Fitters and Machinists	2%	2%	5%	8%	27%	3%	26%		13%	22%
4	4.3%	Earthmoving plant operators	2%	3%	3%		19%		3%			12%
	2.5%	Truck drivers			2%		72%		1%			2%
	1.4%	Forklift drivers			6%		100%					9%
	1.3%	Structural Steel Construction Workers	13%	3%	6%	4.3%	44%	11%	1%			
5	6.1%	Other labourers	8%	1%	5%	1.2%	48%	1%	3%			7%
	1.7%	Building and plumbing labourers	3%	7%	2%		11%					1%

Note: Skills match represents the percentage of job advertisements requiring that skill, for each occupation. Skills with an occupation match of less than 1% are excluded

Source: Accenture Analysis; Burning Glass Data

Accordingly, 47% of the carbon workforce could transition into the renewable energy jobs created with minimal upskilling, while 12% could transition into critical minerals

Of the current carbon workforce, **15,600 (17%)** are currently aged over 55. Considering that the energy transition is unlikely to affect carbon-intensive industries in the short-term, these workers will likely retire before their jobs are significantly affected by the energy transition.

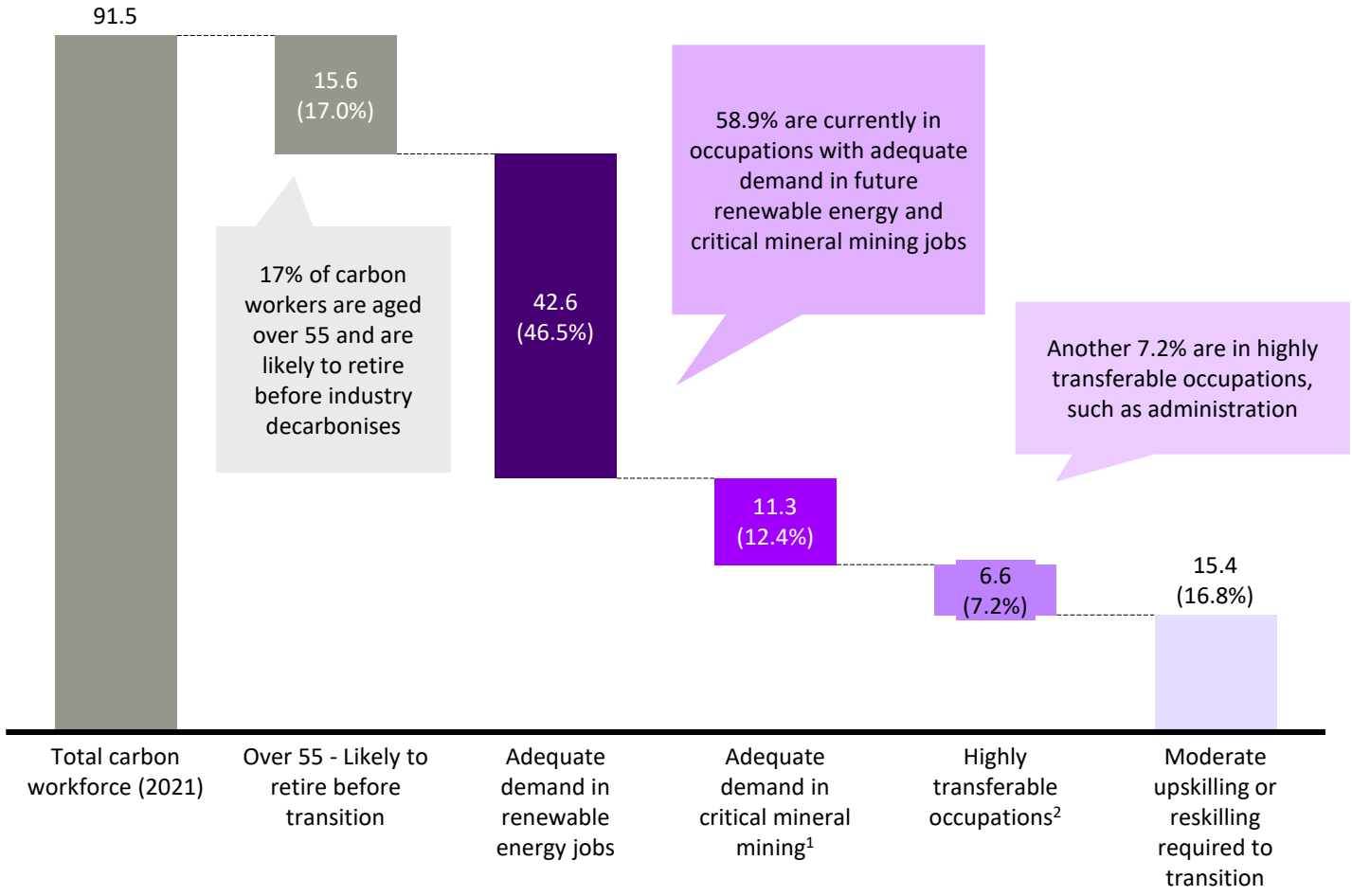
Of the remaining workers, an estimated **42,600 carbon workers (46.5%)** could transition into the renewable energy jobs created without changing occupations. These workers may require upskilling in key solar, wind, hydrogen or storage skills but will not need any training in the core fundamental skills that their occupation requires.

Whilst this analysis excludes critical mineral mining, Accenture projections[3] also suggest that a **further 11,300 carbon workers (12.4%)** could transition into these industries that will support the renewable energy transition. This will predominantly include Lithium, nickel and copper mining.

Of the remaining carbon workers, **6.500 (7.2% of the carbon workforce)** could also transition into new industries with little to no upskilling required. This represents occupations that generally do not require industry specific skills and are commonly required across the economy, such as administrative and sales roles.

Transferability of the carbon workforce

Thousands of workers (000's), Australia



Notes: See appendix 4 for industry classifications and appendix 7 for complete methodology; 1. Estimate is based on a strong policy support scenario of the increase in employment in critical mineral mining from 2020 to 2040; 2. Highly transferable occupations refer to occupations where employment in carbon intensive industries account for less than 2% of the total employment in that occupation

Source: 3. Sunshot: Australia's opportunity to create 395,000 clean export jobs, Accenture (2021); ABS, Accenture analysis

The key mismatch between the carbon workforce and the renewable energy industry is between the number of electricians and drillers, miners and shotfirers required

Whilst most key occupations have a similar demand across the carbon workforce and renewable energy industry, there is a significant mismatch between the number of electricians and drillers, miners and shotfirers required.

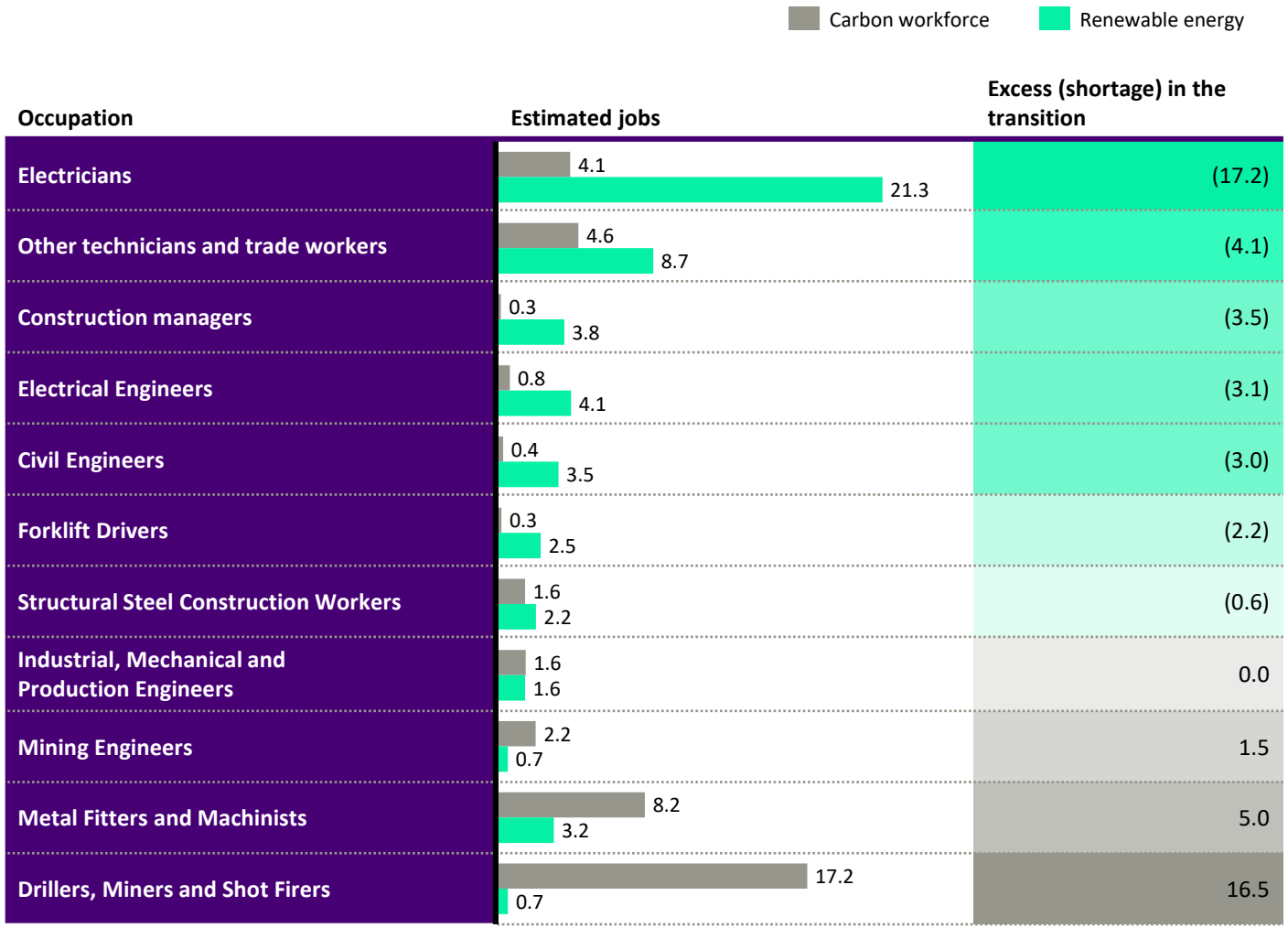
The energy transition is expected to require 21,300 electricians between 2025 and 2050, whereas the carbon workforce currently only employs 4,100 electricians, 17,200 less than renewable energy generation and storage.

Furthermore, the current estimated demand for drillers, miners and shotfirers in renewable energy generation and storage is only 700 workers, compared to the 17,200 workers currently working in carbon intensive industries. A number of these workers could transition into energy transition mineral mining, which has been excluded from this analysis.

There is also a small difference between the engineering demand of these two industries. Whilst carbon intensive industries generally require more mining engineers and industrial, mechanical and production engineers, renewable energy generation and storage will require more electrical and civil engineers.

Difference in occupation demand between carbon-intensive and renewable energy industries

Number of workers (000's), 2021 & 2025-2050, Australia



Notes: Carbon workforce jobs as of the 2021 census; Renewable energy jobs forecasted from 2025-2050
Source: ABS Census 2021, Accenture analysis of data provided by Climateworks

Case Study: Drillers, miners and shotfirers

Current workforce: 63,800[8]

Median salary: $124,340[3]

Top industries: Coal (36%), Iron ore (13%), Gold (11%)[6]

Top locations: Bowen Basin, QLD (12%), East Pilbara, WA (7%), Goldfields, WA (6%), Lower Hunter, NSW (6%)[6]

Education: On the job training and VET courses[5]

Skill level: 4[6]

Top technical skills: Directional drilling, mining operations, forklift operations, hammering[4]

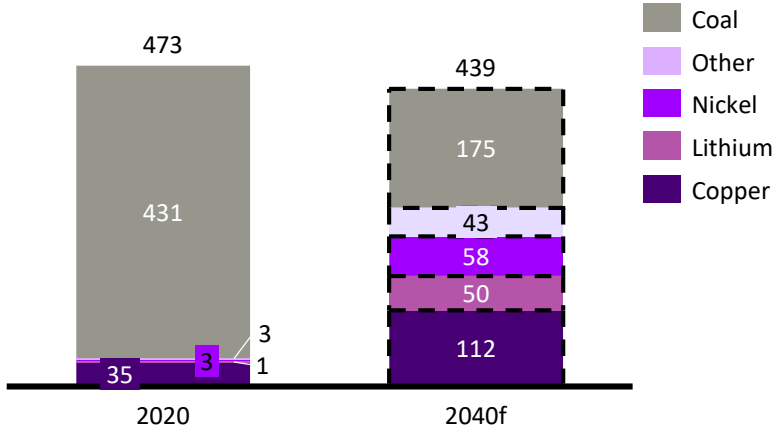
Short to medium term pathway: Transition into minerals mining

Global demand for coal is expected to decline significantly over the next 20 years, with a forecasted 59% decline in global revenue.[1] In Australia alone, 35% of Australia's coal-fired capacity will shut down by 2030, with AEMO expecting this to increase even higher to 60%.[2]

Whilst coal mining will decline, there will be demand for drillers, miners and shotfirers in mining minerals for electric vehicles, wind turbines, solar PV and batteries. Australia is already the largest miner of lithium, producing over 50% of global supply.[1] Continued demand for these minerals will see many drillers, miners and shotfirers able to transition into these growing industries.

Global revenue from coal and energy transition minerals

Billions USD



Ranking of key workforce skills

Rank of skill priority by selected industries, 2019, Australia

Likely to have sufficient skill | May require upskilling

	Mineral mining	Coal mining	Oil and gas drilling
Technology application	1	5	4
Systems mindset	2	2	2
Learning agility	3	3	3
Management skills	4	1	7
Data analysis	5	7	9
Literacy and numeracy	6	6	1
STEM skills	7	8	5
Communication	8	4	10
Entrepreneurial	9	11	12
Customer service	10	12	6
Financial skills	11	9	11
Sustainability skills	12	10	8

Drillers, miners and shotfirers in coal, oil and gas **generally have sufficient skill** for critical mineral mining.[7] **Technological and data skills should be the focus of upskilling**, as they are a higher priority in mineral mining

Source: 1: IEA, 2: AEMO, 3: ATO, 4: Burning glass, 5: National Careers Institute, 6: ABS Census Data 2021, 7: PwC, 8: ABS Labour Force Australia, Detailed, November 2022

Case Study: Drillers, miners and shotfirers

Current workforce: 63,800[7]

Median salary: $124,340[3]

Top industries: Coal (36%), Iron ore (13%), Gold (11%)[6]

Top locations: Bowen Basin, QLD (12%), East Pilbara, WA (7%), Goldfields, WA (6%), Lower Hunter, NSW (6%)[6]

Education: On the job training and VET courses[5]

Skill level: 4[6]

Top technical skills: Directional drilling, mining operations, forklift operations, hammering[4]

Medium to long term pathway: Transition into engineering technician roles

Many drillers, miners and shotfirers could also leverage their existing skillsets to reskill into new occupations. This could include a training pathway into building and engineering technician roles.

Demand for building and engineering technicians is expected to increase in by 31% over the next 10 years.[4] This would likely see an increase in the median salary, which is already comparable to wages in drilling, mining and shot firing. In most states, a Certificate IV in Engineering is a fee-free TAFE cource. The key to upskilling these workers will be to incentives part time training over the 4 year certification, and focus on developing the skills gap of software skills.

		Other building and engineering technicians
Desirability	% Change in salary (salary)	-7% ($115,141)
	Current workforce	32,300
	Projected 10-year growth (jobs)	+31% (~42,300)
	Cost to retrain	Free in most states
	Overall desirability	**High**
Feasibility	Time to retrain	4 years
	Change in skill level	+2
	Skill similarity	6/10
	Overall feasibility	**Moderate**

Comparison of top skills demanded

2019 – 2022, Australia

Skill match | Partial skill match | No skill match

Drillers, miners and shotfirers	Equipment repair and maintenance	Scheduling	Microsoft office and productivity tools	Project management	Budget management	Enterprise resource planning
	Other building and engineering technicians					
Mining and drilling operations and equipment						
Project management				x		
Scheduling		x				
Microsoft office and productivity tools			x			
Equipment repair and maintenance	x					
Material handling						

Note: Skill match means that a skill has relatively the same importance in both occupations. A partial skills match means that the skill is present in both occupations but with a different level of importance

Source: 1: IEA, 2: AEMO, 3: ATO, 4: Burning glass, 5: National Careers Institute, 6: ABS Census Data 2021, 7: ABS Labour Force Australia, Detailed, November 2022

4 Developing the green workforce of the future

Despite strong environmental performance, Australia has historically fallen behind global leaders on coordinated green skill policy

The Environmental Performance Index (EPI) ranks 180 countries on 40 indicators across climate change performance, environmental health, and ecosystem vitality, to gauge how close countries are to established environmental policy targets. Australia has performed relatively well, with an (EPI) of 60.1 and global ranking of 17 as of 2022.

Despite this, Australia lacks a coordinated approach to developing skills required for the green economy. From a comparison of x countries skill policies, the International Labour Organisation (ILO) ranked Australia 4/10.

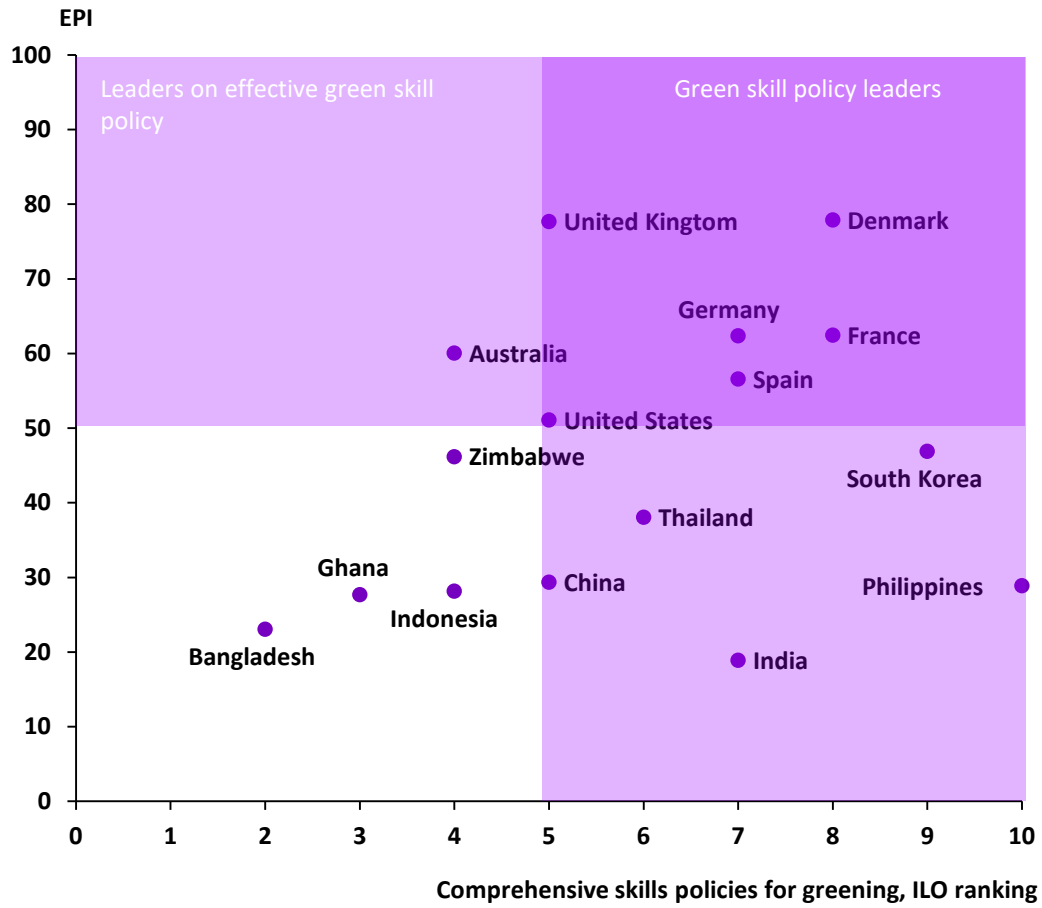
Comparatively, many developed nations with a similar environmental performance ranking outperformed Australia. For example, whilst Germany's EPI is marginally higher than Australia's at 62.4, they scored 7/10 on coordination for green skill policy.

This partially reflects the STEM crisis in Australia, with poor skill development across innovation and technology driven sectors. For instance, 24.2% of German graduates studied engineering, compared to only 8.2% in Australia.[1]

However, considering that many developing nations with weaker environmental outcomes have outperformed Australia skill policy, Australia's skill crisis also reflects a lack of coordination between industry and government.

Effectiveness of environmental and green skill policy

Environmental performance index, 2022 & ILO green skill policy ranking, 2019



Source: 1: Clean Energy Council; EPI (2022); ILO (2019)

Whilst policy has improved considerably since 2020, future policies and programs should build on three key objectives to prevent a critical shortage of skilled workers

Since 2020, the Australian governments and industry have certainly taken greater action to address the jobs and skills shortage

Australian Government

1. Established a **$1 billion JobTrainer fund** from 2020-22, to offer free or low fee training in priority certifications, with matched contributions from state and territory governments[1]
2. The 2022-23 federal budget includes **$922 million** in funding over the next five years towards **480,000 fee-free TAFE places**, and to establish the TAFE Technology Fund to modernise training facilities[2]
3. Committing **$105 million to the New Energy Apprenticeships and New Energy Skills programs**. This will include mentoring programs and up to **$10,000 for apprentices** in a clean energy role[2]
4. Allocate **$12.9 million over the next 3 years** to establish the new **Jobs and Skills Australia**. This will bring together employers, employees, governments and training provider to better identify current and future skills and training needs[2]

Other examples

1. Queensland Government : In 2022, as a part of the **$100 million Equipping TAFE for our Future initiative**, $17 million was committed to the Electro Group's Renewable Energy Training Facility, along with $10.6 million towards the Hydrogen and Renewable Energy Training Facility[3]
2. Fortescue Future Industries: **The Green Skills Academy** focuses on upskilling employees in renewable energy skills, especially for hydrogen[4]

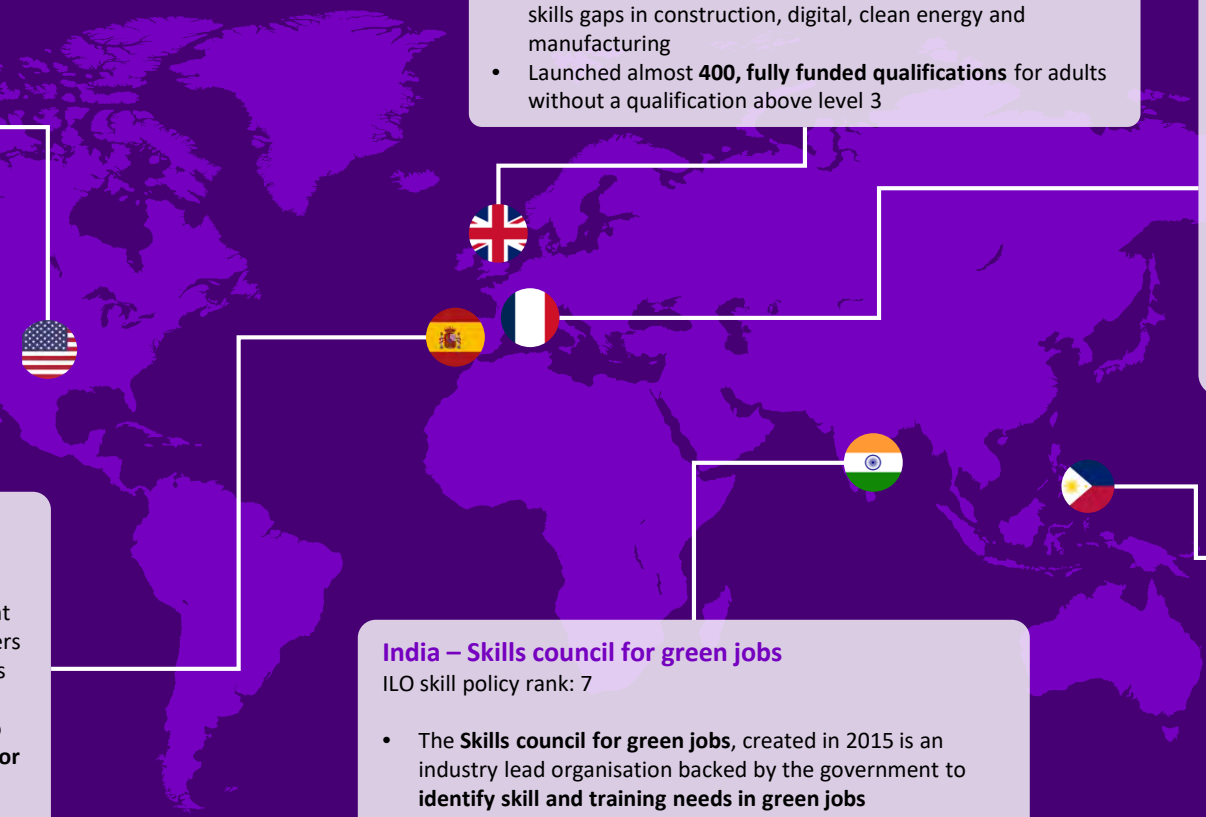
To build future policies and programs, Government and industry should focus on three objectives to prevent a critical shortage of skilled workers

Policy objective	Challenge addressed	Description
Increase the pipeline of future workers	Short-term skills shortage	• Incentivise greater enrolment in STEM degrees, especially in engineering
		• Incentivise greater enrolment in critical trade certifications, especially in electrotechnology for electricians
Upskill the existing workforce	The renewable energy training need	• Increase incentives for existing workers to participate in renewable energy training courses, such as solar and wind
		• Support industry to teach current workers new technical skills in emerging industries such as battery storage and green hydrogen
Upskill and reskill carbon workers	Medium – long term skills shortage	• Support carbon workers to upskill in their existing occupation and transition into green industries
		• Support carbon workers that cannot find work in their current occupation to reskill into new roles required in the future

Each policy objective will require increased **coordination** between the federal government, state governments and industry to ensure the evolving needs of the workforce can be met efficiently

Source: 1: Department of Education; 2: The Commonwealth of Australia; 3: Queensland Government; 4: Fortescue Future Industries

Australia should also look to best practices from other global policy leaders to prevent a critical shortage of skilled workers in the energy transition



United States – Upskilling in hydrogen
ILO skill policy rank: 5

- The **Hydrogen Education for a Decarbonised Economy** will deliver training in advance hydrogen technologies and end-use applications through regional hubs
- **Collaborate with industry and university partners** to develop certifications, credentials, qualifications and standards for training and education

United Kingdom – Lifetime Skills Guarantee
ILO skill policy rank: 5

- **Lifetime Skills Guarantee** program to align education with skills gaps in construction, digital, clean energy and manufacturing
- Launched almost **400, fully funded qualifications** for adults without a qualification above level 3

France – Upskilling the automotive industry
ILO skill policy rank: 8

- **Automotive-industry support plan** was extension in 2021 include a **EUR 50 million fund** to retrain automotive workers in electric vehicle production, jointly funded by government and industry
- The French metallurgy observatory will complete a **skills gap analysis** between declining and new jobs to tailor training needs

Philippines – Green Jobs Act
ILO skill policy rank: 10

- The **2016 Green Jobs Act** is a whole-of-government approach to identify skill needs, train and certify workers in green jobs. The package includes a **50% tax deductions on skills training**

Spain – A Just Transition for coal workers
ILO skill policy rank: 7

- **Spain's Just Transition Agreements** between the government and regional representatives to support displaced coal workers is highly transparent, with measurable and tracked objectives
- Each agreement identifies the **regional challenges and opportunities** and **invites participation** from stakeholders to deliver **tailored support, such as early retirement packages or retraining**

India – Skills council for green jobs
ILO skill policy rank: 7

- The **Skills council for green jobs**, created in 2015 is an industry lead organisation backed by the government to **identify skill and training needs in green jobs**
- Introduce green job vocational education in schools, universities and engineering institutions
- Developed **44 nationally approved qualifications** and **trained over 500 thousand candidates**

Source: IEA (2023); ILO (2019)

5 Appendix

Appendix 1: Climateworks scenarios

The Australian Industry Energy Transition Initiative (ETI) aims to position the Australian industry to maximise the shift to net zero emissions supply chains by 2050 and help Australia build an economy that takes advantage of the transition. The Australian Industry ETI has created three scenarios designed to compare the extent of Australia's push to industrial decarbonisation:

- Incremental scenario: Assumes a lack of domestic incentives and industry action which leads to slow decarbonisation throughout the economy
- Industry-led scenario: Assumes that domestic action on climate is in line with Australia's carbon budget for 2°C warming, reaching net zero in 2050, however this is insufficient to meet the Paris Agreement goals. Despite this, leadership in existing heavy industry accelerates technology deployment and abatement, but significant offsets are needed to remain within a 1.5°C budget.
- Coordinated action scenario: Assumes Australian industry decarbonises rapidly with substantial government incentives complementing industry leadership, driving strong abatement in all sectors in line with 1.5°C. Zero emissions technologies are widespread, with far lower offsets needed for a 1.5°C-compatible budget compared to other scenarios

This analysis explores job opportunities and skills required by deploying abatement technologies across the Australian energy system

EXHIBIT 1

Key features of the core scenarios

Parameter	Incremental	Industry-led	Coordinated
Carbon budget constraint - overall economy	None	2°C, 83%	1.5°C, >50%
Carbon budget constraint - industry	None	1.5C, >50%	1.5C, >50%
Net zero by 2050 target	No	Yes	Yes
Technological innovation, testing, accelerated deployment	Low	Moderate	High
Government climate and energy policy	Low	Moderate	High
Vehicle-to-grid battery availability	Low	Moderate	High
Global community's response to Australian industry's product offering	Negative	Moderate	Positive
Government support for new industries	Low	Moderate	High

Source: Climateworks Centre

Appendix 2: Jobs modelling methodology

Jobs modelling methodology

Total number of direct jobs created[1]	=	**A. Energy generation and storage jobs**	+	**B. Ongoing operations and maintenance jobs**	+	**C. Electricity transmission/distribution**		
A. Energy generation and storage jobs	=	(Energy requirement (MW)	×	Job-Years/MW	)	/	Average construction time (Years)	
		Climateworks data		Clean Energy Council report[1]			Desktop research	
B. Ongoing operations and maintenance jobs	=	Energy requirement (MW)	×	Jobs/MW				
		Climateworks data		Clean Energy Council report[1]				
C. Electricity transmission and distribution	=	CAPEX spend	×	Jobs/$M CAPEX				
		Climateworks data		Transgrid[2]				
Energy requirement (MW)	=	CAPEX spend	/	$/kW of capacity		/	1,000	
		Climateworks data		AEMO report[3]			kW to MW conversion	

Indirect jobs
Indirect jobs are captured through using REMPLAN and a direct : indirect job ratio for each category

Source: 1. Clean Energy Council (2021); 2. Transgrid (2020) – Will use an average of job factors detailed from pages 10 to 13; 3. AEMO Gen Cost Report (2020)

Appendix 3: Key job assumptions

Key assumptions for jobs modelling

Assumptions by renewable energy technology

Technology	Wind	Solar	Hydrogen	Battery	Transmission
Jobs Assumptions					
Australian construction job-Years/MW	2.8 job years/MW[a]	2.3 job years/MW[a]	3.5 job years/MW[c]	0.25 job years/MW[b]	N/A
Jobs/$M CAPEX	N/A	N/A	N/A	N/A	0.6 jobs/$M CAPEX[d]
Average Construction time	2+ years[e]	12 months[f]	18 months[b]	6-9 months	N/A
Australian O&M jobs/MW	0.22 jobs/MW[a]	0.11 jobs/MW[a]	1.0 jobs/MW[c]	0.1 jobs/MW[g]	N/A
Indirect : direct jobs ratio	1.92[h]	1.92[h]	1.93[i]	1.10[j]	2.17[d]
Capacity Assumptions					
$/kW of Capacity	$1,700/kW[k]	$1,075/kW[k]	$3,250/kW[k]	$1,058/kW[k]	N/A

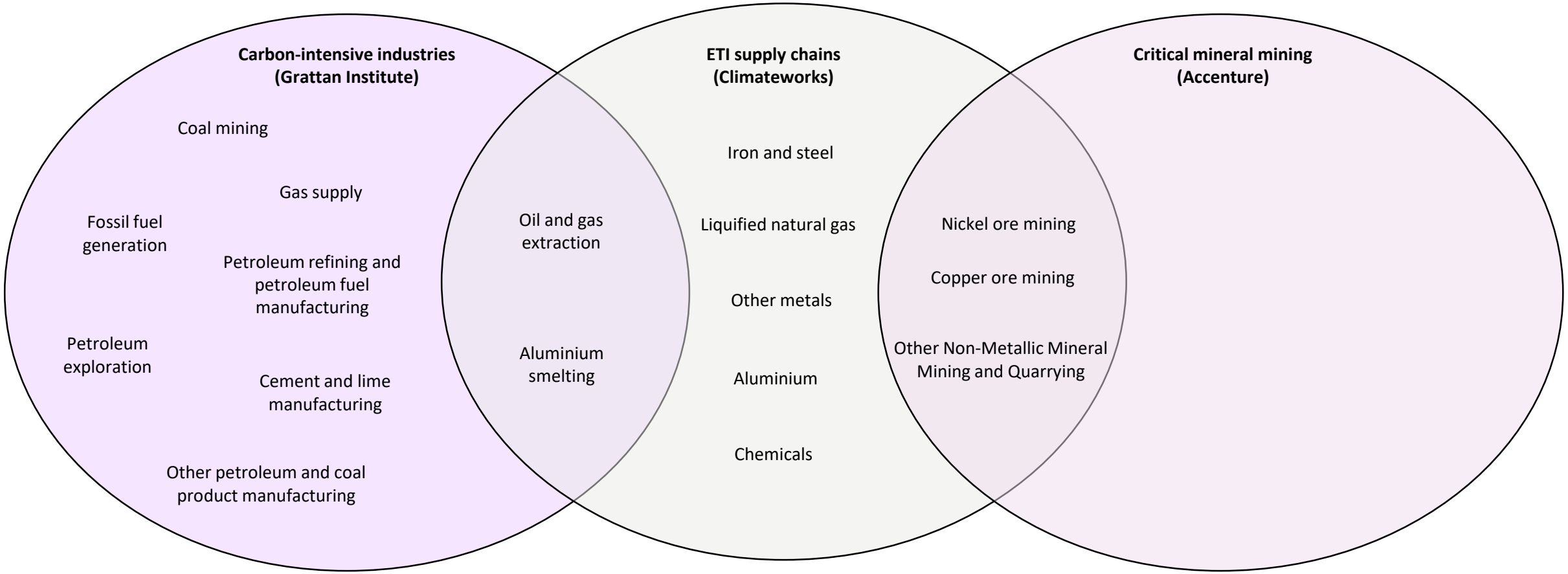
Notes: a. Jobs calculated are inclusively of only of the construction/installation stage and do not include manufacturing or operations/maintenance (Clean Energy Report (2020)); b. Victorian Government (2020); c. ABEL Energy Bell Bay Powerfuels Project (2022) – Scaled down; d. Transgrid (2020); e. European Wind Energy Association (2021); f. Marble Solar Farm (2021) g. Tesla Big Battery Project (2022) h. Weighted average across electricity generation, electrical equipment manufacturing, heavy and civil engineering, and construction services h. Industrial gas manufacturing proxied through basic chemical manufacturing i. Weighted average across electrical equipment manufacturing, heavy and civil engineering, construction services; k. AEMO Gen Cost Report (2020)

Sources: Remplan

Appendix 4: ANZSIC Industry Classification

Industry classification for analysis

ANZSIC 4 digit industries and ETI industries



Source: ANZSIC ABS Industry Classification; Grattan Institute; Accenture

Appendix 5: Skills in renewable energy jobs by occupation

Skills required in renewable energy jobs

Percentage of jobs that require each skill by ANZSCO 4 digit occupation, Sep 2019 - 2022

Electrical | Software | Construction | Engineering | Management

Occupation	Top stable skills					Top growing skill
Electrical engineer	Electrical design (16.7%)	Project management (16.5%)	Engineering design and installation (12.3%)	AutoCAD (8.9%)	SCADA (6.9%)	Python (1.1%)
Construction manager	Project management (16.5%)	Budgeting (24.7%)	Stakeholder management (14.8%)	Scheduling (14.4%)	Microsoft Project (5.1%)	Wind power (0.6%)
Civil engineer	Project management (16.5%)	Geotechnical engineering (10.3%)	AutoCAD (8.5%)	Engineering design and installation (8.1%)	Structural design (7.7%)	DevOps (1.5%)
Other building and engineering technicians	Preventative maintenance (12.8%)	Enterprise resource planning (8.9%)	Project management (6.1%)	Forklift operation (4.4%)	Painting (4.1%)	Data analysis (1.0%)
Electrical Engineering Draftspersons and Technicians	Selenium (27.1%)	Java (18.8%)	Electrical work (10.6%)	Atlassian JIRA (9.8%)	AutoCAD (9.5%)	DevOps (9.0%)
Electricians	Electrical work (100%)	Preventative maintenance (13.4%)	Hand tools (12.2%)	Wiring (11.6%)	Electrical systems (7.7%)	Solar installation (0.6%)
Metal Fitters and Machinists	Forklift operation (20.2%)	Welding (20.1%)	Preventative maintenance (19.6%)	Machine operation (16.5%)	Hydraulics (10.2%)	Wind power (0.3%)
Earthmoving plant operators	Excavation (25.0%)	Global positioning system (GPS) (20.6%)	Front end loaders (19.1%)	Demolition (14.5%)	Skid-steer loader (10.7%)	Wind power (0.3%)
Truck drivers	Forklift operation (34.2%)	Logistics (7.2%)	Heavy lifting (4.5%)	Sorting (3.1%)	Haulage (2.2%)	Lifting ability[1] (1.9%)
Forklift drivers	Forklift operation (99.3%)	Heavy lifting (9.3%)	Logistics (8.2%)	Scanners (8.2%)	Machine operation (4.4%)	Solar panels (0.1%)
Structural Steel Construction Workers	Forklift operation (17.4%)	Power tools (6.6%)	Painting (5.7%)	Heavy lifting (5.4%)	Welding (5.4%)	Python (1.1%)
Other labourers	Forklift operation (29.6%)	Power tools (10.5%)	Hand tools (6.0%)	Welding (4.9%)	Machine operation (4.1%)	Solar panels (0.3%)
Building and plumbing labourers	Construction labour (27.6%)	Power tools (16.6%)	Demolition (6.9%)	Forklift operation (6.8%)	Carpentry (6.2%)	DevOps (0.2%)

Note: Skills match represents the percentage of job advertisements requiring that skill, for each occupation. Skills with an occupation match of less than 1% are excluded
Source: Accenture Analysis; Burning Glass Data

Appendix 6: Renewable energy skills definition

Renewable energy skills included in analysis

Definition of skills by skill cluster

Skill family	Skill cluster	Skill	Skill Definition
Energy and utilities	Clean energy	Clean energy	Energy, as electricity or nuclear power, that does not pollute the atmosphere when used, as opposed to coal and oil, that do.
		Green energy	Energy that comes from natural sources such as sunlight, wind, rain, tides, plants, algae and geothermal heat. These are naturally replenished.
		Geothermal	Heat energy generated and stored in the Earth.
		Clean technology	Any process, product, or service that reduces negative environmental impacts by improving energy efficiency or sustainable resource use.
		Biomass	Industry term for getting energy by burning wood, and other organic matter.
		Renewable energy systems	Work experience with renewable energy systems
		Renewable resources	Natural resource which replenishes either through biological reproduction or other naturally recurring processes in a finite time in a human time scale.
		Renewable energy	Energy collected from renewable resources naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat.
	Solar energy	Solar energy	Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis.
		Solar panels	Solar panels absorb the sunlight as a source of energy to generate electricity or heat.
		Solar installation	Working experience installing solar power systems that converts sunlight into electricity, either using photovoltaics (PV) or concentrated solar power.
		Solar systems	Work experience with solar powered systems
		Photovoltaic systems	A photovoltaic system, also PV system or solar power system, is a power system designed to supply usable solar power by means of photovoltaics.
		Pvsyst	PC software package for the study, sizing, simulation and data analysis of complete PV systems.
		Photovoltaic energy	Convert light into electricity using semiconducting materials that exhibit the photovoltaic effect, studied in physics, photochemistry, and electrochemistry.
		Solar technology	Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis.
		Solar products	Products powered by sunlight, either directly or through electricity generated by solar panels.
		Commercial solar products	Working experience in Commercial Solar Projects. Solar power is the conversion of energy from sunlight into electricity, either directly using photovoltaics (PV), indirectly using concentrated solar power, or a combination.
	Wind energy	Wind power	Work experience with wind power, the use of air flow through wind turbines to mechanically power generators for electric power.
		Wind farm construction	Working experience of wind farm/turbine construction.
		Wind turbines	Work experience on wind turbines.
		Wind turbine technology	Working experience of Wind Turbine Technology. Wind turbines are manufactured in a wide range of vertical and horizontal axis types. The smallest turbines are used for applications such as battery charging for auxiliary power for boats or caravans or to power traffic warning signs.

Source: Burning Glass

Appendix 7: Carbon workforce transition methodology

Total carbon workforce	-	A. Over 55 and likely to retire before transition	-	B. Adequate demand in renewable energy jobs	-	C. Adequate demand in critical mineral mining	-	D. Highly transferable occupations	=	Moderate upskilling or reskilling required to transition

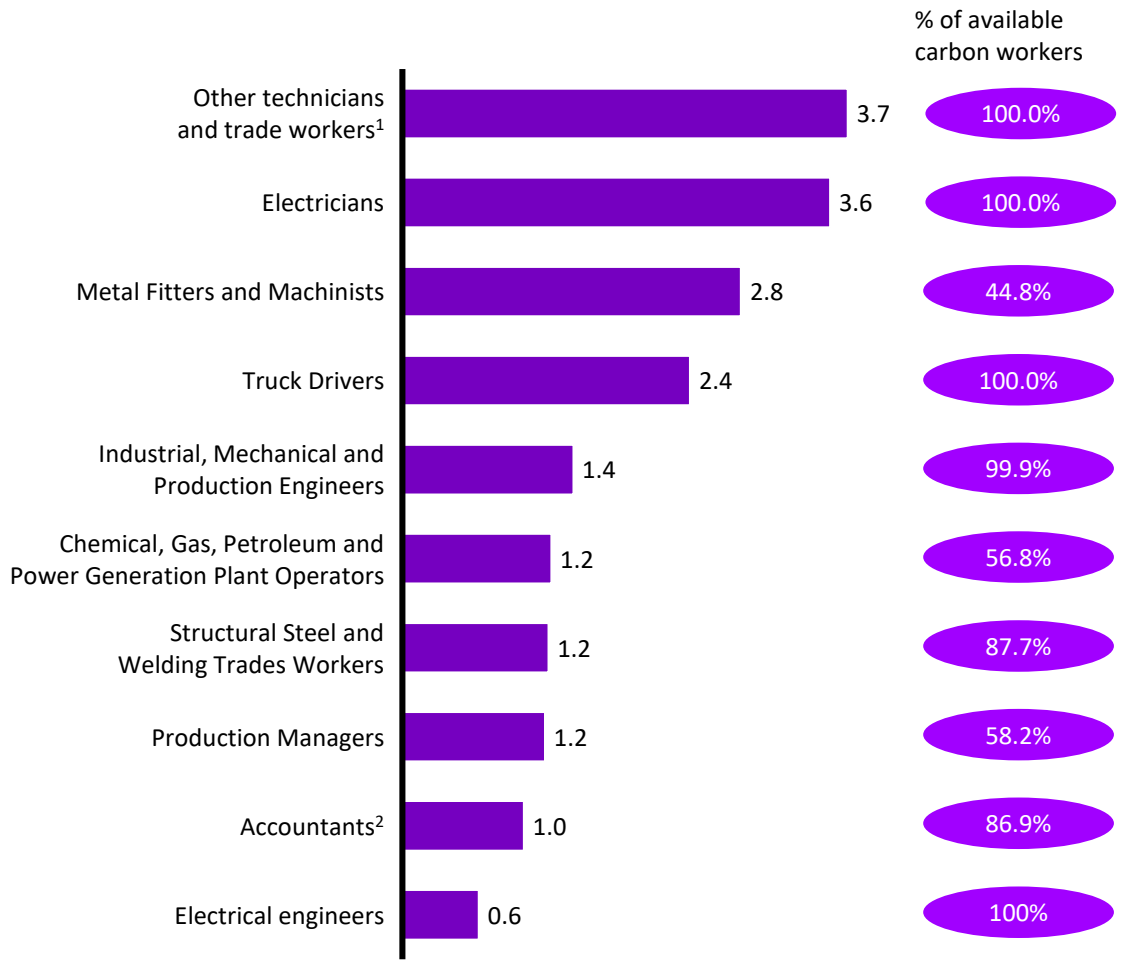
			For each occupation = i	Description	Assumption	Example: Drillers miners and shotfirers
A. Over 55 and likely to retire before transition	=	$\sum_{i=1}^{n} A_i$	A_i = Carbon workers over 55	Sum of all carbon workers over aged 55	The impact of the energy transition on carbon-intensive industries will be in the medium to long term.	**A = 3000**
B. Workers in occupations with adequate demand in energy generation and storage	=	$\sum_{i=1}^{n} B_i$	B_i = min (RE $jobs_i$, (Carbon $jobs_i$ – A_i)	Sum of the minimum of the renewable energy jobs created and carbon workforce for each occupation	All carbon workers can transfer between industries up to the maximum demand in renewable energy jobs, without chaining their occupation	RE jobs = 700 Carbon jobs = 17,200 B = min (600 , (17,200 – 3000)) **B = 700**
C. Workers in occupations with adequate demand in critical mineral mining	=	$\sum_{i=1}^{n} C_i$	C_i = min ((Carbon $jobs_i$ – A_i – B_i), Critical mineral $jobs_i$)	Sum of the minimum of the renewable energy jobs created and carbon workforce for each occupation	Remaining carbon workers can transfer between industries up to the maximum demand in critical mineral mining without chaining their occupation.	Critical mineral jobs = 3,900 C = min ((17,200 – 3,000 – 700, 4,000) **C = 3,900**
D. Other workers in highly transferable jobs	=	$\sum_{i=1}^{n} D_i$	D_i = Carbon $jobs_i$ – B_i – C_i if i is considered a highly transferable occupation	Sum of the remaining carbon workers not required in renewable energy jobs or critical mineral mining, only for occupations considered transferable (selected managers, selected professionals, sales workers, administrative workers)	Remaining carbon workers in non-industry reliant occupations (i.e. accountants, administrative workers) can transfer to other industries without chaining their occupation	Since drillers miners and shotfirers are specific to mining and resource industries, **D = 0**
E. Moderate upskilling or reskilling required to transition	=	$\sum_{i=1}^{n} E_i$	E_i = Carbon $jobs_i$ – A_i – B_i – C_i – D_i	Sum of remaining carbon workers	Since there isn't adequate demand in renewable energy or critical mineral mining for that occupation, moderate upskilling or reskilling would be required for these workers to transition	= 17,200 – 3,000 – 700 – 3,900 – 0 **= 9,500**

Note: Numbers may not sum due to rounding

Appendix 8: Occupation breakdown of transferability analysis

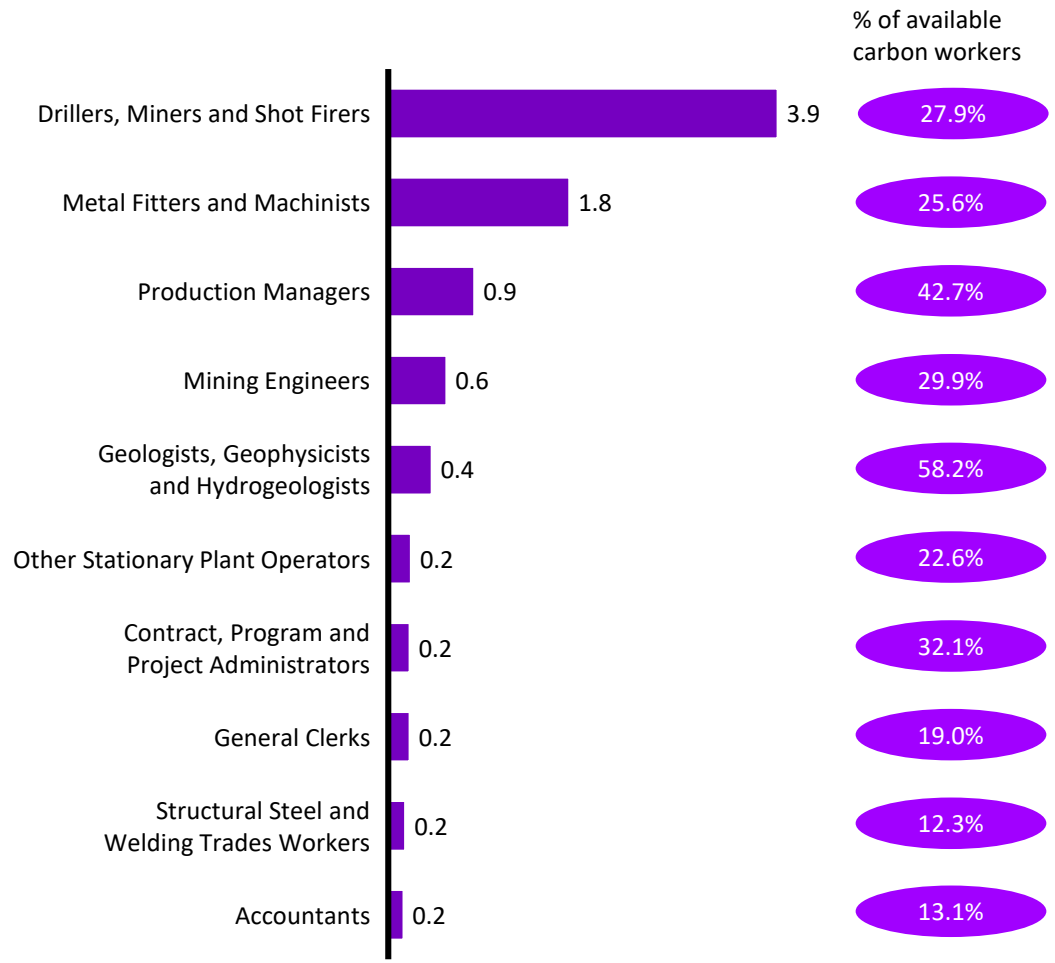
Transferable to renewable energy

Thousands (000's) of workers, 2025 - 2050



Transferable to critical minerals

Thousands (000's) of workers, 2025 - 2050



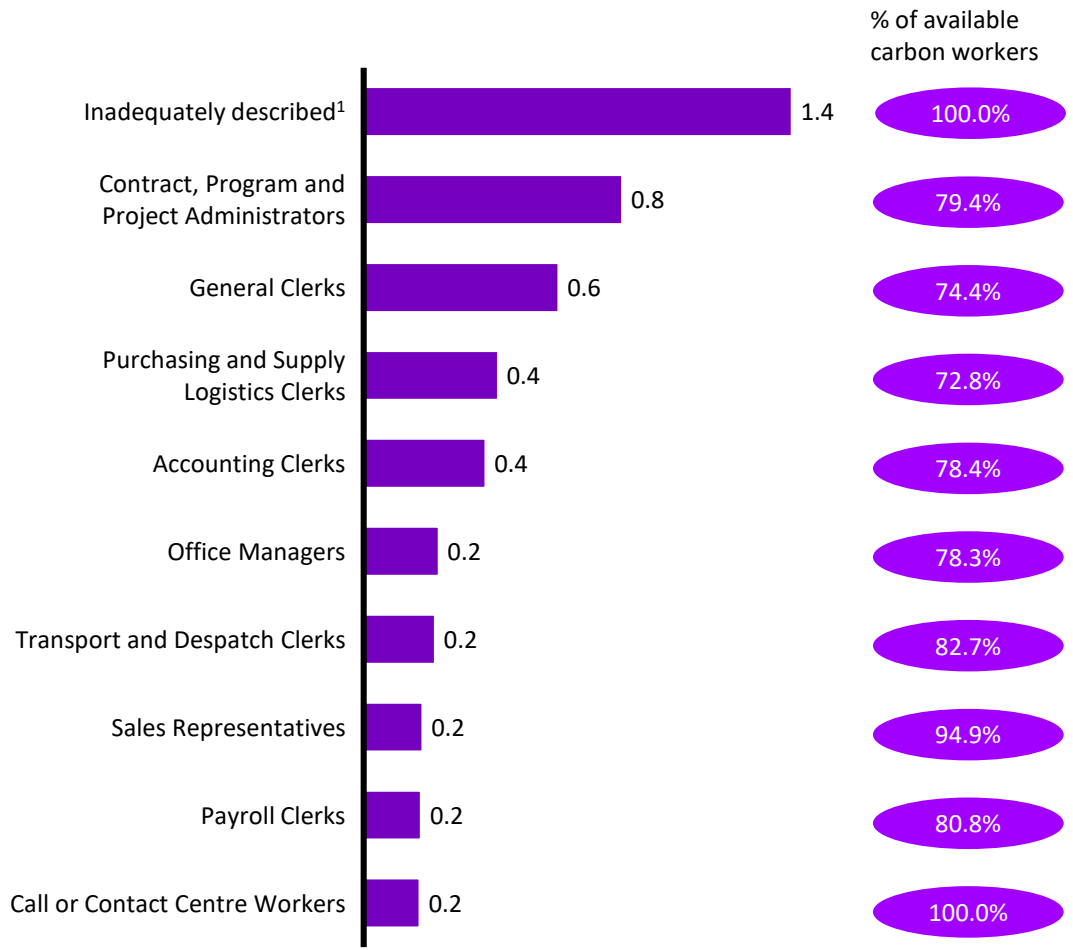
Notes: 1: Includes other building and engineering technicians and undefined technicians and trade workers; 2: Whilst accountants are considered highly transferable, the analysis first considers whether there is adequate demand in renewable energy jobs or critical mineral mining industries. When the maximum demand is reached, the analysis assumes remaining workers would transition into other Australian industries with minimal upskilling

Source: Accenture Analysis of data provided by Climateworks; ABS 2021 Census Data, Burning Glass Data

Appendix 8: Occupation breakdown of transferability analysis

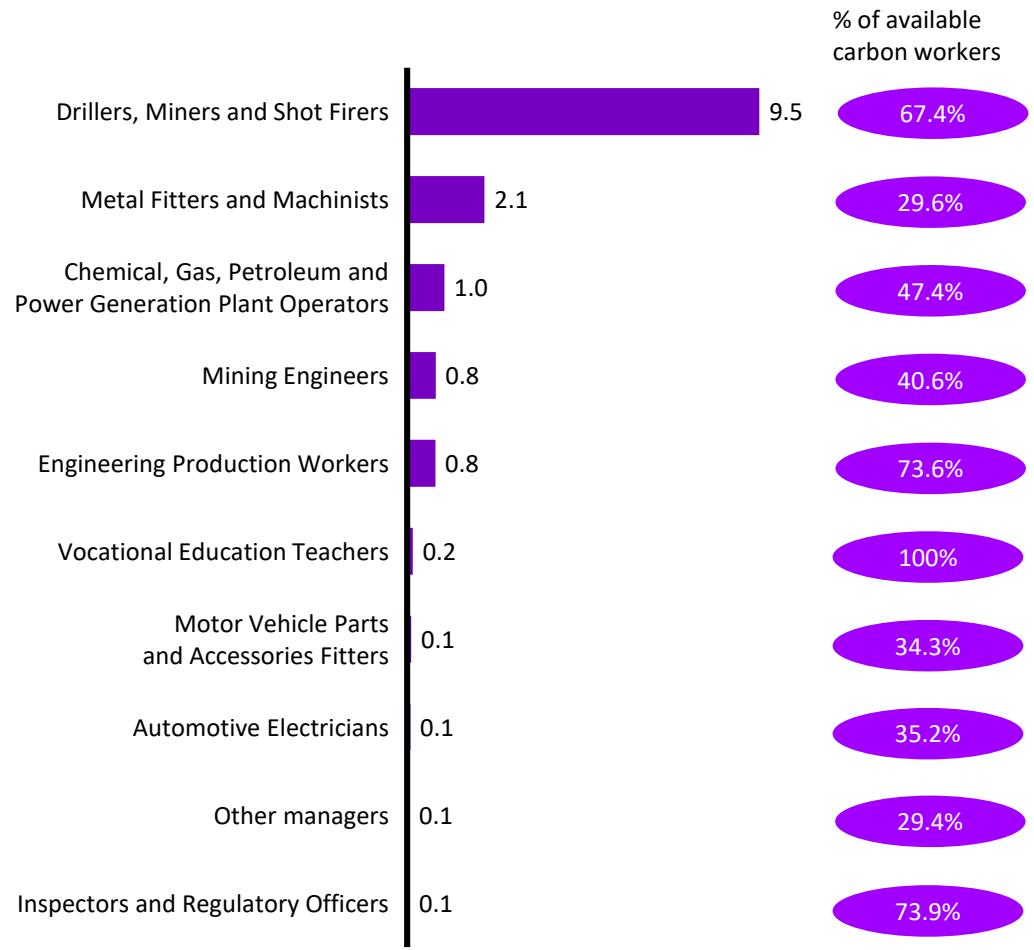
Transferable to other industries

Thousands (000's) of workers, 2025 - 2050



Moderate upskilling or reskilling required

Thousands (000's) of workers, 2025 - 2050



Notes: 1: Inadequately described workers are included in highly transferable, since it cannot be known whether moderate upskilling or reskilling is required in the transition

Source: Accenture Analysis of data provided by Climateworks; ABS 2021 Census Data, Burning Glass Data

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