



Australian Government



Jobs and Skills Australia

The Clean Energy Generation:

Workforce needs for a net zero economy

Summary

October 2023



Acknowledgement of Country

Jobs and Skills Australia acknowledges the Traditional Owners of Country throughout Australia and recognises the continuing connection to lands, waters and communities. We pay our respect to Aboriginal and Torres Strait Islander cultures, and to Elders past, present and emerging.

Overview

Reaching the Australian Government's net-zero emissions target by 2050 will require a workforce transformation that is substantial but not unprecedented. Like the post-war industrial transformation and the digital transformation of the late twentieth century, a new generation of workers will be required, both from existing energy sectors and through new pathways into clean energy. New jobs, skills, qualifications, training pathways, technologies and industries will emerge over the next 30 years.

Australia will need to consider the full range of levers across the education, training, migration, procurement, and workplace relations systems to ensure a sustainable and equitable path towards net zero. This report analyses the opportunities, risks and reforms that are needed for a successful transformation of our workforce, and:

- offers an Australian-first definition of the clean energy workforce, what it currently looks like and what it needs to look like to ensure the workforce grows at the pace and scale required. It finds we have enough workers overall and most likely enough university graduates but outlines the risk of a shortfall of VET qualified workers, especially amongst electricians and other trades.
- identifies both the emerging skills gaps in regional Australia as well as the opportunities for growth in the regions where new clean energy industries will emerge.
- offers opportunities for a tertiary skills, training and qualifications system that is fit-for-purpose to keep pace with rapidly changing technologies and emerging occupations, recommending innovative solutions to on-the-job skilling and all types of industry-led training, from TAFE Centres of Excellence to industry accredited microcredentials.
- tackles the barriers and challenges women, First Nations people and migrants face in participating in the sector, and the skills and talent the economy currently misses out on.
- offers a worker-centred approach to support transitioning communities, acknowledging that competition for skilled migrants is high and, while workers with clean energy skills are heavily concentrated in our regions, we have been slow to attract and support them.

Unique contributions of this report

While this isn't the first report to look at the Australian clean energy workforce, it provides several new and unique contributions that others don't. It also builds and expands on the large volume of work led by agencies across all levels of government, as well as industry groups and research bodies.



Defines the workforce

For the first time, a comprehensive definition of the clean energy workforce has been produced. Every industry in the economy is categorised and grouped based on its role in meeting net zero.



Examines the supply of workers

This is the first study that has considered where the supply of workers will (or won't) come from. With a finite number of workers in Australia, this element is important to understand whether workforce demand can be met.



Takes a holistic view

By taking a whole-of-economy view, this study considers the broader impacts of the net-zero transformation. We also take a collective view of higher education, VET and migration systems to supply workers.



Uses new data

JSA has pioneered the use of new data and techniques to analyse the workforce. Unit record data lets us explore the characteristics of workers and examine the real-world pathways they take into new roles.



Provides gap analysis

Our supply and demand modelling shows when and where workforce gaps are likely to arise, helping governments pre-empt and mitigate skills shortages. This includes gap analysis across a range of scenarios and sensitivities.

The net zero challenge

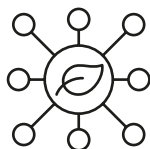
The net zero transformation presents an unprecedented opportunity to revitalise the Australian education and training sector, working with industry to develop a more diverse workforce and create sustainable employment for generations to come. This includes opportunities for our regional labour markets and industries that have long been in decline. With the right investment we can offset the jobs at risk in areas like coal-fired power and ensure these workers and their communities are given the support they need to transition and find new opportunities.

However, the transformation also presents a major challenge. If we don't fine tune our workforce pipelines, skill shortages could prevent us from reaching net zero by 2050, and opportunities to broaden our industrial base will be missed. We also need to make sure that the jobs created are accessible and shared with all Australians, particularly underrepresented cohorts and workers in transitioning sectors.

Ambitious net zero targets will need to be matched with ambitious workforce and skills policy. It will also require cohesive, collective action across all levels of government and better collaboration with industry, unions and the education and training sectors. This report assesses what is needed to reach net zero by 2050 and how to get there. It is guided by three overarching objectives which should inform all workforce planning for this sector:



Objective one: the energy transition isn't hindered by skill shortages. Australia has the workforce it needs to meet and exceed our clean energy ambition.



Objective two: workforce opportunities are sustainable and equitably shared with all Australians, particularly communities impacted by decarbonisation and disadvantaged groups that were underutilised in traditional energy.

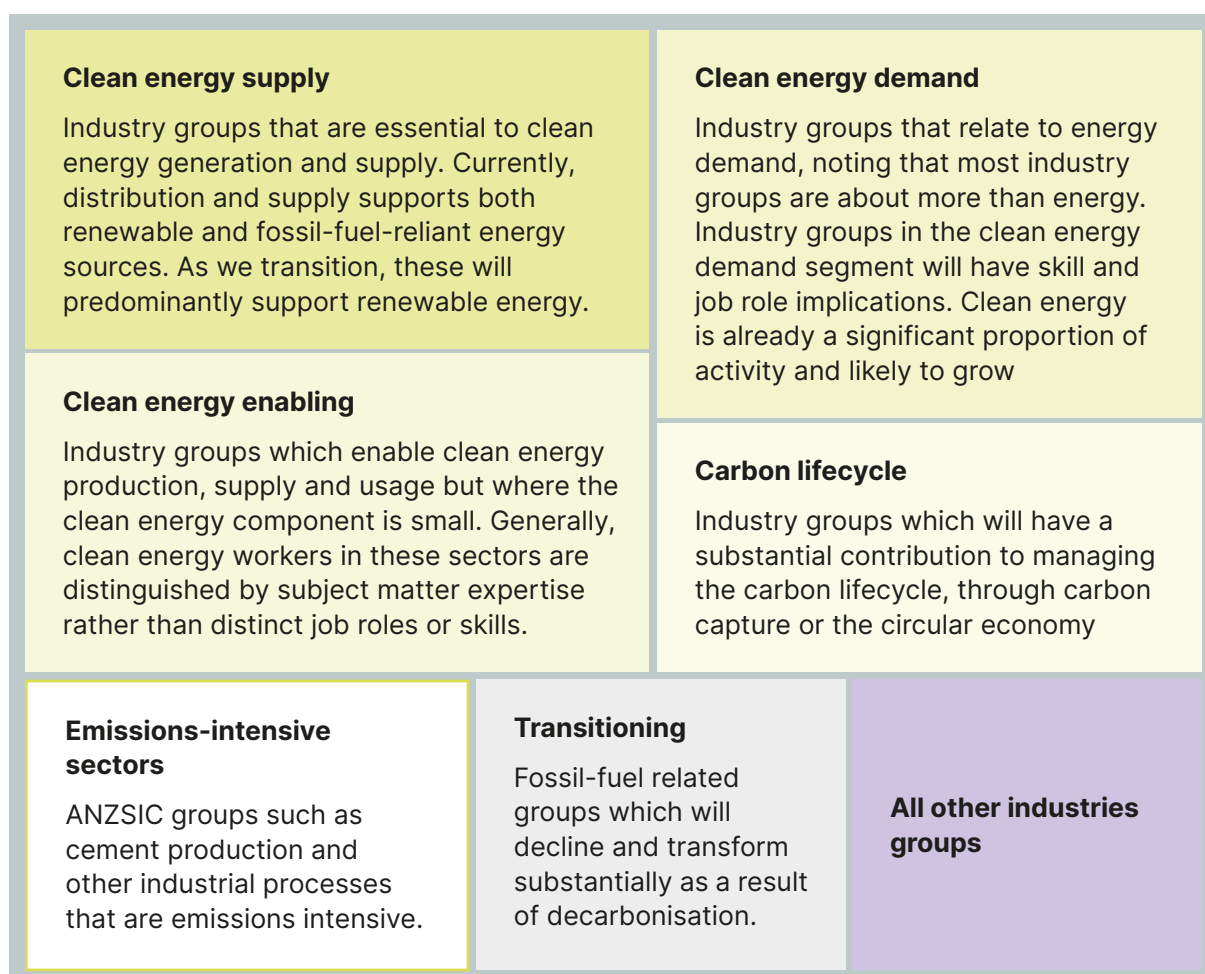


Objective three: people in transitioning sectors and their communities are given the support they need to access new employment opportunities that work for them.

Defining the clean energy workforce

In an Australian first, we have defined the jobs and industries that make up our clean energy workforce. Rather than viewing clean energy as an isolated segment of the economy, we have acknowledged the role that every industry plays in one way or another. This means clean energy jobs are found right across the workforce, extending well beyond obvious sectors like wind, solar and hydroelectricity into parts of construction and research and development, amongst others.

Based on feedback from our Discussion Paper and engagement with the Project Steering Group, Jobs and Skills Australia (JSA) workforce mapping has been applied against the definition of clean energy to describe what constitutes the clean energy workforce and related sectors. These industry categories span energy supply, energy demand, enabling clean energy workforce, the workforce associated with the carbon lifecycle, and the workforce from transitioning sectors.



While there are many occupations that form part of the clean energy workforce, the most critical are found within trades, technical occupations and engineering professions, where training times and licensing and accreditation requirements impose (justified) barriers to entry. The study identifies 38 occupations that are critical to at least one segment of this workforce:

Technicians and Trades Workers

- Architectural, Building and Surveying Technicians
- Civil Engineering Draftspersons and Technicians
- Electrical Engineering Draftspersons and Technicians
- Other Building and Engineering Technicians
- Automotive Electricians
- Motor Mechanics
- Aircraft Maintenance Engineers
- Metal Fitters and Machinists
- Structural Steel and Welding Trades Workers
- Plumbers
- Electricians
- Airconditioning and Refrigeration Mechanics
- Electrical Distribution Trades Workers
- Electronics Trades Workers
- Telecommunications Trades Workers
- Chemical, Gas, Petroleum and Power Generation Plant Operators

Managers

- Policy and Planning Managers
- Research and Development Managers
- Construction Managers
- Engineering Managers
- Production Managers

Labourers

- Structural Steel Construction Workers

Professionals

- Marine Transport Professionals
- Architects and Landscape Architects
- Urban and Regional Planners
- Chemical and Materials Engineers
- Civil Engineering Professionals
- Electrical Engineers
- Industrial, Mechanical and Production Engineers
- Mining Engineers
- Other Engineering Professionals
- Agricultural, Fisheries and Forestry Scientists
- Chemists, and Food and Wine Scientists
- Environmental Scientists
- Geologists, Geophysicists and Hydrogeologists
- University Lecturers and Tutors
- Vocational Education Teachers
- Occupational and Environmental Health Professionals

Australia's clean energy workforce is:

Predominantly male

A higher proportion of women work in white collar segments (education, training, research etc). Where women are represented in clean energy, they are dominate in roles like general clerks, office managers, accounting clerks, commercial cleaners and interior design, rather than trade qualified and engineering roles.

On par with transitioning sectors for age of the workforce

The segments with the youngest workforce are energy usage and performance, while the oldest are transport and some enabling segments.

More highly qualified than transitioning sectors

In general, the clean energy workforce contains higher proportions of VET-qualified workers than the broader labour force. The clean energy supply segment comprises a larger proportion of workers with higher education qualifications than the transitioning segment which includes workers in coal-fired power stations.

Underrepresented among First Nations people

A smaller proportion of First Nations people work in clean energy than the broader labour force. Notably, a higher proportion work in the transitioning segment, including coal mining.

Underrepresented among migrants

Around 26% of the clean energy workforce were born overseas, with some of the enabling segments having the highest proportions (over 30%). Workers come from all around the world, but the largest group are from Southern Asia, followed by North-West Europe.

Typically paid less than in transitioning sectors

In general, clean energy sectors lag behind the pay and conditions available in more established sectors.

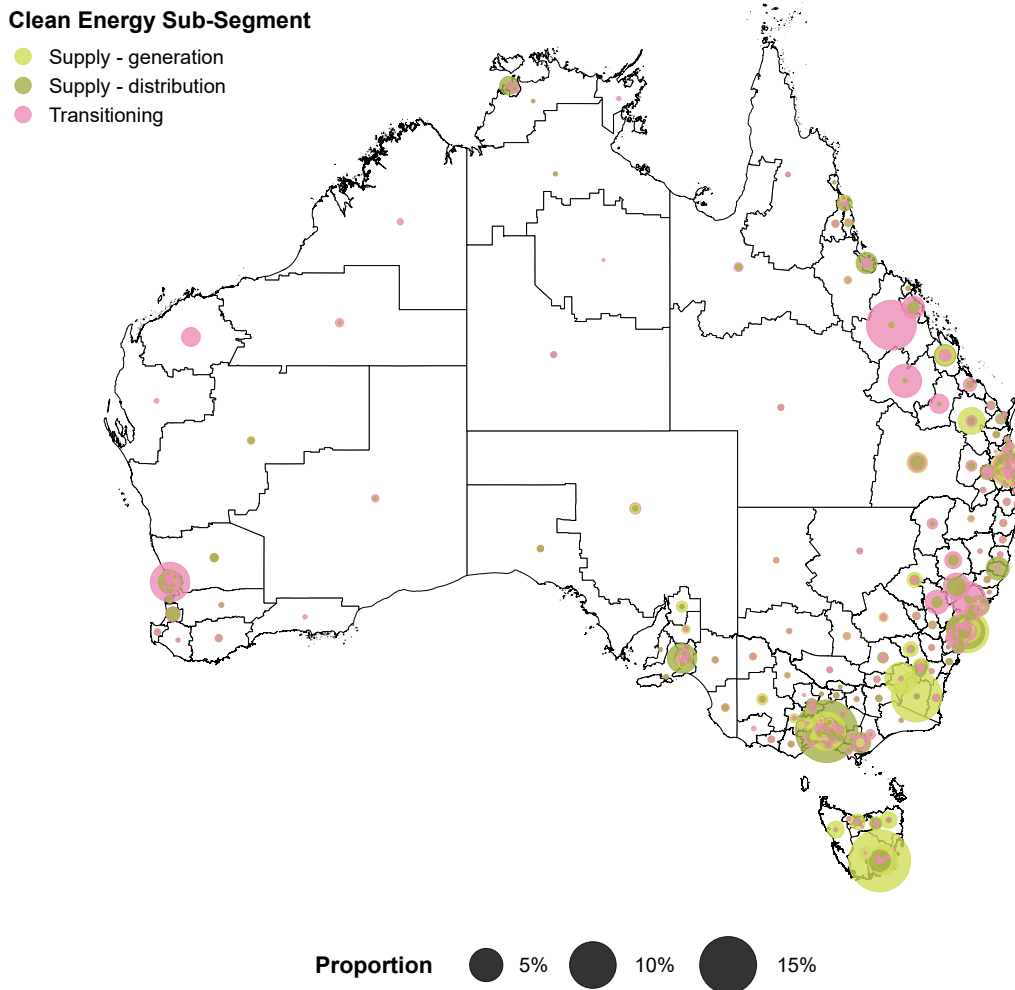
Predominantly employed in the construction phase

Unlike traditional energy employment, there can be a higher degree of variability and project-based work in clean energy. For example, large-scale solar farms are a project-based industry where businesses may lack certainty while waiting to win contracts, secure finance or gain approvals. Workforce needs are also typically front-ended (during construction phases), meaning there are fewer long-term employment opportunities.

Employed across Australia

Regional differences mean different locations are better suited to certain technologies and therefore attract different types of workers. Tasmania has a high concentration of clean energy supply workers working in hydroelectricity, whereas Queensland and NSW have a high share of workers in transitioning sectors. Workers are often needed in regional and remote areas away from sources of labour supply. In some instances, this requires short-term moves or fly-in-fly-out work, which can be inaccessible for apprentices, particularly in their first year.

Places of Work (SA3) by Clean Energy Sub-Segments
(Supply Generation, Supply Distribution and Transitioning) including proportions



Education and training

Tertiary education will continue to deliver the fundamental skills needed for this workforce. There are three key elements of clean energy education and training pathways:

- existing **broad-based qualifications**, like the Certificate III in Electrotechnology and Bachelor of Electrical Engineering. They provide the fundamental skills for a range of roles, including but not limited to clean energy.
- **clean energy top-up and electives**, including post-trade and post-graduate qualifications, allow workers and students to gain specific clean energy skills and specialise. However, the availability of these is limited.
- **new qualifications** targeted to emerging sectors, like the Bachelor of Renewable Energy and Certificate III in Electric Vehicles, are beneficial where new technologies require a larger suite of specialised skills.

The tertiary sector will need more support, more collaboration and more innovation to meet the needs of net zero. We've identified three priority areas for attention:

System design

- Frameworks for deeper collaboration between VET, higher education and industry
- New models for course delivery to better align graduates with emerging needs
- Clearer pathways for students to navigate and access
- A cohesive and connected tertiary education system with fewer obstacles
- Consistent approaches to occupational licencing

Funding and program design

- New and responsive curriculum development for emerging needs
- Servicing thin markets and regions through competitive models
- Minimising capital constraints through better collaboration
- Incentivising employer involvement in education and training

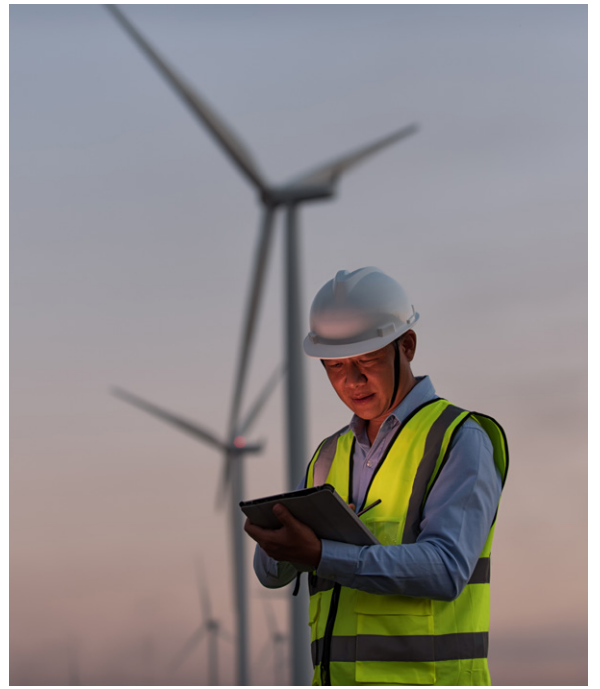
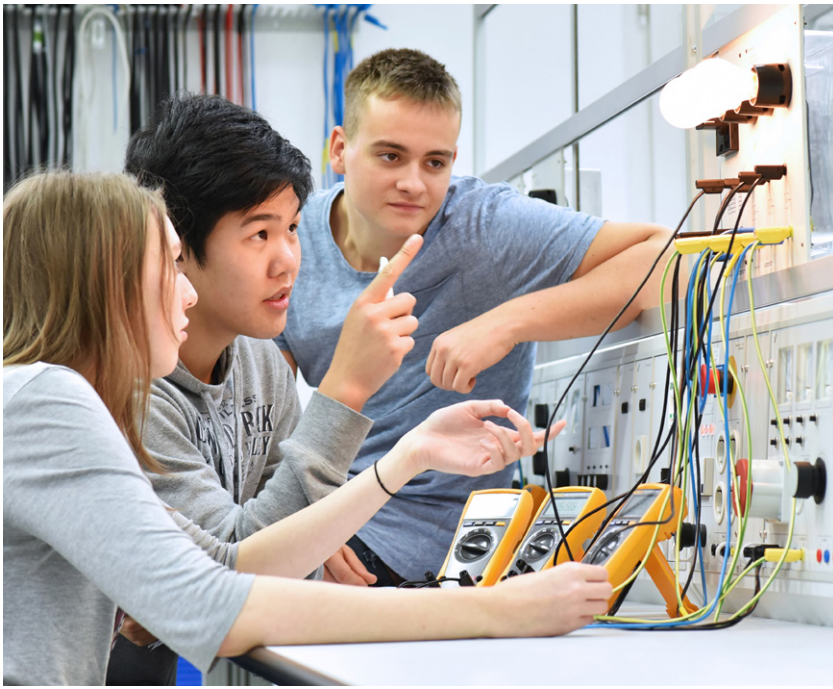
Student pipeline

- Increasing student participation in STEM
- Growing and supporting the trainer, teacher and researcher workforce
- Doubling down on efforts to get women into trades
- Supporting more First Nations people into education and training
- Better targeting of incentives and supports for apprentices

Stimulating a training culture

Despite a proven need to increase the number of apprenticeships in relevant trades, there is significant underinvestment in this pipeline. Leveraging government procurement and financing is a way to set standards regarding apprenticeship uptake, workplace gender equality, and secure employment. This idea is incorporated in the Australian Skills Guarantee, which will introduce new national targets to ensure one in 10 workers on Australian Government funded major projects is an apprentice, trainee or paid cadet.





Migration

The 2023 Review of the Migration System identified that while migration alone will not address the challenges of transitioning to a clean energy economy, a well-designed and fit-for-purpose skilled migration program is part of the solution. In an increasingly competitive and global market for skills, Australia will need to position itself as a destination of choice to attract and retain workers in critical roles.

International students are already an important pipeline of skilled workers in Australia and will continue to be. However, there are many international students that would like to remain in Australia but can't or do stay but struggle to find employment related to their field of study. Ensuring these students are set up for success during and after their studies will be key.

Industry transitions

While new employment opportunities will be created from the net zero transformation, jobs will be also be lost in sectors that are emissions intensive, particularly coal-fired power. Australia's remaining coal-fired power stations will gradually close over the coming 30 years, impacting their workforces which are concentrated in a handful of regions, including Latrobe Valley (VIC), the Hunter region (NSW), Collie (Southwest WA), and Central Queensland.

Transitioning industries employ a diverse range of workers. Many generalist occupations, like accountants and truck drivers, are also employed in high numbers in growing industries. Other occupations, like Power Generation Plant Operator, have limited employment prospects outside transitioning industries and are therefore at greater risk. Common transition pathways, identified using historical real-world transitions data and skills similarity analysis, include Earthmoving Plant Operators, Electrical Linesworkers and Fire Protection Equipment Technicians.

While some transitioning workers will move into clean energy jobs, this isn't the only (or necessarily the best) outcome. Policy analysts are often keen to use modelling exercises that map transitioning workers to new opportunities at a macro level, but this is only a conceptual exercise and can undervalue the circumstances of individuals and the barriers they face. Mismatches in skills, location, timing and preferences are just some of these considerations. Targeted, localised and individualised supports will be needed to drive outcomes that work for the individual worker and their community.

Projected workforce demand and shortfalls

Our study includes preliminary economic modelling of three possible future scenarios with the central scenario being broadly aligned with Government climate and energy policy.

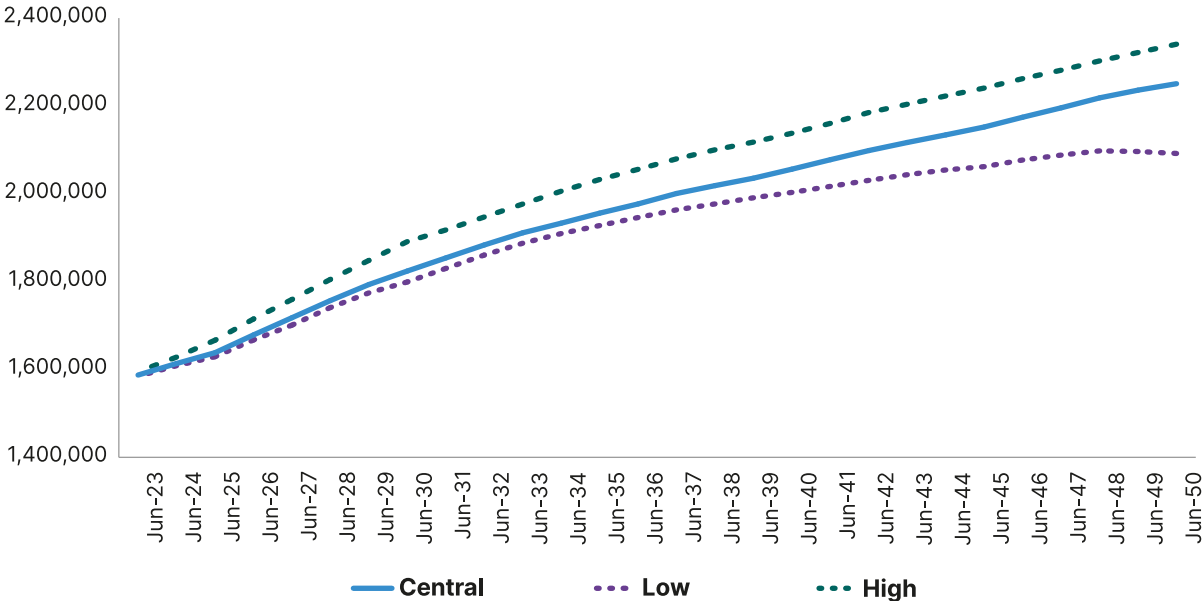
The preliminary modelling suggests that under the central scenario we will need close to two million workers in building and engineering trades by 2050, an increase of around 40%. Occupations with the highest growth rates (2023-2030) include Telecommunications Trades Workers, Electronics Trades Workers, Electrical Engineering Draftspersons and Technicians, Structural Steel Construction Workers, Construction Managers, Plumbers and Electricians. Depending on different policy approaches to electrifying the National Energy Market (NEM) and reaching our renewable energy goals, the preliminary modelling shows we will need approximately 26,000 to 42,000 more electricians in the next seven years, and the clean energy supply workforce will likely need to grow from approximately 53,000 workers today to 84,000 by 2050.

There is strong growth in trades and technical occupations, particularly for occupations that are critical to clean energy such as Electricians, Metal Fitters and Machinists, and Plant Operators. However, our supply forecasts strongly suggest there is insufficient capacity in the training and migration pipelines to meet this demand.

Growth in these occupations will also be concentrated in regional Australia, presenting a great opportunity, as clean energy will continue to provide well paid employment that might otherwise be lost as global demand for fossil fuels decreases. However, the concentration of growth in trades and technical employment in regional Australia will require an even more substantial uplift in education and training to ensure that job opportunities can be accessed by local workers.

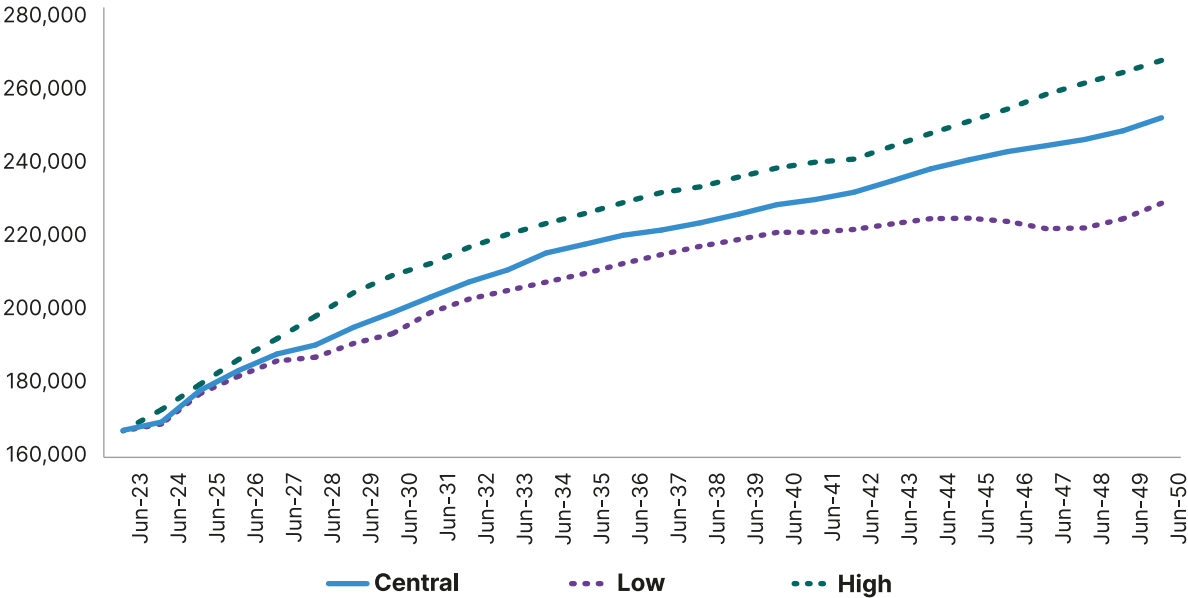
With active investment and clear policy direction to ensure all emissions-intensive sectors have the incentives to transition to lower emissions technology, Australia can achieve more employment growth, industrial diversity and productivity while still decarbonising the domestic economy. When coupled with a higher level of ambition and investment, Australia can also expand its production of low-emissions goods to create an export market that replaces what we can expect to lose from fossil fuels.

Demand for critical clean energy occupations, to 2050



Source: Deloitte Access Economics 2023

Demand for Electricians, to 2050



Source: Deloitte Access Economics 2023

Emerging and transforming sectors

Workforce change means more than just the number of jobs that will be created or lost. While it's easy to assume that the biggest impact will be in the sectors that need to grow the most, this is not necessarily the case. Increasingly over the next thirty years, the skills and roles of existing occupations will change in response to decarbonisation, even if overall demand does not increase. New occupations are also emerging which, even in small numbers, can be particularly difficult to grow, including in:

New fuels and storage

For example, the bioenergy sector provides opportunities for skilled employment growth in regional areas and additional revenues streams to support employment in agriculture. This could see demand for new skills in agricultural science and chemical engineering.

Transport

Transport will see major skills change as internal combustion engines are replaced with electric vehicles (and vehicles that use alternative fuels). Demand for specialist electric vehicle mechanics will increase, as will the demand for mechanics to work across both vehicle types.

Energy performance

In energy performance, skill roles of energy auditors on the one hand and air condition and refrigeration mechanics and facility managers on the other as examples of new growing roles and existing roles which will have changed skill and knowledge requirements.

Barriers for workers and communities

Women

The clean energy sector cannot grow at the scale required without the participation of half of Australia's population, but this won't happen without addressing significant barriers that exist. Many female engineers report experiencing gender discrimination and bullying in the workplace and do not feel they have equal access to career progression opportunities, salary advancement or mentoring. The energy sector also has the third highest incidence of workplace sexual harassment, with 71% of women having experienced sexual harassment in the last 5 years.

First Nations people

The transitioning energy sector, particularly coal mining, has been a major employer of First Nations people (3.4%). The emerging clean energy sector is yet to reach these levels, with First Nations employment levels around 1.9%. Growing the supply of First Nations tertiary graduates will take time but is critical to ensuring First Nations employment in the clean energy sector does not mimic the trends of the transitioning sector in concentrating First Nations employment at the lower skilled and lower paid operational level of the workforce.

Safety culture

Working with clean energy infrastructure can be high risk, as is handling materials like hydrogen, ammonia and biofuels. A safety culture is vital and must consider remoteness, new technologies and processes, regulation inconsistencies and low awareness.

Hiring and retention

The Clean Energy Council outlines several factors that exacerbate skill shortages within the sector, including:

- **Visibility** – occupations within and pathways into the clean energy sector are poorly understood as most workers enter the sector by side-stepping from other industries.
- **Location** – the regional location of most employment opportunities is a significant impediment to attracting qualified individuals, such as graduates.
- **Mobility and entitlements** – workers can experience challenges transitioning from one project to another.

Findings and opportunities

Alignment across all sectors of the economy is needed to drive long-term change.

Coordination between businesses, workers and all levels of government will be needed to overcome the structural changes arising from climate change and environmental degradation. Long term policy guidance from governments can catalyse the necessary investments in our industries and regions.

Strategies need to look beyond state and territory borders, and be regularly updated to reflect both new and revised policy settings, in alignment with rapidly changing technologies. Developing this workforce should also be a national effort, with consistency and coordination the objective.

Many of the skills needed to decarbonise already exist in our economy. This means that our education and training sectors are already set up to deliver many of the skills we need. The challenge will be scaling the delivery of these skills, and developing top-up pathways for workers to bridge gaps and specialise. Innovative and agile course design approaches will help education and training sectors respond faster to emerging skills needs.

A harmonised education, training and migration system with a step change in how we train trades and technical workers is a priority. As skills needs continue to transcend VET and higher education sectors, the value and potential for greater collaboration is high. The clean energy sector is primed to be a test case for new approaches to collaboration.

A shared responsibility for inclusive pathways. We can't grow the workforce at the pace and scale required if large groups of the population are excluded, including women, First Nations Australians, people with disability, and recent migrants whose skills' potential are underutilised. The net zero transformation requires a shared commitment between industry, government, and communities to share the benefits of clean energy work, through foundational and pre-vocational training, clear diversity targets, and a transition framework built around the individual worker.

Australia will likely need 32,000 more electricians in the next seven years and close to 2 million workers in building and engineering trades by 2050, based on preliminary modelling. The preliminary modelling also shows a steady supply of engineers is likely but there will likely be smaller shortfalls amongst some scientists needed for the transition.

Regional Australia can benefit from the net zero transformation. The implications of the workforce transformation at the local level will be more significant in some parts of Australia, particularly those with a high proportion of employment in emissions intensive sectors. Overall economic growth and development provides good prospects for supporting these communities, provided there is local investment in new industries and impacted workers receive targeted training and other forms of support to transition into roles that build on their existing skills. The preliminary modelling indicates there will also be new opportunities in the regions as clean energy industries emerge. For example, in Northern NSW and Eastern Victoria.

Supporting workers and communities undergoing transition. The most positive and sustainable outcomes for workers and employers are individualised ones. Local support networks play a crucial role in this as does timing, especially for workers at different stages of their career and local support. The new Net Zero Authority will have a critical role driving consistency and coordination of these supports.

A higher ambition? Australia can be a renewable energy superpower, but it will require significant effort. There is a potential path for Australia to take even fuller advantage of decarbonisation, expanding its production of renewable energy beyond what is our current domestic requirement. This would see Australia exporting renewable energy to the world, in the form of hydrogen, as well as extending further along the minerals value chain to process and refine more iron, aluminium, and critical minerals such as lithium here in Australia. Given proper planning, this transformational change could create generations of new employment opportunities for our regions.

Conclusions

Climate change and the transition to Net Zero is a crowded policy space and the workers needed to drive the transition are often forgotten in these debates.

For the 50-year-old working today in a coal-fired power station, this report sets out a framework to guide the supports they need for the next phase of their working life.

For the 38-year-old mid-career electrician who wants to enter the VET teaching workforce or make a career change to solar or EV battery production, this report recommends training options, funding and incentives that should be explored.

For the 22-year-old female electrical apprentice, there is recognition of the barriers she faces in the trades but also recommendations on how the classroom and workshop can become more inclusive as well as policies that can support and fund her to stay in the sector.

For the 17-year-old school leaver, there is advice on pathways to promising careers in existing trades and emerging occupations right across the clean energy value chain

For the primary school student in regional Australia still ten years from full-time working life, there is a commitment that their schooling and post-school training matters – not just for them and a more equal Australia, but for realising the economic possibilities of a decarbonised economy.

For more information, see
*The Clean Energy Generation:
Workforce needs for a net zero economy*
in full at

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