RACE for 2030
RELIABLE AFFORDABLE CLEAN ENERGY

Building a net zero workforce

The Australian Electricity Workforce for the 2024 Integrated System Plan: Projections to 2050.

Policy brief

UTS Institute for Sustainable Futures

AEMO

Australian Government
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Cooperative Research Centres Program

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RACE for 2030

Project partners

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Acknowledgement of Country

The authors of this report would like to respectfully acknowledge the Traditional Owners of the ancestral lands throughout Australia and their connection to land, sea and community. We recognise their continuing connection to the land, waters, and culture and pay our respects to them, their cultures and to their Elders past, present, and emerging.

What is RACE for 2030?

Reliable, Affordable Clean Energy for 2030 (RACE for 2030) is an innovative cooperative research centre for energy and carbon transition. We were funded with $68.5 million of Commonwealth funds and commitments of $280 million of cash and in-kind contributions from our partners. Our aim is to deliver $3.8 billion of cumulative energy productivity benefits and 20 megatons of cumulative carbon emission savings by 2030. racefor2030.com.au

Disclaimer

1 Introduction

This report provides the projected electricity workforce requirements associated with the Australian Energy Market Operator's (AEMO) 2024 Integrated System Plan (ISP)[1]. Projections are segmented to include technology, location and occupation, and cover the generation and storage of electricity and the construction of new transmission lines included in the ISP.

Workforce projections aligned to the ISP were first developed in 2022 under a RACE for 2030 project co-funded by some Australian state governments. The first recommendation in that report was for "AEMO to consult with ISP stakeholders on integrating employment profiles into the ISP". Feedback during stakeholder consultation supported the role of the ISP in emphasising workforce needs, with high level commentary on workforce requirements and workforce projections included in the 2024 ISP. This 2024 workforce projection report was commissioned by AEMO and is referred to as a Supporting Document in the 2024 ISP.

The aim of this report is to provide stakeholders with an in-depth understanding of the workforce implications of different electricity scenarios. Specifically, the report enables state governments, the electricity, and training and education sectors, to develop appropriate and responsive polices, plans and programs. Quality projections of energy sector employment – that cover both location and occupation – are widely recognised as an essential part of delivering an energy transition that is orderly and ensures the full advantages are realised for the Australian economy[2].

The project was conducted by the Institute for Sustainable Futures, University of Technology Sydney (ISF) in partnership with AEMO and funded by the RACE for 2030 Cooperative Research Centre. An Industry Reference Group made up of representatives from state governments and industry provided valuable insights.

These kinds of projections allow for the development of appropriate training plans and facilities, policy that maximises regional and local economic development, and the action required to ensure that skills shortages are avoided.

The workforce projections cover electricity generation, storage, and transmission construction for the three core ISP scenarios:

- Step Change includes a rapid energy transition with strong economic growth. It supports Australia's commitment to keep global temperature rise to below 2°C.
- Progressive Change reflects a constrained economic and supply chain environment, meaning less energy is required to meet the needs of a smaller economy. While meeting legislated commitments, cumulative electricity sector emissions to 2050 are 36% higher than under the Step Change.
- Green Energy Exports includes an exceptionally fast rate of decarbonisation aimed at Australia making its contribution to keeping global temperatures to below 1.5°C, with a strong emphasis on a green exports economy and electrification. Cumulative electricity sector emissions to 2050 are 46% reduced compared to the Step Change.

AEMO assigned likelihoods of 43% for Step Change, 42% for Progressive Change and 15% for Green Energy Exports.

2 Findings

Electricity sector jobs increase steeply in all scenarios in the run up to 2030

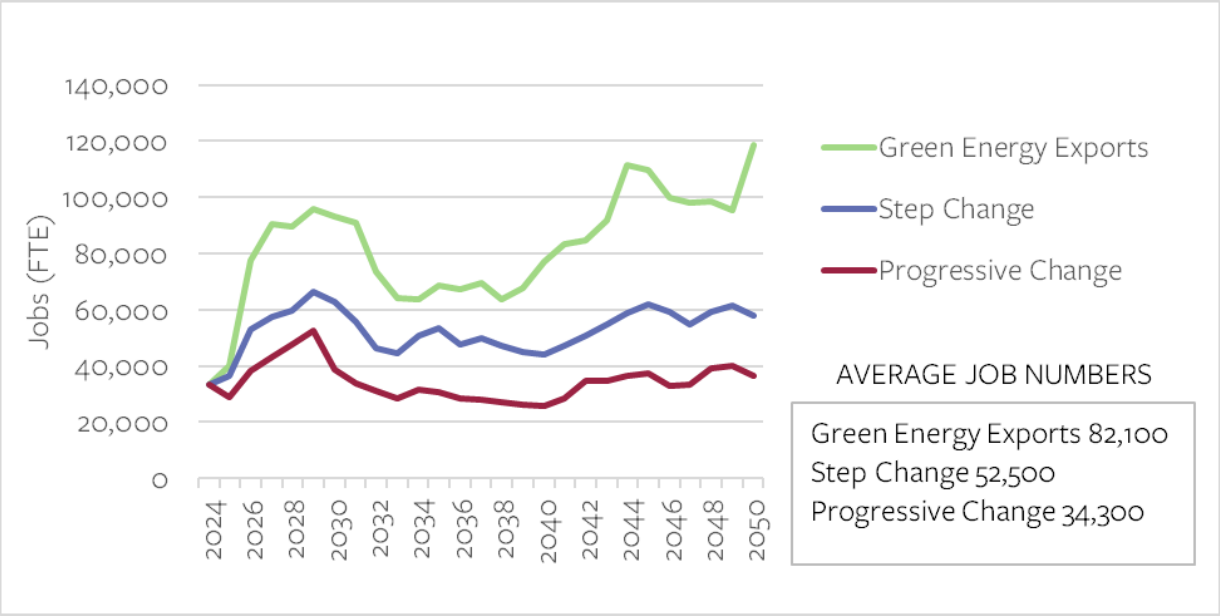

Figure 1 NEM: total job numbers by scenario

All three scenarios have a peak in 2029, followed by a significant drop off, caused by the construction boom to meet 2030 targets (Figure 1).

- **Step Change**: the electricity sector workforce reaches 66,300 in 2029, and averages 52,500 from now to 2050. After the 2029 peak, jobs drop to 44,400 over four years, a reduction of nearly 5,500 per year, and then generally plateau during the 2030s before rising again in the 2040s.
- **Progressive Change**: jobs peak in 2029 at 52,700, and then drop to 28,400 (below present levels) over four years, shedding 6,000 jobs each year. Jobs generally fall during the 2030s, before rising again in the 2040s.
- **Green Energy Exports**: employment averages 82,100, with a peak of 96,000 in 2029. This is a rise of nearly 63,000 in just five years, which would be very hard to achieve. This is followed by dramatic falls (nearly 32,000 in four years). After a brief plateau, jobs rise steeply to reach 111,400 in 2044, and 118,700 by 2050.

A very rapid scale-up of the electricity workforce is required

Under all scenarios, a very rapid workforce increase is required. In Step Change, an extra 33,000 workers are needed after just five years (Figure 2), doubling the workforce by 2029. The ramp up for Green Energy Exports is far steeper, with a combined increase of 63,000 needed by 2029, effectively trebling the workforce. Even in Progressive Change, which assumes a significantly constrained economy, an increase of about 19,000 is anticipated by 2029 to meet peaks in infrastructure construction.

Most of the job growth is in renewable energy which doubles by the end of the period in Step Change (Figure 2) and increases fivefold in Green Energy Exports. The proportion of renewable energy jobs is close to 60% in 2024 and

between 71% and 83% by 2050 in all scenarios. Storage employment increases from 4% in 2024 to between 14% and 25% in 2050, with a peak of 9,500 in the mid-2030s. Transmission construction (including lines and substations) reaches peaks of between 5,000 and 7,000 in 2028 and 2029.

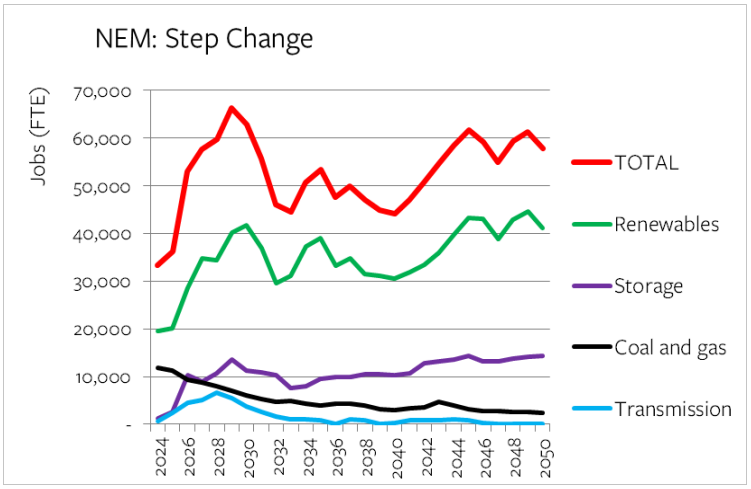

Figure 2 National Electricity Market, jobs by technology group, Step Change

Fossil fuel employment in power stations for producing gas or coal for Australian electricity generation[1] declines steadily over the period, to just over 2,000 jobs in 2050. This is a drop from 35% of the workforce now to between 2% and 6% in 2050. This decline is outstripped by the increase in other electricity sector jobs, which may offer some opportunities for transition employment. However, these jobs will not necessarily be in similar occupations or locations, so planning and diversification will be needed to ensure a smooth and just transition for coal regions and communities.

Most jobs in the electricity sector will be in operations and maintenance by the 2030s

Under all scenarios, construction dominates the employment profile through the 2020s but operations and maintenance (O&M) employment gradually increases as the fleet of renewable energy generation and storage increase. O&M employment exceeds 50% in all scenarios by 2033, and by 2050 makes up more than 65% of the workforce.

Australian governments and other stakeholders are developing policies to increase local manufacturing for renewable energy technologies, including the Future Made in Australia program which identifies clean energy manufacturing as a priority area[3]. These projections include onshore manufacturing based on the findings of a 2020 industry survey[4], and vary from 2% for solar to 23% for onshore wind. We undertook sensitivity analysis on increasing this share to between 10% and 30% of onshore manufacturing for all technologies. This could add 1,200 jobs on average over the period in Step Change (900 in Progressive Change and 1,900 in Green Energy Exports), noting that the achievable increases are very uncertain.

Demand is highest for trades & technicians, with an average of 14,100 needed until 2041

The largest group of occupations is trades and technicians, averaging 14,100 until 2041 under Step Change [2]. Wind technology creates the most employment on average for trades and technicians, with wind and solar nearly equal for professionals and managers. Solar creates the highest number of labouring jobs, machine operators and drivers, and administration roles. The key trends across occupational groups in Step Change are:

- **Trades and technicians**: demand reaches 16,500 by 2030, and then stays above 13,300.
- **Professionals**: an average of 7,700 until 2041 across a wide range of occupations including engineers, finance, health and safety.
- **Managers** (e.g., construction or operations managers): around 6,500 on average.

[1] It is important to note that these jobs only represent coal and gas for domestic electricity production, not coal and gas for export.
[2] Overall numbers include both offshore wind and batteries, but these technologies are not included in the detailed occupational breakdowns, as robust occupational data are not available for these technologies.

- **Labourers**: 5,300 on average, with peak requirements reaching 9,900.
- **Machine operators and drivers** (e.g., truck drivers or crane operators): averaging at 3,200, with peaks of 5,900.
- **Administrative staff**: 2,900 on average.

Average employment projections illustrate the bulk distribution of jobs between technologies but from the perspective of skills, training, and labour supply, the specific occupations and peaks in employment may be the most important variable. Those occupations primarily needed in construction are very volatile. Electricians, mechanical trades, and operations managers increase over the entire period as they are also required for operations and maintenance.

- Demand for electricians almost doubles by 2030, then fluctuates somewhat around 8,000, with average demand of 7,400 between 2024 and 2041. Most of the demand is in wind and rooftop solar, followed by transmission construction.
- Mechanical trades and technicians follow a similar trajectory, increasing three-fold over the next decade to reach 3,100 in 2034, then remaining relatively stable through the rest of the period. Wind is the major source of demand.
- Roles that follow construction are the most variable. Demand for construction labourers and electrical engineers rises three-fold by 2029.
- Demand for administrative staff is also volatile, although not to the same extent, while demand for operations and production mangers generally increases steadily over time as operating projects increase.

The energy transformation creates significant numbers of jobs across the National Electricity Market, with the highest number in NSW

New South Wales has the highest level of employment, with an average of 18,400 jobs in Step Change, closely followed by Queensland with 15,800 jobs. Victoria is next with 12,200 jobs. Solar and wind account for between 61% and 69% of jobs in all states except Tasmania, where hydro and wind account for 75% of jobs. The distribution of employment between states is similar in Progressive Change. In the Green Energy Exports scenario, the highest number of jobs are created in Queensland (32,300 on average), followed by New South Wales (22,600) and Victoria (15,900). Growth in South Australia and Tasmania is also very strong in Green Energy Exports.

Workforce projections for the 2022 and 2024 ISP compared

Comparing the capacity projections for the 2022 and 2024 ISPs, the ambition for 2030 has increased with a total capacity of just over 145 GW reached in the current ISP compared to approximately 123 GW in the 2022 ISP for the Step Change scenario. This is reflected in the workforce profile, with a very steep rise required from 2026 to 2029. The pattern is similar in the Progressive Change workforce projections for the two ISPs, with a steep capacity increase, and a corresponding workforce increase, required in the run up to the 2030 target.

The increase in workforce requirements from now until 2030 has become steeper in all three scenarios (Figure 3). While this is challenging, it is needed to enable Australia's emission targets to be reached, noting that a Constrained Supply Chain sensitivity which AEMO tested in this ISP did not meet emission targets. It is hard to see how emission targets will be reached without rapidly scaling up the workforce each year from now until 2030.

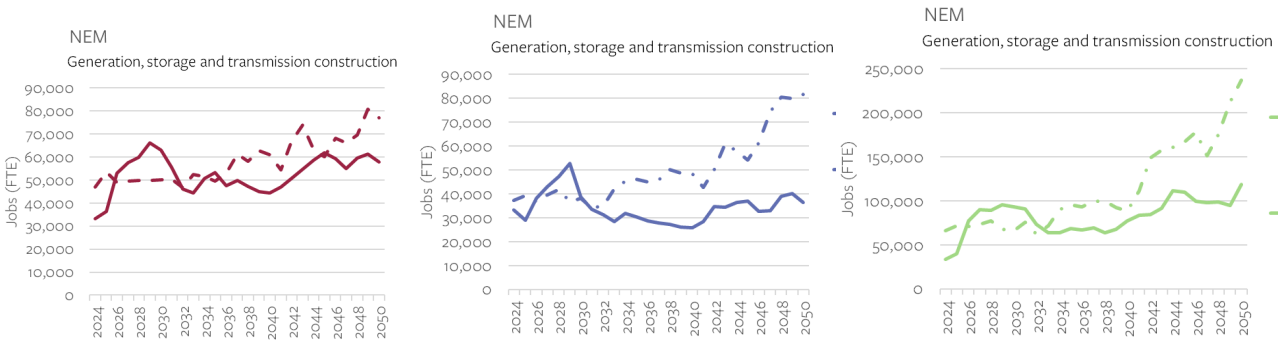

Figure 3 Workforce projections for the 2022 (dashed lines) and 2024 ISP (solid lines) – Step Change, Progressive Change and Green Energy Exports. Note the different scale for the Green Energy Exports graph where jobs go to 250,000 as opposed to 90,000.

Additional workforce requirements

The electricity workforce needed nationally to deliver the energy transformation is considerably larger than outlined in this research. The workforce required for energy efficiency, demand and energy management, and electrification will be significant, with considerable overlap with the occupations already identified in shortage for electricity supply, such as electricians and engineers. There is a dearth of information on the current and future scale of the demand-side workforce, with estimates for 2030 varying from 200,000 to 400,000[5]. This information gap needs to be urgently addressed if we are to develop the energy workforce of the future.

Lack of good quality data means the occupational shares for batteries and offshore wind, the workforce needed in mining or mineral processing for renewable energy technologies, the ongoing workforce in the electricity networks and retailers, decommissioning, and the off-grid hydrogen production in the eastern states is not included in these projections. The modelling also does not include Western Australia or the Northern Territory, as the ISP only covers the National Electricity Market (NEM).

Projections do not include electricity retailing or the operation of the transmission and distribution networks.

3 Discussion and recommendations

3.1 Skill shortage risks

The rapid increase in requirements for in-demand occupations brings with it a high risk of skill shortages which could impact the achievement of the optimal development pathways under the ISP. Skills shortages create the risks of delays, increased project costs (wage inflation, recruitment costs and liquidated damages), and increase the cost of capital for future projects to reflect increased risk.

This is a global problem, as noted by the International Energy Agency:

> *"Labour and skills shortages are already translating into project delays, raising concerns that clean energy solutions will be unable to keep pace with demand to meet net zero targets".*[6]

This only exacerbates the issue in Australia, as bringing in expertise from elsewhere may be increasingly challenging in areas where Australia has developed an increasing reliance (e.g. wind farm technicians, engineers). The timetable for the delivery of renewable energy generation, transmission, and storage to maintain energy security as coal-fired power stations retire is tight. The 2024 ISP states:

> *"Although the ISP cannot forecast exactly where and how the generation, storage and transmission of the future will emerge, the* [*optimal development path*] *is clear that urgent investment and delivery across the sector is needed to ensure secure, reliable, affordable, low-emission electricity through the NEM. ... However, planned projects are not progressing as expected, due to the time needed for approval processes, investment decision uncertainty, cost pressures, social licence issues, supply chain issues and workforce shortages."*[7]

In the context of tight labour markets with unemployment very low even in the context of historically high employment participation rates, the National Skill Shortage Priority List identifies one-third of all occupations in national shortage – almost double the number in 2021. Almost half of professional and trade and technician occupations are in shortage.[8] Consequently, there are skill shortages in many of the key occupations within renewable energy.

The infrastructure pipeline

Whilst the labour market has eased somewhat throughout 2024, overall conditions remain tight. The labour market context for the development of renewable energy is also challenging due to a number of factors, including the infrastructure pipeline which draws upon many of the same occupations, regional labour markets, and the capacity of the training system to scale up the energy workforce.

Infrastructure Australia has observed that governments have taken steps to smooth what it previously described as an unprecedented infrastructure pipeline, but it is still projecting 'extraordinary growth' in regions across New South Wales, Queensland and the Northern Territory. Infrastructure Australia's survey of the construction industry found labour and skill shortages were rated as the primary risk to market capacity. Across public infrastructure which incorporates building and transport as well as energy, there is a large supply shortage and the deficit for trades and labourers is yet to peak.[9]

Consequently, the renewable energy sector will be competing for professionals, trades, and technicians against infrastructure projects, in particular 'mega-transport' projects able to offer employment in capital cities instead of remote and regional locations, and generally higher pay.

Structural challenges to growing the electricity workforce: training capacity and diversity

Powering Skills Organisation, the primary Skills Council for the electricity sector, has identified a range of key challenges to expand the capacity of the training system to increase the energy workforce:

- Lack of diversity in the workforce: the energy sector has low participation amongst women and First Nations people in particular, which limits its capacity to grow rapidly.[10]
- Coordination across sectors: there is competition between sectors for the same groups of workers and a fragmentation of responsibility across Skills Councils. Infrastructure Australia has also advocated for the development of a National Infrastructure Workforce Strategy.
- A shortfall in VET trainers: there is a labour shortage for trainers that also needs to be scaled rapidly.
- Inefficiencies in energy training packages: a package of reforms are proposed to improve the speed in development of training packages and delivery of training.
- Gaps in clean energy skills and options in training packages: there are gaps in elective skills and post-trade qualifications required to build the energy workforce with the right skills.

Jobs and Skills Australia has also identified a range of reforms to increase capacity such as establishing TAFE Centres of Excellence.[11]

New government policies are being implemented or under development but need to be accelerated. There are a range of structural challenges that need to be addressed to increase the capacity of the training system to scale up the workforce.

3.2 Boom and bust cycles

The expected trajectory of the construction workforce requirements to deliver the energy infrastructure needed for the energy transition is highly variable, with increases of nearly 27,000 in just the five years to 2029 in the Step Change (50,000 in the Green Energy Exports). These peaks are followed by sharp drop offs: the Step Change peak is followed by losing 24,000 construction jobs over four years, and the Green Energy Exports scenario loses 38,000 jobs in the same period.

The capacity projection in the ISP is not a plan, of course, it is an indication of the least cost pathway to meeting electricity demand and meeting Australia's emission targets. This generally requires building everything as late as possible. The associated workforce projection illustrates the challenge for the supply of skilled labour, and the potential for the boom to be followed by serious contraction in the renewables industry.

There are significant risks for the supply chain if this "lumpiness" is not addressed, as evidenced at present with the difficulty to find the personnel to deliver projects. Risks are exacerbated by the competing demands for infrastructure build in other parts of the economy, and by the fact that much of the infrastructure is in rural areas with restricted labour supply. The troughs increase the difficulty of putting effective training programmes in place as the pipeline is not steady. These profiles are for all technologies, while specialist skills that are technology specific, and requirements within a state, are likely to be even more volatile.

There is a focus among policy makers on increasing the pipeline of skilled workers, which is certainly necessary. We recommend exploring the option of smoothing the development pathway to reduce supply chain risks and increase opportunities for workforce development. Bringing projects forward from the late to the early 2030s, rather than deferring projects in the first decade, may allow a smoother workforce profile without compromising emission targets.

Constrained supply chain sensitivity

The 2022 Workforce Projections for the ISP report recommended AEMO "consult with ISP stakeholders on including a sensitivity for capacity development that results in smoothed employment profiles". Following stakeholder consultation, AEMO undertook a constrained supply chain sensitivity analysis intended to model the impact of combined delivery risks. While this sensitivity did not specifically refer to employment, it did have the suggested impact of reducing the 'lumpy' build profile. This scenario made specific assumptions on temporary delays in transmission build and generation and storage project construction, as well as additional cost imposts, with the effect of pushing back project development.

While the employment profile was somewhat smoothed, as would be expected, this sensitivity did not meet Australia's legislated emission targets as insufficient renewable generation came online by 2030. The sensitivity was not designed with the intent of reducing the volatility of project development and the associated employment, which would require bringing projects forward as well as pushing them back, so is not a test of whether it is possible to meet emission targets without a highly volatile workforce profile.

3.3 Recommendations

The employment projections for the ISP combined with analyses of the labour market context and the capacity and performance of the training sector highlight major risks of skill shortages. There is an urgent need for governments, training providers, and industry to take coordinated action to develop and implement skills, training, and workforce development strategies. This is particularly important in regional areas and the REZs to increase labour supply and create local employment and training opportunities. Employment and training should be designed to facilitate a rapid build-out and increase the equity of the energy transition, with training or development initiatives including opportunities for First Nations people and communities most impacted by the energy transition.

A series of reports have been released in the past year. Jobs and Skills Australia undertook a comprehensive review with recommendations on growing the clean energy workforce[12]. Powering Skills Organisation, a skills council for the Australian energy sector, has developed a strategy for changes to the training system to increase the supply of electricity sector workers[13]. A jobs strategy to increase First Nations employment in the energy sector was released by the First Nations Clean Energy Network[14].. The Queensland Government has released a renewable energy jobs plan and the New South Wales and Victorian governments are currently developing workforce plans. It is urgent that governments, training authorities and industry act on the range of recommendations in these reports and implement measures to scale up the electricity workforce.

Our recommendations focus on two important areas not addressed in these reports: workforce volatility and the information and research priorities to address gaps in understanding. Despite the welcome attention on workforce and skills, governments are still struggling to understand workforce and the detailed occupations and skills needed across the energy sector, particularly for the demand-side workforce.

There is widespread agreement that the projected volatility in workforce requirements raises serious challenges for labour supply, increases the risks and costs of the energy transition, reduces the opportunities for local employment, and increases the socio-economic burden (e.g. provision of housing for temporary workers). Much of the construction activity will occur through tenders under the Capacity Investment Scheme (CIS) or associated state tenders such as the Long-Term Energy Supply Agreements in New South Wales, which provides some leverage to influence the pace of development by, for example, narrowing the minimum and maximum capacity tendered annually or through the sequencing of tenders.

As of 1 July 2024, the Australian Skills Guarantee introduced mandatory targets for 10 per cent of labour hours to be completed by apprentices or trainees, with sub-targets for women, on major construction and information technology projects funded by the Commonwealth government and valued over $10 million. Procurement through

the CIS and associated state tenders provide a lever to increase industry-wide investment in training and workforce development.

Jobs and Skills Australia observed that employer intakes of learning workers need to increase in clean energy and recommended the Australian Skills Guarantee be expanded to include generation and transmission projects as 'one means of stimulating a training culture'.[15] In addition to embedding employment and training targets within the CIS, these targets could be included in procurement by the Clean Energy Finance Corporation (CEFC) or the Australian Renewable Energy Agency (ARENA) which do not currently incorporate employment or training requirements.. Alongside government programs and investment in training capacity, embedding training requirements in procurement can increase employer participation.

Our first two recommendations are aimed at smoothing workforce profiles and the third at increasing the supply of skilled labour by integrating training into energy sector construction. Recommendations 4 and 5 are aimed at enabling the inclusion of the demand-side workforce in energy sector projections, and recommendation 6 is aimed at improving the coverage and usefulness of workforce projections.

We recommend that:

1. The Federal and State Governments consider mechanisms to smooth development and avoid boom-bust cycles without compromising emission targets through the design and implementation of schemes for increasing capacity, such as the Capacity Investment Scheme and Renewable Energy Zones.
2. AEMO consider the cost and emissions implications of smoothing the workforce profile through scenario modelling for the next ISP.
3. The Federal and State Governments, the Clean Energy Finance Corporation and Australian Renewable Energy Agency extend the Australian Skills Guarantee to cover the Capacity Investment Scheme and other publicly funded renewable energy and transmission projects.
4. Research bodies in partnership with industry develop data and methods to include the demand-side workforce in projections, as this workforce is almost entirely uncharacterised despite its crucial role in the energy transition. This requires developing employment indicators for energy efficiency and electrification tasks (in FTE/PJ or GWh) to enable the inclusion of energy efficiency, demand management, energy management, and electrification in workforce projections associated with the ISP.
5. AEMO modify the ISP outputs to support projections for the demand-side workforce, by including outputs in PJ/year or GWh/year for energy efficiency and electrification that affect electrical demand in the ISP; outputs will need to include details of the activities undertaken. While demand scenarios are a key input to any electricity scenario and include energy efficiency and electrification, the associated activities and resulting demand reductions or increases are not currently reported in any detail.
6. Research bodies in partnership with industry develop or revisit employment indicators to improve the coverage, reliability, and usefulness of workforce projections, including:
    - Developing occupational indicators for batteries and offshore wind to support training strategies.
    - Revisiting the employment indicators for major technologies, in particular wind and solar, with reference to the Australian industry to ensure realistic projections.
    - Developing better employment indicators for onshore manufacturing for solar, wind, and batteries.
    - Developing employment indicators where these are not currently available, including hydrogen production, renewable energy and fossil fuel decommissioning, and extraction and processing of critical minerals.

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