RACE for 2030
RELIABLE AFFORDABLE CLEAN ENERGY

E3 Fast track

Electricity Sector Workforce Projections for the 2022 ISP: Focus on New South Wales. Revision 1.

Final report

UTS Institute for Sustainable Futures
AEMO
Australian Government Department of Industry, Science and Resources
AusIndustry Cooperative Research Centres Program

RACE for Everyone
Research Theme E3: Future Energy Workforce

ISBN: *978-1-922746-30-6*

Industry Report
Electricity Sector Workforce Projections for the 2022 ISP: Focus on New South Wales

This report has been revised to correct an error in modelling offshore wind occupation and maintenance employment and the omission of some pumped hydro employment from the Slow Change scenario.

Citation

Rutovitz, J., Langdon., R, Mey, F., Briggs, C. (2023) Electricity Sector Workforce Projections for the 2022 ISP: Focus on New South Wales. Revision 1. Prepared by the Institute for Sustainable Futures for RACE for 2030

January 2023

Contributors

Acknowledgements

We would like to thank the NSW and Victorian State governments for making this work possible. We would also like to thank our project partner the Australian Energy Market Operator (AEMO) for their invaluable help, and the Industry Reference Group: the Australian Power Institute, Clean Energy Council, Department of Climate Change Energy & Water (Commonwealth of Australia), Department of Energy and Public Works (Queensland), Department for Energy and Mining (South Australia), Energy Consumers Association, Energy Networks Association, Office of Energy and Climate Change (NSW Treasury), the University of NSW, and the Department of Environment Water Land and Planning (Victoria) for their insights, which have made this work much better. Any errors and omissions are, however, entirely the responsibility of the authors.

What is RACE for 2030?

RACE for 2030 CRC is a 10-year co-operative research program with AUD350 million of resources to fund research towards a reliable, affordable, and clean energy future: https://www.racefor2030.com.au

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.

Contents

List of figures

List of Abbreviations

Acronym	Term
AEMO	Australian Energy Market Operator
GW/GWh	Gigawatt / Gigawatt Hours
ISF	Institute for Sustainable Futures
ISP	Integrated System Plan
kW/kWh	Kilowatt / Kilowatt Hours
NEM	National Electricity Market
MW/MWh	Megawatt /Megawatt Hours
O&M	Operations & Maintenance
PV	Solar Photovoltaic

1 Introduction

This report provides electricity sector workforce projections for New South Wales (NSW) and is part of a wider project which provide projections for the National Electricity Market based on the 2022 Integrated System Plan (ISP) developed by the Australian Energy Market Operator (AEMO). Projections cover electricity generation and transmission construction.

The project was undertaken by the Institute for Sustainable Futures, University of Technology Sydney (ISF) in collaboration with the AEMO and was funded by the RACE for 2030 Co-operative Research Centre and by the NSW and Victorian State governments. The project has benefited from an Industry Reference Group made up of state government, industry, and university representatives.

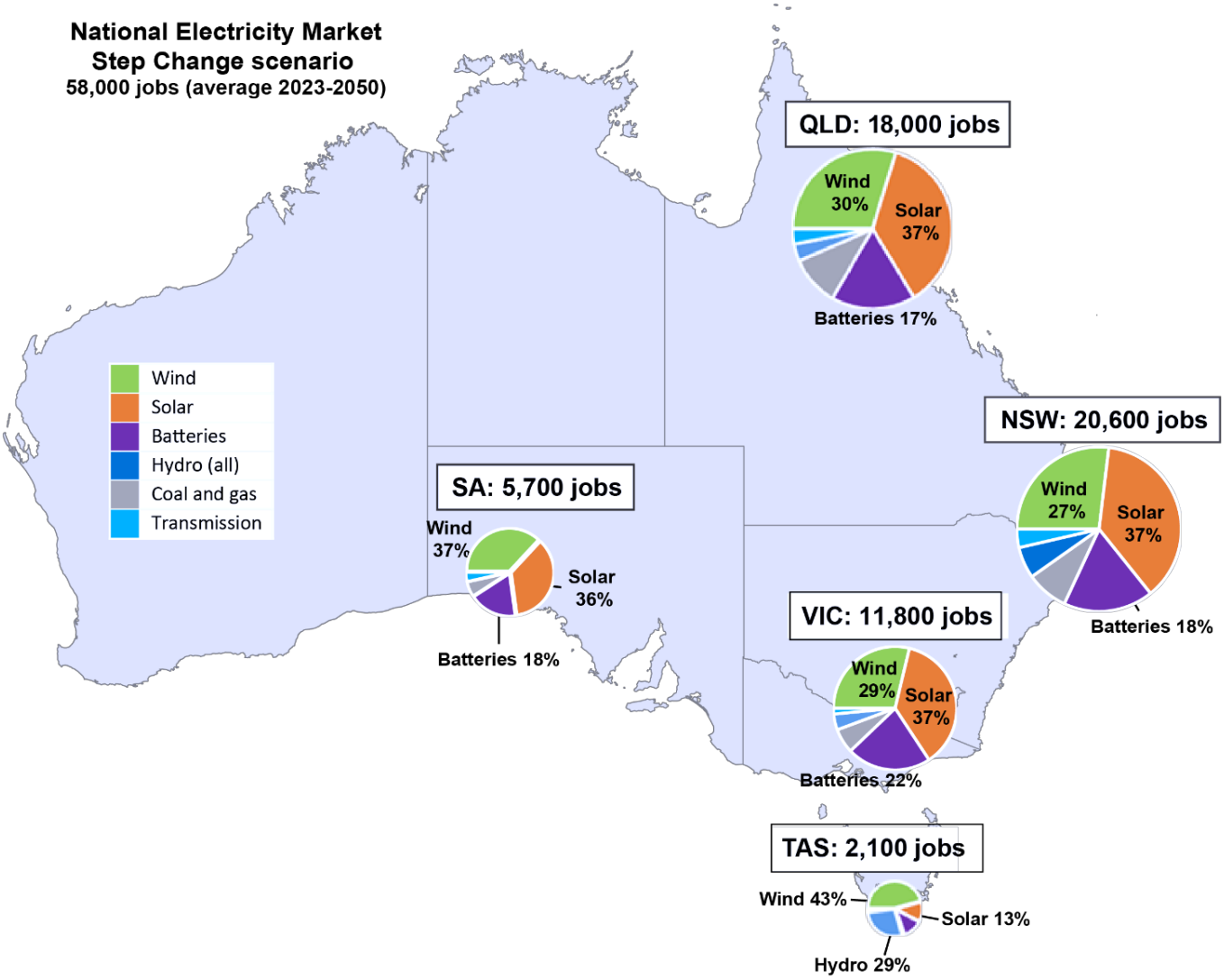
The report provides electricity sector workforce projections for NSW broken down by technology, occupation, and location for three ISP scenarios and one sensitivity:

- **The Step Change scenario**: includes rapid consumer-led transformation of the energy sector and coordinated economy-wide action moving fast to fulfil Australia's net zero policy commitments. Energy stakeholders consider this the most likely' scenario, as the NSW Electricity Infrastructure Roadmap is broadly aligned with this scenario and during this project, Victoria and Queensland released energy plans similarly aligned.
- **The Hydrogen Superpower scenario:** includes strong global action, significant technological breakthroughs, and a near quadrupling of NEM energy consumption to support a hydrogen export industry. There is large-scale development of the renewable energy sector, especially in the 2030s and 2040s.
- **The Slow Change scenario**: features a slow pace of policy and technology change, assuming a challenging environment following the COVID-19 pandemic, with the risk of industrial load closures. This scenario is considered unlikely and would not reach Australia's decarbonisation targets.
- **The Offshore Wind sensitivity**: the ISP includes a sensitivity to the Step Change scenario that takes account of the Victorian target to build 9GW of offshore wind by 2040 and assumes a lower cost. In all other scenarios, no offshore capacity is projected until the late 2040s. Offshore wind displaces onshore wind and utility-scale PV and reduces the overall capacity needed, with 9% (13 GW) less generation capacity over the entire NEM by 2050. In NSW, Offshore Wind reduces the overall generation capacity by 14% (6.8 GW) by 2050.

The Progressive Change scenario was not included as the workforce profile is very similar to the Step Change.

To put the workforce demand in NSW in context, NSW is the leading state for renewable energy employment, averaging 20,600 full-time jobs per year. This is followed by Queensland (18,000) and Victoria (11,800). The share by technology is very similar for the three largest states, with solar contributing 37%, wind 27%-30% and batteries 17%-22%. South Australia has a higher proportion of wind (37%), while Tasmania has a very different distribution, with 29% of jobs in hydro.

Figure 1 Average electricity sector jobs by State, 2023-2050 (Step Change)



See the main report *The Australian Electricity Workforce for the 2022 Integrated System Plan: Projections to 2050* (Rutovitz et al, 2022). for details on the methodology including a full list of employment factors, results for the National Electricity Market as a whole, and a comparison of results by State, and recommendations for further work to support planning for workforce development.

Racefor2030.com.au/fast-track-reports

2 Workforce projections for NSW by scenario

Employment projections for each of the four workforce scenarios are presented in Figure 2:

- Under the Step Change scenario, employment averages 21,000, increasing from 18,000 in 2023 to a peak of around 29,000 jobs per year.
- Under the Hydrogen Superpower scenario, employment is very volatile, averaging 25,000 per year, with two main peaks in the mid 2020s at around 29,000 and in the 2040s, peaking at 33,000.
- Under the Slow Change scenario, employment rises to 18,000 in the mid 2020s and then falls to 6,500, and averages 13,000 per year.
- The Offshore Wind scenario is very similar to the Step Change scenario, with some periods of lower employment from the late 2030s. The slight variations in employment reflect the displacement of onshore wind and utility-scale PV by less labour-intensive offshore wind from the late 2030s onward. In this scenario NSW has 6.8 GW less generating capacity at 2050 than in the Step Change.

Figure 2 NSW, electricity sector jobs by scenario

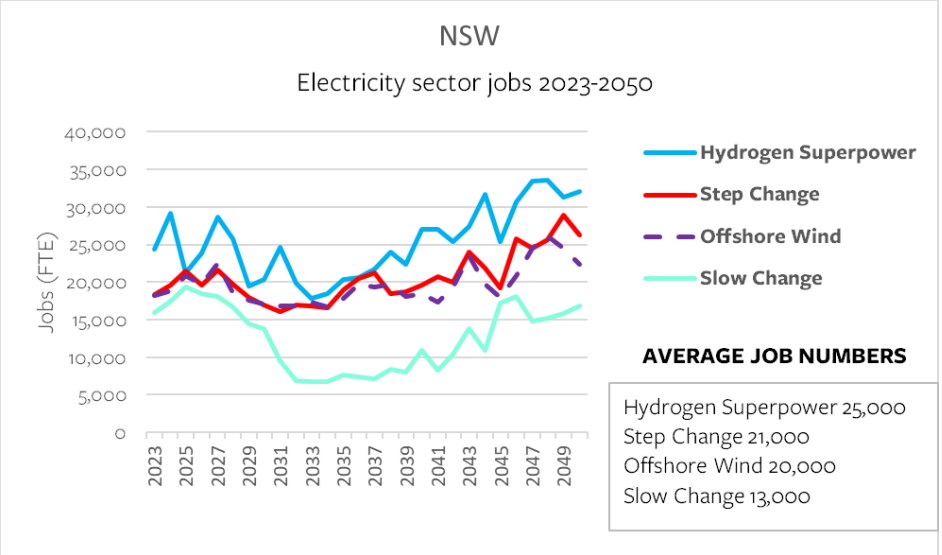


Figure 3 shows the total employment by project phase, whether it is construction, manufacturing, operations and maintenance or fuel supply. Under all scenarios, construction dominates the employment profile through the 2020s but ongoing operations and maintenance (O&M) employment gradually increases, as the fleet of renewable energy generation and storage increases.

In the Step Change, Offshore Wind, and Hydrogen Superpower scenarios, O&M employment is between 64% and 69% by 2050 (48% in the Slow Change scenario).

Figure 4 shows the breakdown between renewable generation, fossil fuel generation, storage, and transmission construction. Most of the employment growth in all scenarios is produced by renewable energy. Fossil fuel employment falls to less than 1,000 jobs by 2050 in all scenarios[1].

Jobs are presented as full time equivalent (FTE) for each year and are the sum of people working on construction projects, operations and maintenance, manufacturing, and fuel supply for coal and gas generation in that year. One FTE could be one person working full time, two people working full time for six months, or an ongoing full-time job in operations and maintenance. Construction jobs are by their nature temporary, although workers may move from one project to another and be in continuous employment.

The numbers of jobs added varies significantly by scenario, particularly by the end of the projection period. Taking the 2023 total in the Step Change scenario (18,500) as the reference point in all cases, in the Step Change scenario there are 1,200 additional jobs in 2040 (7,800 extra by 2050), in the Hydrogen Superpower scenario there are 8,700 additional jobs in 2040 (13,700 extra by 2050), in the Slow

[1] This is only calculating employment in fossil fuels for Australian power generation.

Change scenario there are 8,300 **fewer** jobs in 2040 (2,900 fewer by 2050), and in the Offshore Wind scenario there are the same number of jobs in 2040 (3,900 extra by 2050).

Figure 3 NSW, jobs by phase (all scenarios)

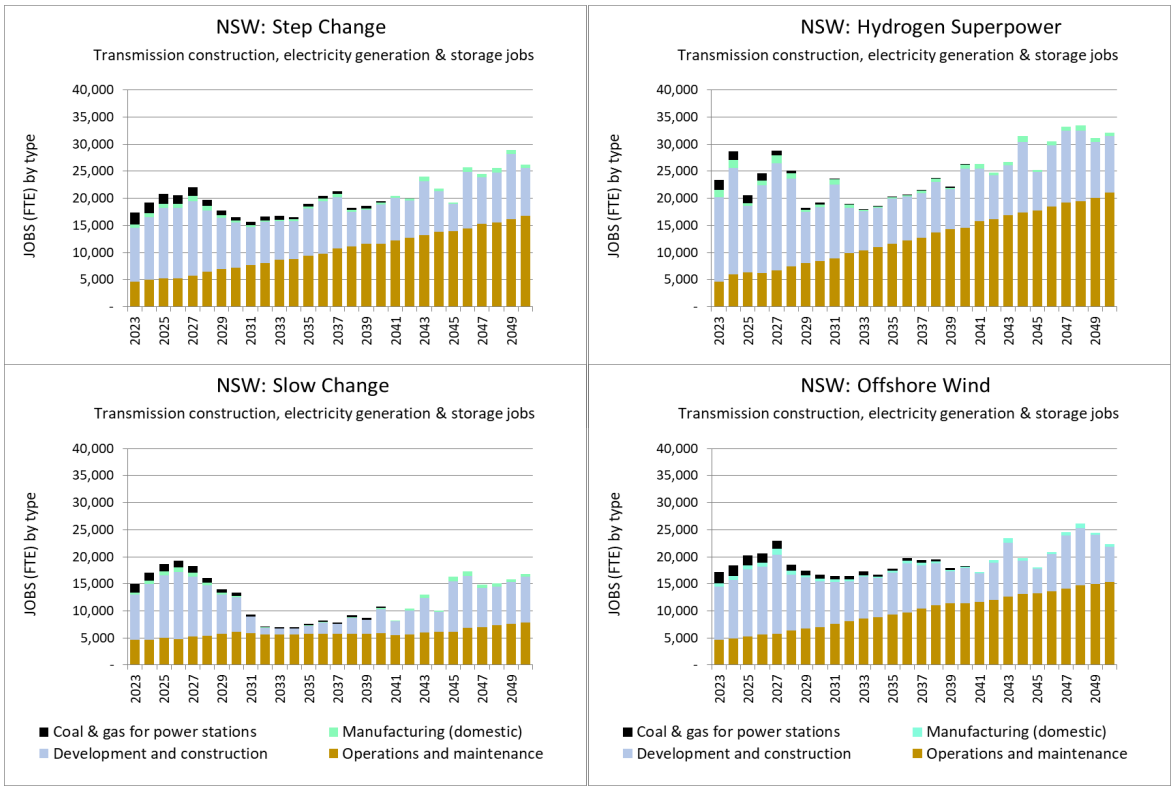
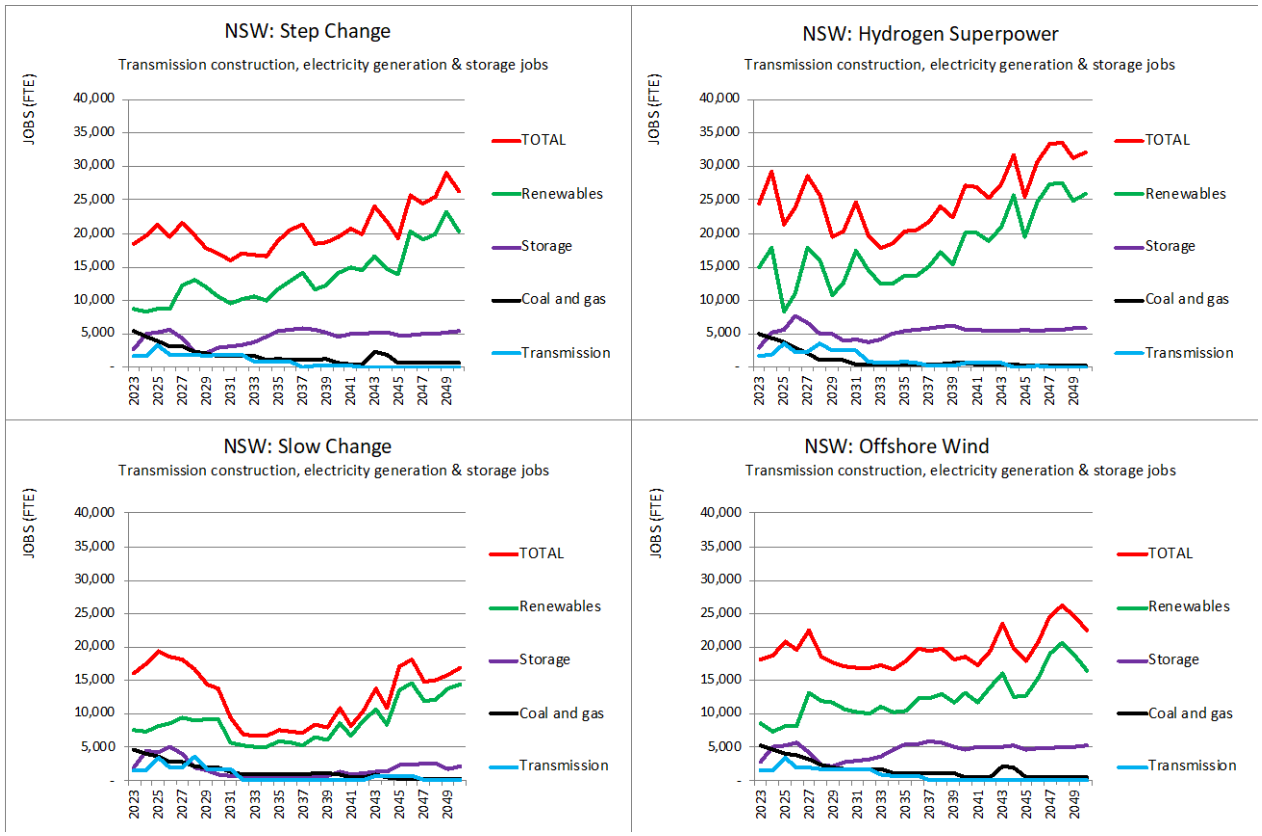


Figure 4 NSW, jobs by technology group (all scenarios)



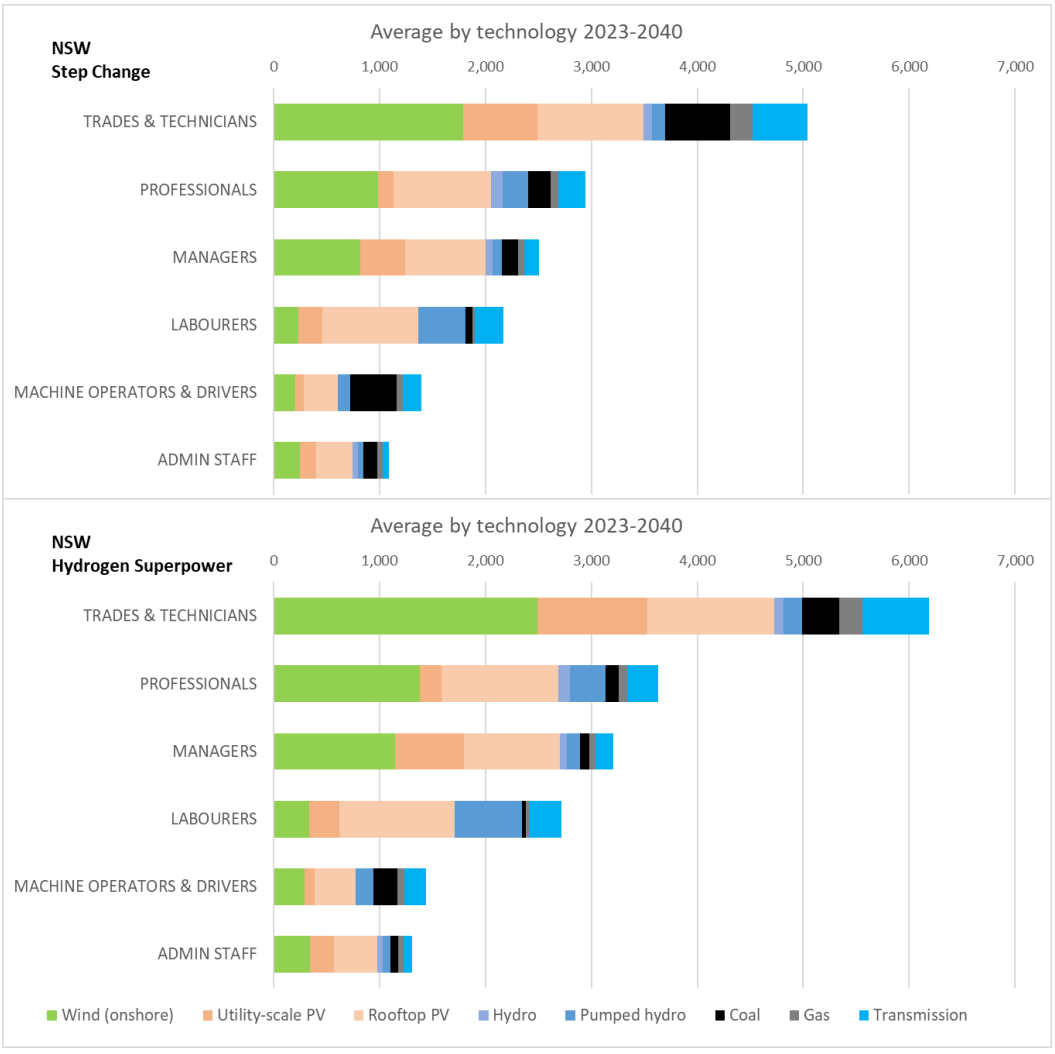
3 NSW employment by occupation

Occupational employment trends are important for government, industry, the training sector, and the community to understand what type of jobs will be required as a result of the energy transition.

Average annual employment projections illustrate the bulk distribution of jobs between technologies, and the occupations that are most in demand overall. Figure 5 shows the average annual employment demand from 2023 until 2040 by employment grouping:

- The largest group of occupations is trades and technicians which average 5,000 jobs per year until 2040 under the Step Change scenario and just over 6,100 jobs per year under the Hydrogen Superpower scenario.
- The next largest groups are professionals at just under 3,000 jobs per year (which includes a wide range of 'white collar' occupations such as finance, health and safety, and engineers), and just over 3,600 jobs for Hydrogen Superpower.
- Managers account for 2,500 jobs per year on average under the Step Change scenario, led predominantly by construction managers. Managers account for 3,200 jobs on average in the Hydrogen Superpower scenario.
- An average of 2,100 labourer jobs are projected per year in Step Change (especially construction labourers), just under 1,500 jobs for machine operators and drivers (e.g., truck drivers, crane operators) and just over 1,000 jobs for administrative staff. Under the Hydrogen Superpower scenario, there would be demand for 2,700 labourers on average, 1,400 machine operators and drivers, and 1,300 administrative staff.

Figure 5 NSW, average occupational structure



From the perspective of skills, training, and labour supply, the peaks in employment are the most important, with training provision in the medium term likely to be designed to cater to the next ten to fifteen years. The peak labour requirement year in this period is chosen to illustrate requirements for the most in-demand occupations.

Labour requirements in 2028 (the peak year before 2035 in the Step Change scenario) are shown in Figure 6. There are more than 2,500 electricians, about 800 construction managers and 800 mechanical trades and technicians needed in the Step Change scenario. In the Hydrogen Superpower scenario these requirements are much higher, with around 3,700 electricians and 1,200 mechanical trades needed. Annual requirements for in-demand occupations in the Hydrogen Superpower are shown in Appendix A.

Annual requirements for the six most in-demand occupations over the entire period are shown in Figure 7. Those occupations needed in large numbers primarily during construction (such as construction labourers and managers, and electrical engineers) are very volatile, while occupations such as electricians and mechanical trades increase steadily over the entire period.

Figure 6 NSW, in-demand occupations during peak year (2028)

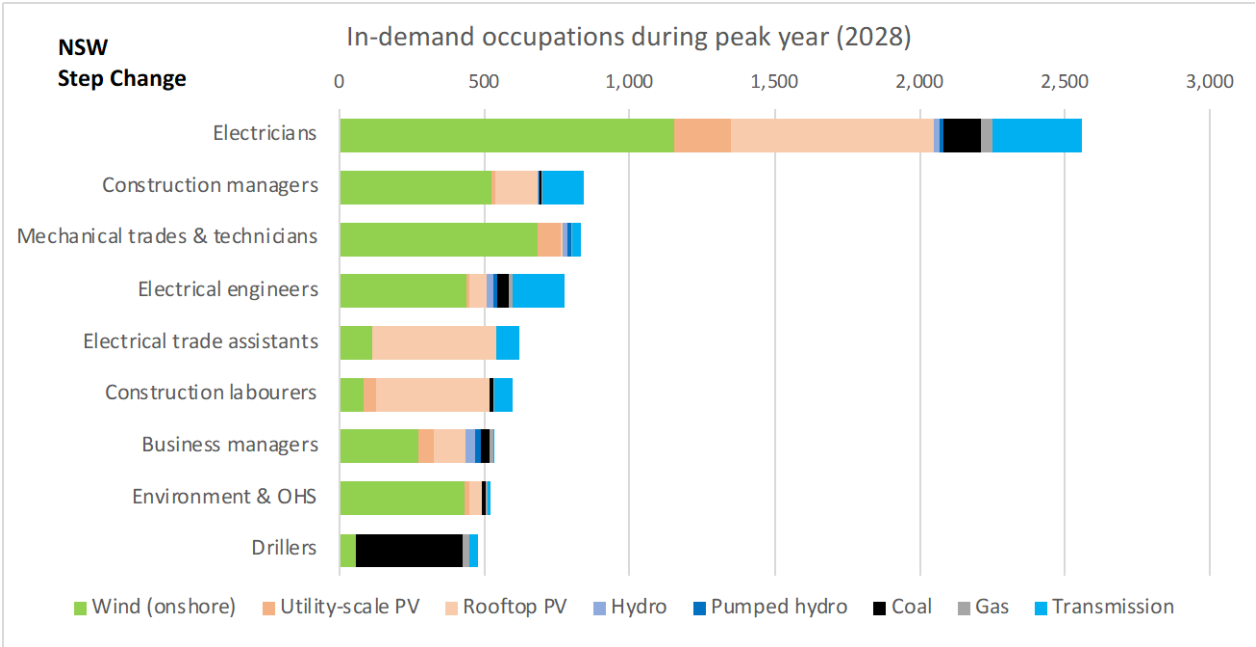
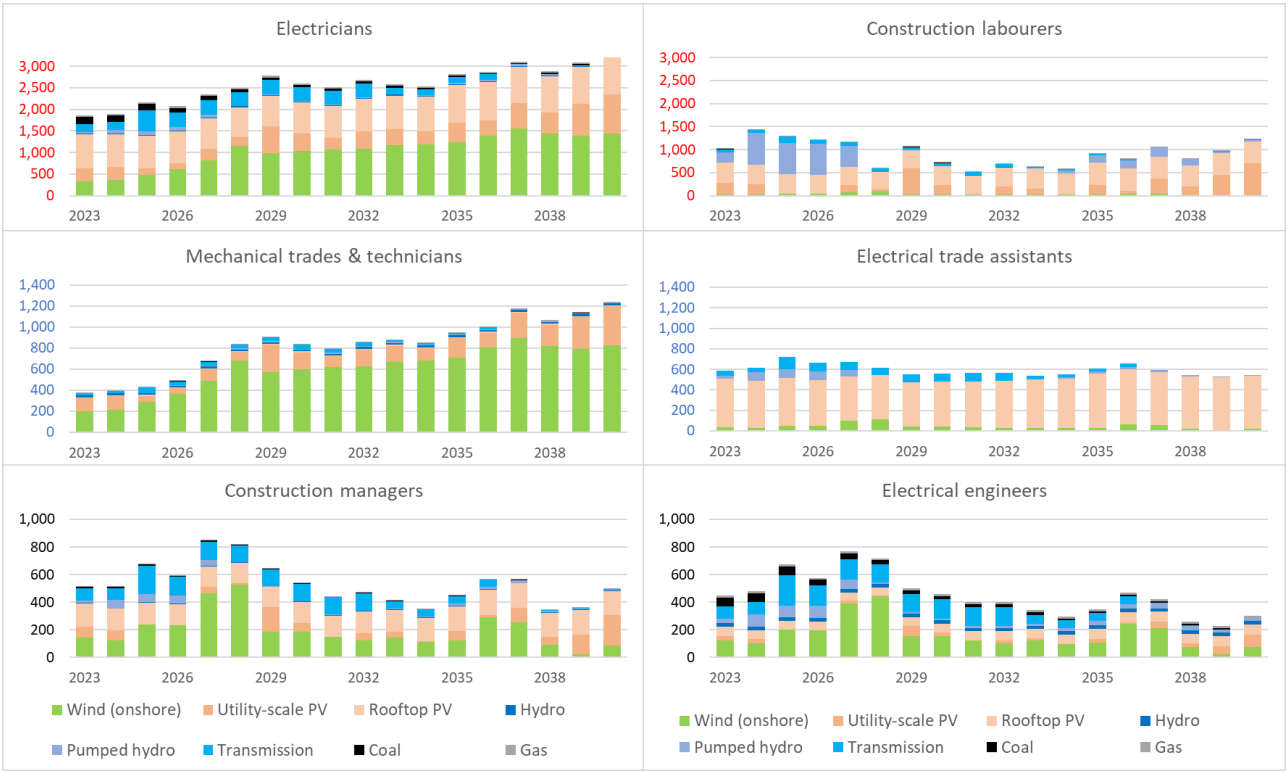


Figure 7 NSW, in-demand occupations annual requirement by technology, Step Change



Note different scales: electricians & construction labourers 0-3,000, mechanical trades & technicians & electrical trade assistants 0-1,400, construction managers and electrical engineers 0-1,000

4 Workforce projections by technology for NSW

Under all scenarios, most employment growth occurs in wind farms and utility-scale PV. Figure 8 shows the average employment by technology over the period, while Figure 9 shows the annual variation.

- Rooftop PV and distributed batteries combined account for between 35% and 44% of average electricity sector employment in all scenarios.
- Wind accounts for an average of between 25% in the Offshore Wind scenario and 31% of all electricity sector employment in the Hydrogen Superpower scenario. The lower proportion of wind employment in the Offshore Wind scenario reflects the fact that offshore wind elsewhere displaces some onshore wind in NSW.
- Utility-scale PV accounts for an average of between 13% and 15% of employment in all scenarios.

Repowering is replacing wind turbines or solar panels, either at the end of their life, or because technology improvements mean that the replacements are sufficiently higher performance to make replacement economic. Repowering is included for wind, utility-scale PV, and rooftop PV, with employment factors and construction times assumed to remain the same as during construction. Employment associated with recycling is not included.

Figure 8 NSW, average electricity sector jobs by technology and scenario

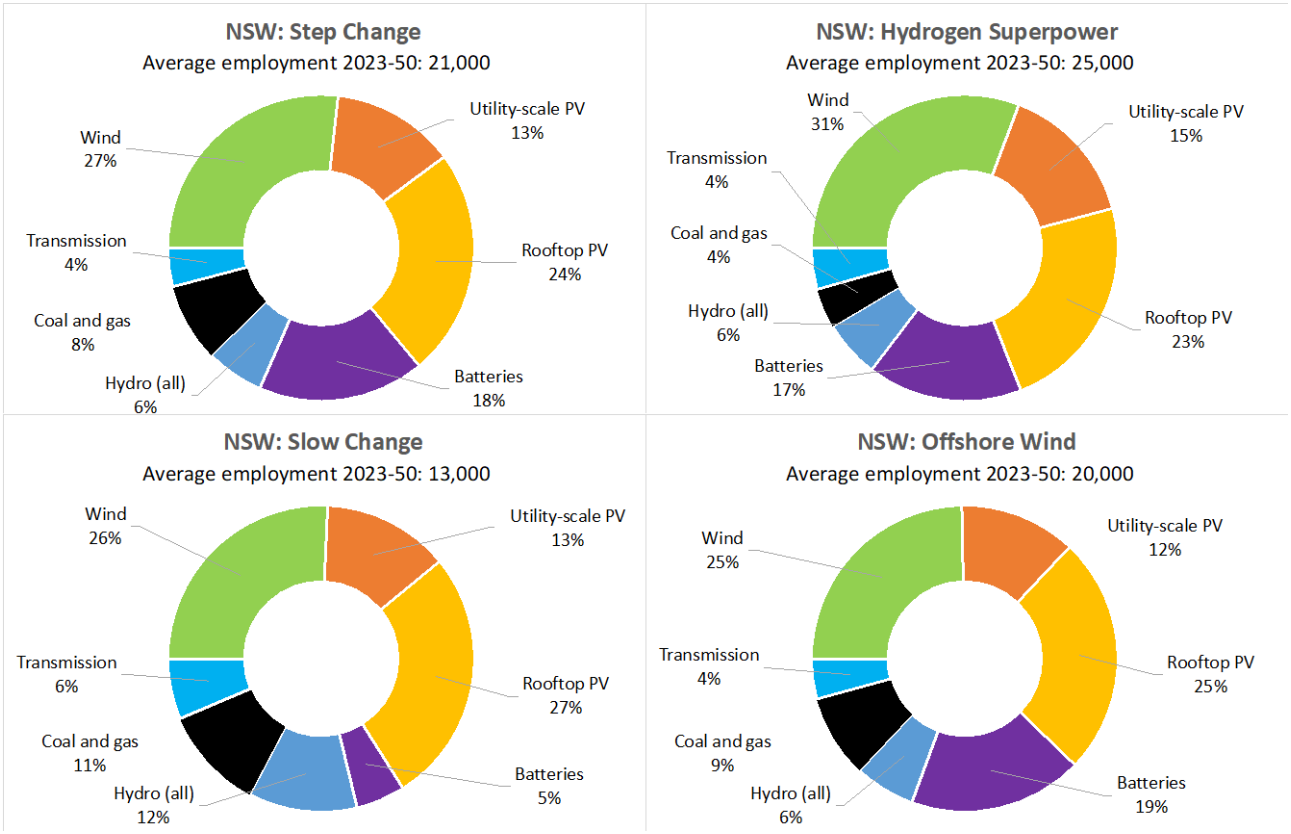
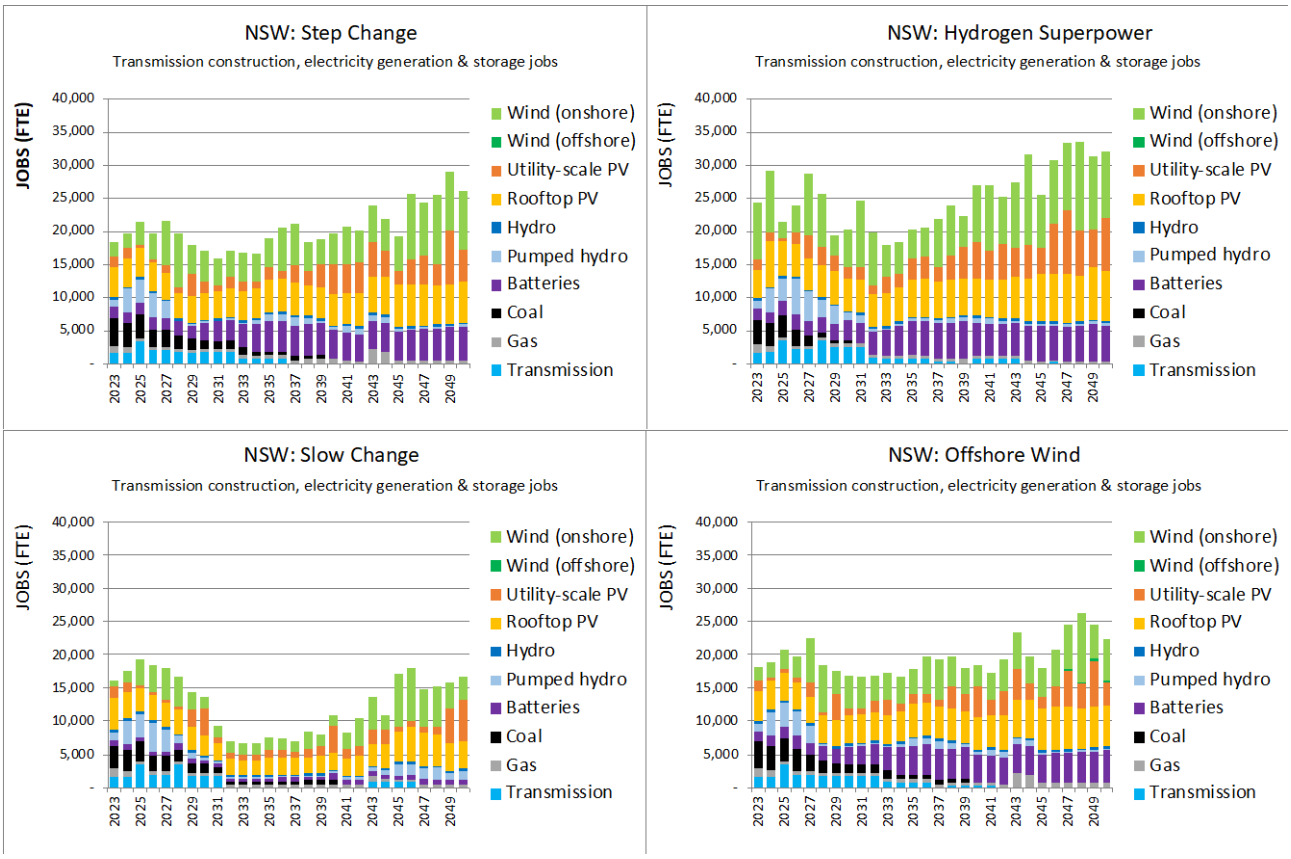


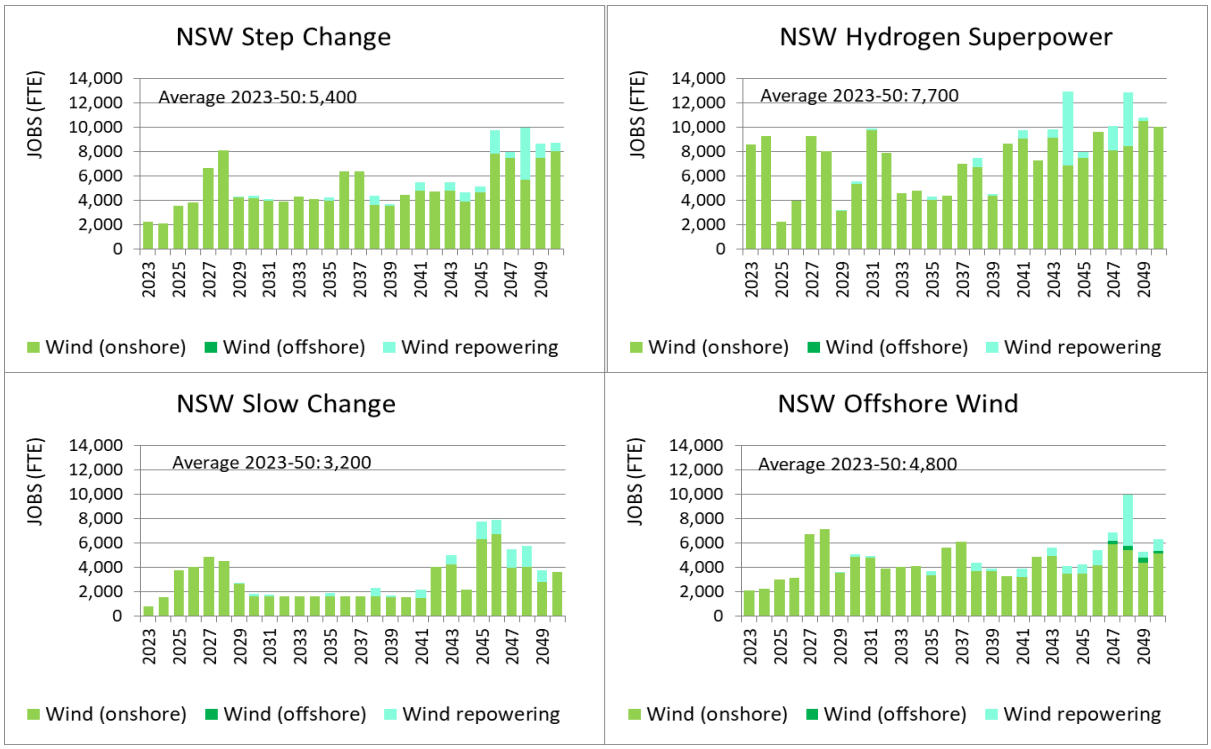
Figure 9 NSW, jobs by technology (all scenarios)



4.1 Wind

Total jobs in wind power for all four scenarios are shown in Figure 10 with an average of between 3,200 jobs in the Slow Change and up to 7,700 jobs in the Hydrogen Superpower scenario. In the Step Change, employment fluctuates after increasing reasonably steadily until the late 2020s. Repowering starts playing a noticeable role in the late 2030s, reaching a maximum of nearly 8,600 jobs in 2048 in the Step Change scenario.

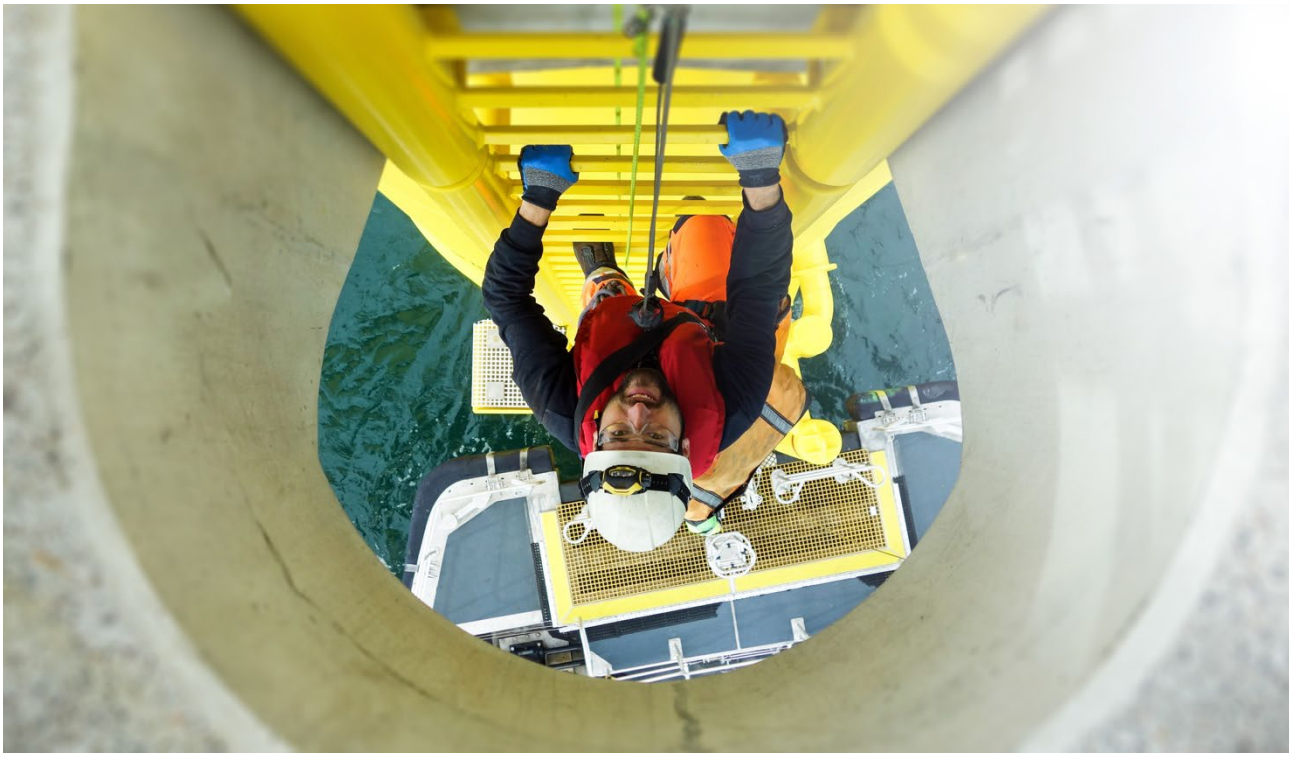
Figure 10 NSW, jobs in wind (all scenarios)



In the Offshore Wind scenario, the average wind employment is 600 jobs below the Step Change scenario. There is no offshore wind projected for NSW until the late 2040s, and onshore wind is displaced by offshore wind elsewhere. By 2050 NSW onshore wind capacity is 4.6 GW lower than in the Step Change scenario, with only 1.1 GW of offshore wind has been installed.

Employment is greatest in the Hydrogen Superpower scenario with an average of 7,700 jobs. Employment is volatile, with peaks in 2023, 2027/28, and 2031/32. A peak in repowering jobs occurs in 2043 and 2048.

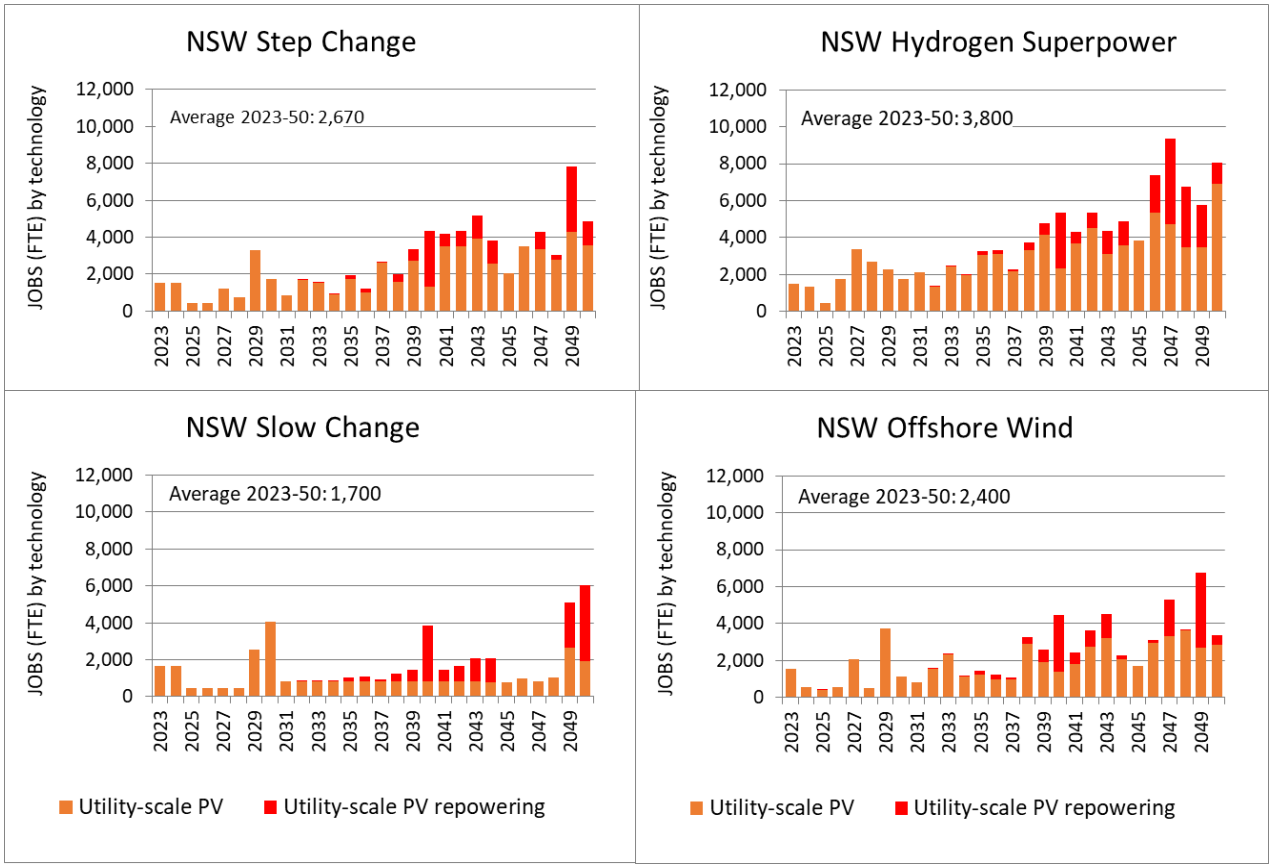
Average employment in the Slow Change is only 3,200 jobs with marginal growth until 2045.



4.2 Utility-scale PV

Total jobs in utility-scale PV for all four scenarios are shown in Figure 11. Averages range from 1,700 jobs in the Slow Change scenario to 3,800 jobs in the Hydrogen Superpower scenario. Under the Offshore Wind scenario, a large portion of new utility-scale PV installations are displaced by offshore wind construction, particularly from the mid-2030s. Hydrogen Superpower projects strong growth in utility-scale PV with a peak of over 3,000 jobs in the mid-2020s and reaching around 9,000 jobs by the mid-2040s factoring in repowering.

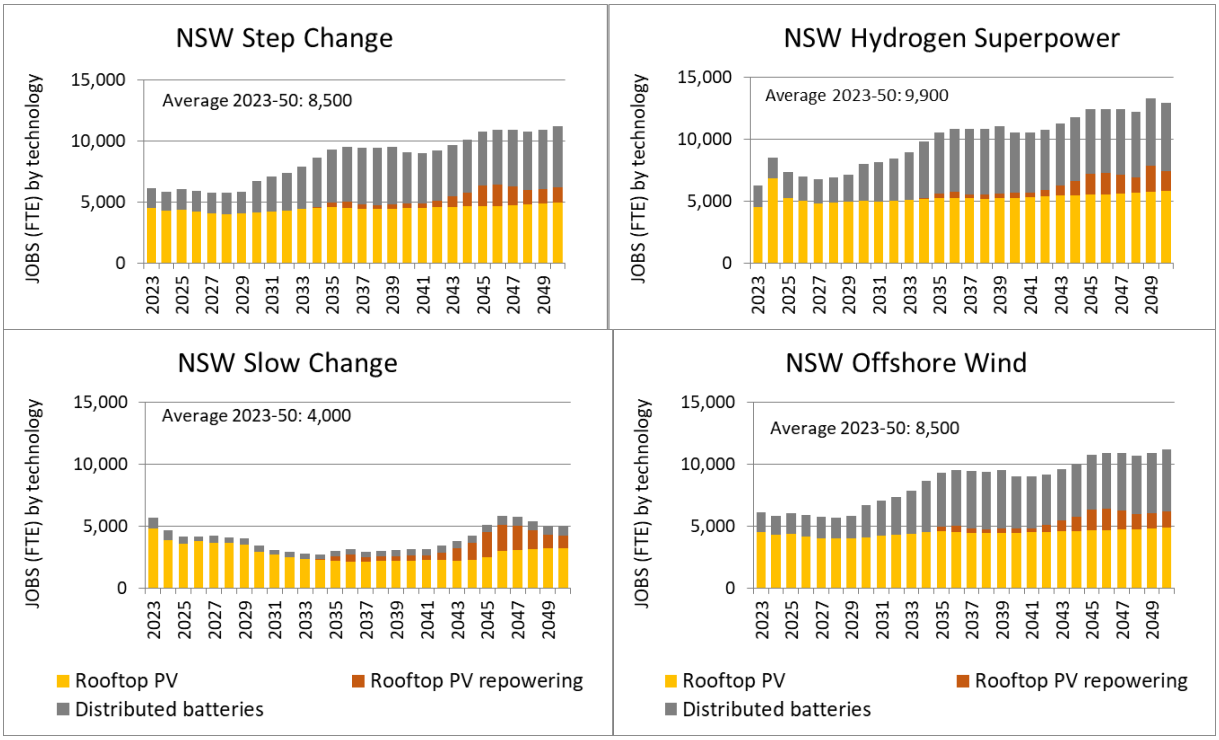
Figure 11 NSW, jobs in utility-scale PV (all scenarios)



4.3 Rooftop PV and distributed batteries

Total jobs in rooftop PV and distributed batteries are shown in Figure 12. Step Change and Offshore Wind are the same with an average of 8,500 jobs for these scenarios between 2023 and 2050. Hydrogen Superpower shares the same employment profile but with a larger share of jobs each year and an average of 10,000 jobs between 2023 and 2040. The Slow Change projects a much lower proportion of distributed battery jobs with an average total of 4,000 jobs between 2023 and 2050. Rooftop repowering contributes to the share of total jobs from the mid-2030s in all scenarios.

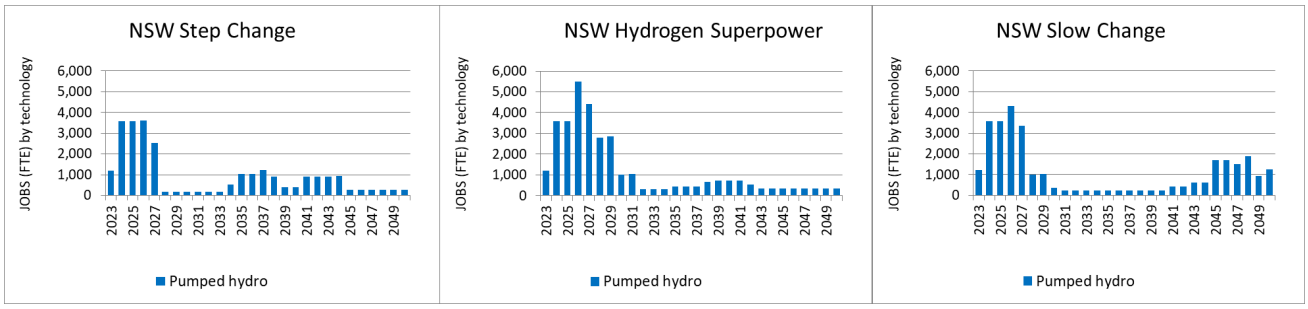
Figure 12 NSW, jobs in rooftop PV and distributed batteries (all scenarios)



4.4 Large scale storage: utility batteries and pumped hydro

Large scale storage jobs are shown in Figure 13 and Figure 14; the profile for Offshore Wind is the same as the Step Change scenario.

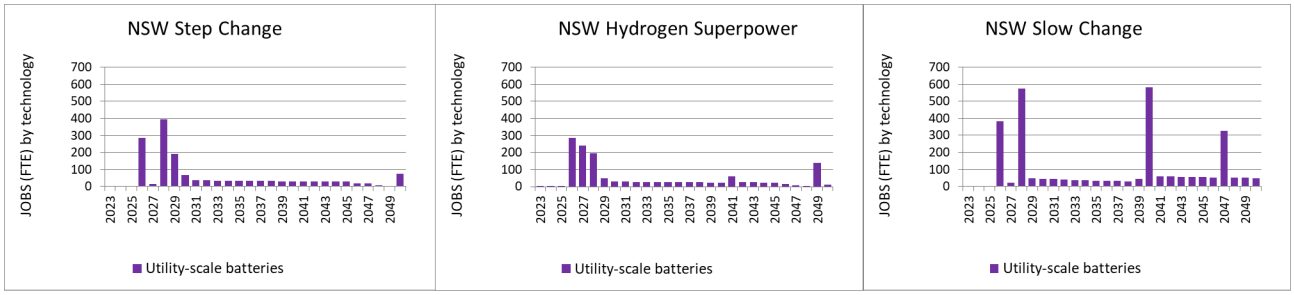
Figure 13 NSW, jobs in pumped hydro (Step Change, Hydrogen Superpower, and Slow Change)



Jobs in pumped hydro are volatile, reflecting the periods when new facilities are constructed, with all scenarios averaging at around 1,000 jobs between 2023 and 2050. The largest peak across all scenarios is in the 2020s, reflecting the build out of Snowy 2.0., Step Change and Offshore Wind reach a total of 3,500 jobs between 2023 and 2026, and then smaller waves of around 1,000 jobs in the mid to late 2030s and mid-2040s. Hydrogen Superpower accentuates the 2020s peak, reaching a total of 5,500 jobs in 2026, with a smaller wave in the late 2030s. Slow Change peaks at 4,300 jobs in 2026. After 2029 jobs remain low until the mid-2040s when there is another peak in construction.

Utility batteries employment is quite low compared to other technologies, with an average of 100 jobs across all scenarios. All scenarios feature a peak in employment around the mid to late 2020s. Slow Change features the largest peaks in jobs at around 600 jobs in 2028 and 2040.

Figure 14 NSW, jobs in utility batteries (Step Change, Hydrogen Superpower, and Slow Change)



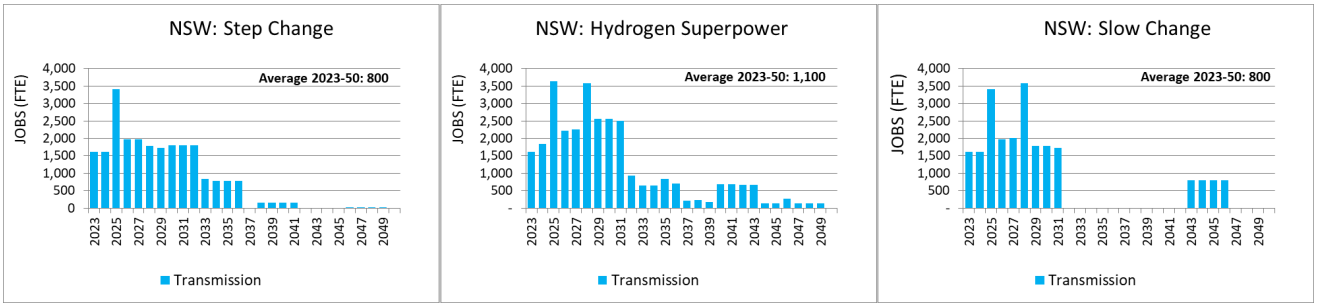
4.5 Transmission construction

Employment in transmission construction[2] is compared for the Step Change, Hydrogen Superpower, and Slow Change scenarios in Figure 15 (the Offshore Wind scenario is the same as Step Change, so is not shown).

Jobs in the Step Change reach a peak in 2025, followed by a period of between 1,700 and 2,000 jobs until the early 2030s, dropping to around 700 jobs until the mid 2030s. The Hydrogen Superpower scenario has two peaks of just over 3,500 jobs in 2025 and 2028, employment reduces significantly in 2032, fluctuating between 600 and 1000 jobs until the mid 2030s, dropping to around 200 jobs in 2037 and picking up again to around 600 jobs in the early 2040s. Slow Change follows a similar peaky profile as the Hydrogen Superpower scenario but with less employment each year. Transmission construction employment drops to nothing in the Slow Change scenario between 2032 and 2042 before another period of construction in the mid-2040s with around 800 jobs.

It should be noted that actual employment is likely to be more variable than shown here, as these calculations assume that employment is spread evenly across the construction period for each project.

Figure 15 NSW, jobs in transmission (Step Change, Hydrogen Superpower, and Slow Change)

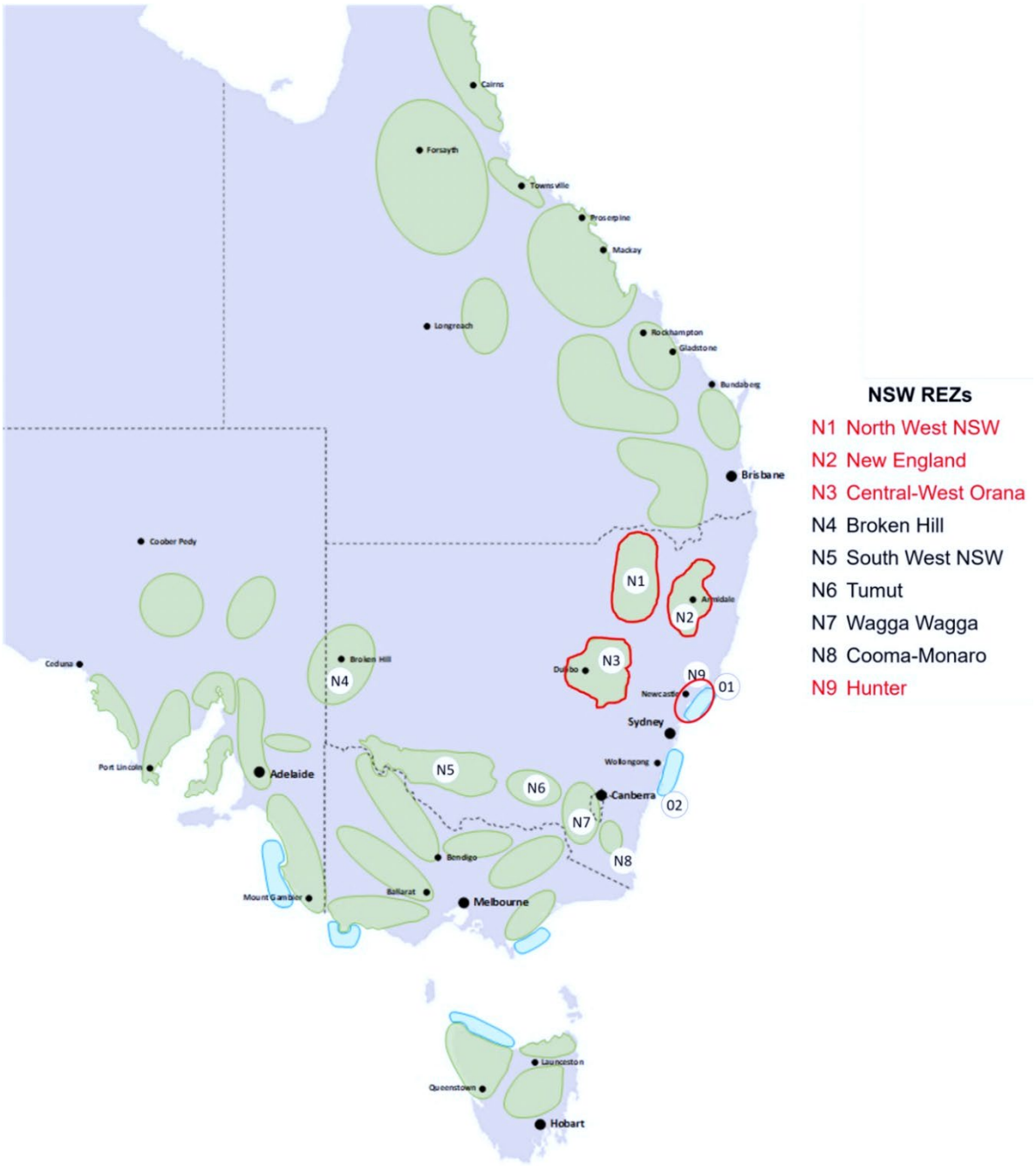


[2] This projection only includes transmission construction as it would be extremely difficult to separate operations and maintenance for the new lines from the operations and maintenance for the rest of the network.

5 Electricity sector workforce projections, by REZ

In NSW, over 35 GW of new utility-scale wind and solar renewable generation is projected in the Step Change Scenario for the candidate REZs by 2050. Figure 16 shows all candidate REZs identified in the ISP, with the four modelled here indicated in red. The modelled REZs are North West NSW, New England, Central-West Orana, and Hunter[3], noting that the employment associated with any offshore development in Offshore Zone 1(O1) has been allocated to Hunter. Employment associated with electricity infrastructure in the rest of the NSW, including the other REZs, has been modelled as 'Rest of NSW'.

Figure 16 Candidate REZs for NSW, and the REZs with modelled employment



[3] NSW has announced an additional REZ for the Illawarra, however Illawarra is not included in the ISP candidate REZs and so is not included in this analysis.

The distribution of employment growth across the REZs is shown in Figure 17, noting that estimates for REZs include utility scale technologies only (wind, utility-scale PV, utility-scale batteries and pumped hydro) and do not include rooftop PV or distributed batteries. Average jobs vary somewhat by scenario.

Most employment is centred around the Central West Orana and New England REZs, with a small amount projected for the Hunter around the mid to late 2020s in all scenarios. A small amount is also projected for South West NSW in the 2040s in both the Step Change and Offshore Wind scenarios. The Hydrogen Superpower scenario brings the employment in South West NSW forward, starting in the 2030s.

For the Step Change scenario, NSW employment averages 10,000 jobs, with an average of 3,100 jobs in New England, 3,000 jobs in Central West Orana, 400 jobs in South West NSW, and 100 jobs in the Hunter between 2023 and 2050. The Hydrogen Superpower scenario projects an increase of 600 jobs in New England, and 1,600 jobs in Central West Orana, compared to Step Change. The Slow Change scenario projects a reduction of 400 jobs in New England and 2,100 jobs in Central West Orana on average, compared to Step Change.

Figure 17 Employment by New South Wales REZ (all scenarios)

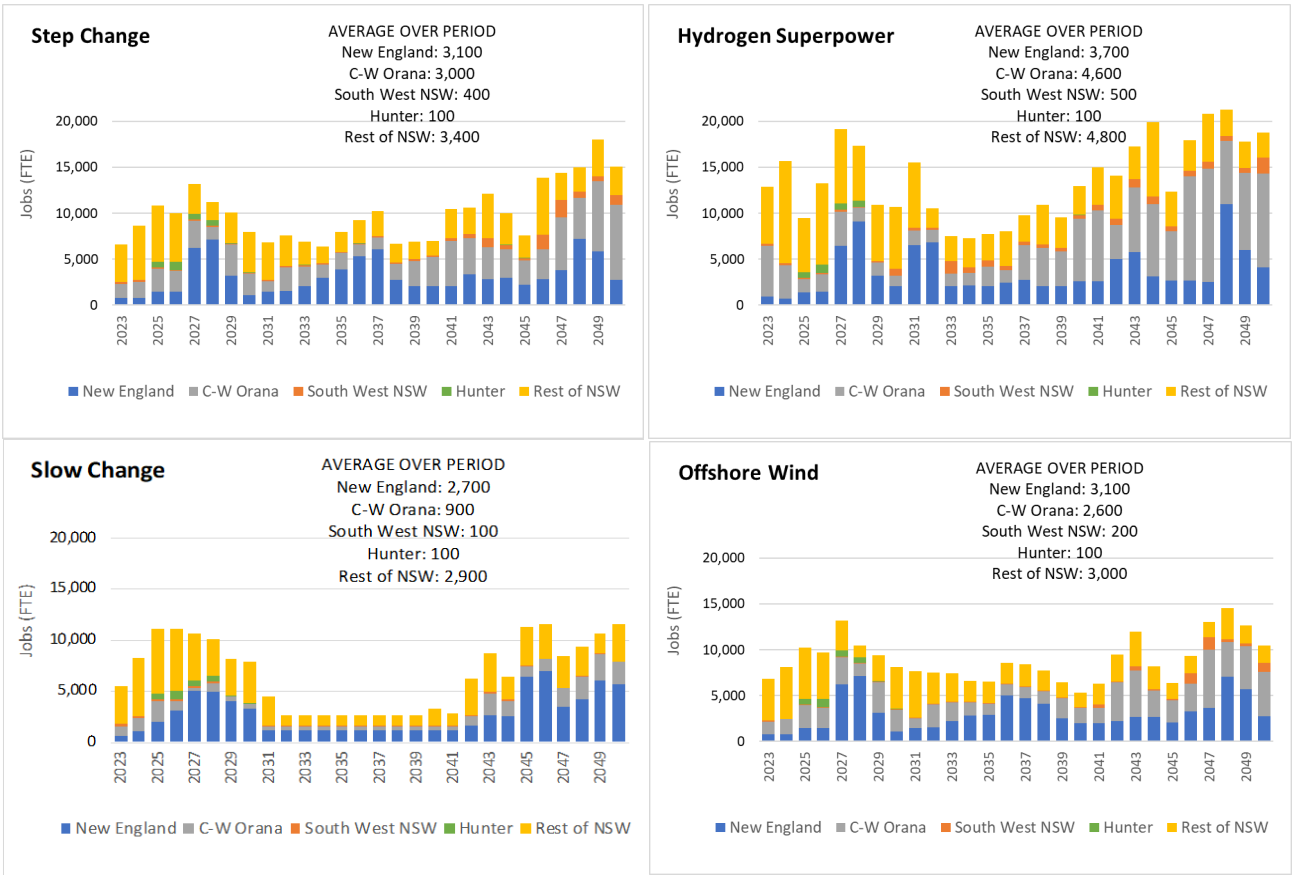
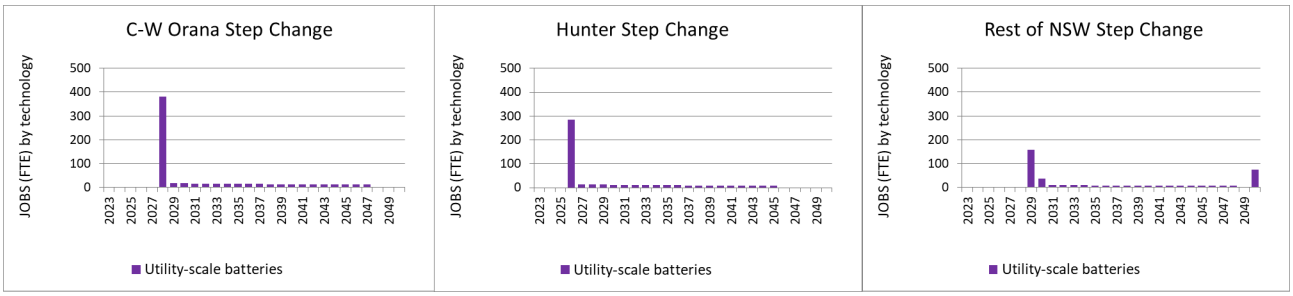


Figure 18 shows the utility battery employment in the Step Change scenario for the Central West Orana REZ, the Hunter REZ and Rest of NSW. There is little employment other than during a couple of construction periods. This projection only includes committed utility-scale storage projected in the ISP, whereas there is a significantly larger pipeline of NSW utility storage proposed projects; see Briggs et al. (2022) for a discussion of potential employment associated with this pipeline[4].

[4] Briggs, C., Langdon, R., Jacobs, J. & Rutovitz, J (2022) *Skills Audit for Renewable Energy in NSW*, report prepared for NSW Department of Education and Training. p64.

Figure 18 Employment in utility batteries by REZ and rest of NSW, Step Change



Utility-scale PV employment in the Central West Orana, New England, and Rest of NSW is compared for the Step Change and Hydrogen Superpower scenarios in Figure 19. New England has a large peak in solar farm employment in 2029 in Step Change and drops sharply, with more peaks in the mid-2030s and again throughout the 2040s. There is less employment under Hydrogen Superpower for New England with two peaks in the late 2020s and late 2040s. Utility-scale PV employment in the Central West Orana under Step Change is volatile, while Hydrogen Superpower employment increases gradually with higher peaks in employment but less frequently.

Figure 19 Employment in utility-scale PV by REZ and rest of NSW, Step Change and Hydrogen Superpower

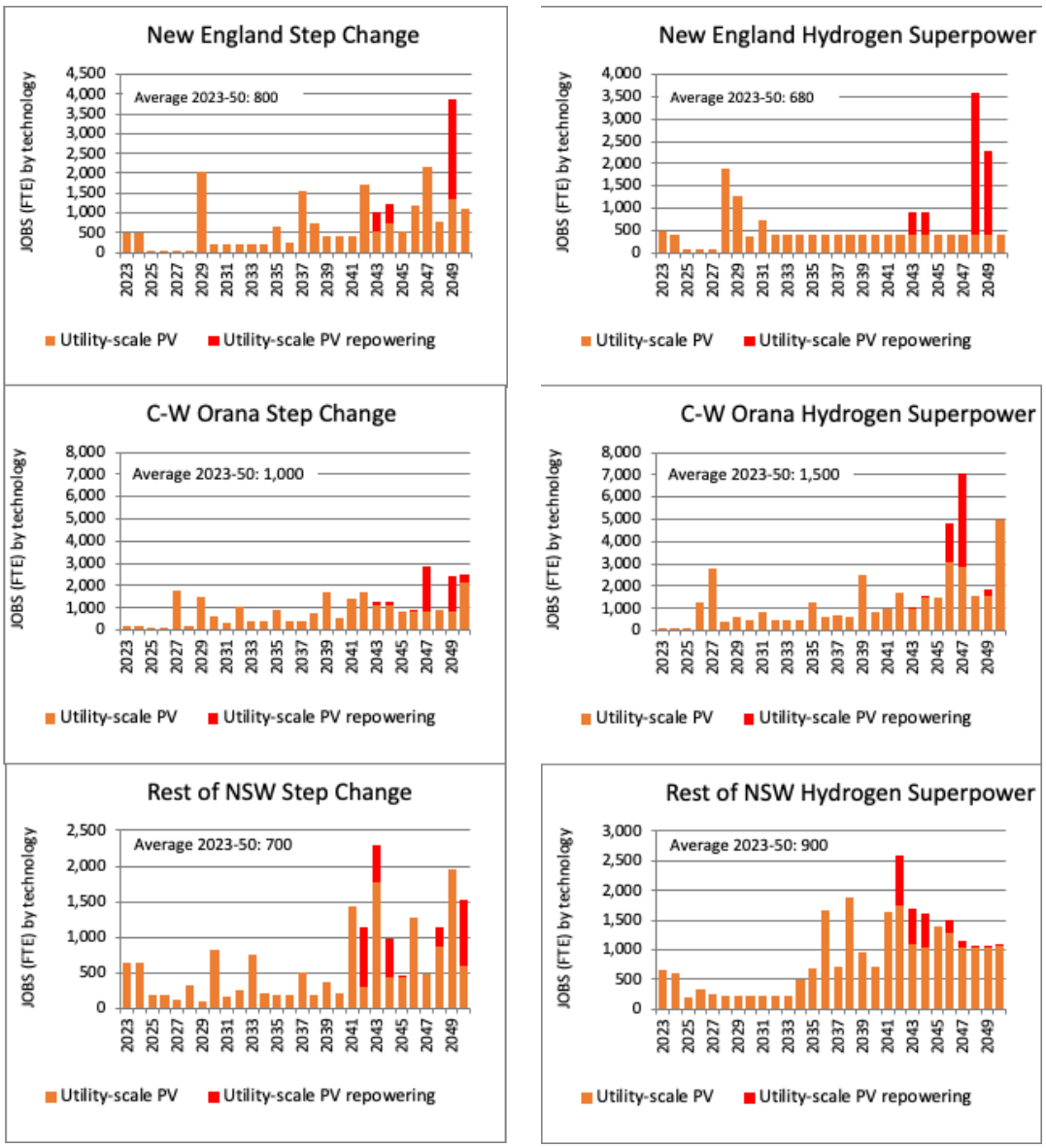
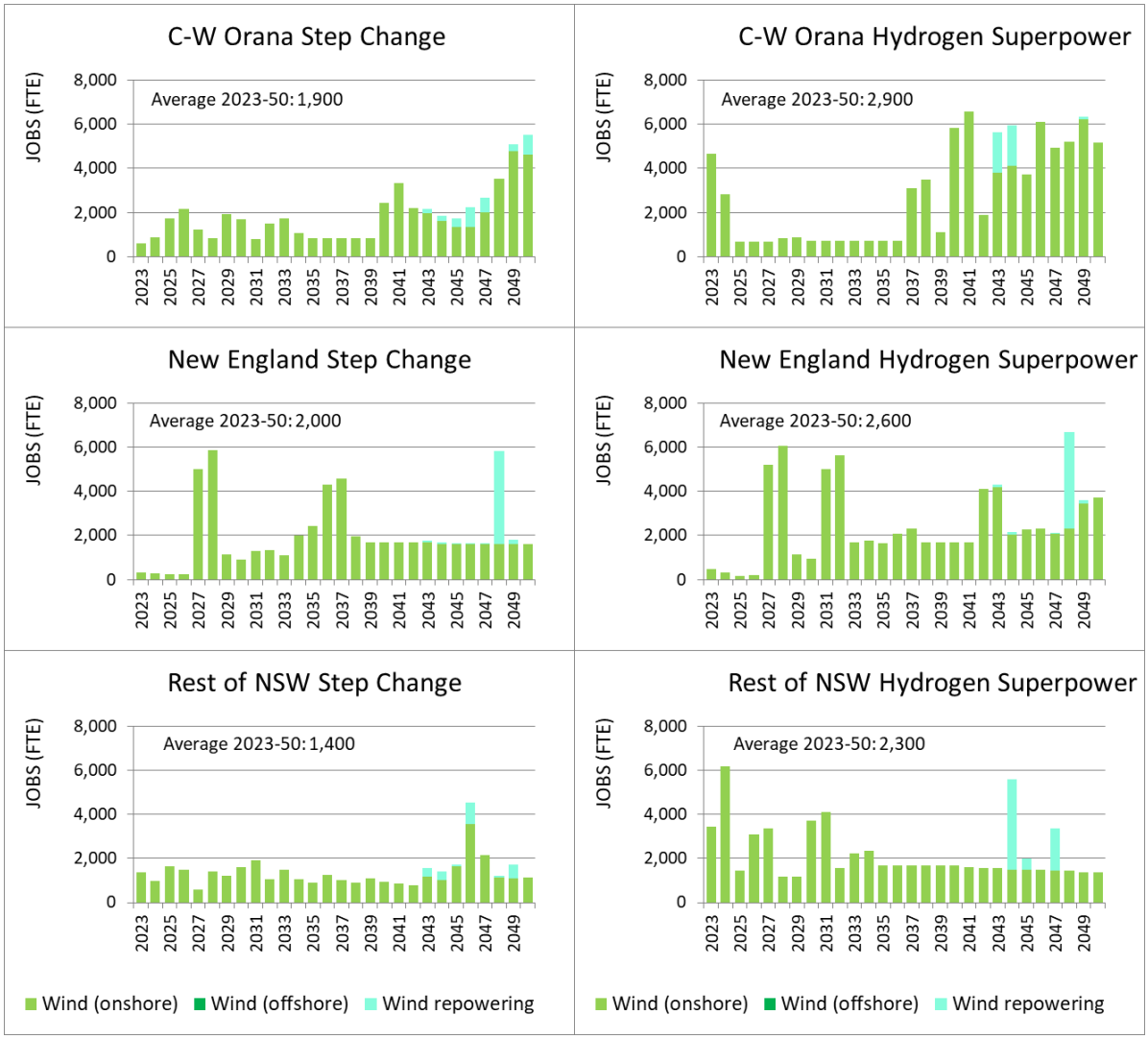


Figure 20 compares wind employment for three REZs and the Rest of NSW in the Step Change and Hydrogen Superpower scenarios. Much of the wind employment in Central West Orana is between 2023 and the mid-2030s under Step Change, this is brought forward to the early 2020s under Hydrogen Superpower. Wind employment in both scenarios increases dramatically after the late-2030s. The Hydrogen Superpower scenario increases the peaks of employment in both REZs. For the Rest of NSW, the Hydrogen Superpower scenario front loads wind employment over the period, creating substantial peaks between 2023 and early-2030. New England employment is very similar under the Step Change and Hydrogen Superpower scenarios, with two additional employment peaks under Hydrogen Superpower in 2031 and the early-2040s. Most of the wind employment in NSW under Hydrogen Superpower is projected to occur in REZs.

Figure 20 Employment in wind by REZ and rest of NSW, Step Change and Hydrogen Superpower



Appendix A Additional information on occupational breakdowns

Figure 21 NSW, in-demand occupations during peak year (2034) for the Hydrogen Superpower

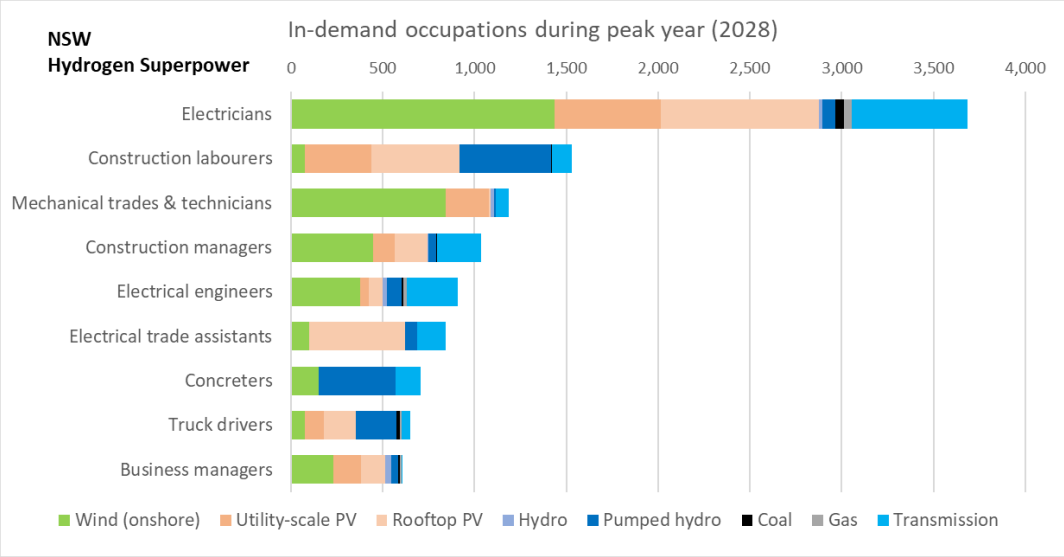
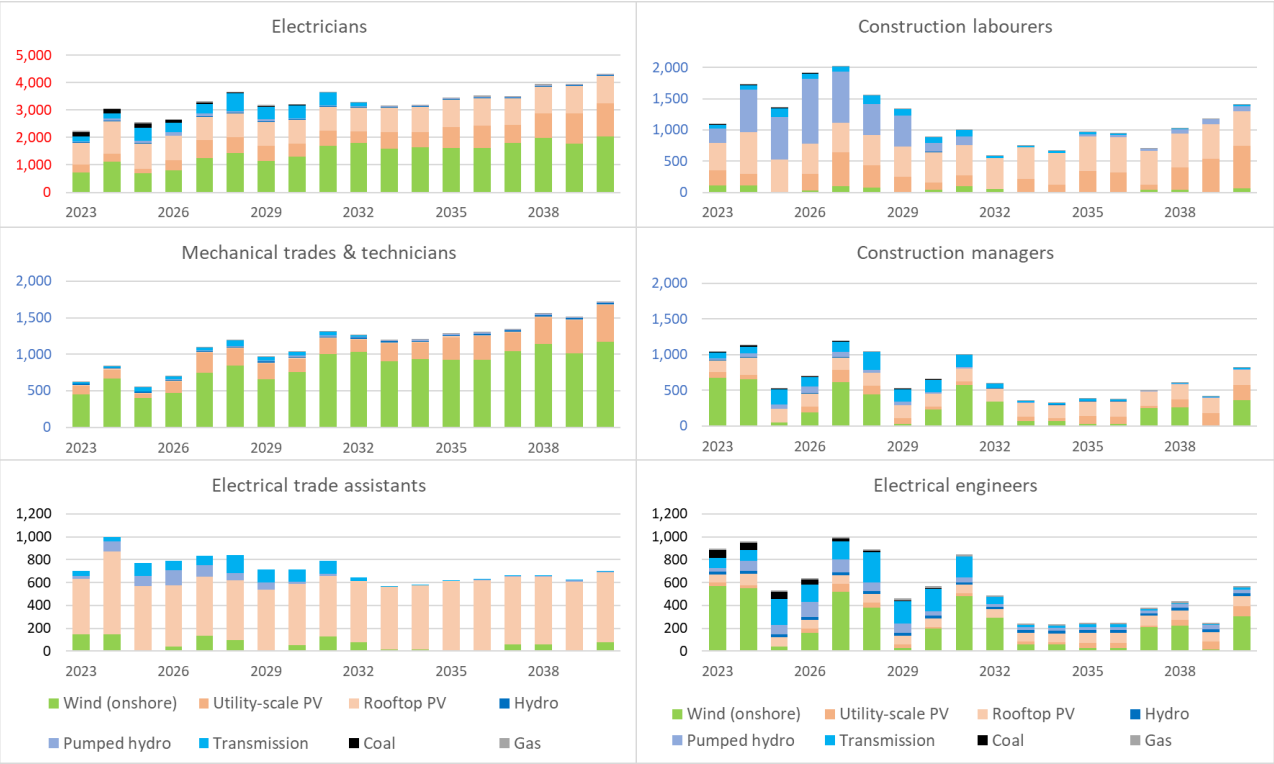


Figure 22 NSW, in-demand occupations annual requirement by technology, Hydrogen Superpower



Note different scales: electricians 0-5,000, construction labourers, mechanical trades & technicians & construction managers 0-2,000, electrical trade assistants and electrical engineers 0-1,200

Figure 23 NSW, utility-scale PV average employment by occupation, 2023-2040

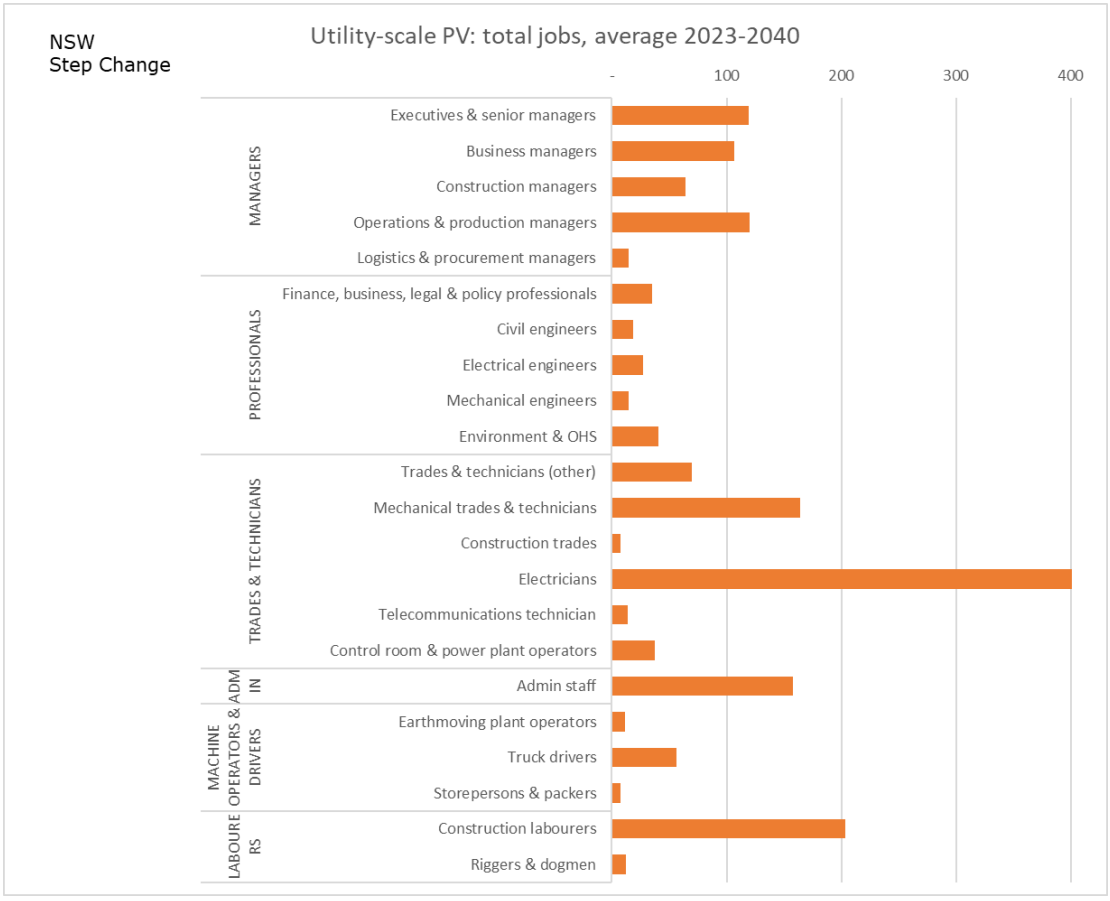
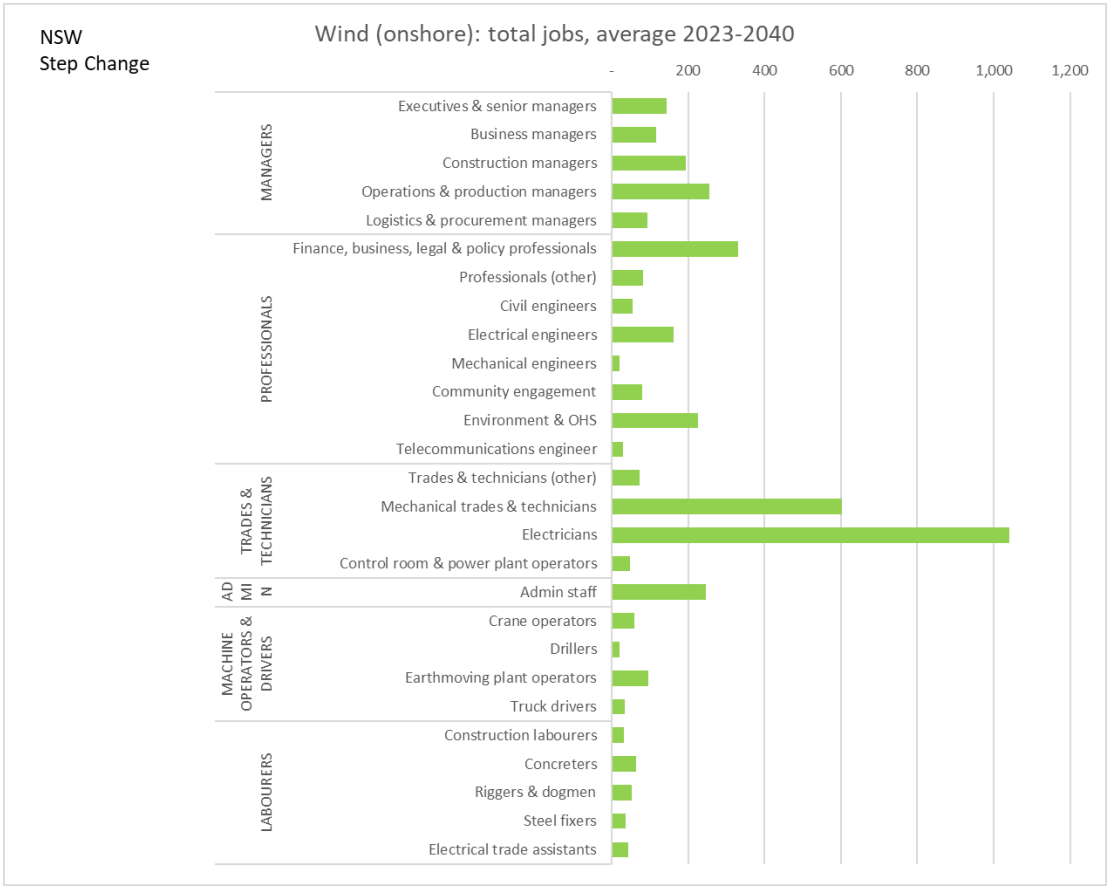


Figure 24 NSW, utility-scale PV average employment by occupation, 2023-2040



RACE for 2030

RELIABLE
AFFORDABLE
CLEAN
ENERGY

www.racefor2030.com.au

Australian Government
Department of Industry, Science, Energy and Resources

AusIndustry
Cooperative Research Centres Program