RACE for 2030
RELIABLE AFFORDABLE CLEAN ENERGY

CT12-Building a net zero workforce

The Western Australian Electricity Workforce: Projections to 2050

Final Report

UTS Institute for Sustainable Futures

Government of Western Australia Department of Training and Workforce Development

Australian Government Department of Industry, Science and Resources

Cooperative Research Centres Program

Final report

RACE for Change

Research Theme CT12: Building a net zero workforce

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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

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Executive Summary

To meet net zero goals set out in Western Australia's sectoral emissions reduction strategy it is projected that 96% of electricity consumed will be renewable by 2050. Ensuring WA's future electricity sector is reliable, low carbon and fit for purpose, will require a significant amount of construction of new renewable generation capacity. It will also demand several thousand kilometres of new transmission lines and substations. Constructing, operating, and maintaining new generation and transmission assets will require a large, skilled workforce.

WA's electricity sector workforce could triple by 2031 if a High demand scenario were to eventuate, which would result in an increase from just over 8,000 full time equivalent (FTE) now to just under 30,000 FTE by 2031. The High demand scenario assumes significant industrial growth, particularly in the hydrogen and ammonia sectors. The Low scenario, without significant industrial growth, sees energy sector employment peak in 2032 at nearly double the current level.

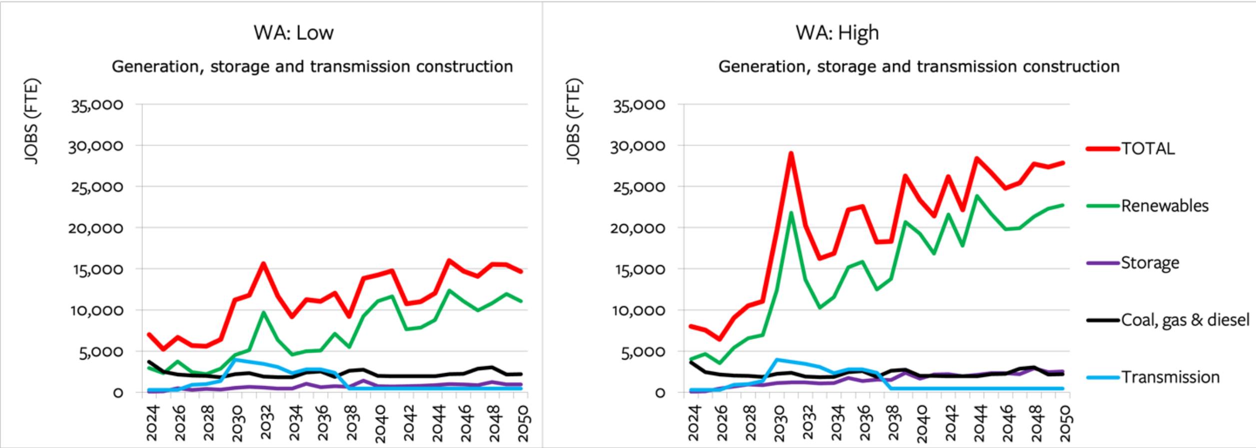

Figure E1 Jobs by technology group (generation, storage, and transmission construction, both scenarios)

Workforce planning is essential due to the rapid expansion of new generation capacity required and the structure of WA's economy. A significant proportion of the new energy generation, storage and transmission infrastructure will be needed in regional or remote areas, and recruiting sufficient workers is likely to be challenging.

Jobs growth over the next decade occurs in renewables, transmission construction and storage, while coal, oil and gas jobs slowly decline.

In the High scenario, wind jobs grow by 8,700 FTE between now and 2031, peaking at 12,200 FTE by 2050. Solar farm jobs grow by 9,600 FTE by 2031, and peak at 10,700 FTE in 2042. Batteries jobs increase steadily from a very low base, reaching nearly 2,900 FTE in 2048.

In the Low scenario, wind jobs increase by 3,200 FTE by 2031 and peak at 5,300 FTE, while solar farm jobs increase by 5,600 FTE by 2032 and peak at 6,900 FTE. Batteries jobs increase to nearly 1,400 FTE in 2039, and then level off at approximately 1000 FTE.

In both scenarios, transmission construction jobs grow by 3,600 FTE by 2031 and peak at 3,900 FTE in 2030. Storage jobs peak at just under 1,000 FTE in 2039, growing by 970 FTE. Coal jobs decline in line with coal fired power station closures by 2030, while oil and gas jobs decline very slowly over the period.

In the High scenario, around 70% of the workforce will be in new generation, storage and transmission construction by 2030, with around 20% in operations and maintenance. The operations and maintenance workforce increases steadily to service the growing pool of new solar farms, wind farms, and battery storage. This workforce is projected to be around 80% of the electricity sector workforce by 2050 (79% in the Low scenario) (Figure E2).

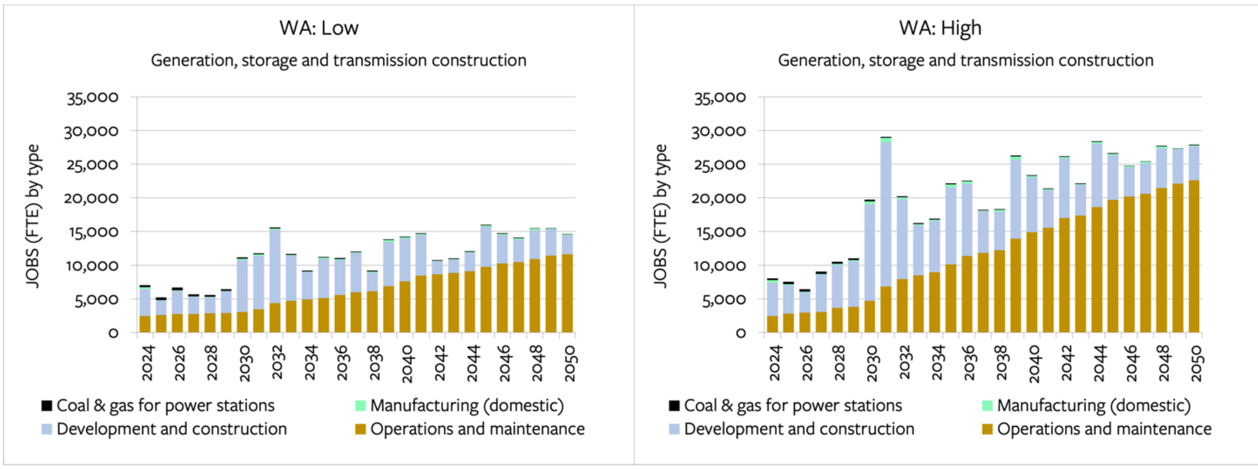

Figure E2 Workforce by project phase (generation, storage, and transmission construction, both scenarios)

The electricity sector requires a skilled workforce with trades, technicians, professionals, and construction managers all in high demand. Trades and technicians are in highest demand at 6,500 FTE on average, mostly driven by wind and solar. Electricians are the largest single occupation (Figure E3), peaking at 5,400 FTE in 2039. Electricians are required during the commissioning stages of new projects, and for ongoing operations and maintenance. Construction labourers are in high demand in solar farms, wind, and transmission projects, peaking at 2,300 FTE. Managers (e.g., construction managers) and professionals (e.g., electrical engineers) are also in high demand.

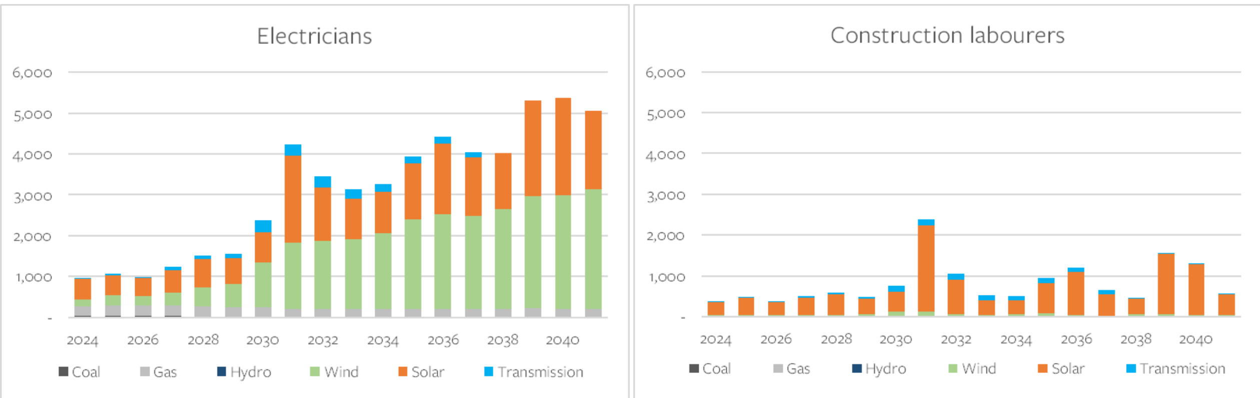

Figure E3 Two in demand occupations, High scenario

The Western Australian electricity sector workforce is projected to experience significant volatility over the next decade, in line with the anticipated growth in renewable energy generation capacity. In the near term, electricity sector employment would benefit from measures that smooth employment peaks and reduce the boom-bust nature of employment demand driven by construction.

The sector will compete with other sectors, such as mining and building construction, for workers. A coordinated approach to workforce planning is needed to understand the broader implications across the economy of workforce or skills shortages, particularly for skilled workers in high demand, in the case of electricians.

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1 Introduction

Western Australia has a target to reach net zero emissions by 2050[1], and to this end has introduced a set of energy scenarios covering all sectors in the economy [1].

Western Australia's energy transition includes a mix of energy generation to meet the needs of residential and industrial energy users. The share of energy from renewables is projected to increase rapidly over the next two decades, resulting in a huge demand for a workforce to build and operate the new generation capacity and the transmission lines to connect to energy users across the state.

Western Australia has a unique electricity sector structure, with a significant proportion of generation either off grid or very remote, reflecting the geography of the state and the importance of the resources sector. The Western Australian Government is committed to working with all sectors to achieve climate targets including both grid connected and off grid or remote elements.

1.1 Modelled regions

A regional profile of employment demand for Western Australia's electricity sector is essential to plan for the future workforce requirements. Four regions are modelled, to understand when and where workers will be needed across Western Australia over the next 20 years, and include:

SWIS: South West Interconnected System

Includes the region highlighted in teal, from Albany in the south, Perth in the West, Kalbarri in the North, and Kalgoorlie in the east.

Central Pilbara

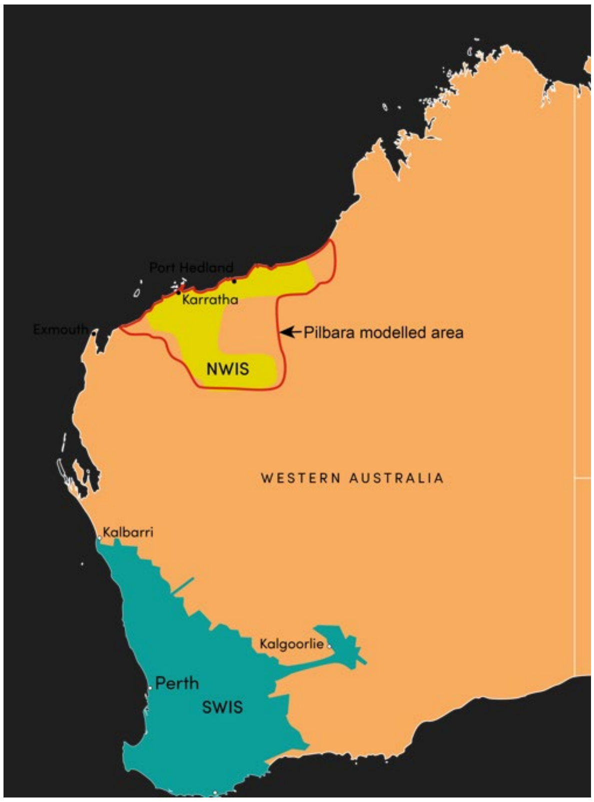
The central Pilbara contains the majority of the State's iron ore and LNG industry contained within the red circle and includes the North West Interconnected System highlighted in yellow.

Horizon Towns

The Horizon Towns are scattered right across the state.

Offgrid

The Offgrid region spans the remaining areas on and offshore.



[1] The Climate Change Bill (2023) is still to be passed into law https://www.wa.gov.au/service/environment/environment-information-services/climate-change-legislation.

2 Methodology

2.1 Overview

In line with international standard approaches to estimating energy sector employment, our study 'The Western Australian Electricity Workforce: Projections to 2050' utilises an employment factor methodology.

To calculate construction, development, and manufacturing employment in the electricity sector, an employment factor (full-time equivalent job-years/megawatt of installed capacity) is applied to the total of constructed capacity (megawatt) anticipated each year. To estimate employment in operations and maintenance, a factor for jobs per megawatt is applied to the aggregate capacity. Employment factors are reduced each year to reflect productivity improvements. Figure 1 provides a summary of the methodology (see also box JOBS AND JOB-YEARS).

Manufacturing employment for year	=	MW installed per year	x	Manufacturing employment factor for that year (job-years/MW)	x	% Onshore manufacturing
Construction employment for year	=	MW installed per year	x	Construction employment factor for that year (job-years/MW)	/	Average construction time
Operation and Maintenance jobs	=	Cumulative capacity	x	O&M employment factor for that year (jobs/MW)		
Fuel employment	=	GWh used per year	x	Fuel employment factor for that year (job-years/GWh)		
Employment factor for year	=	Base year employment factor	x	Technology decline factor for year (equals CAPEX for year / CAPEX for base year)		

Figure 1 Employment calculation: methodological overview

While the employment calculation is straight forward, the robustness of results is determined by the accuracy of modelling inputs, which include capacity projection scenarios and employment factors. The Institute for Sustainable Futures team has developed employment factors over many years from real-world projects, using surveys supplemented with information from literature. Capacity projection scenarios were provided by the Western Australian Government and Horizon Power, with the exception of the Low scenario for the SWIS.

JOBS AND JOB-YEARS

Calculating jobs that are project-based and time-limited, such as construction, and those which are ongoing, such as maintenance, require differing approaches.

For **construction and manufacturing jobs**, workforce demand is dependant on project timeline. In some cases, construction workers may be able to find continuous employment by moving from one project to another, yet this requires a planned and steady flow of projects. When calculating jobs in construction we use **job-years per MW**, with one job-year representing one job over the course of the year at full time capacity. This of course, could also be broken down to represent two people working full time equivalent over the course of six months or six people working full time for two months.

Operations and maintenance jobs are ongoing and represented as **jobs per MW**. Given the nature of these jobs, they are always characterised as jobs per MW, irrespective of whether it is one-person full time or two people part time over a year.

Fuel supply jobs, which are jobs in coal mining or gas production, are calculated as the total employment to generate one GWh of electricity. Unlike operations and maintenance employment, which is fixed, fuel supply jobs will vary depending on the generation capacity of each power station in GWh per year.

Jobs per annum are always presented as the Full Time Equivalent (FTE) sum of workers across manufacturing, construction projects, operations and maintenance, and fuel supply in coal and gas generation in that year, irrespective of whether those jobs will continue in the following year.

2.2 The energy scenarios

Energy capacity scenarios were developed using a combination of data sources provided by the Western Australian Government, energy sector stakeholders, and the 2024 Wholesale Electricity Market Electricity Statement of Opportunities (2024 WEM ESOO) [2]. Energy scenarios provide the key input to calculate employment, in the format of megawatts (MW) of installed capacity until 2050, by region and technology. The scenarios are described in Table 1.

The single scenario provided for the SWIS was modified to provide both a High and Low scenario. The Low scenario was created by assuming that demand other than for hydrogen production would remain the same. Hydrogen demand was assumed to reduce in parallel to the differential between the High and Low scenarios for the Pilbara and Offgrid, such that the proportion of overall Western Australian hydrogen production in the SWIS remained the same. The resulting reduction in capacity was derived assuming that all hydrogen production demand would be met by wind and solar, using the same capacity factors as the High scenario.

The High scenario was created by replacing the rooftop PV and distributed batteries in the single SWIS scenario with the High scenario for these technologies from the 2024 WEM ESOO [2]

Table 1 Installed capacity scenarios by region

Region	Scenario	Definition
SWIS	High	Based on the 'Future Ready' scenario from the SWISDA [3], which factors in the decarbonisation of existing heavy industry largely through electrification and allows for the creation of a hydrogen export industry. Additional growth is included in rooftop PV and distributed batteries using the high forecasts from the 2024 WEM ESOO [2].
	Low	Based on the 'Future Ready' scenario, with electricity demand for hydrogen production reduced compared to the High scenario in the same ratio as in the Pilbara and Offgrid Low scenarios.
Pilbara	High	Current Trajectories plus Loads: this scenario includes potential loads associated with the Strategic Industrial Areas (SIA), designated for use by strategic and heavy industries that generate large investment, employment and value production for WA. SIA growth is largely concentrated in the hydrogen and ammonia value chain.
	Low	Current Trajectories: provided from publicly available data in consultation with industry
Offgrid	High	Includes a substantial amount of hydrogen industry development late in the forecast period.
	Low	Does not include significant hydrogen export development across the forecast period.
Horizon Towns	Central	One growth scenario with projected increases in grid-scale solar and wind.

The employment projections are modelled from the capacity and storage scenario data supplied for each of the four regions, with a sum of all regions used to generate results for Western Australia as a whole. Figure 2 shows the cumulative electricity generation and storage capacity for Western Australia for the High and Low scenarios. Figure 3 shows the cumulative electricity generation and storage capacity for the SWIS and Pilbara for both the High and Low scenarios.

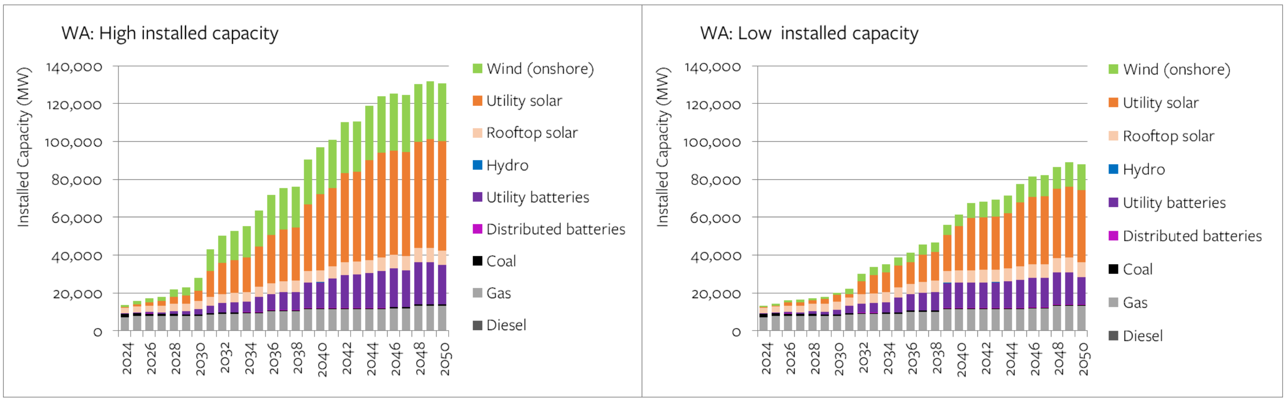


Figure 2 WA, megawatts of installed capacity, by technology (both scenarios)

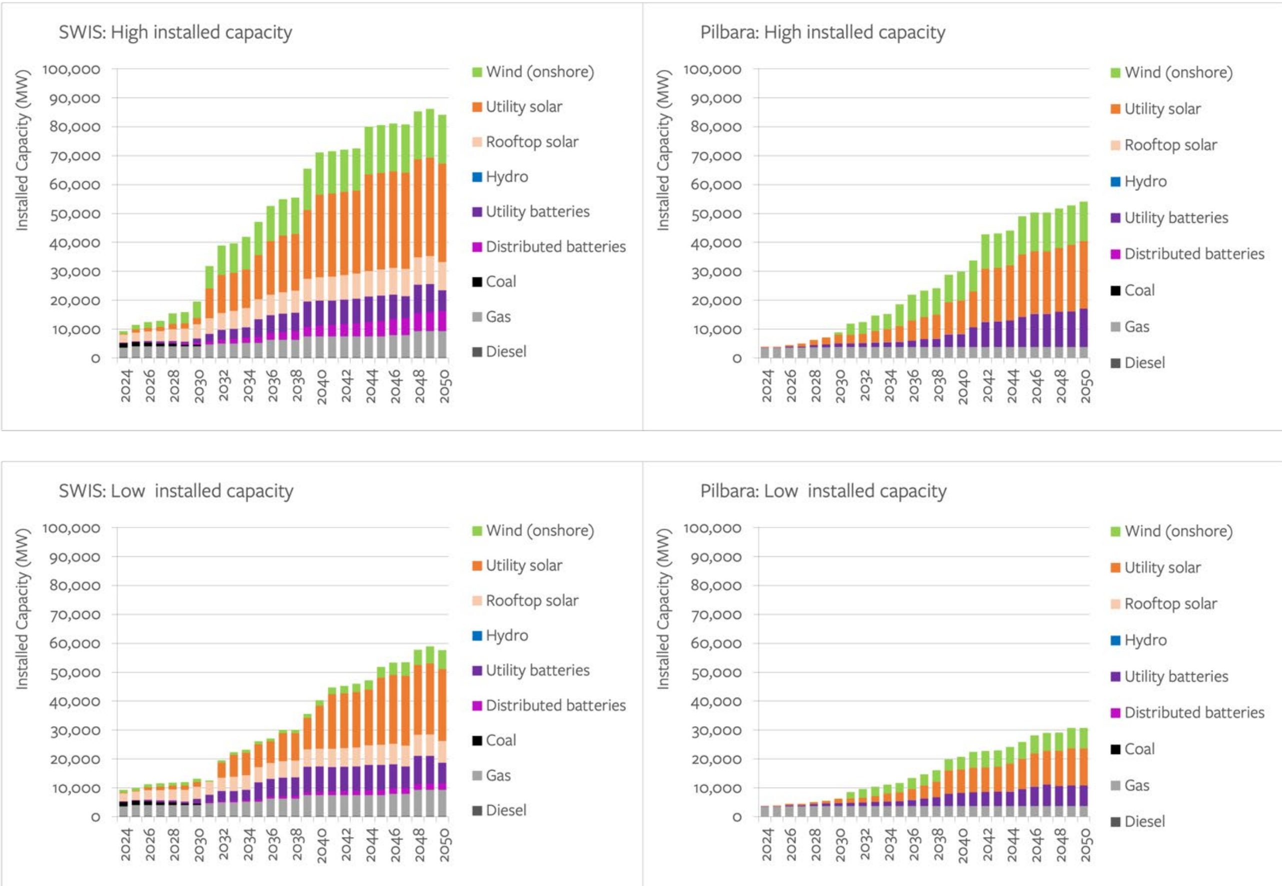


Figure 3 SWIS and Pilbara megawatts of installed capacity (both scenarios) .

2.3 Transmission construction

Transmission construction projections were provided by the Western Australian Government in kilometres of line per project, with project start and end dates, for the SWIS and Pilbara regions. All transmission lines were modelled as double circuit transmission lines, which feature a higher employment intensity compared to single circuit transmission lines.

It is important to capture both line and non-line (e.g., substations) transmission assets when modelling the workforce implications of transmission expansion and upgrades. Our modelling uses an employment factor of FTE jobs per $ million for non-line transmission construction. Non-line transmission costs were derived from an average ratio (of 0.89 $million/km) from National Electricity Market (NEM) employment modelling carried out for the 2024 ISP [4].

No transmission construction was modelled for the Offgrid and Horizon Towns regions.

2.4 Employment factors

Employment factors for Australia have been derived over the course of several industry surveys in 2020 and 2021 [5,6], with survey gaps supplemented by literature review. Employment factors have been updated using decline factors to reflect that technology costs and employment intensity tends to decline as technologies mature. The final employment factors used in this analysis are given in Table 2, with the full derivation of these detailed in Rutovitz et al 2025 [7]. The employment factor for gas fuel has been revised for this project, as employment per petajoule (PJ) of gas extraction has been falling steadily over the last two decades. Employment in gas is converted from PJ to GWh based on conversion factors for electricity production and presented as job-years/GWh in Table 2 below.

Table 2 Employment factors for the 2024 Western Australia workforce projections

	Construction/ installation	Manufacturing	Australian manufacturing	O&M	Fuel
	Job-years/MW	Job-years/MW	Job-years/MW	Jobs/MW	Job-years/ GWh
Brown coal	11.08	5.41	1.62	0.22	0.01
Gas	1.27	0.92	0.28	0.14	0.007
Hydro	7.36	3.48	1.04	0.14	
Wind (onshore)	2.65	1.54	0.35	0.21	
Utility Solar	1.61	3.08	0.07	0.09	
Rooftop PV	4.19	2.86	0.12	0.13	
Utility batteries	0.53	0.50	0.08	0.03	
Distributed batteries	4.44	0.50	0.08	0.23	
Pumped hydro	7.18	3.48	0.70	0.08	
Transmission line construction					
Construction/installation (Job-years/km)					
Double circuit	3.7				
Construction/installation (Job-years/$m)					
Transmission (other)	1.90				

2.4.1 Gas employment

Employment per PJ of gas production has been falling overall in Western Australia for the past fifteen years (Figure 4). Employment is calculated by combining ABS data for the gas sector [8] with production data from Australian primary energy statistics [9]. The current (2023) employment of 0.007 FTE/GWh$_{electrical}$ is a factor of ten smaller than the previously calculated value, reflecting the increasing economies of scale as production has increased in Western Australia.

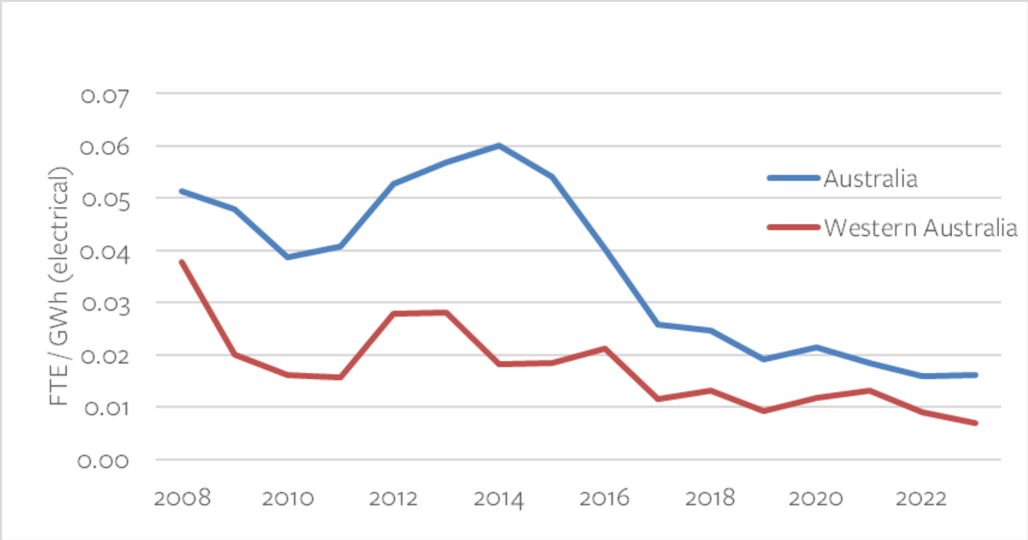


Figure 4 Employment per GWh$_{electrical}$ in gas production

2.5 Decline factors

Cost declines for renewable energy technologies are significant, as innovations and efficiencies continue. Cost decline is considered a good proxy for estimating the workforce efficiencies gained during the construction phase of renewable energy projects. The manufacturing workforce, which operates adjacent to the electricity sector workforce, also presents a strong case that employment declines alongside overall cost reductions.

Wind turbines, for example, have experienced significant construction cost efficiency gains largely through an increase in overall turbine size. Wind turbines have increased in size from 0.5 MW to 3 MW over the last twenty years. Efficiencies in construction costs result in an associated decline in the employment created per MW; there may be additional work in installing a larger turbine, but this additional work is not directly comparative to the total MW installed. Decline factors applied will impact projected workforce requirements significantly.

To calculate decline factors for the Western Australian electricity sector, cost declines are utilised for each technology, for both the manufacturing and construction phases. The equation for technology cost decline is outlined in the equation below, where the decline factor (represented as a percentage) for a given year X, is equal to the projected technology cost for that year over the technology cost in the base year, in this case the base year is 2024.

$$Decline\ factor\ for\ year\ X = \left(\frac{technology\ cost\ (yr\ X)}{technology\ cost\ (base\ yr)}\right)$$

Following this, we then calculate an employment factor for each year:

$$Employment\ factor\ (yr\ X) = Employment\ factor\ (base\ yr)\ \text{x decline factor (year X)}$$

Decline factors are derived from the cost assumptions used by the Western Australian Government in their energy scenarios, which were from CSIRO GenCost data supplemented by the Draft AEMO 2023 'Inputs and Assumptions Workbook' (Australian Energy Market Operator, 2023; Graham et al., 2023). No decline is applied to coal technologies. Decline factors for each technology are presented in Table 3.

Decline factors have not been applied to operations and maintenance employment. The operations and maintenance (O&M) factors in use are generally low compared to international standards, and industry consultation in 2020 did not suggest they would reduce further. This may be reconsidered in future work as there are efforts to reduce operational costs via automation.

Table 3 Decline factors for 2030 and 2050

Technology	2023	2024	2030	2050
Gas	100%	100%	89%	83%
Hydro	100%	100%	100%	100%
Utility batteries	100%	100%	47%	33%
Distributed batteries	100%	100%	52%	37%
Wind (onshore)	100%	97%	65%	55%
Utility-scale PV	100%	96%	64%	40%
Rooftop PV	100%	95%	69%	34%

2.6 Regional adjustment

A regional adjustment has been applied to employment factors in all regions other than the SWIS, to allow for the additional time taken to reach work sites. These factors were derived by the Western Australian Department of Training and Workforce Development from their database on resource extraction costs (Table 4).

Table 4 Regional employment multipliers

Region	Construction	O&M
SWIS	1	1
Pilbara/Offgrid	1.13	1.36
Horizon Towns	1.15	1.79

2.7 Occupational structure

The indicators used to form the basis of the occupational employment projections in this study were derived from two surveys – the 2021 transmission construction survey and the 2020 renewable energy survey [5,6], supplemented by information from literature. Full details of the occupational shares are given in Rutovitz et al, 2025 [7]. The following technologies have occupational employment factors:

- Utility-scale PV
- Onshore wind
- Pumped hydro (hydro assumed the same)
- Transmission line, sub-station, and associated asset construction
- Rooftop PV
- Coal and gas (inclusive of power station operations and maintenance and fuel supply)

There are two different sets of occupational employment factors for each technology. All the renewable technologies have a set for development and construction and a set for operations and maintenance. Coal and gas have a set for operations and maintenance and a set for fuel supply; construction is not calculated, as no data is available, however employment will be dominated by operations and maintenance and fuel for these technologies in any case.

Occupational shares are derived according to the Australian and New Zealand Standard Classification of Occupations (ANZSCO), at two levels:

- 1-digit occupational groups (e.g., managers, professionals, labourers)
- Composite: this may be a 2-digit, 3-digit or 4-digit ANZSCO coded occupation, depending on the size of the workforce requirement and common industry understanding (e.g. electrician)

The occupational shares are applied to the total employment numbers for each technology by phase to calculate the mix for the electricity supply sector (note: occupational shares are not yet available for offshore wind or batteries). Total numbers are influenced by the mix of phases over time and particular years. In later years, the operations and maintenance share of employment will have a greater influence, while peak years tend to be dominated by construction.

Note that occupational employment is not calculated for any gas generation construction that is projected to occur in WA between now and 2050, nor for installation or operation of batteries.

2.8 Repowering

Repowering a renewable asset, such as solar panels or wind turbines, refers to the process of replacing hardware either due to end of life or because improvements in the technology have significantly enhanced performance, meaning it is more profitable to upgrade to a new generation asset.

We include repowering in the model for utility-scale solar, rooftop PV and onshore wind, with the construction times and employment factors remaining the same as for new infrastructure.

Replacement is assumed to occur after 30 years for utility-scale solar and after 25 years for onshore wind. As in the previous work, we assume rooftop PV is repowered after 25 years. While there may be some variance in the timescale of repowering, with some happening later than assumed, it is also likely that in some cases this repowering occurs earlier to take advantage of improvements in turbine or panel efficiencies.

Using historic data for utility-scale wind and solar, we assume all existing utility-scale capacity previously installed is repowered. We only include 80% of rooftop PV, assuming that replacement will be more variable.

2.9 Caveats and omissions

The projections developed in this study use installed capacity scenarios that were developed using a combination of data provided by the Western Australian Government, energy sector stakeholders, and the Australian Energy Market Operator. Employment projections are therefore reflective of the inputs and assumptions of those scenarios.

There are many assumptions that go into future electricity sector capacity scenarios, as electricity demand will be influenced by many factors, including population, national and state level industrial development, and global demand for Australia's exports. Electricity scenarios vary significantly, particularly in the years beyond 2040, according to different assumptions on industrial growth. The employment factors also become increasingly uncertain along the period. While we apply corrections for future trends, like productivity increases, this cannot account for all potential step changes in work practices (e.g., automation) or sectoral shifts (e.g., downturn in Australian nickel demand). Therefore, the results should be interpreted as indicative of a range of futures, and data gaps, assumptions and omissions should be kept in mind.

Modelling omissions:

- The employment projections in this study do not include energy efficiency, electrification of homes and businesses, industrial electrificaiton, or energy and demand management. This workforce, however, is likely to be very significant and more research is needed in this space to adequately account for the scale of employment generated by decarbonising the energy system.
- There is insufficient reliable data available on occupational shares for offshore wind or batteries, or for the construction of gas power plants, so the occupational share forecasts do not include these technologies. It is recommended that industry surveys are undertaken so that detailed occupational share data for these sectors can be included in future projections.
- Excluded from the employment projections are the adjacent professional services linked to but not directly connected to renewable energy (for example, regulators).
- Jobs in mining and/or mineral processing associated with renewable energy technologies and the decommissioning and recycling workforce, are not included. The mining workforce is significant in Western Australia, and it is advised that these projections are extended to include the mineral extraction workforce as relevant to battery storage.
- The hydrogen workforce is only partly included in this study, as the employment embedded in the renewable energy generation (wind and solar) for green hydrogen production that is included in the High scenarios. As the industry is nascent, robust employment indicators are unavailable, with many of the specifics of the hydrogen sector landscape still unknown. Research and data collection is needed in order to include employment linked to the production and supply chain for hydrogen.

3 Electricity sector workforce projections for the state

3.1 Workforce projections by scenario

Electricity sector workforce projections for Western Australia are presented for both High and Low scenarios in Figure 5. Employment demand is extremely peaky, increasing by 21,500 FTE between 2025 and 2031 under the High scenario, a three-fold increase in just seven years. Jobs increase by 10,400 FTE in the Low scenario, with the largest spike in jobs growth in 2032. Rapid increases in employment growth and decline in the High scenario across the 2030s and 2040s, with variations between 4,000 and 17,000 FTE, demonstrate a need for development planning to smooth the boom and bust employment trajectory for the state. Highs and lows in employment demand are less severe in the Low scenario, but there are rapid periods of growth of 9,100 FTE over 3 years to 2032, followed by rapid decline of more than 6,400 FTE in just two years. The projected volatility in employment modelling results presents a convincing case for both infrastructure scheduling and workforce planning, noting that construction timelines of between 1 and 5 years, dependant on technology, are already factored into modelled results.

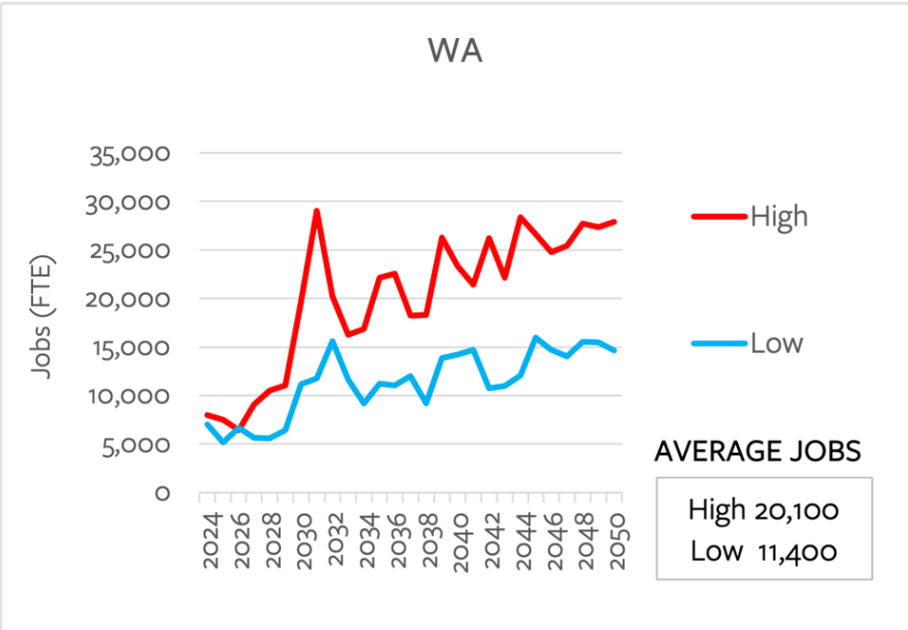


Figure 5 WA, electricity sector jobs by scenario (generation, storage, and transmission construction)

High scenario

- Employment peaks in 2031 at 29,040 FTE
- Huge jobs growth, with an additional 21,500 FTE between 2025 and 2031
- Growth is very volatile, with fluctuations of 4,000 FTE to 17,000 FTE through the 2030s and 2040s

Low scenario

- Employment peaks in 2032 at just over 15,600 FTE
- Large but more steady increase in jobs to the early 2030s, with a 9,100 FTE increase
- Employment still volatile but with longer periods of stability between periods of rapid growth and decline
- Significant growth and decline between 2030-34, 2038-39, and 2042-45, in some cases fluctuating by more than 6,400 FTE in two years.

Figure 6 shows total employment by job type. Job types are differentiated by project phase and include manufacturing, development and construction, operations and maintenance, and fuel supply.

Employment by type gives a picture of short- and long-term employment creation, where construction jobs are typically short-term roles (in the absence of planned workforce continuity across projects) and operations and maintenance jobs typically provide longer-term jobs, with opportunities for ongoing career pathways.

In the High scenario, most jobs are in construction to 2030, peaking at 21,400 FTE development and construction jobs in 2031. A positive trend sees strong growth in operations and maintenance roles from 2030, as the fleet of new renewable generation and storage capacity becomes operational, increasing from 23% of all jobs in 2030 to 63% of all jobs by 2040.

The Low scenario features steady growth of operations and maintenance roles, reaching 45% of all jobs by 2035 and maintaining this to 53% of all jobs by 2040. Peaks in the construction workforce occur between 2030 and early 2040.

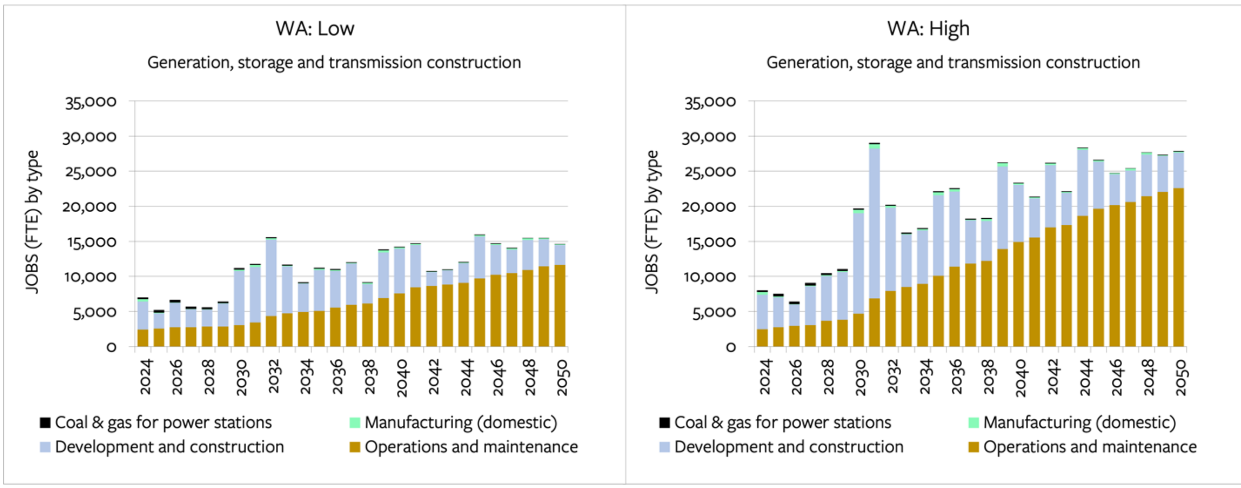


Figure 6 WA, jobs by phase (both scenarios, generation, storage, and transmission construction)

Employment growth is predominantly in renewables and transmission construction, highlighted in Figure 7. Jobs in renewables grow by 17,700 FTE by 2031 in the High scenario, and by 7,300 FTE by 2032 in the Low scenario. Transmission construction is identical across both scenarios with major jobs growth occurring by 2030 with 3,600 FTE. Storage jobs grow by 2,000 FTE by 2039 in the High scenario and 1,100 FTE in the Low.

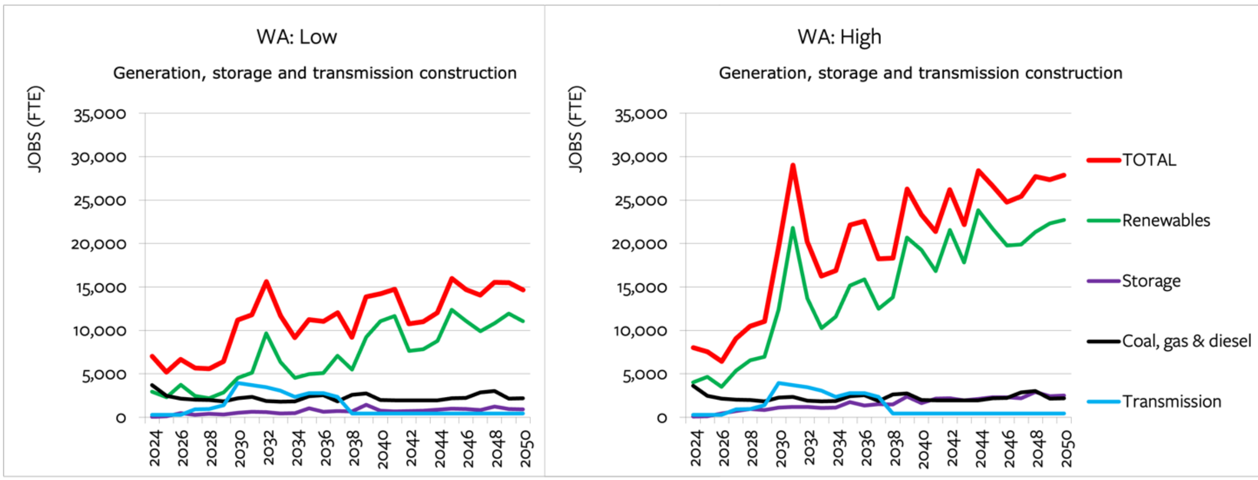


Figure 7 WA, jobs by technology group (both scenarios, generation, storage, and transmission construction)

Coal, gas and diesel jobs are almost identical between scenarios, declining gradually, with slight variations across the period.

Jobs by technology highlights

- Jobs in renewables grow by 17,800 FTE by 2031 in a High scenario
- Jobs in renewables grow by 6,800 FTE by 2032 in a Low scenario
- Transmission construction jobs grow by just over 3,600 FTE by 2030, and then decline slowly by 1,500 FTE by 2037, remaining steady at just under 500 FTE to 2050
- Coal, gas and diesel jobs decline gradually from 2024 through to 2050.

3.2 Employment by occupation

Occupational demand projections provide an overview of the types of roles that are likely to be in high demand across a range of technologies in WA. Detailed projections of occupations in high demand support government, industry, the training sector, and the WA community with valuable information for policy development, recruitment, training development, and career planning.

Figure 8 provides average demand by occupational group. Results are presented for WA, as an average between 2024 and 2040, for the High scenario.

- Trades and technicians are in highest demand across all technologies at just over 6,000 FTE on average across the period, mostly driven by wind (e.g. wind turbine technicians) and solar.
- Managers (e.g., construction managers), and professionals (e.g., electrical engineers) are also in high demand at just under 2,800 FTE and just over 2,500 FTE respectively, predominantly in wind and solar.
- Gas and diesel demand a higher proportion of trades and technicians and machine operators and drivers, due to the operations and maintenance phase of these incumbent technologies and the fuel transportation requirements.

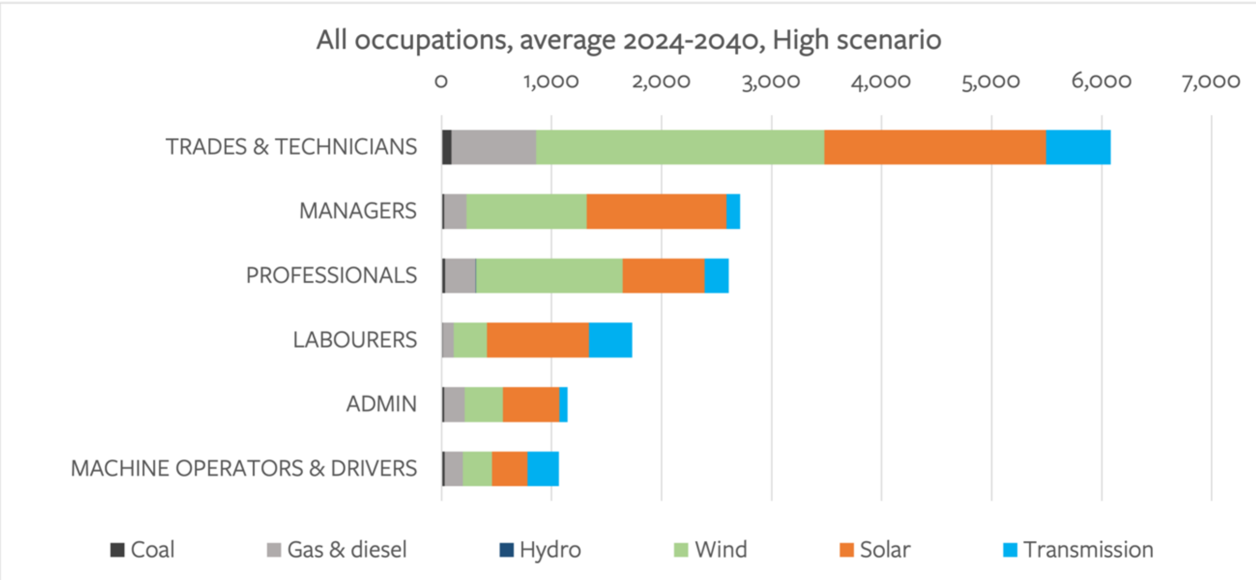


Figure 8 WA, average demand by occupational group, High scenario

Figure 9 provides a more detailed overview of individual occupations in high demand, results are presented for WA, in the peak year of 2031 for the High scenario. An understanding of key occupations in highest demand is important for workforce planning, and career pathway development.

- Electricians are in highest demand in 2031, with 4,200 FTE roles required across gas, wind, solar, and transmission technologies. Electricians are required during the commissioning stages of new generation and non-line transmission (e.g., substations) assets.
- Construction labourers are the next highest occupation in demand, at just over 2,300 FTE. Construction labourers are required as site preparation workers and assembly workers for wind, solar and transmission technologies.
- Admin staff are also in high demand at just under 2,000 FTE. Admin staff are required in the planning and approvals phase of new projects and to help coordinate construction.
- Mechanical trades and technicians cover wind turbine technicians and solar farm assembly technicians, at just over 1,700 FTE.

- Construction managers are in high demand and also difficult to source due to the level of project specific experience required.
- Other trades and technicians include roles that do not fit in well with ANZSCO occupations.

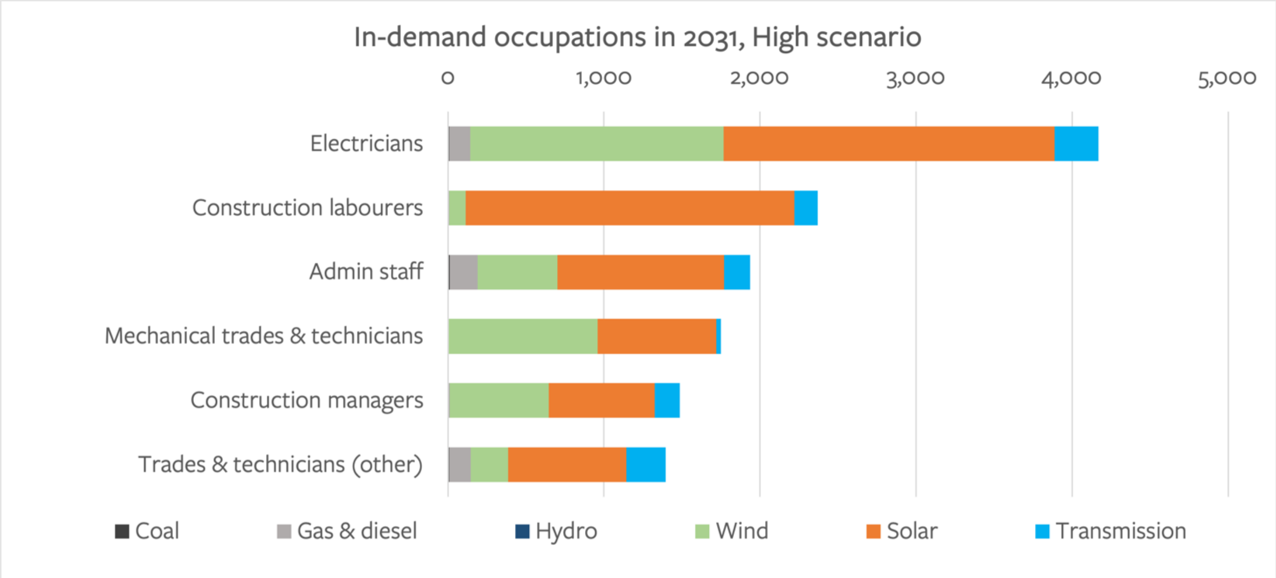


Figure 9 WA, occupations in highest demand, High scenario peak year

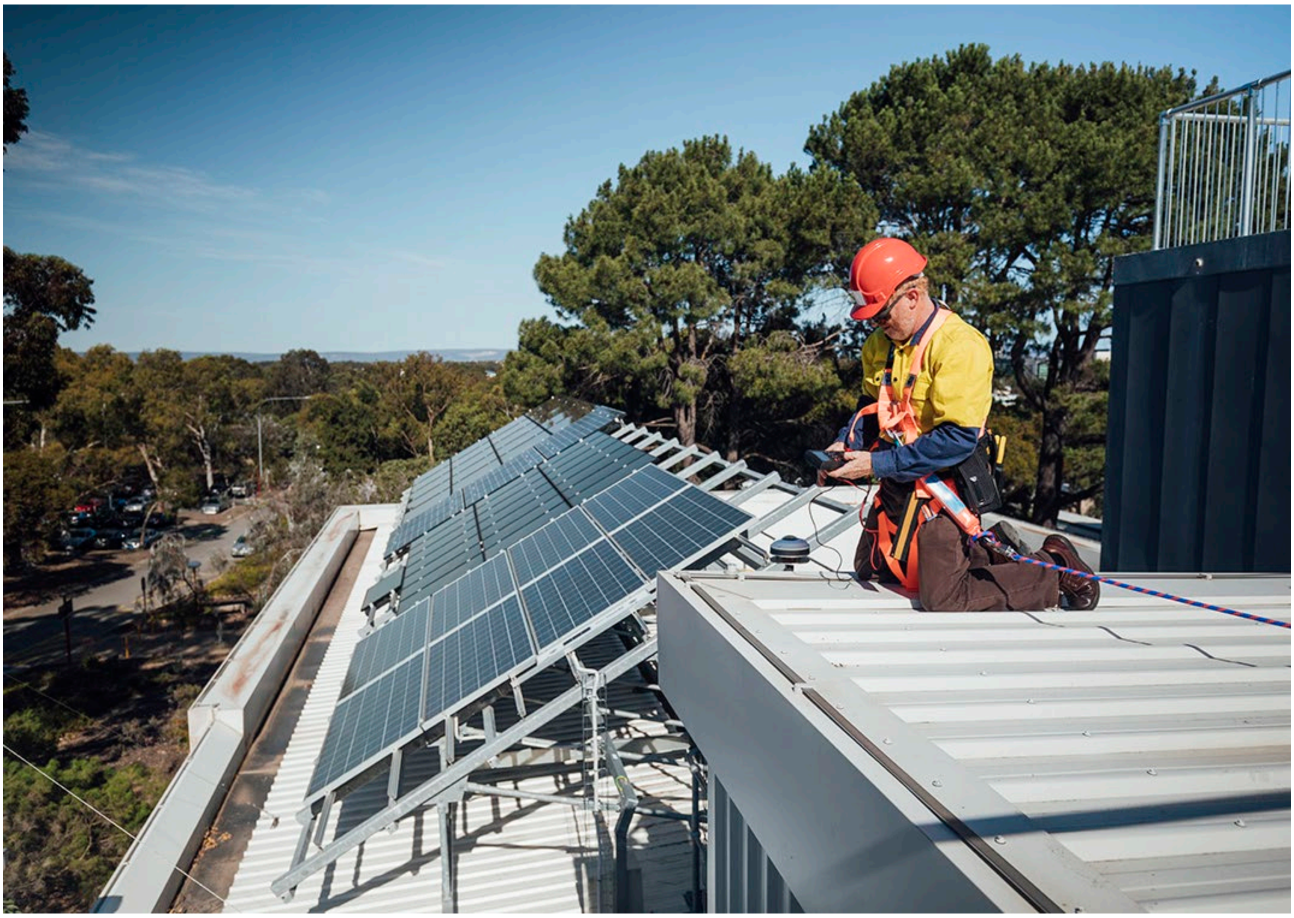


Figure 10 shows the annual requirements for occupations in highest demand across WA. Most of the demand for these key occupations is in wind and solar, due to the major construction growth of these technologies in the 2030s and the ongoing operations and maintenance roles as these technologies are commissioned. Transmission construction demands electricians, admin staff, and construction labourers during the 2030s. Gas and diesel demand a steady number of admin staff across the period, at around 200 FTE.

- Electricians: grow from just under 1,000 FTE now to 4,200 FTE by 2031; most of the employment growth is in wind and solar with peaks of employment in transmission during the 2030s.
- Mechanical trades and technicians: largely made up of wind turbine technicians and solar technicians, grow from modest numbers, around 200 FTE now to 1,700 FTE by 2031.
- Admin staff: reach a total of just under 2,000 FTE by 2031, with a significant share in solar and wind.
- Construction labourers: reach 2,300 FTE by 2031 mostly in solar.
- Finance, business, legal and policy professionals: are in high demand during the design, planning and development phase of construction, and legal and business professionals are in high demand once generation capacity is operational. Professionals grow from just under 400 FTE now to just over 1,100 FTE by 2031, mostly in wind and solar.

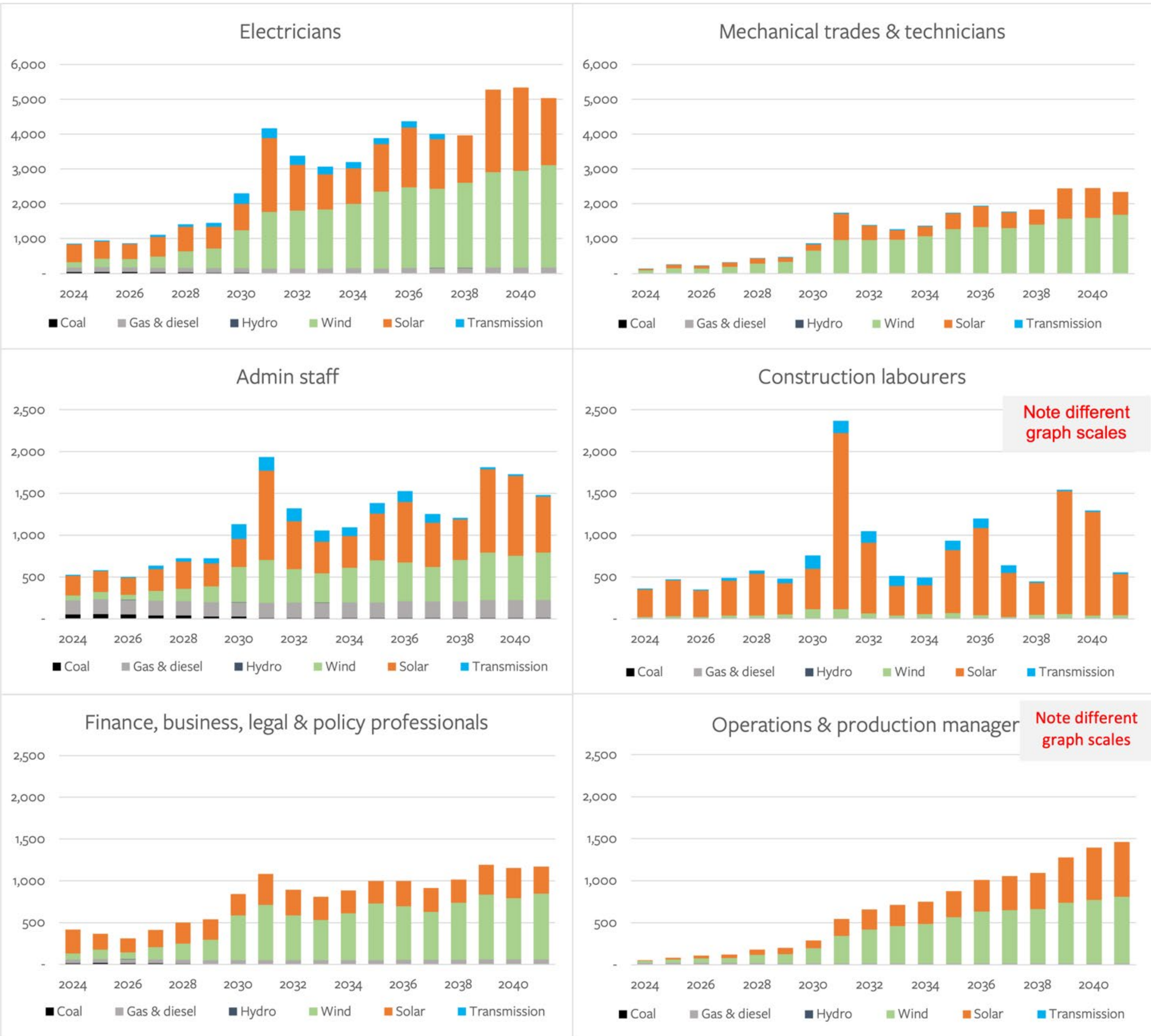


Figure 10 WA, in-demand occupations annual requirements by technology, High scenario

4 Complementary workforce opportunities

4.1 Manufacturing sensitivity

Australia's share of manufacturing for the electricity sector is low, and the share occurring within Western Australia is even lower. We apply proportions to the employment factors for manufacturing for each technology, based on the expected supply chain employment occurring in Western Australia.

The estimated base case share of manufacturing for Western Australia uses experience in the rest of Australia, with the Australian proportion occurring onshore for most technologies estimated after surveys were carried out in 2020. We have used the same shares for gas and hydro, while wind, solar and batteries use the factors from the rest of Australia reduced by 50%.

A manufacturing sensitivity has been undertaken that is reflective of WA's aspiration to increase the share of supply chain occurring within the state. In the manufacturing sensitivity we increase the base case share by 2031 to 5% and 10% for utility and rooftop solar respectively, and to 30% for wind power and batteries. We undertook several interviews which informed the choice of the enhanced levels for manufacturing.

Some of the areas identified where local renewable energy manufacturing could grow include the battery supply-chain, wind tower manufacturing and various parts of solar manufacturing (e.g. ingots, frames)[10,11].

Consequently, we examine an enhanced manufacturing sensitivity, where an increased proportion of manufacturing employment occurs onshore. It is assumed the manufacturing proportion increases linearly to reach the enhanced level shown in Figure 11 by 2034 and then stays at that level until 2050. The percentages of local content which could be reached are highly uncertain, particularly for new industries such as batteries and offshore wind.

Table 5 shows the base case proportions that are used for the workforce projections presented throughout the report, and an enhanced proportion which is used for a sensitivity.

Table 5 WA manufacturing percentages used, base case and advanced.

	BASE CASE	ENHANCED MANUFACTURING	
	2024-2050	**2024**	**2031-2050**
Gas	30%	30%	30%
Wind (onshore)	7.8%	7.8%	30%
Utility Solar	1.2%	1.2%	5%
Rooftop PV	2.1%	2.1%	10%
Utility batteries	7.5%	7.5%	30%
Distributed batteries	7.5%	7.5%	30%

Figure 11 shows the increase in overall employment under the High scenario with increased onshore manufacturing, and Figure 12 shows the same increase, highlighting what happens in the manufacturing phase alone. While the increase is modest compared to overall electricity sector workforce requirements, the average manufacturing employment triples, to reach 600, and reaches a peak of just over 2,000.

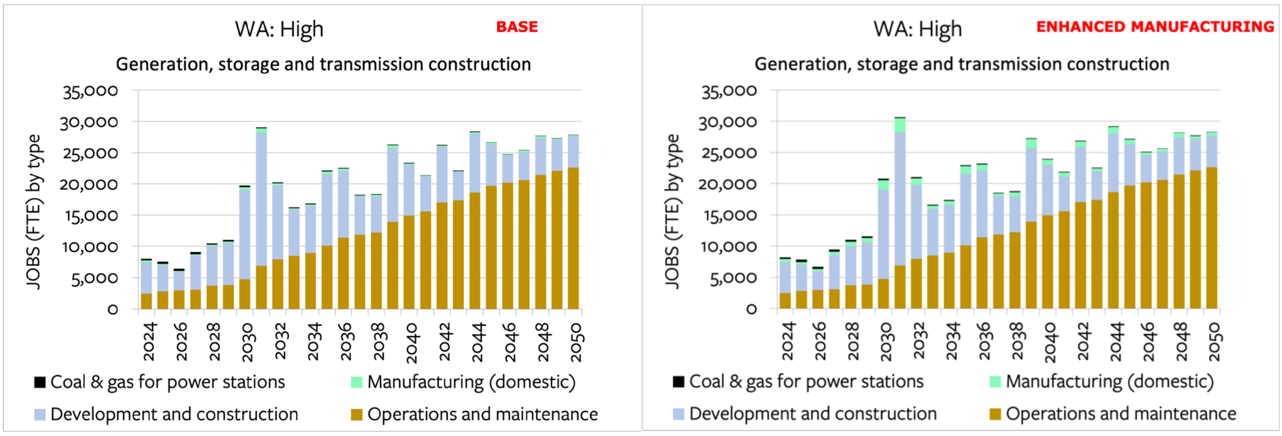


Figure 11 Change in overall employment with active policies to increase onshore manufacturing, High scenario

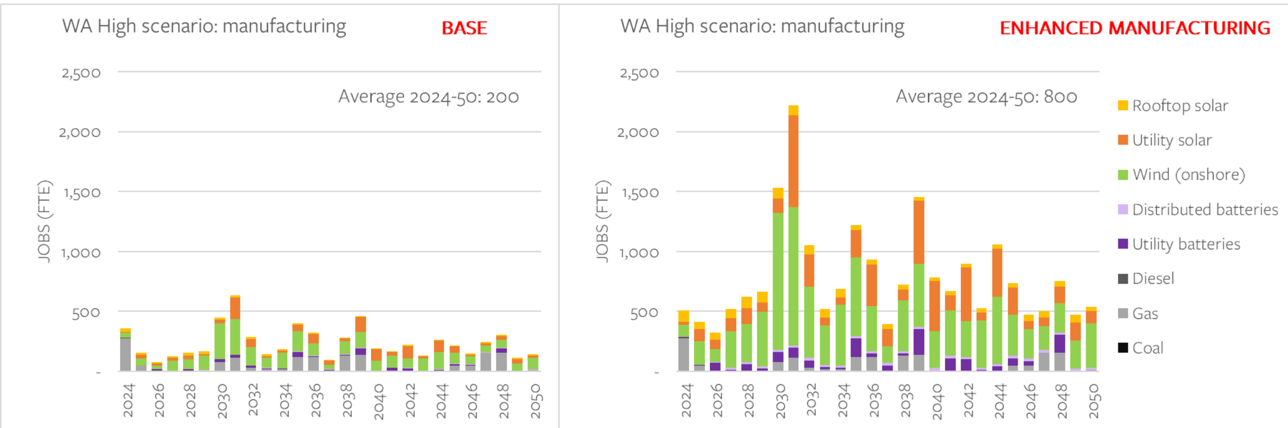
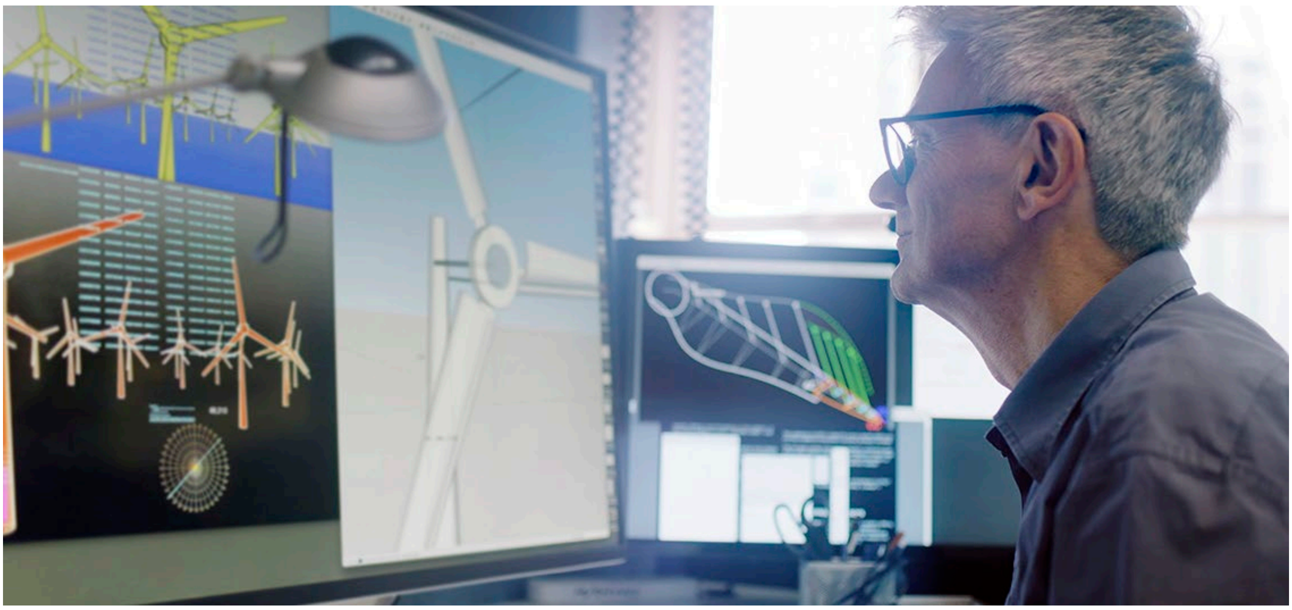


Figure 12 Change in manufacturing employment with active policies, High scenario



4.2 Hydrogen jobs – a snapshot

The hydrogen workforce is only partly included in workforce projections as part of this study. Specifically, the modelling includes only employment in the renewable energy generation to produce green hydrogen, and does not include jobs running the electrolysers or otherwise processing the produced hydrogen. As the industry is nascent, robust employment indicators for the hydrogen production element are unavailable, with many of the specifics still unknown. Research and data collection is needed to better represent the workforce involved in the production and supply chain for hydrogen. While the workforce for the associated renewable generation is likely to be the most significant numerically, the hydrogen production jobs are likely to be highly skilled and may also be subject to skill shortages. This snapshot departs from the quantitative assessment of employment and provides a qualitative assessment of employment and skills opportunities for the hydrogen sector.

Australia was one of the first countries in the world to adopt a national hydrogen strategy [12], and the sector is at various stages of development across the country. The Western Australian Government has updated their Renewable Hydrogen Strategy 2024-2030, with aims to become a producer, consumer and exporter of renewable hydrogen [13]. In 2019, The Western Australian Renewable Hydrogen Strategy was first launched, followed by the Western Australian Renewable Hydrogen Roadmap in 2020, which lays out the State's plans to build a thriving sector across the state.

Growing the hydrogen sector requires educating, skilling, up-skilling and training a workforce to be able to work across the hydrogen supply chain. Drawing on an analysis of three recent studies [14–16] of the skills and workforce requirements of the hydrogen sector, we have developed a summary of key hydrogen supply chain areas or sector phases and their associated occupations (Table 6). It is important to note that jobs in large-scale renewable projects that provide the electricity for green hydrogen production make up the bulk of the numbers needed for green hydrogen, and are not included in our modelling of the generation workforce. The skills analysis presented in Table 6 provides qualitative information only for the hydrogen production phase workforce; these workers are not included in workforce projections for this report.. We have highlighted the occupations where there is crossover and therefore competition for certain jobs/roles with the electricity sector workforce.

Across the three studies there was a general view that many of the occupations and roles exist in the current labour market, but they may need to be augmented with specialised skills for the hydrogen sector. The study conducted by Energy Skills Queensland [15] demonstrated there is strong crossover with existing roles in the coal seam gas/liquified natural gas sector, with many positions requiring minor contextualised training to transition to hydrogen, some needing some hydrogen specific training and others that have little crossover and require specialised hydrogen training. A similar study conducted in France [17], however, identified that a total of 84 professions will be required across the hydrogen supply chain, with 27 necessitating in-depth expertise, 41 requiring a basic understanding of hydrogen and 16 roles that will not need any hydrogen knowledge. As the hydrogen industry takes shape, it is essential that the energy and hydrogen sectors are approaching workforce planning collaboratively to ensure that both can succeed.

Table 6 Hydrogen jobs across business phases and supply chains

Supply chain / phase	Explanation	Associated occupations
Business development	Involves the establishment of hydrogen businesses and facilities, including the planning and design	Managers; finance, legal, research and regulatory experts; IT professionals; communications workers; community and stakeholder engagement professionals; sales; as well as a range of consultants and advisors (such as environmental, cultural heritage etc.), engineers, industrial designers.
Construction and installation	Involves the construction of facilities, and the installation of equipment	Trades and technicians; labourers; engineering trades; mechanical fitters; plumbers and gas fitters; high voltage electricians; surveyors.
Hydrogen production	Covers the production process, including water treatment, and other industrial activities associated with the production of hydrogen (green or blue)	Engineers (chemical, civil, commissioning, electrical, electronics and grid connection); technicians and tradespersons (electricians, fitter and turners, electrical fitters, process control technicians); specialists (water treatment plant operator).
Hydrogen processing	Involves processing and manufacturing hydrogen into other products such as ammonia and fuel cells, and its storage	Engineers; process operators; metallurgists; manufacturing process workers; engineering technicians; materials scientists.
Hydrogen distribution	Includes the distribution of hydrogen, including transportation of the product in various forms	Production operators and technicians; construction workers.
Operations, maintenance and safety	Involves maintaining facilities, and ensuring safe practices and workplaces (across all supply chain/phases)	Electricians; occupational health and safety officers; onsite emergency response teams; managers (engineering, maintenance, operations); inspectors.
Hydrogen as a transport fuel	Covers the process of hydrogen as a transport fuel, including the installation of refuelling stations, the transition of vehicles and equipment	Service station workers; automotive trades and technicians; electrical installers; hydrogen dispenser technicians; heavy vehicle operators; technicians and operators (refuelling); engineers.
Hydrogen as an export fuel	Includes the compression and liquefaction of hydrogen into multiple carriers, and the associated export activities	Shipping and marine logistics; engineers (chemical and grid connection); safety and quality control professionals; specialists; technicians and tradespersons.

Derived from: [14–16]. It should be noted this is an initial summary, and not an exhaustive list of potential occupations.

4.3 First Nations ownership and employment

The clean energy transformation that is underway presents an opportunity for generational change for Australia's First Nations communities. Through direct ownership or partnerships with developers, land use agreements, employment opportunities, and access to low cost, clean energy solutions for rural and remote communities dependent on costly diesel, there are many ways in which First Nations can participate in and benefit from the switch to renewables.

Western Australia has a significant Aboriginal and Torres Strait Islander population, with 3.3 percent of the population identifying as First Nations. Over 70% of Western Australia has native title in place [18], with 40% of the state exclusive native title, and roughly 8.7% of the state made of up of the Aboriginal Lands Trust estate [18]. Furthermore, under the Aboriginal Communities Act 1979, many communities across the state operate as 'community lands' with community councils governing and making by-laws related to access, land use, conduct and building safety [18]. Given this context, there is significant scope for First Nations communities in Western Australia to benefit from hosting, co/owning or partnering with renewables developers seeking to take advantage of the State's abundant solar and wind resources.

4.3.1 Ownership and partnerships

There are several mechanisms for First Nations groups to partner, own, invest or benefit from large scale renewables. In Western Australia there are already several examples of native title groups embarking on partnerships and signing Indigenous Land Use Agreements (ILUA) to scope out and develop clean energy projects. Example projects include:

- East Kimberley Clean Energy Project, an Aboriginal Clean Energy Partnership (Balanggarra Ventures Limited, MG Corporation, Kimberley Land Council, Pollination).
- Western Green Energy Hub (WGEH), a partnership between InterContinental Energy, CWP, Mirning Traditional Lands Aboriginal Corporation. ILUA signed.
- Yindjibarndi Energy Corporation (YEC), a partnership between Yindjibarndi Aboriginal Corporation (YAC) and international renewable energy company, ACEN Corporation (ACEN). ILUA signed.

4.3.2 First Nations employment in clean energy

First Nations have low representation in the energy sector, making up just 1.9% of the energy workforce [19]. Across Australia, First Nations employment is comparatively low, with just over half employed, compared to the non-Indigenous population which sits at 64.5% [20]. As Western Australia works towards its 2030 target of 80% reduced emissions from 2020 levels and net zero by 2050 [21], clean energy will be a strong growth sector in the labour market, as shown in this report. As Powering Skills Organisation has identified, while low participation of First Nations in energy sector employment is a challenge, it also is an opportunity to 'increase the supply of workers in training' [19].

A report from the First Nations Clean Energy Network identified that the same structural barriers that impede First Nations employment generally, such as housing, education and health access, impact First Nations employment in the renewables sector [20]. While there is relatively solid First Nations participation in the VET system, representation in qualifications that pertain to clean energy is low.

Increasing First Nations participation in clean energy employment requires coordination across industry, government, education and training, social services and community. There are examples of interventions and organisations that work to overcome many of the barriers:

- In the ILUA signed between Yindjibarndi Aboriginal Corporation (YAC) and ACEN Corporation, there is a commitment for preferred contracting to go to Yindjibarndi-owned businesses, and training and employment opportunities for Yindjibarndi people.
- Working across the supply chain and seeking out First Nations registered suppliers can create First Nations employment. From cultural heritage consultants, through to solar farm maintenance management contracts, First Nations businesses can be utilised to drive greater equity in the energy transition. A recent example is shown in the agreement between Ngarluma Aboriginal Corporation (NAC) and Rio Tinto to build an 80 MW solar farm on Ngarluma Country, Karratha, WA. Embedded in the agreement are commitments to ensure Ngarluma businesses can contract for work throughout the solar farm's development.
- Real Futures is an organisation working across WA (and Australia), to empower First Nations Australians through programs focused on job-readiness, employment and capacity-building for both industry (through cultural competency training) and for community. Its 'Real Jobs For Mob' is co-designed and community-led, and offers holistic employment and training support in eight locations across WA.
- The WA government, through Jobs and Skills WA, works with businesses and First Nations stakeholders across the state to increase First Nations' workforce participation. This includes specialised support for First Nations jobseekers, a dedicated First Nations jobs board and industry support for culturally inclusive and aware workplaces.
- Making sure that workplaces (and places of learning and training) are culturally safe is fundamental to growing First Nations participation in the clean energy sector. Organisations like CareerTrackers, which works across the country, work with both employers and in its case, First Nations university students interning, to create culturally safe and mutually beneficial working environments.

5 Workforce projections by technology

Wind and solar is anticipated to grow significantly in WA over the next decade. Figure 13 shows the share of jobs across all technologies in WA according to a High and Low scenario.

Under the High scenario, wind will demand 38% of the electricity sector workforce, with utility solar demanding the next largest share at 28%. Coal, gas and diesel require 11% of the workforce on average, due to a percentage of gas projected to remain in the energy generation mix to 2050. Under the Low scenario, coal, gas and diesel require a larger percentage of the workforce, at 20%. Utility solar and wind still make up considerable portions of the workforce, with 27% and 24% shares, respectively.

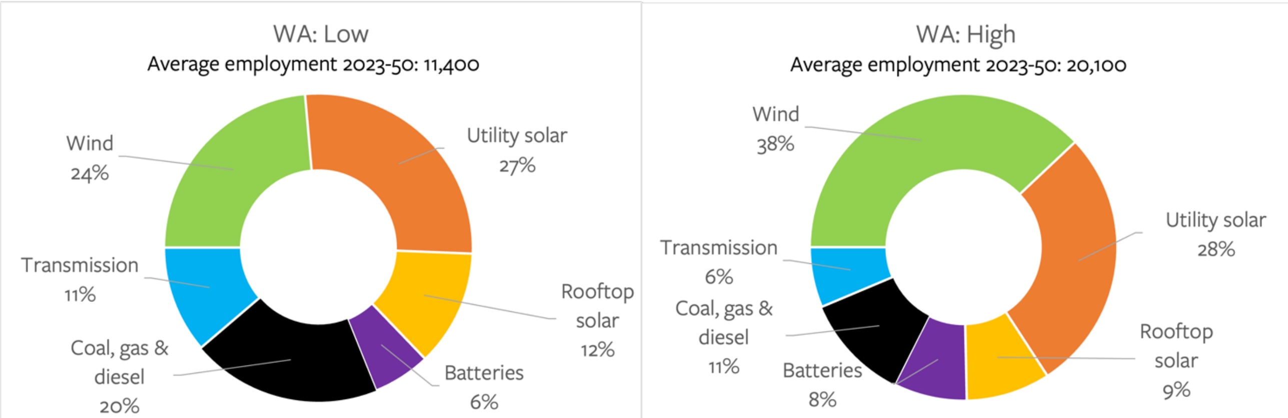


Figure 13 WA, average electricity sector jobs by technology and scenario

Figure 14 shows annual workforce demand by technology between 2024 and 2050. Workforce growth is highly concentrated in wind, utility solar and transmission construction. This is driven by major growth in installed capacity in the SWIS, Pilbara and Offgrid regions in WA. Employment in gas remains steady through to 2050, with a small amount of growth in the late 2040s due to new generation capacity entering the electricity mix.

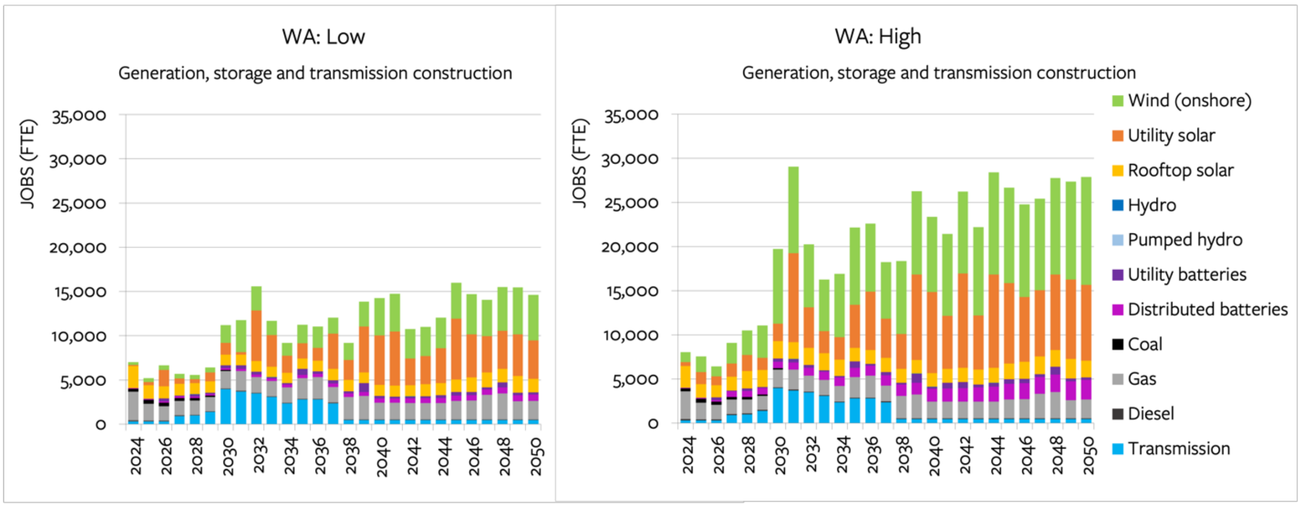


Figure 14 WA, annual jobs by technology, both scenarios

5.1 Wind

Wind is projected to be a major employment generator across WA. Most of the growth in employment in wind is projected to occur over the next seven years to 2031, with the first peak occurring in the same year for both scenarios. In the 2030s and 2040s, there are a few subtle peaks and troughs in employment. Wind repowering describes the repair or replacement of turbines and associated components when they reach their end of life. A very small amount of employment is projected to occur starting from the second half of the 2040s, and this proportion of the workforce will continue to grow as the stock of turbines reach their end of life. The Low scenario does not feature any workforce demand associated with repowering due to the delayed nature of the construction build, and with the long service life of wind turbines, the repowering workforce is pushed later in the 2040s. Jobs in wind average at 7,600 FTE in the High scenario and 2,700 FTE in the Low scenario.

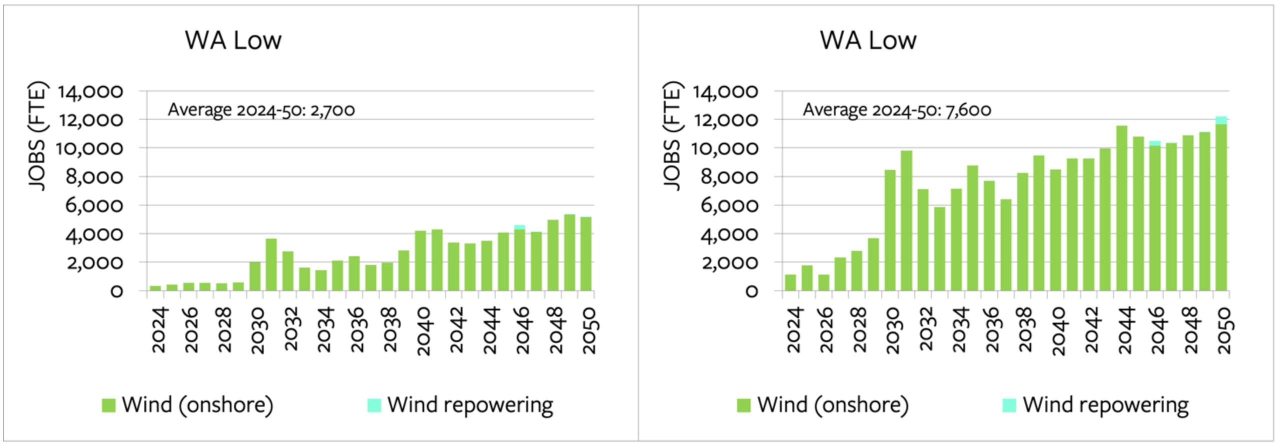


Figure 15, WA jobs in wind, both scenarios

5.2 Utility-scale solar

Solar farms are also expected to drive significant employment growth, however, the growth profile of employment in this sector is highly volatile. In the High scenario, there is a major growth spike in employment of 8,000 FTE in just one year between 2030 to 2031 , then employment declines by 5,400 FTE in the following year. These rapid periods of growth and decline are visible right to 2050 in both the High and Low scenarios, presenting a compelling case for needing to smooth the pipeline of projects. Jobs in utility-scale solar average at 5,600 FTE in the High scenario and 3,100 FTE in the Low scenario.

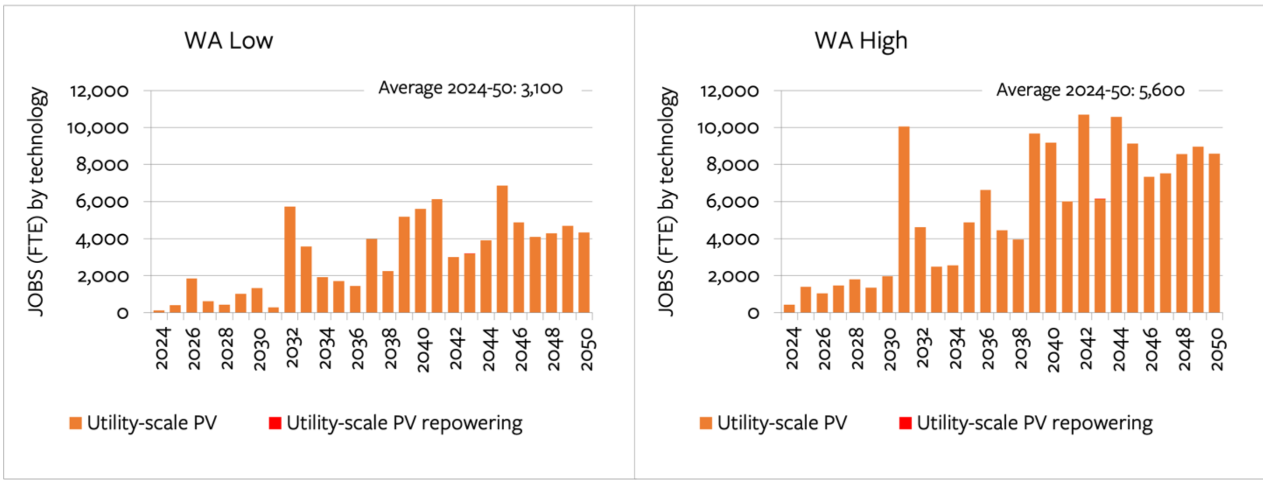


Figure 16 WA jobs in utility-scale solar, both scenarios

5.3 Rooftop solar and distributed batteries

Rooftop solar employment associated with new installations is expected to experience a slight decline in the next few years, then start to grow again later this decade as solar panels are repowered. Distributed batteries jobs experience quite rapid and sustained growth, particularly in the High scenario.

The reason for the decline in rooftop solar may be due to the employment decline factor built into the model to simulate efficiency improvements in the time it takes to install the technology.

Rooftop PV repowering is anticipated to provide employment from the mid-2030s onwards as panels reach their useable lifetime and are replaced or upgraded for larger capacity. We assume that panels reach the end of their life after 25 years, and that 80% of panels will be repowered.

Average employment in rooftop solar, repowering, and the accompaning distributed battery storage technology is expected to be 3,000 FTE for the High scenario and 1,800 for the Low scenario.

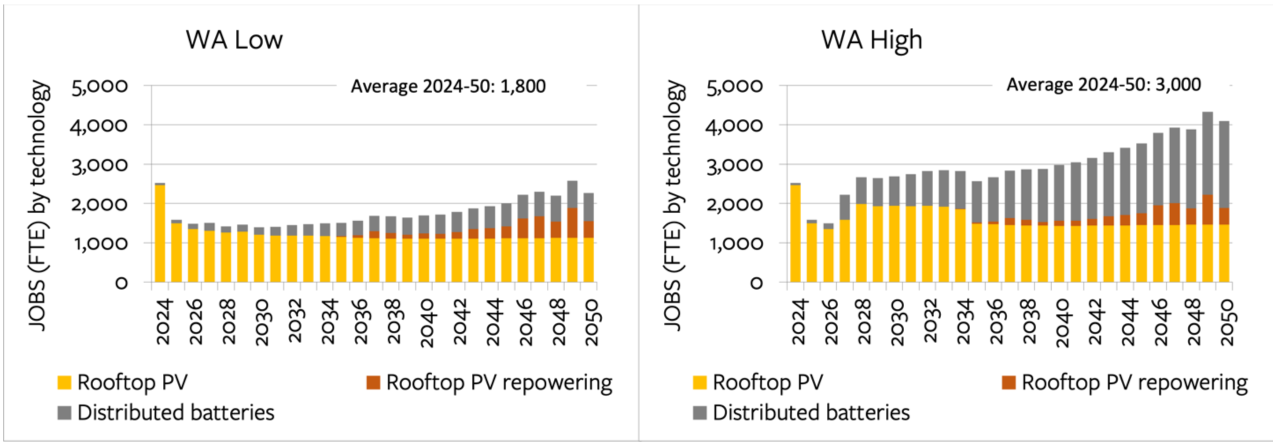


Figure 17 WA jobs in rooftop PV and distributed batteries, both scenarios

5.4 Large scale storage

Utility-scale battery storage is very similar across the two projected scenarios. The main difference in the High scenario is the slight increase in installed capacity in the couple of years after 2040. Job growth is quite variable, but with smaller growth and decline than in other technologies. Construction project timelines have been set at one year for batteries, however, if projects tend towards multi-year this workforce pipeline is likely to smooth out. Employment demand peaks in 2035, 2039 and 2048 in the High scenario, with approximately 700, 1,000 and 900 FTE respectively.

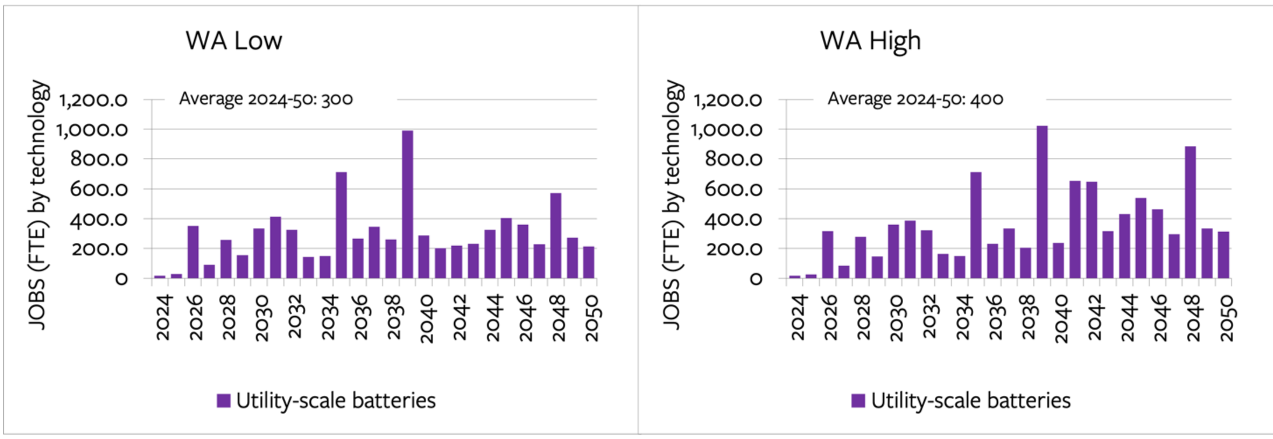


Figure 18 WA, jobs in utility-scale batteries, both scenarios

5.5 Transmission construction

The employment profile for transmission construction is presented in Figure 19. Jobs peak at almost 4,000 FTE in 2030 and then decline slowly to almost 2,400 FTE by 2037. Jobs drop sharply in 2038 to about 450 FTE and remain at this level through to 2050. Only one transmission scenario was presented in energy scenario data, so it is assumed this applies to both the High and the Low scenarios.

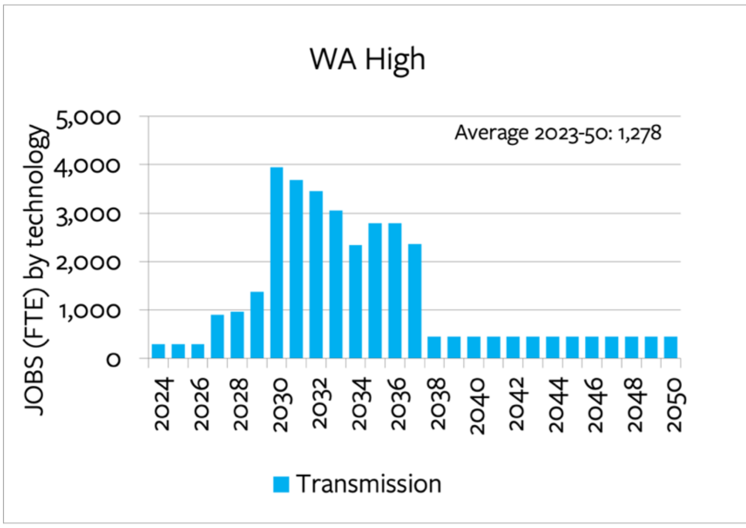


Figure 19 WA, jobs in transmission construction, High scenario

5.6 Coal, gas and diesel

Employment in the fossil fuel generation sector declines slightly to 2030 and remains steady until 2050 with small peaks in increased employment demand. Employment in coal generation ceases by 2030 as existing plants, which are not suited to ramping up and down to firm renewables, retire. Gas generation employment however, continues to 2050 as gas plants are more flexible and therefore better suited to firming renewables when battery capacity is exhausted. Diesel remains a small part of the generation mix and is largely used to firm renewables in isolated power systems which don't have access to reticulated gas.

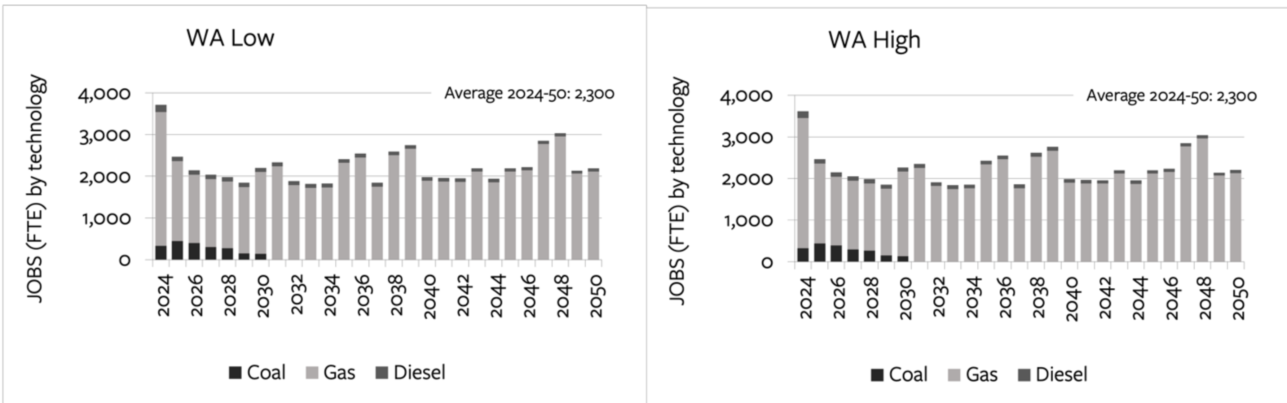


Figure 20 WA, jobs in fossil fuels, both scenarios

6 Workforce projections by region

A regional workforce demand profile is important for workforce planning, appropriate location of training and development activities, and providing community services to workers and their families. To achieve this, it is essential to understand the number of workers likely to be temporarily or permanently located in areas featuring new construction projects or ongoing operations and maintenance requirements and when this demand is likely to happen. Regional workforce demand profiles also allow for planning to maximise the opportunities for local workers to benefit from job opportunities, especially the longer term roles in operations and maintenance.

Figure 21 provides a profile of workforce projections for four regions: the SWIS, Pilbara, Offgrid and Horizon Towns regions. Major workforce demand is concentrated in the SWIS and Pilbara regions. An average of 11,300 jobs is anticipated to be located within the SWIS, and 6,700 jobs in the Pilbara region. The Offgrid region is a vast area covering all the regional and remote locations outside of the major centres, stretching from the very south of the state right up to the northern tip. Average jobs across this region are 2,200 FTE. Horizon Towns feature a very small amount of employment in comparison, averaging 200 FTE between now and 2050.

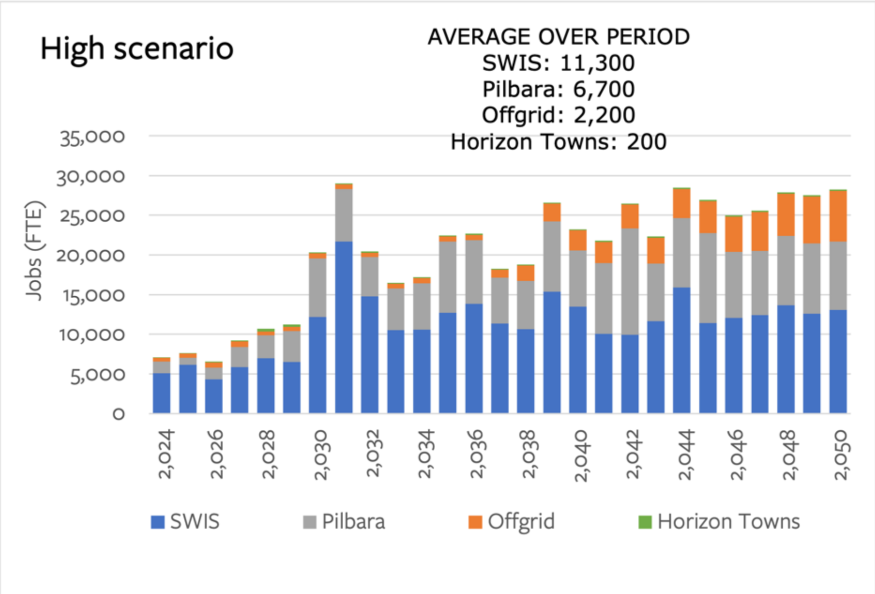


Figure 21 Annual regional jobs projections for WA, High scenario

6.1 SWIS

High scenario

The SWIS region experiences major jobs growth in wind, utility-scale solar and transmission.

- The region features a rapid spike in employment growth in transmission construction jobs in 2030, at almost 2,900 FTE jobs which remains for most of that decade.
- Growth in wind jobs is steady until 2030 when they spike rapidly by almost 2,000 FTE in just one year.
- Jobs in utility solar remain low until 2031 when they increase by 8,600 FTE. Jobs in solar farms fluctuate significantly throughout the 2030s. Employment volatitility decreases in the 2040s but still sees periods of rapid growth and decline.
- Jobs in gas increase slightly during the late 2030s and 2040s due to an increase in anticipated capacity.
- Jobs in rooftop solar decline by around 1,000 FTE due to efficiency gains expected between now and 2050.
- A small amount of employment is anticipated in utility-scale batteries, peaking at 600 FTE in 2035

Low scenario

Wind jobs are significantly reduced in the Low scenario, with jobs growth occuring much later.

- Wind jobs peak in 2050 at 2,400 FTE.
- Jobs in batteries peak at 700 FTE in the same year.
- Solar farm jobs peak at 5,200 FTE in 2032.

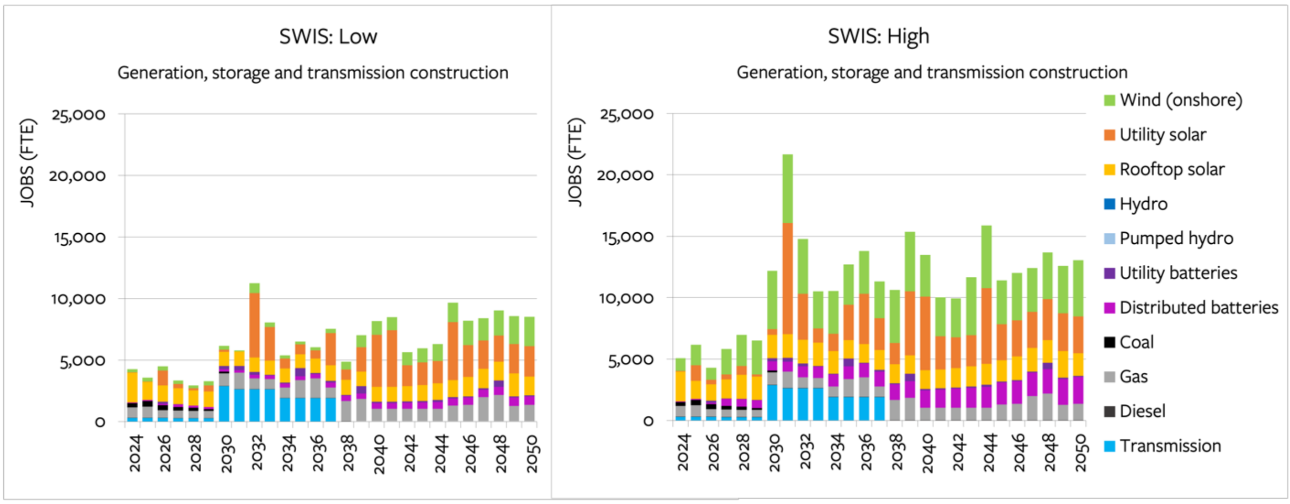


Figure 22 SWIS annual jobs by technology, both scenarios

6.2 NWIS/Pilbara

6.2.1 Employment Projections

High scenario

Jobs in the Pilbara are predominantly in gas and utility solar for the next few years, after 2030 wind and solar start to dominate the generation profile.

- Transmission construction jobs peak between 2029 and 2031, around 1,000 FTE, which then drops down to 450 FTE and remains steady to 2050, aside from another small peak in the mid 2030s.
- Wind jobs pick up from 2030 with growth of 3,300 FTE in just one year. Workforce demand in wind remains strong to 2050. Wind jobs peak in 2035 at 5,600 FTE.
- Solar farm jobs start to grow in earnest from the mid 2030s, peaking at almost 7,000 FTE in 2042.
- Gas jobs decline very slightly between now and 2050.
- Utility batteries experience small jobs growth in 2028 at almost 300 FTE. Greater growth is anticipated during the 2040s but still remains small in comparison to other technologies, peaking at just over 600 FTE.

Low scenario

Jobs during peak employment are around half of those anticipated in the High scenario. Growth is much slower, with peaks occuring much later, during the 2040s.

- Wind jobs peak at 2,200 FTE in 2030.
- Jobs in utility solar peak at 3,100 FTE in 2039.

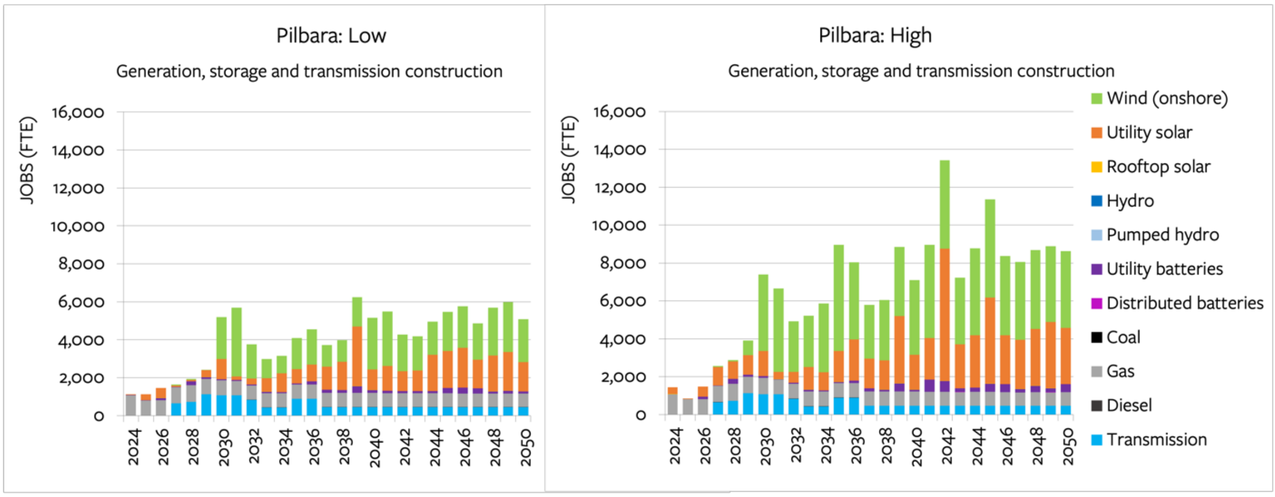


Figure 23 Pilbara annual jobs by technology, both scenarios

6.2.2 Pilbara: the labour market context

In order to place the employment modelling projections in context, a profile of the economy and labour market in the Pilbara was undertaken. The Pilbara regional economy is growing strongly, with gross regional product estimated to have more than doubled from $40 billion in 2018 to almost $90 billion 2024 (Remplan 2025), reflecting increased export prices for commodities such as iron ore. Based on the 2021 census, the size of the workforce in the Pilbara region is estimated to be just under 60,000. The extensive use of FIFO workers makes it difficult to assess the regional labour supply because it is imperfectly measured. ABS surveys ask for 'usual residence' in the past 6 months, and an unknown number of respondents will record the Pilbara or their home residence from another region or inter-state [22]. However, based on Remplan data, the population has been quite stable from 2018 onwards, declining slightly before recovering to 60,000 by 2023 (Remplan 2025).

The Pilbara economy is dominated by mining which comprises almost 90% of output. However, as mining is a capital-intensive sector, only just over half the total workforce is in mining. Construction is the second largest employer with over 10% of the workforce. A collection of service sectors such as accommodation and food services, health services, administrative support are also major employers. Both manufacturing and electricity, gas and water together account for less than 3% of the workforce.

Almost one-quarter of the workforce is concentrated into three key occupations associated with iron ore mining – drillers, miners and shot firers (10.3%), metal fitters and machinists (8.1%) and other building and engineering technicians (4.5%). The two other largest occupations – electricians (4.6%) and truck drivers (4.1%) – are both significant occupations within the renewable energy sector.

The occupational profile of the workforce in the Pilbara is illustrated in Table 7. Just under one-in-five workers are in occupations with the best alignment with the renewable energy workforce.

6.2.3 Implications for Renewable Energy Development

Firstly, the context for sourcing labour for renewable energy projects in the Pilbara region is atypical and challenging. Labour utilisation appears high. In the 2021 census, over 67% of respondents were in the workforce – higher than the national average – but a very high 19% did not state their status. There was also a higher proportion of full-time employment, and wages were very high. The median weekly income for both individuals and households was almost double the average in Western Australia and Australia [23].

Table 7 Key occupations, Pilbara

1-Digit Occupations % of Pilbara workforce		4-Digit Occupations, Major Occupations for the renewable energy workforce	Volume	% of total workforce
Managers	7%	Construction Managers	254	0.5%
		Engineering Managers	131	0.2%
		Production Manages	908	1.6%
Professionals	13%	Civil Engineering	244	0.4%
		Electrical Engineers	177	0.3%
		Occupational & Environmental Health	490	0.9%
Technicians & Trades	32%	Civil Engineering Draftspersons & Technicians	32	0.1%
		Electrical Engineering Draftspersons & Technicians	262	0.5%
		Mechanical Engineering Draftspersons & Technicians	64	0.1%
		Safety Inspectors	90	0.2%
		Electricians	2575	4.6%
		Motor Mechanics	697	1.3%
		Electrical Distribution Trades Workers	24	<0.1%
Community & Personal Service	5%	-	0	
Clerical & Administrative	7%	-	0	
Sales	3%	-	0	
Machinery Operators & Drivers	24%	Crane, Hoist & Lift Operators	481	0.9%
		Earthmoving Plant Operators	615	1.1%
		Truck Drivers	2305	4.1%
Labourers	10%	Concreters	101	0.2%
		Construction labourers	864	1.6%
Total	100%	Major occupations for renewables	10,314	18.2%

Source: ABS Census 2021.

There may be some potential to utilise the construction workforce and electrical contractors (depending on the state of the labour market in the Pilbara), but the high labour utilisation and wages of the mining sector would make it very difficult for the renewable energy sector to attract either new entrants or the existing workforce. Secondly, there may be some potential to recruit from the unemployed and people out of the workforce for entry-level jobs on solar farms. Almost 15% of the population is First Nations which is much higher than the national average of 3.8% (ABS 2021). There have been some cases of solar farms using pre-employment programs for First Nations people as a source of labour for solar farm construction (Vorrath 2023). Thirdly, there could be opportunities to create apprenticeship and traineeship programs for school students, including First Nations students. Past work has found, for example, high interest from wind farm operators in apprenticeship programs for mechanical technicians due to skill shortages and challenges attracting existing trades workers (Briggs et. al. 2024). It is also possible there are technical innovations that reduce the volume of employment required such as redeployable solar farms and further automation on solar farms (Chamber of Minerals and Energy WA 2023). Notwithstanding these options, in practice, there is likely to be an extremely high dependence on FIFO workers. The employment peaks of 10,000–14,000 are significant enough that there will need to be other supporting programs (e.g. housing) to manage an influx of FIFO workers that would be required.

6.3 Horizon Towns

Horizon Towns features a mix of employment across a range of generation technologies. Most of the employment this decade is in gas, diesel, and rooftop solar.

- Jobs growth in wind is relatively small, peaking at 40 FTE by 2029.
- Solar farm jobs see more potential, with significant growth of around 200 FTE anticipated in 2028. These numbers drop by 2030 though to around 50 FTE.
- Utility batteries experience a small peak in employment of just under 60 FTE in 2028 and then drop significantly during the 2030s and 2040s to a handful of roles.
- There is no employment growth anticipated for rooftop solar or distributed batteries.
- Diesel and gas jobs remain relatively steady across the period.

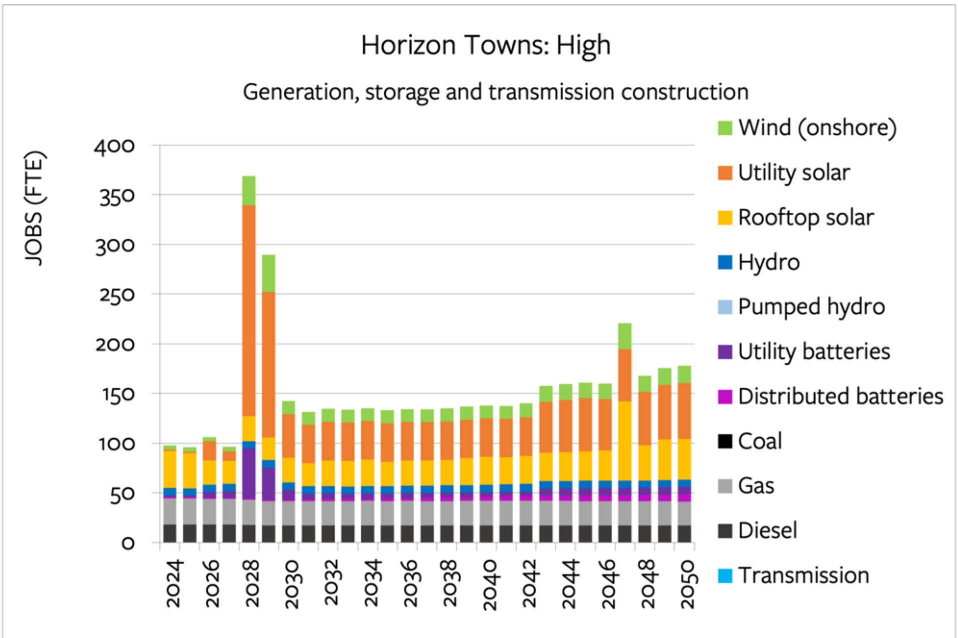


Figure 24 Horizon Towns, annual jobs by technology, High scenario.

7 Discussion and conclusion

7.1 Skill shortages

The rapid increase in the requirement for in-demand occupations during the early 2030s brings with it a high risk of skill shortages which could impact the achievement of Western Australia's energy transition. Skills shortages create the risks of delays and increased project costs (e.g. wage inflation, recruitment costs and liquidated damages), and increase the cost of capital for future projects to reflect increased risk.

Skill shortages in energy sector construction are a global problem [24], which may exacerbate workforce supply issues in Western Australia, as bringing in expertise from elsewhere may be increasingly challenging. The same shortages are evident on the east coast of Australia.

Several jobs plans have been produced recently, with recommendations on growing the clean energy workforce, including the following:

- The Clean Energy Generation [25]
- Powering First Nations Jobs in Clean Energy – Report for the First Nations Clean Energy Network [20]
- The Queensland Renewable Energy Jobs Plan [26]
- NSW and Victorian workforce plans (in development)

Powering Skills Organisation, the primary Skills Council for the Australian electricity sector, has identified a range of key challenges to expand the capacity of the training system to increase the energy workforce. These include the lack of diversity in the workforce, the lack of coordination across sectors, the shortfall in VET trainers, and inefficiencies and gaps in energy training packages [27]. These challenges are all present in Western Australia.

As of 1 July 2024, the Australian Skills Guarantee introduced mandatory targets for 10% 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. Mandatory targets are already being implemented in Western Australia via the Western Australia Priority Start program.

7.2 Boom and bust cycles

The expected trajectory of the construction workforce requirements to deliver the energy infrastructure needed for the energy transition is shown in Figure 25. The profile is highly variable, with increases of nearly 14,000 in just two years from 2029 to 2031 in the High scenario, followed by almost the same reduction in the two years to 2033. In the Low scenario the rise is not so high, however, growth of 8,000 is still required in the two years to 2031. These peaks are followed by rapid declines.

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 workers in other parts of the economy, most notably resources, by the fact that much of the infrastructure is in rural areas with restricted labour supply, and by the likelihood that the renewable sector will be offering lower wage levels.

The troughs increase the difficulty of putting effective training programmes in place as the pipeline is not steady, and the volatility creates a major workforce attraction and retention issue. It could be possible to bring forward projects to avoid these sharp fluctuations, especially in cases where public bodies are involved in the construction arrangements through some form of public procurement in the case of transmission. construction.

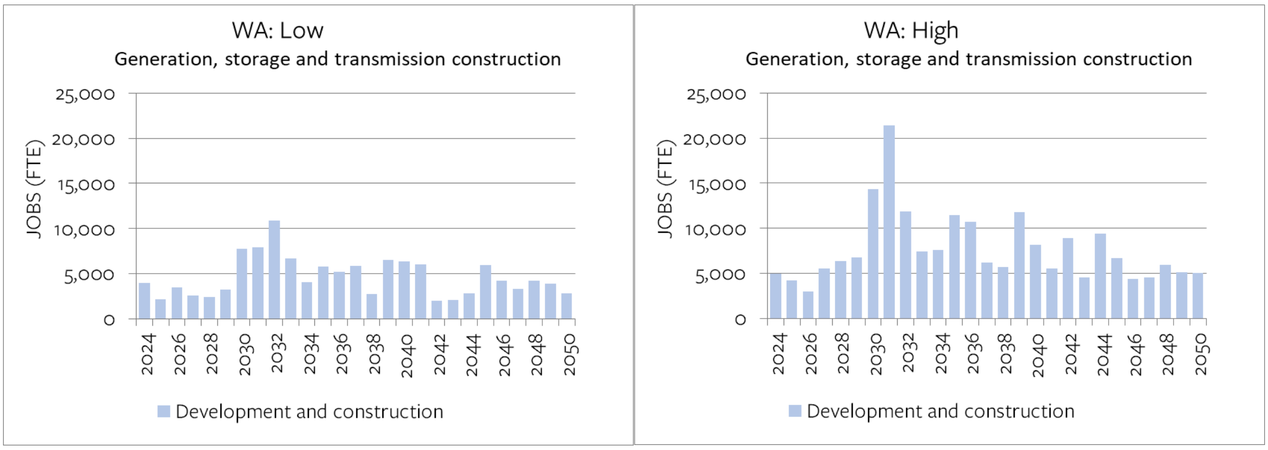


Figure 25 WA, development and construction workforce, both scenarios

7.3 Conclusion

The Western Australian electricity sector workforce is projected to experience rapid periods of growth over the next decade followed by small declines in employment demand. This is in line with the anticipated growth in renewable energy generation construction over the next decade. The number of operations and maintenance roles grows steadily with a growing pool of renewable generation capacity, providing the potential for ongoing job security. In the near term, electricity sector employment would benefit from measures that smooth employment peaks and reduce the boom-bust nature of employment demand driven by construction. In addition to smoothing the employment profile, the total workforce will need to grow to meet both the initial construction growth and to provide operations and maintenance support over the longer term.

The electricity sector will compete for workers with other sectors, such as mining and building construction. A coordinated approach to workforce projections and planning is needed to understand the broader implications across the economy of workforce or skills shortages, particularly for skilled workers in high demand in the case of electricians.

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