Employment, Skills and Supply Chains: Renewable Energy in NSW

Prepared for Department of Planning, Industry and Environment on behalf of the Renewable Energy Sector Board by UTS Institute for Sustainable Futures and SGS Economics and Planning

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About the authors

ISF is an independent research institute within the University of Technology Sydney. We conduct transdisciplinary, project-based research in line with our vision of creating positive change towards sustainable futures.

SGS Economics and Planning is a public policy advisory business informing important policy and investment decisions for more sustainable cities and regions.

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Acronyms

Acronym	Description
ABS	Australian Bureau of Statistics
AC	Alternating current
AEMO	Australian Energy Market Operator
ARENA	Australian Renewable Energy Agency
ASI	Australian Steel Institute
BESS	Battery Energy Storage System
CAPEX	Capital expenditure
CEFC	Clean Energy Finance Corporation
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CWO	Central-West Orana
DC	Direct current
DDSG	Direct drive synchronous generator
DPIE	Department of Planning, Industry and Environment
EPC	Engineering, procurement and construction
ESI	Electricity Supply Industry
ESG	Environmental, social and governance
FIFO	Fly in, fly out
FTE	Full-time equivalent
GRP	Gross regional product
GTO	Group training organisation
GW	Gigawatts
HDPE	High density polyethylene
ICN	Industry Capability Network
IRENA	International Renewable Energy Agency
IRMA	Initiative for Responsible Mining Assurance
ISF	Institute for Sustainable Futures
ISP	Integrated System Plan
JEDI	Jobs and Economic Development Impact
LQ	Location quotient
LTESA	Long-Term Energy Service Agreement
MW	Megawatt
NREL	National Renewable Energy Laboratory
NSW	New South Wales
OEM	Original Equipment Manufacturer
OPEX	Operational expenditure

Acronym	Description
PHS	Pumped hydro storage
PPA	Power purchase agreement
PV	Photovoltaic
RDA	Regional Development Authority
REDS	Regional Economic Development Strategies
RESB	Renewable Energy Sector Board
REZ	Renewable Energy Zone
SA	South Australia
SAP	Special Activation Precinct
SME	Small to Medium Enterprise
STEM	Science, Technology, Engineering and Mathematics
SW	South-west
TAFE	Technical and Further Education
TAS	Tasmania
UON	University of Newcastle
VRET	Victorian Renewable Energy Target
WA	Western Australia

Executive Summary

On behalf of the NSW Renewable Energy Sector Board, the NSW Department of Planning, Industry and Environment (NSW DPIE) commissioned the Institute for Sustainable Futures (ISF), University of Technology Sydney and SGS Economics and Planning (SGS) to identify and assess employment and industry development opportunities under the *Electricity Infrastructure Roadmap* and the establishment of Renewable Energy Zones (REZs) in five regions of NSW.

Under the NSW *Electricity Infrastructure Roadmap*, electricity generation, transmission and storage will be constructed to replace coal-fired power generation scheduled to close within the next 15 years. The *Electricity Infrastructure Investment Act 2020* sets a minimum target of 12 GW of new generation and 2 GW of long-duration storage to be constructed by 2030.

To achieve these targets, five REZs have been established to coordinate investment in new renewable energy generation and transmission infrastructure. The REZs are Central-West Orana, New England, South-West, Hunter-Central Coast and Illawarra.

This report forms advice to the NSW Renewable Energy Sector Board (RESB), which will then develop a plan for the Minister for Energy and Environment on how to cost-effectively maximise local industry development and employment, and opportunities for apprentices and trainees, as REZs are established in NSW.

This Report:

- details our understanding of renewable energy supply chains, employment and skills
- identifies opportunities and barriers to building local capacity and employment
- recommends actions to realise the opportunities.

To complete the report, we:

- analysed workforce and skill requirements across the renewable energy project lifecycle, including inputs, construction, operation and maintenance, decommissioning/recycling and training and education
- developed a baseline of the current state of each REZ's involvement in the entire renewable energy supply chain, as well as their industry, training and labour market capacity
- mapped opportunities across renewable energy supply chains from cradle to grave, including raw material supply and processing (e.g., cement, steel and copper); manufacturing and construction of electricity infrastructure; and the back end of the supply chain (such as recycling)
- assessed opportunities, barriers and strategies to increase local industry development, employment and training.

Our research involved:

- desktop literature review, analysis and modelling
- stakeholder engagement including interviews, workshops in each of the REZs and an online survey of businesses
- input from the RESB and its reference group through workshops to review draft reports.

The report contains the following sections, with key findings highlighted in this executive summary:

- Section 2: Employment and material projections
- Section 3: Renewable energy supply chains
- Section 4: NSW Renewable Energy Zone baseline data
- Section 5: Opportunity evaluations
- Section 6: Barriers
- Section 7: Actions.

We use the term 'local' to mean NSW or specific regions; this differs to the Victorian Renewable Energy Target, which defines 'local' as Australia and New Zealand.

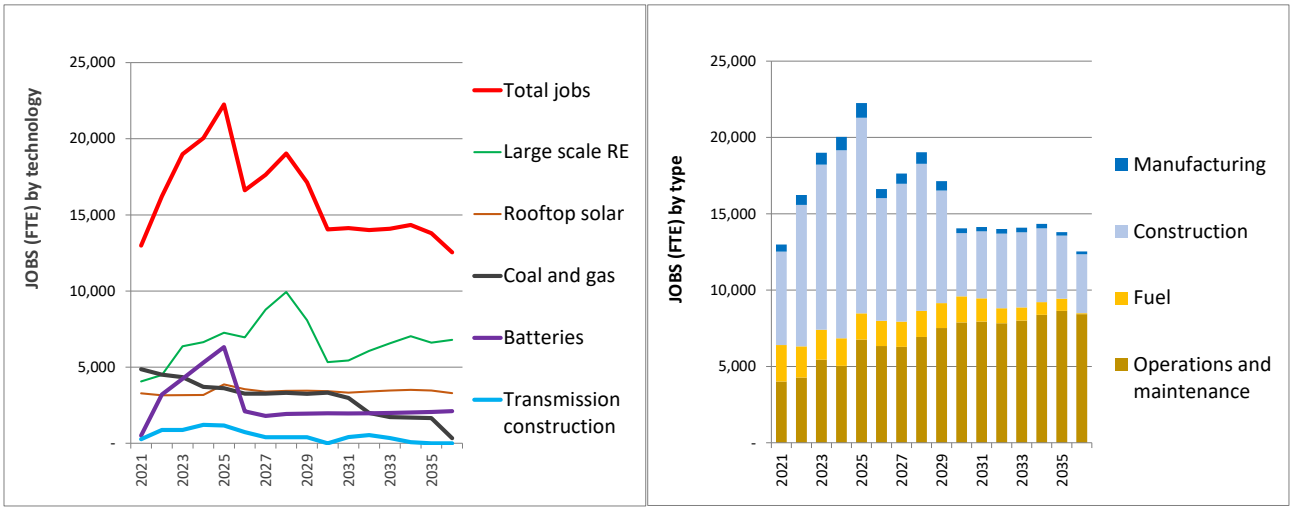
Throughout the report, the Electricity Infrastructure Roadmap will be referred to as 'the Roadmap'.

Employment and material projections

The pace of change within the electricity sector and uncertainty over the timing and composition of the future renewable energy supply makes forecasting employment challenging. For these projections, we developed a 'NSW REZ' scenario by adjusting projected uptake in renewable energy and storage technologies from the Australian Energy Market Operator's (AEMO) *2020 Integrated System Plan* (ISP), which is based on modelling commissioned for the Roadmap. This brings forward the installation of solar, wind, pumped hydro storage and battery storage in line with NSW plans and, therefore, also employment and material demand.

Total employment in the electricity sector fluctuates between 14,000 to 22,000 workers over the next 15 years, with the peaks leading up to 2025 and 2030 reflecting projected construction activity (Figure 1). Most jobs will be in large-scale renewable energy with smaller contributions from battery storage, rooftop solar and transmission construction. Over time, the level of employment in operations and maintenance increases from less than a third to well over half of jobs as the fleet of generation builds.

Figure 1 Employment by technology and type, electricity generation & transmission construction (NSW REZ), 2021-2036



Note: These figures do not include ongoing employment in electricity transmission networks, distribution networks and electricity retailing; rather, they show employment that can be influenced under the NSW Electricity Infrastructure Roadmap – the construction, operation & maintenance and manufacturing of renewable energy generation and storage, transmission construction, employment in coal and gas generation, and associated mining.

A range of Australian energy strategies and roadmaps are including 'energy superpower' scenarios involving large-scale electrification, heavy industry growth and hydrogen exports; if these are realised in NSW, employment in renewable energy will be significantly larger. The high scenario in Australia's *National Hydrogen Strategy* estimates electricity demand would be more than four and a half times the size of the National Electricity Market (COAG Energy Council 2019), resulting in growth in construction and O&M employment and opportunities for local manufacturing based on greater market scale.

The leading source of employment demand is for trades and technicians, followed by professionals and managers, and labourers, with the highest growth in electricians, finance and business professionals, construction labourers, mechanical technicians, construction managers and engineers.

The primary opportunities to increase local employment are:

1. **Increasing local employment in project phases undertaken locally.** While project development, transport and distribution, construction and operations and onsite maintenance are undertaken locally, the workforce may be recruited from other regions of NSW, inter-state or internationally, whether the role is professional, trade or labourers. There are opportunities to increase local employment, and develop apprentices and trainees, especially given that increased local recruitment in the operations and maintenance phase can create permanent regional employment.

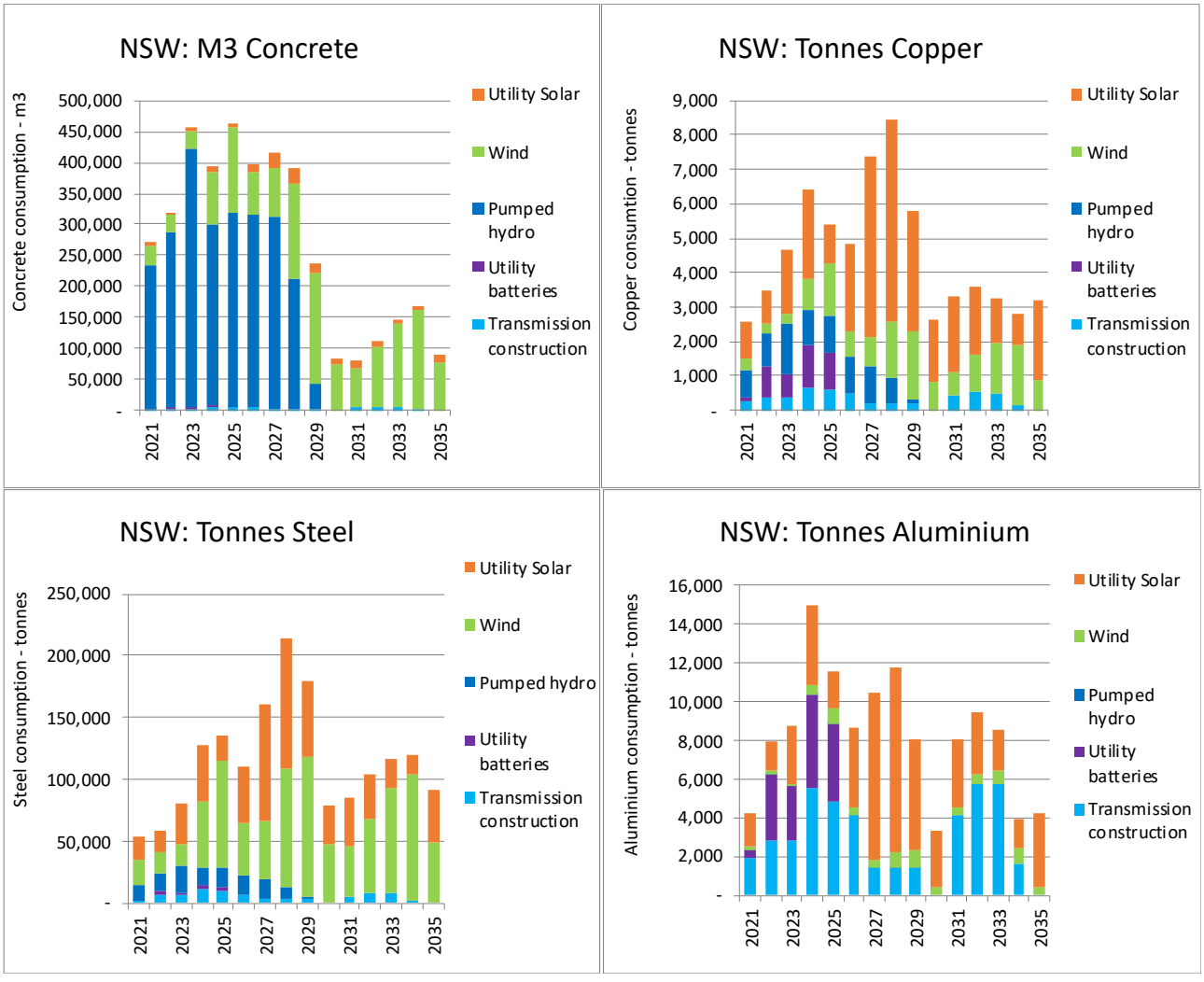
2. **Increasing local industry involvement across the supply chain.** While official data is not available, local content up and down the supply chain in mineral processing, manufacturing and offsite maintenance is widely agreed to be low. The manufacturing employment in Figure 1 reflects the share of Australian industry based on a 2019-20 survey (Briggs et. al. 2020) rather than a projection; consequently, there are opportunities to increase NSW jobs beyond this figure, especially due to the scale of the build-out, longer timeframe and coordinated approach to development, which is a first for Australia. The emerging end-of-life opportunities of recycling and re-use are also not reflected.

In generating projections for key inputs on the material demands (Figure 2) we found:

- substantial demand for concrete, overwhelmingly driven by pumped hydro energy storage (PHES) with significant contributions from wind farms, with the timing of PHES construction having a major influence on concrete demand
- wind towers, PHES and solar farms will generate significant demand for steel, although transmission towers are a minor contributor to demand
- copper demand is lower than steel, and driven primarily by solar farms, as well as PHES, wind farms and, to a lesser extent, utility batteries and transmission towers
- aluminium demand is also lower than steel, primarily required by solar farms with secondary demand from utility-scale batteries and transmission towers.

Note that these projections do not separate local and imported content. With the exception of concrete, most material inputs are embodied in imported components. If NSW increases local production of components such as wind towers there will be a significant increase in demand for local steel.

Figure 2 Concrete, copper, steel and aluminium requirements, NSW REZ scenario



Renewable energy supply chains

In identifying opportunities to increase local industry involvement upstream and downstream in the supply chain, from the construction then operations and maintenance phases, we have mapped the supply chain for each technology upstream from mining through mineral processing to manufacturing, and downstream to include end-of-life and recycling. Our value breakdown is based on publicly available data. Each supply chain map identifies material inputs, as well as areas of existing industry or where there could be opportunities for industry to develop.

Table 1 outlines our key findings - see section 3 for the detailed supply chain maps and value breakdown for each technology.

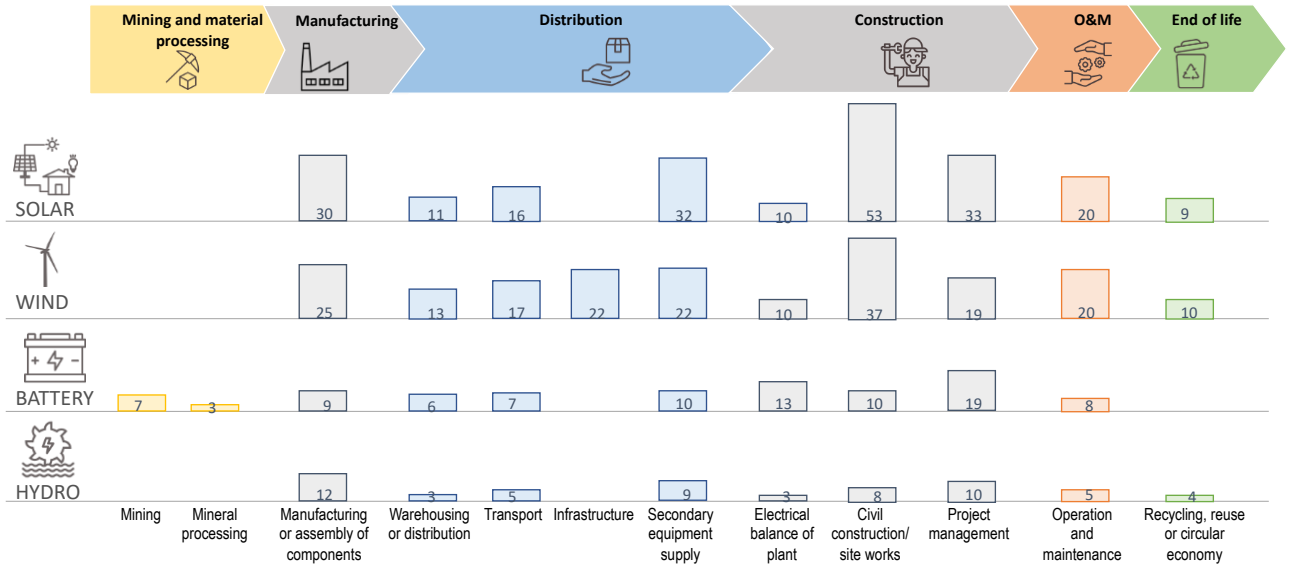
Table 1 Overview of renewable energy technology supply chains

	Mining and mineral processing	Manufacturing	Construction	O&M and end-of-life
Wind	Existing capacity in coal, copper ore and fly ash inputs Opportunities in rare earths and nickel oxides	**47% of value** Local content is low outside turbine foundations Major opportunity in wind towers (10%) and local steel supply Other opportunities in assembly (e.g., drive-train assembly 9%, nacelle structural assembly 5%)	**22% of value** High local content in development, planning, finance and onsite construction Opportunity for increased local employment	**O&M 31% of value** Some growth in offsite repair (e.g., gear boxes) but potential limited due to centralised global repair centres Future employment in recommissioning Opportunities to develop/increase recycling
Solar	Existing capacity in coal, copper ore, silver ores and fly ash inputs	**30% of value** Low local content Opportunities in solar mounting and racking and local steel supply Other opportunities in electrical balance of plant	**60% of value** High local content and opportunity for increased local employment	**O&M 10% of value** Major opportunity to develop end-of-life sector
Battery storage	Existing capacity in coal, copper ore, nickel oxides and fly ash inputs Opportunities in cobalt and lithium and to extend into mineral processing	**37% of value** New capacity establishing in battery pack assembly (23%) and cell manufacturing (6%)	Relatively high share of value in containers, spares and transport (20%) Emerging local industry in installation (13%)	Limited data but there appears to be a high-value opportunity for re-conditioning and recycling
PHES	Existing capacity in coal, copper ore and fly ash inputs	Local concrete manufacturing Value-distribution of inputs varies significantly (e.g., underground pipes mean high steel content) Other opportunities in penstock (e.g., pipes)	High local content potential with high volume of trades and labourers Low recent experience will lead to international recruitment in professionals	**O&M 1-2% p.a.** Long lifetime (50-years+) – focus more on repair and maintenance than end-of-life
Transmission (lines and substations)	Existing capacity in coal, copper ore and fly ash inputs	Local content in foundations (3%) Opportunity for tower manufacturing with local steel supply (21%) Opportunity in balance of plant supply	Established capacity in line civil works (14%) and tower erection and line stringing (18%); civil and electrical construction of substations (43%) Skill shortages barrier to increased local jobs.	**O&M 1% p.a.** Limited data but there appears to be an opportunity to integrate with existing recycling (e.g., metals)

Note: values in brackets represent percentage of total project cost, excluding end-of-life. The quality of data varies significantly between technologies.

Our survey of NSW regional businesses found significant capacity across the supply chain, especially within construction and manufacturing for solar and wind farms but also distribution, equipment supply and transport (Figure 3).

Figure 3 Local capacity within NSW renewable energy supply chains



Note: There were 200 full and 57 partial responses to the survey. The numbers in the boxes are the respondents who stated they have capacity in each phase. Detailed lists of capacity can be found in the survey results in Appendix 3.

NSW REZ baseline data

For each REZ, we compiled a profile of baseline data using ABS data on:

- the existing structure and performance of the regional economy based on industry composition and changes in recent years
- the occupational composition of employment
- labour market capacity – the level of employment and unemployment, population growth and the composition of unemployment
- educational institutions and capacity
- regional economic development strategies.

Our profiling revealed the following insights:

- The labour markets in each of the regions are tight with low levels of unemployment. We expect significant competition for labour from the existing workforce and tapping into school leavers, the unemployed or those not currently participating in the labour market.
- Agriculture is the dominant industry and contributor to productivity in many of the regions. It is also volatile, with production and productivity influenced by climatic events such as droughts and floods, as well as international markets. This volatility can be reduced with industry diversification and with a transition to industries with a more consistent economic output that are less impacted by broader climatic and market issues.
- The local transfer of labour and skills is likely to be strongly linked to agriculture and mining. Mining offers jobs for those with engineering-related skills, trades and technicians who can transition towards related engineering aspects of renewable energy. Of the three REZs earmarked for generation, only the Central-West Orana REZ contains a manufacturing base. The transfer of skills from agriculture to renewable energy may be more challenging (although wind maintenance contractors tell us they recruit technicians from the agricultural sector with a mechanical background). This will require regionally-specific programs to assist movement between sectors.

Different regions have different strengths and opportunities. The Parkes Special Activation Precinct (SAP) in the Central-West Orana and the Wagga Wagga SAP adjacent to the South-West REZ provide opportunities for large-scale manufacturing or assemblage supported by road and rail connections that will benefit the import and export of product. Regions close to large population centres (Newcastle for the Hunter and Central Coast REZ, Wollongong in the Illawarra REZ and Wagga Wagga in the South-West REZ) can also leverage the depth of labour to support higher knowledge-intensive industries related to the establishment of the REZs – particularly important for jobs in engineering, law etc. Both Newcastle and Wollongong also have port access with land available to support adjacent industries and access to onshore and future offshore wind farms. Port Kembla has critical steel production facilities.

We have compared employment demand in major occupational groups with local supply for the three western REZs, finding that employment demand exceeds supply for all REZs in peak periods for both wind and solar. Figure 4 shows the supply-demand balance for wind energy in the New England REZ as an example.

Figure 4: Wind generation, current labour supply vs demand, New England, construction and operation

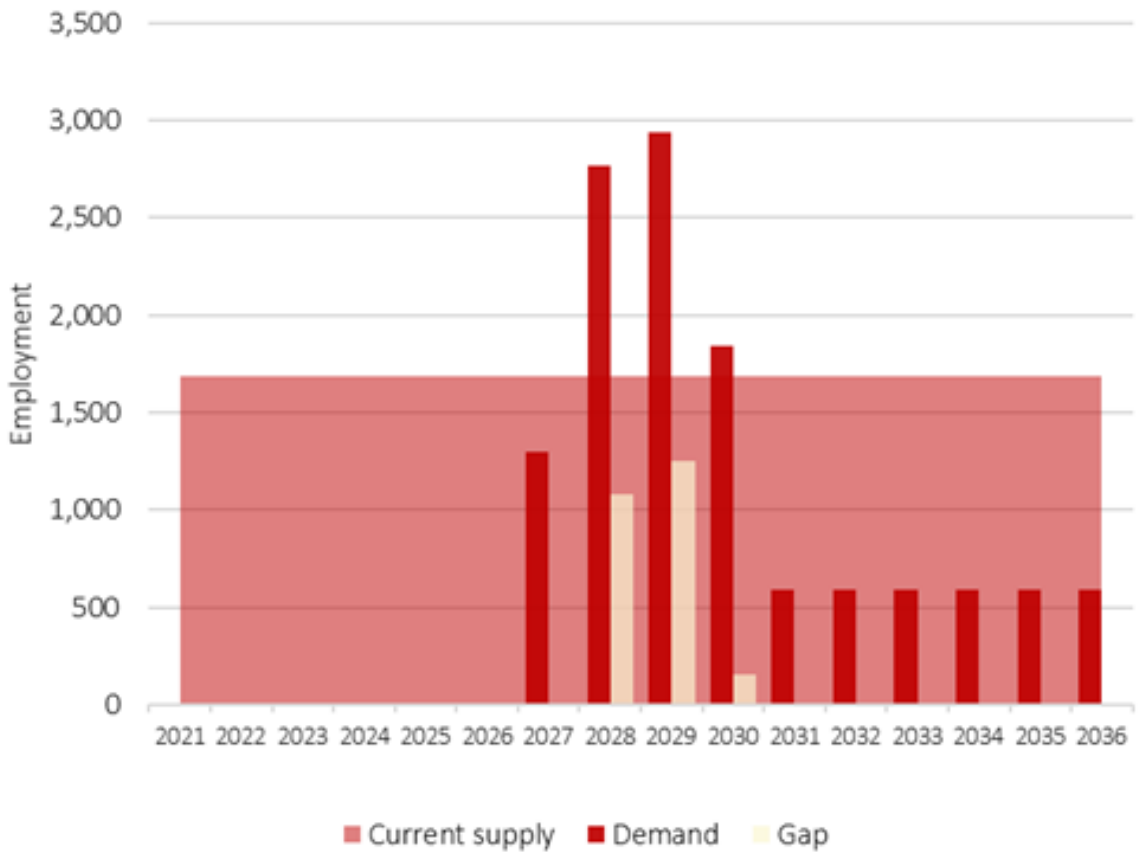


Chart sources: ISF 2021, ABS Census data, 2016, SGS Economics and Planning

From this, we believe filling local employment requirements will need an active labour market and training programs. Minimising fly-in, fly-out (FIFO) requires the creation of longer-term employment opportunities such as those in operations and maintenance to attract workers to settle in a region.

Opportunity evaluation

We evaluated opportunities against three key criteria with sub-criteria (see Section 4.2 for detail):

- viability for NSW (e.g., local sources of competitive advantage)
- value of opportunity (e.g., size of employment and revenue)
- cost of opportunity (e.g., impacts on renewable energy project cost, requirements for publicly funded infrastructure).

Our assessments provided ratings as:

- green (high likelihood or value, or low opportunity cost)
- orange (medium likelihood, value, or opportunity cost)
- red (major barriers, low value, or high opportunity cost).
- See

Table 2 for more details.

Several opportunities are worth pursuing:

- Increasing local employment in onsite project phases will achieve project cost savings as well as local jobs, with two of the four opportunities evaluated green in all three areas, with the other two evaluated as having two green and one amber criteria.
- In manufacturing phase, four of the six opportunities have one green and two amber ratings, reflecting high-value opportunities for NSW but generally requiring proactive policy for local industry development.
- Both end-of-life and mining/ material processing have two green and one amber rating, with strong comparative advantages in battery mining and mineral processing in particular and strong economic and environmental drivers for developing end-of-life sectors for renewable energy technologies.

Table 2 Opportunity evaluation heatmap for NSW

Opportunity	Viability	Value	Cost	Notes
Wind tower manufacturing				New facility would create 175-200 jobs directly and 2,000 jobs in steel supply chain. NSW production cheaper than Victoria but would add 0.25 – 0.9% to project costs. There could be expansion opportunities to export to other states and produce offshore wind and pumped hydro.
Transmission tower manufacturing				New automated factory stated to be cost-competitive in South Australia. 80-100 direct jobs and 300 jobs in steel supply chain.
Wind farm manufacturing (non-tower)				Other types of wind manufacturing more challenging but there could be opportunities in assembly and some components, such as cages.
Battery storage supply chain				Opportunity to establish integrated supply chain in Australia and NSW with mining (cobalt, nickel), mineral processing, manufacturing (e.g., battery pack assembly) and end-of-life recommissioning and recycling sector, equating to $7.4 billion and 34,000 jobs across Australia by 2030.
Solar farm infrastructure				Low local content but opportunities in areas such as steel foundation piles, mounting structures and trackers, component assembly and telecommunications
Electrical balance of plant				Low local content but there could be opportunities in areas such as component assembly or low-voltage cables.
Transmission construction workforce				Peak workforce of more than 1,000 in NSW but due to low activity in recent years skill shortages need to be addressed to increase local employment (e.g., engineers, lineworkers).

Solar construction workforce				Opportunity to increase local employment and create jobs for the unemployed and First Nations communities.
Wind maintenance technicians				Opportunity to reduce project costs and create high-quality, ongoing blue-collar jobs through training for local wind farm maintenance technicians.
End-of-life				Opportunities within REZs for co-location of local recycling, materials processing and manufacturing facilities with efficient logistics of distribution, collection and transfer of components/materials.
Mining and minerals				Australia and NSW can be internationally competitive in material processing due to its supply of raw materials, access to low-cost renewable energy and reputation for reliability and security (Accenture, 2021). 9,500 full-time equivalent (FTE) jobs Australia wide could be created in material processing by 2030 with a diversified supply chain. Opportunity to transition coal miners.
Offshore wind				Over 10 gigawatts (GW) of projects under development off the coast of NSW. Similar employment opportunities to on-shore wind. Employment across Australia scales up to between 3,000 – 4,000 jobs annually from 2030 and in higher scenarios with local supply chain development to 5,000 – 8,000 jobs each year.

Barriers

We identified barriers to increasing local industry development, employment and training through interviews, workshops and survey results.

In the business survey, around half of businesses said there were ‘no constraints’ and a similar proportion ‘some constraints’ to realising opportunities. Only a small proportion cited ‘major constraints’ (Figure 5). The number one barrier identified by survey respondents on their capacity to realise opportunities created by the Roadmap and the REZs was skills shortages (Figure 6).

In interviews and workshops, stakeholders went into more detail:

- Stakeholders highlight a range of factors that contribute to skills shortages, including wider labour market dynamics (e.g. shortages in occupations such as electricians) and renewable energy sector drivers (e.g. short construction phase timeframes, uncertainty around project timing). These issues create barriers to investment in apprenticeships, workforce building and training.
- Challenges with the provision of training include structural issues with the vocational education and training (VET) sector and a lack of training market capacity in renewable energy, especially in the context of thin markets in regional areas where demand has not been sufficient to underpin investment.
- Barriers relating to the supply chain include constraints on participation by small to medium enterprises (SMEs) and regional suppliers, compressed timeframes that limit the opportunity for new entrants and difficulties including new suppliers in established supply chains.
- Other issues – such as the adequacy of infrastructure in regional areas to attract and retain workers and cope with increased economic development (e.g., housing supply) – may be outside the scope of the RESB remit but can influence long-term employment and industry development. Stakeholders are concerned about the negative impacts of short-term construction on local communities without investment in enabling infrastructure.

Figure 5: Business perception of constraints to realise opportunities, renewable energy and transmission projects

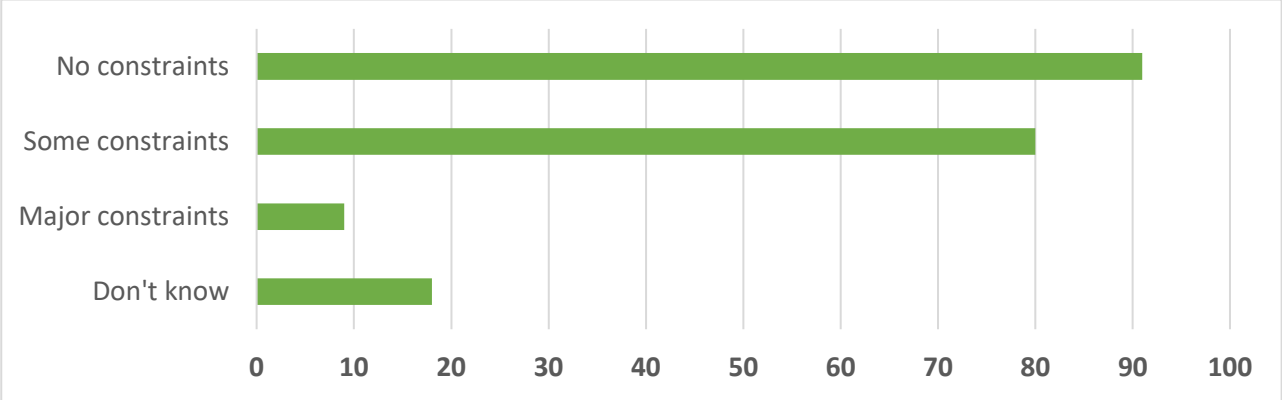
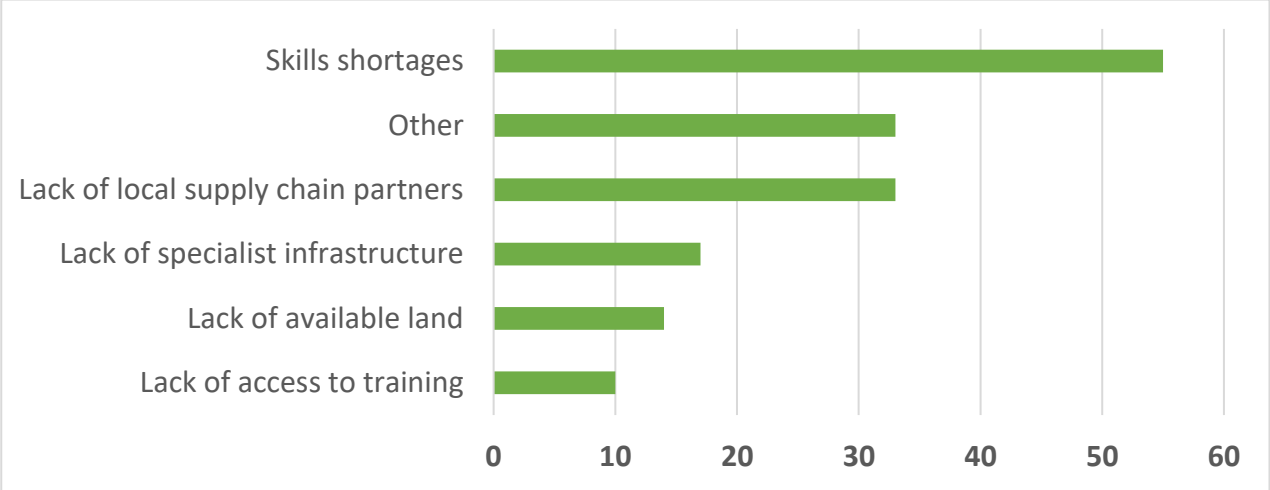


Figure 6: Business perception of the primary constraint to realise opportunities



Note: Both figures measure the total number of respondents. 'Other' included a range of barriers but a significant number were also labour, skills and training-related.

Actions

To realise these opportunities, we recommended actions for the RESB to consider including in its plan for the NSW renewable energy sector. These actions span procurement, skills and training, strategic planning and infrastructure, and economic development.

Area	Action	Sub-actions
Procurement 	1A: Require all tenders under the *Electricity Infrastructure Investment Act 2020* (EII Act 2020) to submit a local industry participation plan for evaluation against merit criteria	• Set targets and incentives for local content in the supply chain • Disaggregate large contracts into smaller value work parcels to facilitate SME participation • Set incentives in tender criteria for the establishment of local facilities within REZs and NSW • Recognise group industry development proposals that can achieve greater impact and economies of scale • Set incentives for exceeding compliance with the NSW *Aboriginal Procurement Policy* (APP) • Require monitoring and evaluation plans
	1B: Require all tenders under the EII Act 2020 to submit a workforce development and training plan for	• Evaluate the number and total labour hour targets for the engagement of apprentices, trainees, cadets and interns • Recognise the development of ongoing training capacity and encourage group proposals between projects

Area	Action	Sub-actions
	evaluation against merit criteria	• Recognise programs or commitments to engage unemployed people, increase gender diversity and increase First Nations participation • Recognise programs to engage local professionals (e.g., engineering interns) and trades in regional areas.
	1C: Reduce barriers for SME participation in renewable energy procurement	• Undertake a business and skill mapping project to understand where opportunities for SME participation align with local capability • Provide tailored financial support (grants/loans etc.) for SMEs to upgrade technology and processes • Provide capacity-building training and information to registered or interested businesses • Require tenders under the EII Act to demonstrate how they are implementing SME-friendly measures in their bids • Engage early, through targeted communication and the involvement of Industry Capability Network (ICN), to give SMEs time to invest and participate
	1D: Use a procurement portal to streamline the procurement process across the state	• Investigate if the ICN portal can enable access to tender information, submissions and information dissemination regarding renewable energy projects • Develop a publicly available implementation timeframe to clarify when certain regions are likely to see investment so that the business community can appropriately plan • Link the ICN portal to the Renewable Energy Supply Chain Business Directory (Action 4D) • Consider linking the ICN portal to online platforms to support workforce redeployment (Action 2C) • Provide educational resources on how to access grants and other assistance to get workers into regions, pre-employment training and how to engage apprentices • Investigate a sharing platform for the industry for construction equipment, mobile recycling equipment
Skills and training 	2A: Establish a Skills and Workforce Development Working Group in each REZ for energy, resources and infrastructure	Establish working groups to support the development and implementation of a workforce development strategy comparable to the model of *Energising Tasmania* to build a workforce with accredited qualifications that can be deployed across the renewable energy, construction, resource and manufacturing sectors. Include representatives from government, industry, regional development, unions and training organisations (public and private). Include the following activities in the working group scope: • information sharing on project pipeline and forward labour demand to assist with sequencing and smoothing of demand • skills mapping and auditing local training capacity • identifying local workforce training needs for the REZ • developing and implementing mechanisms for workforce redeployment • monitoring and evaluating training strategies
	2B: Dedicate funding to increase training system capacity for clean energy workforce development	Use the employment purpose funding earmarked in the EII Act 2020 to supplement initiatives to address skills and training capacity issues such as: • Train the trainers: grants to increase the volume and currency of knowledge amongst trainers • funding for registered training organisations (RTOs) to expand subsidised training offerings • training market development, particularly for priority occupations, to include development of new qualifications, innovative delivery methods

Area	Action	Sub-actions
		(e.g., mobile training units), skill sets and micro-credential, and industry partnership initiatives to create training capacity • locally available group training organisations • aligning skills requirements with existing TAFE initiatives e.g., Specialist Advanced Training Centre at Western Sydney Aerotropolis • investigating with TAFE NSW and other RTOs the potential for training and innovation hubs
	2C: Develop frameworks and platforms to facilitate workforce redeployment within the renewable energy sector and across other sectors	Develop frameworks and platforms to facilitate workforce redeployment including: • a NSW digital passport that recognises skills and qualifications of the renewable energy and transmission sector workforce • online talent community platforms for each REZ listing jobs and apprenticeships (which could leverage existing platforms) • a micro-credentialling framework, offerings and pilots that target skills shortages. Potentially leverage existing funding streams through the Smart and Skilled program and new institutions such as the NSW Institute of Applied Technology.
	2D: Draw on Federal-State co-funding to establish Transgrid as the national trainer for transmission construction and to develop a training strategy to increase the local transmission construction workforce	Funding would allow Transgrid to scale up its training to increase the supply of the transmission construction workforce across the National Electricity Market. Other recommendations are: • Transgrid and Essential Energy investigate initiatives to increase the redeployment of workers between the transmission and distribution networks • include targets for the engagement of apprentices and trainees for transmission construction projects in tender criteria • set targets to employ unemployed workers and First Nations people within transmission construction project tender criteria • increase female participation in the sector • develop internship partnerships for engineers between universities, Transgrid and companies working in engineering, procurement and construction (EPCs) • fund the development of site supervisor courses to support on-the-job training of workers for renewable energy generation and transmission construction.
	2E: Develop a training strategy to increase the number of electricians in regional areas	Electricians are the largest occupation in the sector and a training strategy to increase supply should include: • VET in schools for clean energy and transmission • procurement guidelines to increase apprentices in renewable energy, transmission and storage projects • enhancing the uptake and completion of apprenticeships and electrical training by girls and young women in schools and industry programs by active promotion and mentoring • pilots for increasing workforce redeployment, beginning with electricians between renewable energy and other sectors (e.g. micro-credentials or bridging courses) and within renewable energy (e.g. digital passport). Strategies to increase the supply of electricians could be piloted in Central-West Orana through the Workforce and Skill working group.
	2F: Develop a training strategy to increase the supply of wind	Addressing this skill gap can be complemented by actions 1A and 1B, alongside engagement with the sector on a training strategy for wind farm technicians.

Area	Action	Sub-actions
	farm maintenance technicians	There is also a need to determine whether the fee-for-service training capacity in Victoria could be leveraged or if supporting infrastructure will need to be established in NSW.
	2G: Develop a training strategy to increase the supply of engineers	Infrastructure Australia's market capacity report identified engineers as the occupation most 'at risk' of shortages across the infrastructure sector. Actions to be investigated include: • facilitating partnerships between universities and renewable energy and transmission projects for internships and graduate programs • incentivising partnerships between renewable energy projects and regional universities for internships through procurement guidelines • investigating clean energy VET in schools, with a focus on engineers
Strategic planning and infrastructure 	3A: Develop and implement a circular economy framework for the REZs to build an end-of-life sector for renewable energy	Engage with government, stakeholders, the renewable energy industry, local communities and First Nations people to develop a circular economy framework that can be applied across all the REZs. Actions should include: • using regulation, procurement and planning regulations to create and expand end markets for recycled materials from renewable technologies • establishing a renewable energy directory with industry data on type, location and age for installed technology to enable efficient repair and end-of-life processing • investigating the optimal investment in waste management infrastructure including shared investment with neighbouring states and opportunities for recycling hubs to integrate with hydrogen hubs and the SAPs • accessing grants (e.g., Waste and Recycling Infrastructure Fund – Circular Solar Trials) to support industry compliance and participation in local schemes for collection, transfer or waste processing • engaging with recycling and re-use businesses to identify workforce and skill requirements and to identify opportunities to transition workers to end-of-life industry.
	3B: Develop a coordinated inter-regional implementation plan for the Roadmap that aligns with other regional infrastructure delivery programs	With significant investment in transport and community infrastructure, economic development and industry transition in regional NSW, these major projects must be complementary to build local skills and supply chains. This requires: • a statewide implementation plan to identify infrastructure gaps (e.g., transport, housing and education) • addressing housing supply, including longer-term use of temporary accommodation built for construction workers • aligning infrastructure and services planning to match seasonal and resident population growth in and around the REZs through a statewide regional schedule of works • engaging early with councils to help provide renewable energy infrastructure and ensure strategic planning supports investment in the renewable energy supply chains (e.g., serviced land for manufacturing components locally).
	3C: Investigate opportunities for collaboration between states to maximise local content	Collaboration between states can enhance investment attraction, procurement, infrastructure investment and skills and training.
Economic development	4A: Build the capacity of local manufacturing businesses to participate in	Local manufacturing capacity will reduce supply chain risks and increase the economic benefits for the Roadmap. The Roadmap offers a larger project pipeline but, depending on the level of certainty provided by tender criteria,

Area	Action	Sub-actions
	transmission and generation manufacturing	additional engagement, support and capacity-building may be required to attract new investment. This requires: • market sounding with original equipment manufacturers (OEMs) and investors on major opportunities, which could include wind tower manufacturing, transmission tower manufacturing, nacelle and hub assembly, and electrical balance of plant • an international manufacturing exchange to attract foreign investment and international partnerships with local manufacturers, potentially as a pilot scheme (e.g., a hub at the facility earmarked by Bluescope Steel) • using a portion of REZ access scheme fees to reinvest in local manufacturing pilot programs, grants and loans to build capacity, facilitate international partnerships and scale local businesses. In regions with strong mining labour forces, this could focus on skills transition • a detailed cost-benefit analysis and work with key stakeholders to understand the optimal location for new manufacturing from a whole of NSW economy perspective. • a transport feasibility study to identify any upgrades required (e.g., transporting wind turbine blades along road networks) • linking business attraction schemes to existing schemes focused on manufacturing investment at a state and federal level • investigating scope for a national testing facility for transmission and wind towers to support local manufacturing
	4B: Establish a battery energy storage system innovation taskforce to coordinate industry development opportunities across the supply chain	Australia is one of the few nations that has all the relevant minerals to develop a battery supply chain. A taskforce should be established to coordinate NSW battery supply chain development, develop an industry strategy and advocate for a national strategy. The taskforce should focus on: • coordinated procurement strategy • renewable energy power purchase agreements • investment attraction and engagement • workforce and skill development • investigate and support other barriers and opportunities.
	4C: Broker power purchase agreements (PPAs) for renewable energy supply chain businesses to enhance local content and international competitiveness	Brokering or facilitating PPAs for battery supply chain businesses and clean manufacturing precincts, which could involve: • on-selling PPA capacity by the financial vehicle managing long-term energy supply agreements (LTESAs) • taking the role of ‘anchor buyer’ with the NSW Government inviting or coordinating other buyers to join a PPA negotiated for its own electricity requirements.
	4D: Develop a renewable energy supply chain business directory/registry	Improving the level of knowledge of local and regional capacity among project developers, original equipment manufacturers and EPCs could increase local content. A renewable energy supply chain business directory like the Victorian solar and wind directory, developed with the ICN could: • cover all technologies or be phased by starting with solar and wind and including battery storage, transmission and pumped hydro at a later stage. • collect information for businesses across NSW and not just in REZs • Link to the procurement portal (Action 1D).
	4E: Develop a strategy to improve First Nations	The Roadmap presents an opportunity to increase First Nations employment and economic participation by:

Area	Action	Sub-actions
	employment and economic participation in the renewable energy and transmission sectors	• incorporating the APP within tender criteria and create incentives for achievement of employment and economic participation targets above the minimum standards in the APP • establishing networks for information sharing and best practice on First Nations engagement and employment across the renewable energy, storage and transmission sectors and within each REZ. • enabling long-term economic development and training initiatives for First Nations people in community benefit funds • funding training and engagement with the renewable energy, storage and transmission sectors to support best-practice recruitment practices, pre-employment training and qualifications that create bridges for unemployed First Nations people into work – especially for solar farms and transmission • investigating opportunities for project origination and development on First Nations-owned land • engaging with the renewable energy and transmission sector to develop associated employment opportunities such as cultural exchange and landscape protection and rehabilitation. Action 1c should target increased participation and capacity amongst First Nations-owned businesses
	4F: Implement measures to improve job quality in the renewable energy sector	Well-paid, secure employment, with good training and advancement pathways, is a cornerstone of economic and community development. This requires: • supporting the establishment of industry-level arrangements such as the development of portability of entitlements within the sector as applies in some other construction sectors. • avoiding 'social dumping' from manufacturers with lower standards through tender requirements to comply with environmental, sustainability and governance (ESG) standards, international labour standards, and anti-slavery standards across the supply chain • engaging with the sector to support targets and programs to improve gender equity and diversity within the renewable energy and the transmission and distribution workforce

01: Introduction

About the report

On behalf of the NSW Renewable Energy Sector Board (RESB), the NSW Department of Planning, Industry and Environment (DPIE) commissioned the Institute for Sustainable Futures (ISF) at University of Technology Sydney and SGS Economics and Planning (SGS) to identify and assess the renewable energy sector employment and regional development opportunities, including existing and potential local supply chains.

This report focuses on the electricity generation and transmission infrastructure to be constructed under the NSW *Electricity Infrastructure Roadmap*, including the establishment of renewable energy zones (REZs).

The report forms advice to the NSW Renewable Energy Sector Board. The RESB will prepare a plan for the Minister for Energy and Environment on how to cost-effectively maximise local industry development, employment and opportunities for apprentices and trainees through the electricity infrastructure identified in the Roadmap, including the construction and operation of the NSW REZs. The plan will also focus on protecting the financial interests of NSW electricity customers while being consistent with Australia's international trade obligations.

This report develops a detailed understanding of renewable energy supply chains, employment and skills, as well as the opportunities that exist to build local capacity and employment. To do this, the report:

- maps opportunities across renewable energy supply chains from cradle to grave, including raw material supply and processing (e.g., cement, steel and copper), manufacturing and construction of electricity infrastructure, and the back-end of the supply chain such as recycling)
- analyses workforce and skill requirements across project lifecycles including inputs, construction, operation and maintenance, decommissioning/recycling and training and education capacity
- develops a baseline of each REZ's current state of involvement in the entire renewable energy supply chain, as well as their industry, training and labour market capacity
- assesses opportunities, barriers and strategies for each REZ to increase local industry development, employment and training.

Scope exclusions

We have excluded – or only touched on - several related NSW Government programs and technologies:

- renewable energy industrial precincts (focus of the NSW Net Zero Industry program)
- hydrogen (focus of the Net Zero Industry program)
- distributed solar and storage (not included within the scope of the Roadmap).

Methodology and deliverables

Our research included desktop research and analysis, stakeholder engagement, and synthesis and analysis to develop related actions. Table 3 outlines the methods and if relevant signposts where tools and outputs can be found.

Table 3 Methodology

Method	Description
Desktop research and analysis 	We undertook desktop research and analysis to provide data and insights on: • renewable energy supply chains, including mapping various supply chains, the value breakdown between activities and phases, and a profile of employment in renewable energy, transmission and storage • REZ baseline analysis, including labour market and workforce structure, training, education, and skills development offerings, and a summary projection of employment and population. **Outputs** We present our findings in Sections 2-4 and provide a complete reference list at Appendix 5.
Stakeholder engagement 	Our engagement included: • **Interviews:** In June and July 2021, we held 27 semi-structured interviews with 42 stakeholders, including members of the RESB and other renewable energy sector experts, covering opportunities, barriers and actions. • **Survey:** Our online survey targeting local businesses with current or future capacity to engage in renewable energy supply chains was distributed through relevant peak organisations and local networks and received 200 complete responses and 57 partial responses. • **Regional stakeholder workshops:** We held workshops for each of the five REZs between July and August 2021 with 70 participants. These explored stakeholder views on renewable energy supply chain opportunities and barriers and actions for NSW Government to support local industry development and employment. • **RESB Reference Group workshop**: the RESB reference group provides expert advice to the RESB and includes board members, staff from their organisations and representatives from relevant NSW Government agencies. An additional online workshop was held with the Reference Group on 15 September 2021 to 'stress test' recommended actions. **Outputs:** The **interviews** and a synthesis of the **regional workshop** inputs by themes (Appendix 2) informed the analysis of opportunities, barriers and actions. **Survey results** (Appendix 3) contributed to baseline data on supply chain capacity and opportunities, constraints and actions. **The RESB Reference Group workshop** primarily informed amendments to actions in section 7.
Analysis and evaluation 	Our analysis and evaluation processes informed the actions in section 7. **Opportunities evaluation:** We developed a framework and criteria to evaluate opportunities for each of the REZ regions, taking account of planned electricity infrastructure investments under the EII Act 2020 and the Roadmap, to maximise local content, local employment and local skills. We assessed these opportunities against a criteria framework. We present the evaluation framework is in section 5. **Barrier analysis:** We identified and thematically analysed barriers to realising the opportunities through the research and based on our own expertise and knowledge. **Actions:** The opportunity evaluation, barrier analysis and research data informed recommended actions, which are prioritised actions to overcome the barriers and realise the opportunities. These

Method	Description
	recommended actions are for the RESB to consider in its plan for the NSW renewable energy sector. Actions include a rationale, description, owner/s, stakeholders and timeframes. A longer list of potential actions identified through the research but not included is provided in Appendix 5. **Outputs:** Opportunities evaluation and heatmap: Section 5 Barrier analysis: Section 6 Actions: Section 7

Deliverables

- a comprehensive **Stakeholder Engagement plan**, including proposed engagement tools and methods and agreed with DPIE
- a **Progress Report** provided on 2 July 2021 summarising initial desktop research, a draft framework to evaluate opportunities, a preliminary list of opportunities and early input from stakeholder interviews
- a **Summary Report** presented to the RESB and RESB Reference Group for feedback
- **Final Report** (this report)
- Excel workbook of de-identified survey data
- **Survey data** that may be used to prepare a business directory
- RESB Reference Group **Workshop Report.**

02: NSW Electricity Infrastructure Roadmap and REZs

2.1 Context

Under the NSW *Electricity Infrastructure Roadmap*, new generation, transmission, storage and firming infrastructure will be constructed to replace coal-fired power generation scheduled to close within the next 15 years. The *Electricity Infrastructure Investment Act 2020* sets a minimum target of 12 GW of new generation and 2 GW of long-duration storage to be constructed by 2030.

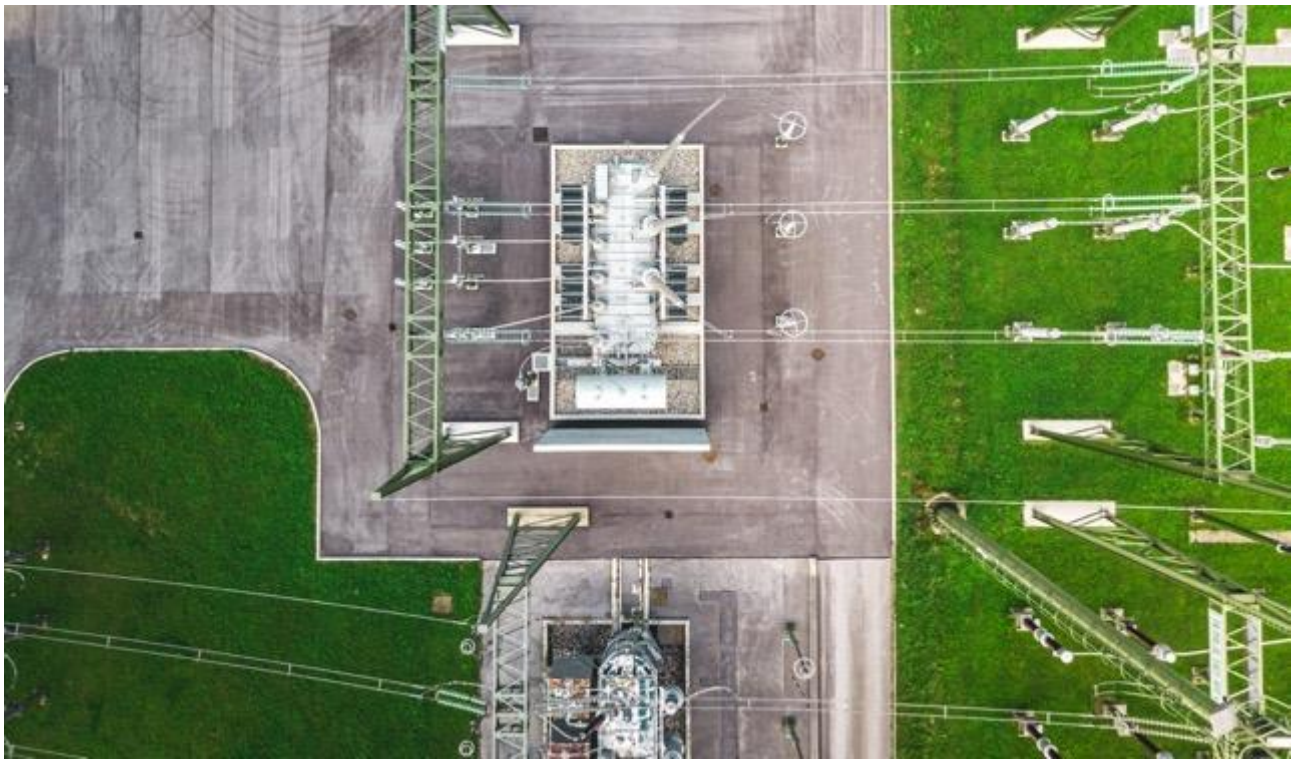
To achieve these targets, five REZs (see Figure 7 to Figure 9 below[1]) have been established to coordinate investment in new renewable energy generation and transmission infrastructure. The REZs are Central-West Orana, New England, South-West, Hunter-Central Coast and Illawarra.

To facilitate private sector investment, the new NSW electricity Consumer Trustee will publish a 20-year Development Pathway and a 10-year Tender Plan for auctions for long-term energy supply agreements (LTESAs). LTESAs are options contracts that provide a guaranteed price for the output of renewable energy generation or long-duration storage.

The Consumer Trustee will also administer tenders for REZ access rights for transmission capacity, which are expected to be undertaken together but may be separate if the Consumer Trustee determines that is preferable.

While a consultation paper on the design of these tenders is being developed, the EII Act 2020 requires the Consumer Trustee to take account of the *Guidelines for Consultation and Negotiation with First Nations Communities* and the *Plan for the NSW Renewable Energy Sector* in carrying out its functions (sections 4(4) and 9(1) of the EII Act 2020, respectively). The Consumer Trustee will determine REZ access fees, which will a include 'community purpose' component and an 'employment purpose' component.

The NSW Renewable Energy Sector Board (RESB) has been established to develop a plan that provides recommendations to the Minister for Energy on how to maximise local industry development and employment. This report was developed as an input into this plan.



[1] Note: maps are not yet available for the Hunter-Central Coast and Illawarra REZs as these zones are at an earlier stage of planning.

Figure 7 Indicative boundary of Central-West Orana REZ

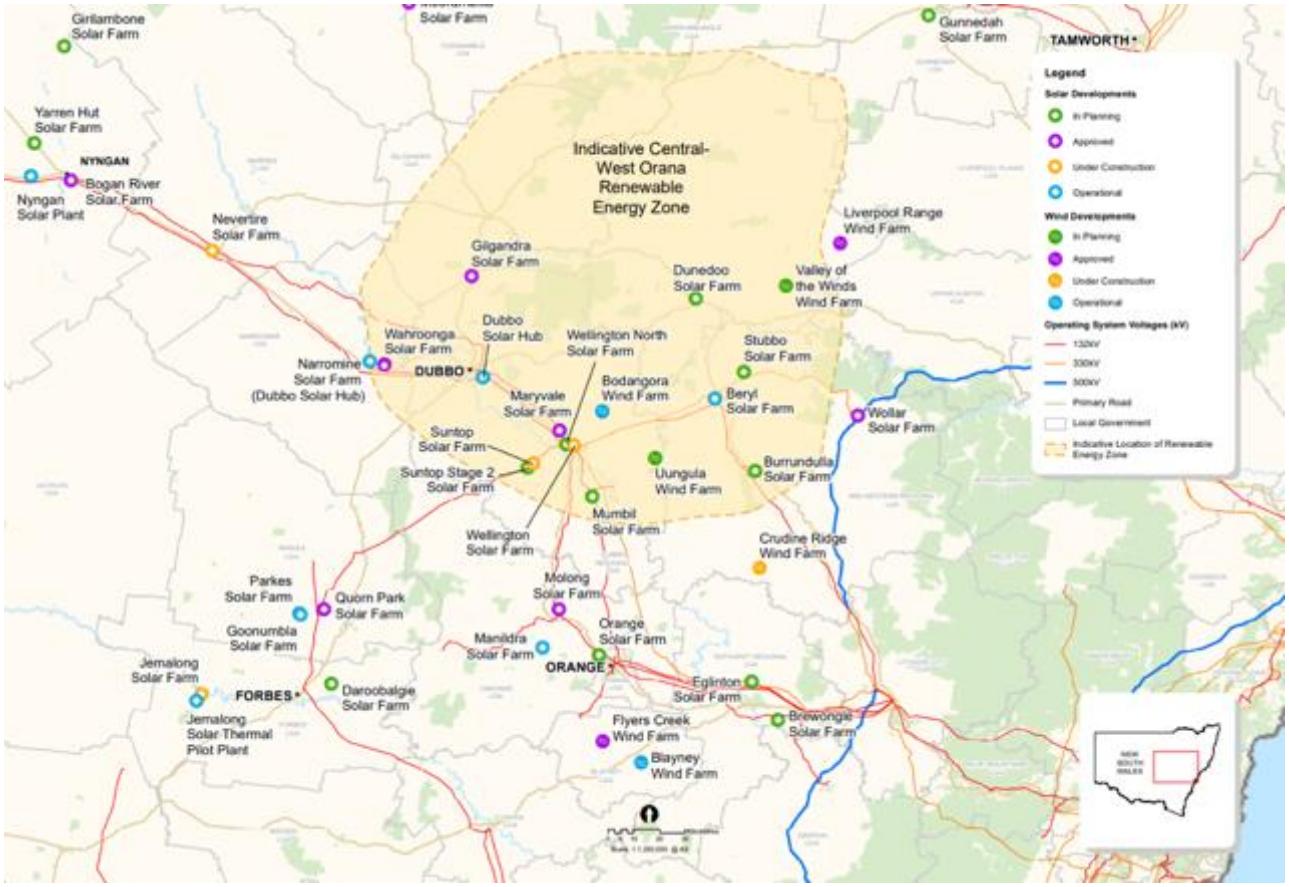


Figure 8 Indicative boundary of New England REZ

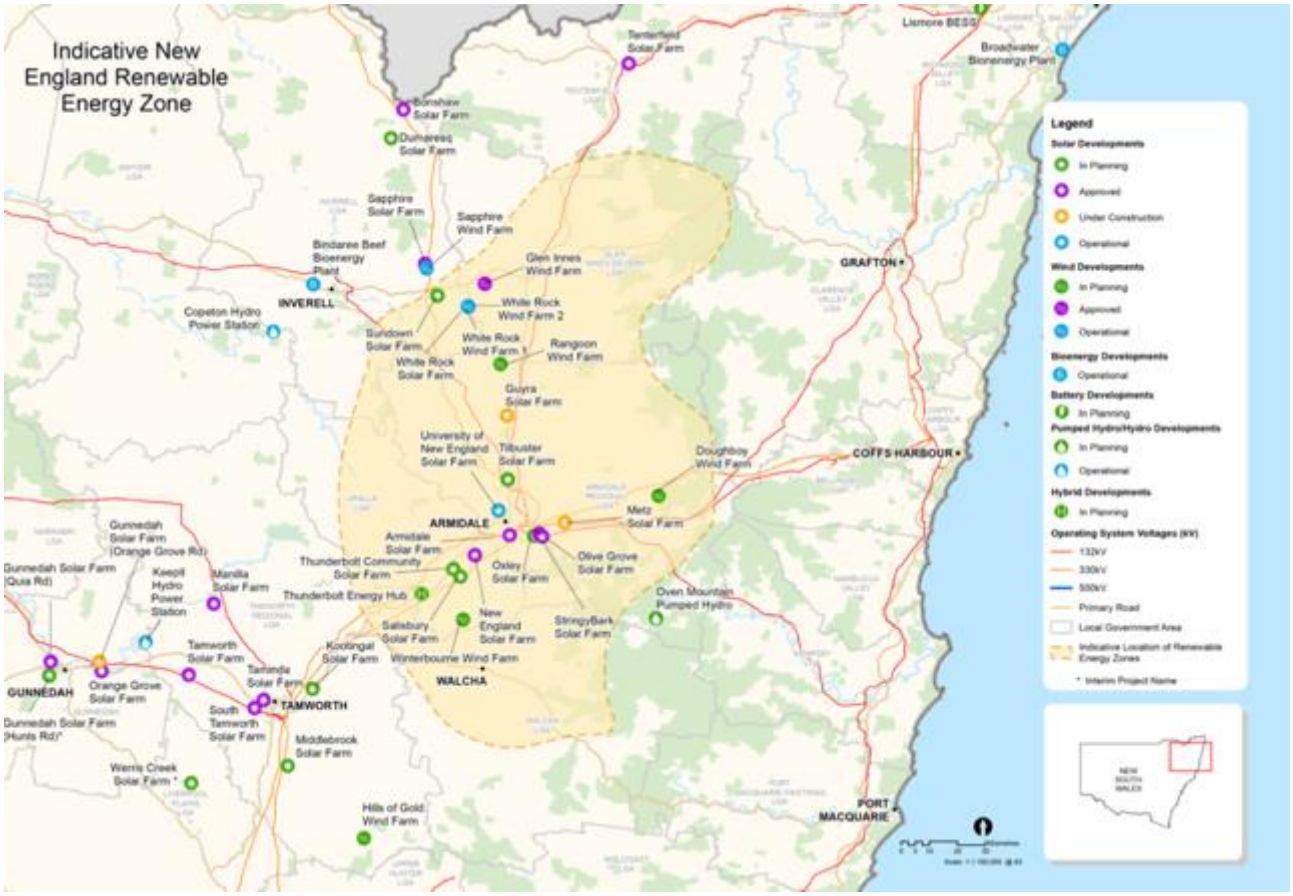
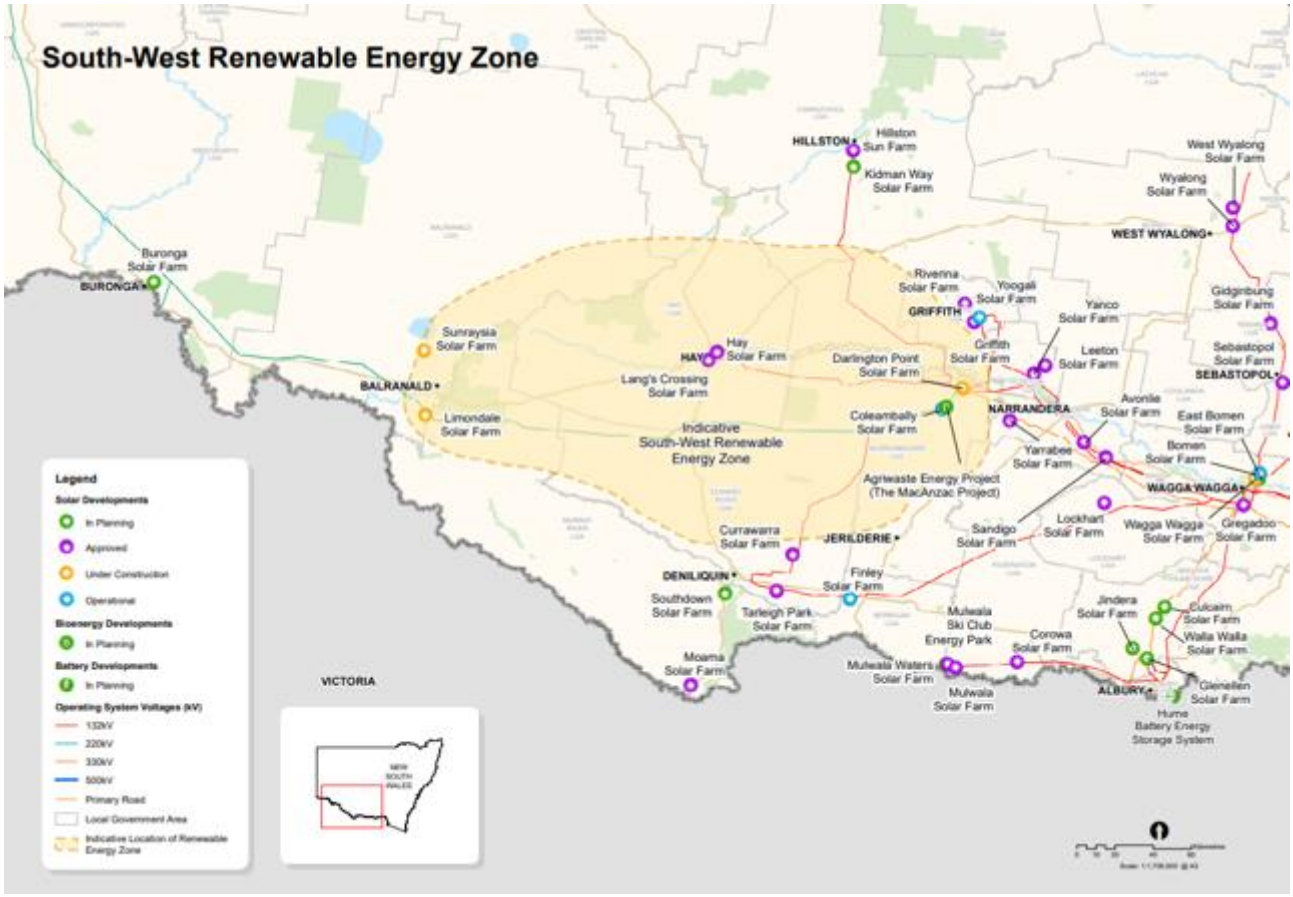


Figure 9 Indicative boundary of South-West REZ



Note: at the time of writing no maps were available for the Hunter or Illawarra REZ.

2.2 NSW-wide employment projections and skill shortages

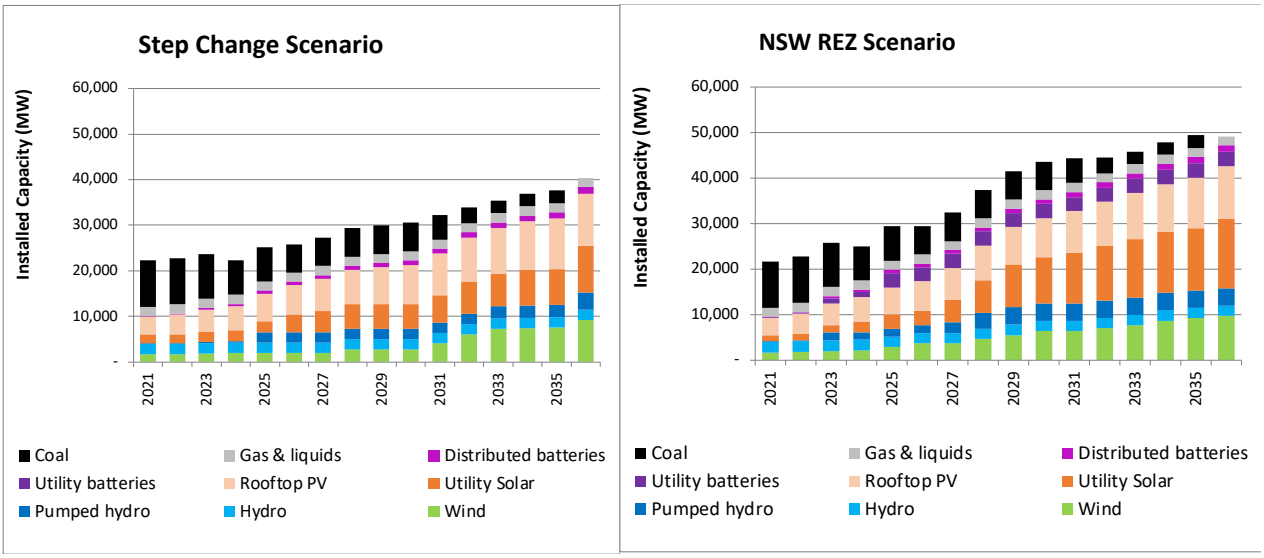
The pace of change within the electricity sector and uncertainty over renewable energy development makes it challenging to forecast employment and material requirements. While the direction of change is clear – all scenarios considered by the independent Australian Energy Market Operator (AEMO) end in 80 to 95% renewable energy by 2040 – there are many different transition pathways.

For example, the clean energy transition could be faster or slower, and there could be a higher or lower share of distributed versus large-scale renewable energy. The employment and material requirements for energy generation and transmission will depend in part on which pathway is taken.

For this report, we developed a 'NSW REZ' scenario based on inputs from another consultant report produced by MBB. This scenario modifies the AEMO's 'Step Change' scenario in its 2020 *Integrated System Plan* (ISP), which is based on the market share of renewable energy growing to 90% by 2035.

However, the current and planned development of renewable energy is occurring more rapidly. The Clean Energy Regulator (2021) has identified nearly 7 GW of 'committed' and 'probable' projects that are likely to be built in the next few years across the National Electricity Market, and the NSW REZ targets will accelerate development compared to the Step Change scenario. We compare the installed capacity for each technology for the NSW REZ scenario to AEMO's Step Change scenario in Figure 10.

Figure 10 Total capacity, NSW REZ scenario and AEMO Step Change scenario, 2021-2036



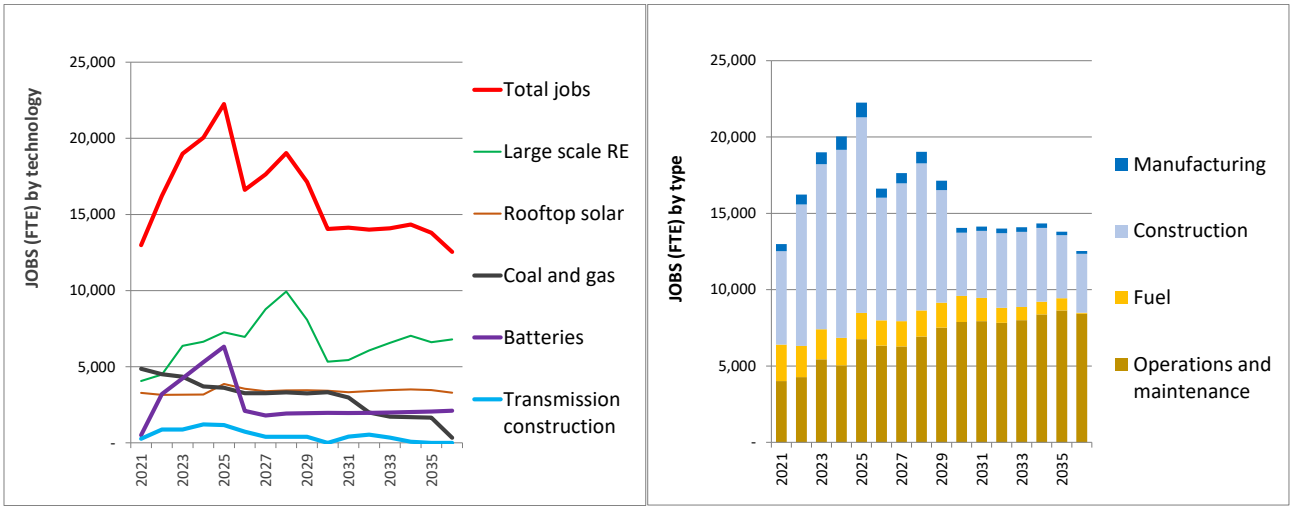
The NSW REZ scenario also includes more up-to-date projections for rooftop PV, commissioned for the 2022 ISP by AEMO from Green Energy Markets (Edis, 2021).

We applied employment factors (FTE/MW) developed through our previous surveys on renewable energy generation (Briggs et. al. 2020) and transmission construction (Briggs. et. al. 2021) to the installed capacity in the NSW REZ scenario.[2] We also collected data on the occupational composition of employment through these surveys.

Based on the NSW REZ scenario, total employment fluctuates between 13,000 and 22,000 jobs over the next 15 years. Most employment is in large-scale renewable energy with smaller contributions from battery storage and transmission construction. Over time, the level of employment in operations and maintenance gradually increases from less than a third to more than half of jobs.

Manufacturing employment reflects the share of local industry based on a 2019-20 survey (Briggs et. al. 2020) and is not a projection of likely or potential employment; indeed, most of the local manufacturing at that time was in Victoria. Effectively, the starting point in NSW is likely to be a lower level of employment in manufacturing but there are greater opportunities to increase NSW local share due to the scale of the build-out and longer timeframe under the roadmap.

Figure 11 Employment by technology & phase, transmission construction & electricity generation, 2021-2036



Note: these figures do not include ongoing employment in electricity transmission, distribution and retailing. At a national level, these sectors represent over half of employment in the power sector (state-specific data is not available).

[2] See Rutovitz et. al. 2020 for details on the methodology and the employment factors.

We have projected occupational employment demand by applying an employment structure for each technology to the employment projected per technology for the NSW REZ scenario. For each technology, we developed an employment structure based on survey results (renewable energy, transmission) or ABS 2016 Census data (fossil fuel power stations - i.e. coal and gas, coal mining) at the 1-digit level (managers, professionals etc) or a more disaggregated jobs structure. We found a spread of employment between occupational groups across the energy sector:

- The largest grouping is trades and technicians with employment demand projected to average around 3,500 workers a year (around one-third of total employment).
- Professionals (an average of just over 2,000 workers a year) and managers (just under 2,000 per year) are the next highest groupings, which together comprise just more than one-third of total employment.
- Labourers (an average of just under 1,500 workers a year) and machine operators (500+ per annum) account for around one-sixth of total employment.
- Just under 1,000 administrative staff are employed on average.

Figure 12 illustrates key occupations. Those projected to have the highest growth are electricians, construction managers, finance and business professionals, electrical engineers (including grid engineers), mechanical trades and truck drivers (Figure 13).

Figure 12 Average employment demand, by occupation (1-digit), 2021-2036, NSW REZ scenario

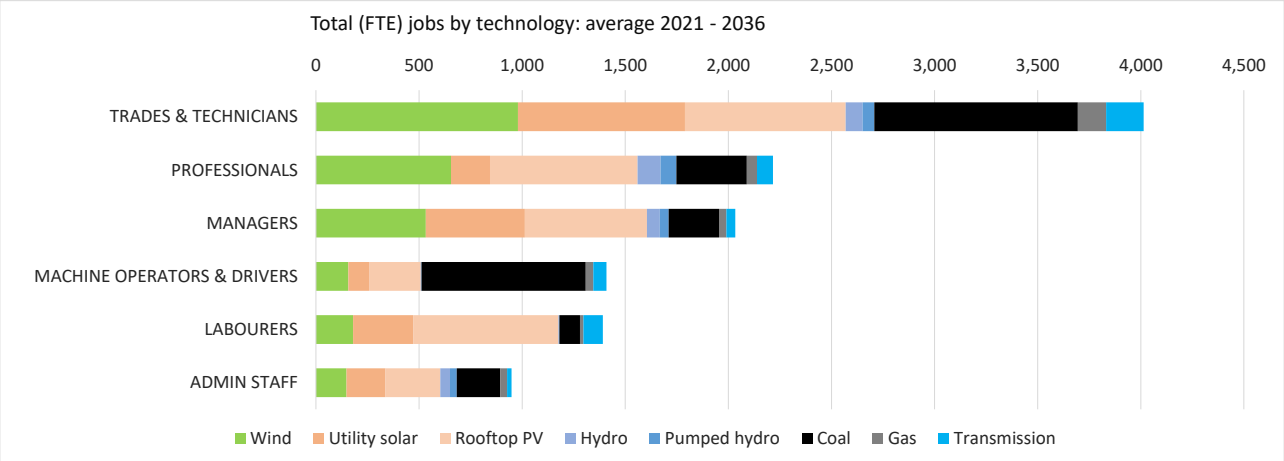
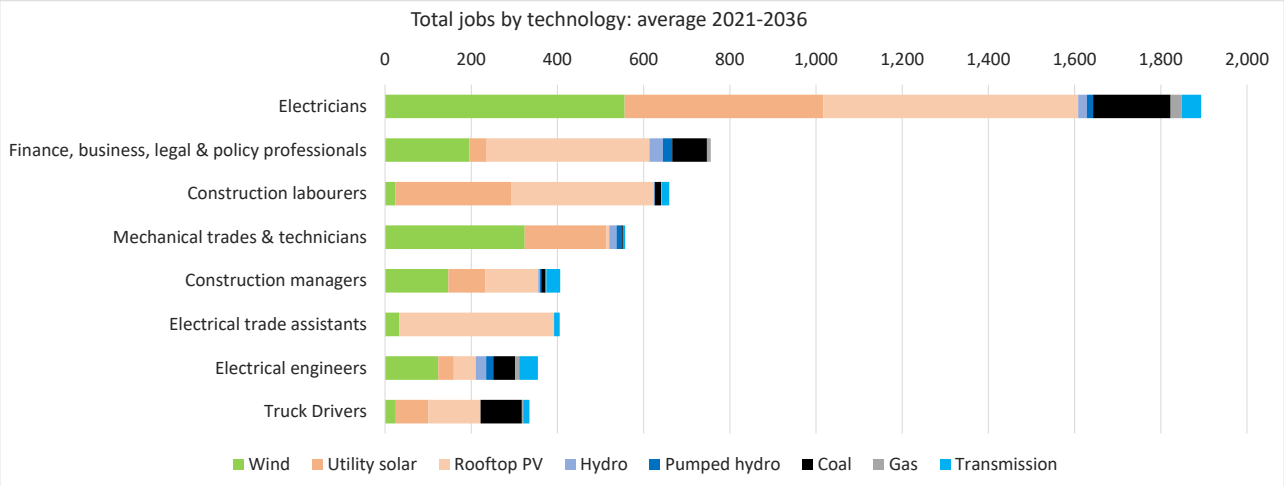


Figure 13 Average Employment Demand, Key Occupations by Technology, 2021-2036, NSW



Based on our surveys conducted during 2019-20, skill shortages – or more accurately 'recruitment difficulties' - have been experienced for construction managers, engineers, electricians, mechanical technicians, transmission lineworkers and riggers, drillers and crane operators (see Table 4). These occupations should be priorities for skills and training to increase employment within NSW and the REZs.

Table 4 Recruitment difficulty and skill shortage assessments, selected occupations

Occupation	Solar and Wind Farms Survey (2019)	Transmission Construction Survey (2020)	Industry trends and observations
Construction managers	High	High	
Engineering managers	n/a	High	
Electrical and grid engineers	High	High	One wind company estimated there were less than 150 grid engineers with the full suite of skills required in Australia.
Civil engineers	High	Medium	National skill shortage reports on civil engineers change from year to year reflecting fluctuations in supply-demand.
Structural engineers	n/a	High	
Mechanical engineer	Low	High	
Environment, health, safety & quality	Medium	Medium	
Telecommunications engineers	High	Medium	Listed on the National Skills Needs List with eligibility for the Australian Apprenticeship Incentives Program and Rural and Regional Skills Shortage List.
Electricians	Medium	Low	Listed on the National Skills Needs List with eligibility for the Australian Apprenticeship Incentives Program and Rural and Regional Skills Shortage List. Large wind OEM noted growth is starting to exceed talent pool and there are increasing challenges with recruiting electricians from regional towns. Increasing complexity creates training challenges.
Mechanical technicians	Medium	Low	Blade technicians have been identified as a priority for wind O&M. A collaboration between renewable energy companies (Vestas, Acciona, Tilt Renewables and Global Power Group) and Federation TAFE in Western Victoria with $1.8 million of industry funding has established the first blade maintenance apprenticeship in Australia.
Transmission lineworkers	n/a	High	All survey respondents noted these were in shortage in Australia.
Riggers	Low	Medium	Transmission EPCs were recruiting riggers internationally as it requires a more specialised skill set than construction riggers in general.
Crane operators	Medium	Low	Not all wind developers experienced shortages but those that did said high crane operator shortages were a constraint that delayed projects.
Drillers	Medium	Medium	Hydro developers noted a shortage which could have a significant impact.

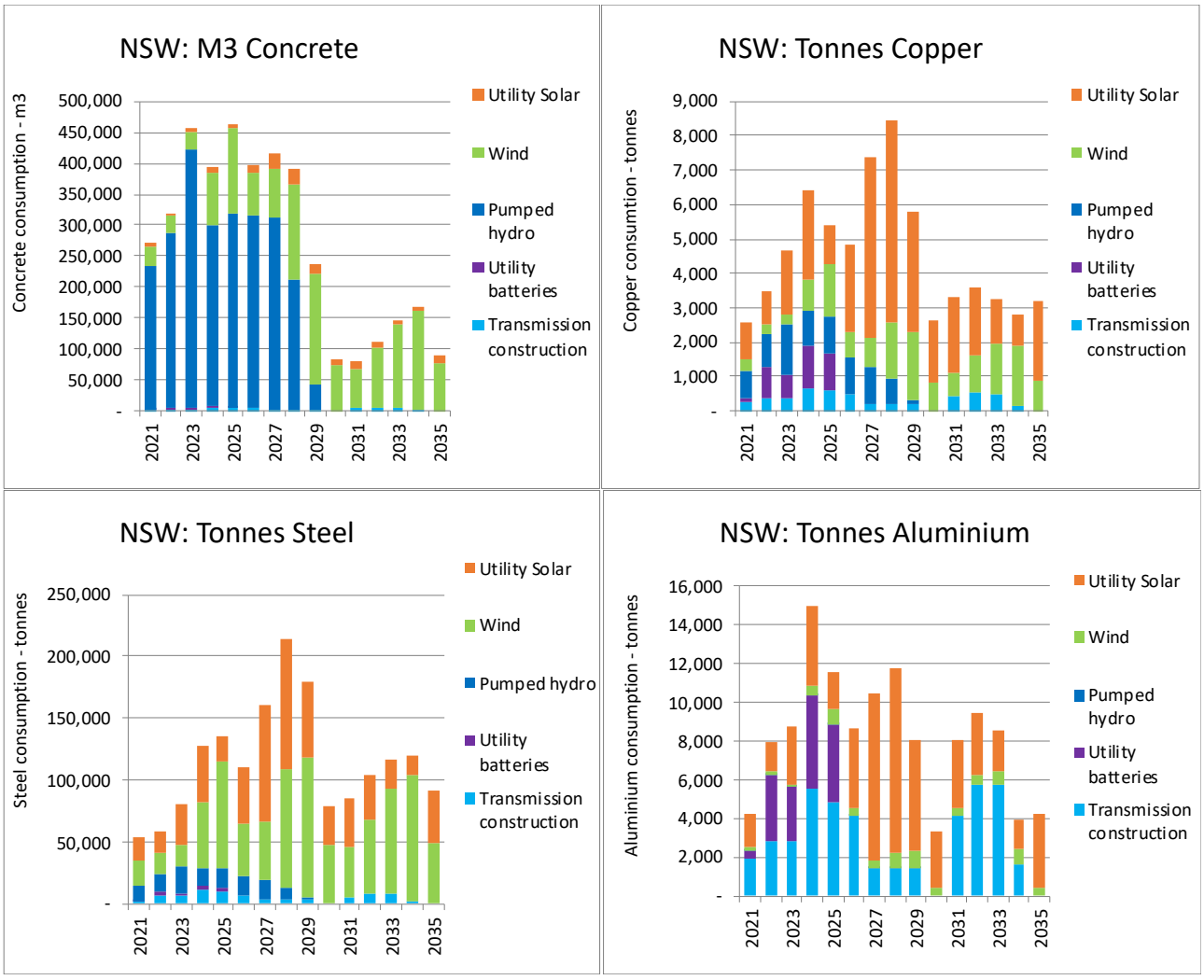
Note: this table is reproduced from Briggs et. al. (2021). Respondents were asked to classify recruitment difficulties as 'low' (less than 4 weeks to find appropriate staff), 'medium' (4 – 8 weeks) and 'high' (unable to find appropriate staff in Australia within 8 weeks). These definitions are aligned with those used in the skill shortages methodology of the Commonwealth Department of Employment (2017). Recruitment difficulties is also used as there are ambiguities and differences in the definition of 'skill shortage' used by businesses. Businesses sometimes use skill shortage to refer to any difficulties in recruitment whereas a skill shortage is not considered to exist in academic literature if the business is not paying the market wage rate and could resolve the shortage with greater pay (see Healey et. al. 2015). Definitions of recruitment difficulties based on time provide a more objective base for assessing labour market conditions.

2.3 NSW-wide material projections

Our key findings in terms of projections on the material demands are:

- Demand for concrete will be overwhelmingly driven by pumped hydro energy storage (PHES) with significant contributions from wind farms. The timing of PHES construction will have a major influence on concrete demand.
- Wind towers are steel-intensive but PHES and solar farms will also generate demand for steel. Transmission towers are a minor contributor to demand.
- Copper demand is lower than steel. It is driven primarily by solar farms, but pumped hydro is also projected to be a significant source of demand for copper. Wind farms also generate demand for copper with lesser usage by utility batteries and transmission towers.
- Aluminium demand is also lower than steel. The profile of demand for aluminium is dominated by solar farms with secondary demand from utility-scale batteries and transmission towers.

Figure 14 Concrete, copper, steel and aluminium requirements, NSW REZ scenario



Concrete

Australia produced 30 million m^3 of concrete per year pre COVID-19, with NSW driving demand, producing about a third (9.5 million m^3 per year) (Cement Concrete Aggregates Australia, 2018). Most of the estimated projection for concrete requirement for renewable technologies construction in NSW REZs is anticipated to occur this decade, reaching about 5 percent of the NSW annual production (Figure 14).

The main source of demand for concrete is for pumped hydro (driven by Snowy 2.0) and is used for construction of pipes, tunnels, dams and reservoirs. However, the demand varies significantly from project to project due to different topographies. While the concrete requirements for utility solar are minimal due to the use of piles for footings, wind requires significant amounts of concrete in the foundations of the wind turbines. It is anticipated that the required concrete can be supplied from NSW.

Steel

Australia produces 5.6 million tonnes of crude steel per year (in 2018) (Australian Steel Institute, 2020) with 3 million tonnes of crudes steel per year production capacity at Port Kembla Steelworks, NSW. Demand for steel for renewable technologies is projected to peak in 2028 at 0.2 million tonnes (four times the current steel demand) with significant demand required for wind and solar technology (Figure 14).

Locally produced steel could be supplied for the manufacturing of wind specifically for concrete reinforcement and turbine manufacturing. Steel requirements for solar farms are in the supporting infrastructure (inverters, transformers, and telecommunication system); however, this supporting infrastructure is prefabricated overseas and imported to Australia. Steel used in the mounting structure could be manufactured in Australia but is also mostly imported as a part of prefabricated kit. The steel required for solar farm fencing is manufactured and sourced locally.

Copper

Australia has one of the largest shares of world copper resources. It mines and exports more than 900kt per year (Minerals Council Australia, 2017), 200kt in NSW (NSW Government, 2021). Copper is a critical mineral in renewable technologies and is used for its electricity and heat conductivity in cables, wiring and heat exchangers.

The main source of demand for copper is projected to be in utility solar farms and pumped hydro, with notable demand in onshore wind farms (Figure 14). For offshore wind farms, the quantity of copper used would be more than double per installed capacity for onshore farms due to lengthy cables connecting the offshore wind farm to the shore. Overall, the quantities required by renewable energy are small in relation to the amount of copper mined and exported so we do not envisage capacity constraints.

Aluminium

Australia holds one of the largest economic bauxite resources in the world, mined in QLD, NT and WA, supplying about 30% of world bauxite (Geoscience Australia, 2016). Australia also exports more than 80% of the produced alumina and aluminium.

Even though NSW contains deposits of bauxite, it is currently uneconomic to mine. NSW does however have an aluminium smelter in Tomago near the proposed Hunter REZ. Tomago Aluminium's commitment to switch to 100% renewable energy by 2029 could open a possibility for development of clean and affordable local manufacturing using 'green' aluminium.

The main projected requirement for aluminium is in utility solar (Figure 14). Aluminium is used for the frames on solar panels, which are currently manufactured overseas, predominantly in China. Significant quantities of aluminium are also projected to be required in transmission lines.

However, even if all the renewable technologies components that require aluminium were manufactured in Australia (12kt/y), they would be only a small fraction of the 1635kt of aluminium that Australia produces (Tomago produces 590kt/y) (Tomago, 2021).

The material projections were generated based on the NSW REZ scenario and using material intensity indicators (Briggs et. al., 2021) summarised in *Table 5*.

Table 5: Material indicators for concrete, steel, aluminium, and copper for the renewable technologies

Technology	Concrete	Steel	Aluminium	Copper
Pumped hydro	850 m^3/MW	43 t/MW	0.025 t/MW	2.0 t/MW
Utility solar	22 m^3/MW	82 t/MW	7.5 t/MW	4.5 t/MW
Wind	190 m^3/MW	120 t/MW	1 t/MW	2.1 t/MW
Utility batteries	0.8 m^3/MWh	2.1 t/MWh	3.4 t/MWh	0.9 t/MWh
Transmission line (single circuit)	39 m^3/km	17 t/km	13 t/km	1 t/km
Transmission line (double circuit)	71 m^3/km	39 t/km	13 t/km	1 t/km
Transmission (other)	278 m^3/$mil	0.1 t/$mil	0.1 t/$mil	0.9 t/$mil

Note: The indicators were derived using a combination of international and national studies, environmental impact statements and reports, installation guidelines and standards that were verified with consultation with experts. The estimated material indicators for pumped hydro were developed based on international life cycle analysis literature as there have been few projects in Australia in the past few decades. Pumped hydro requirements vary significantly from project to project due to location, geographical features, and the diversity of generation and storage capacities, therefore the sensitivities of this estimate should be considered.

03: Renewable energy supply chains

3.1 Introduction

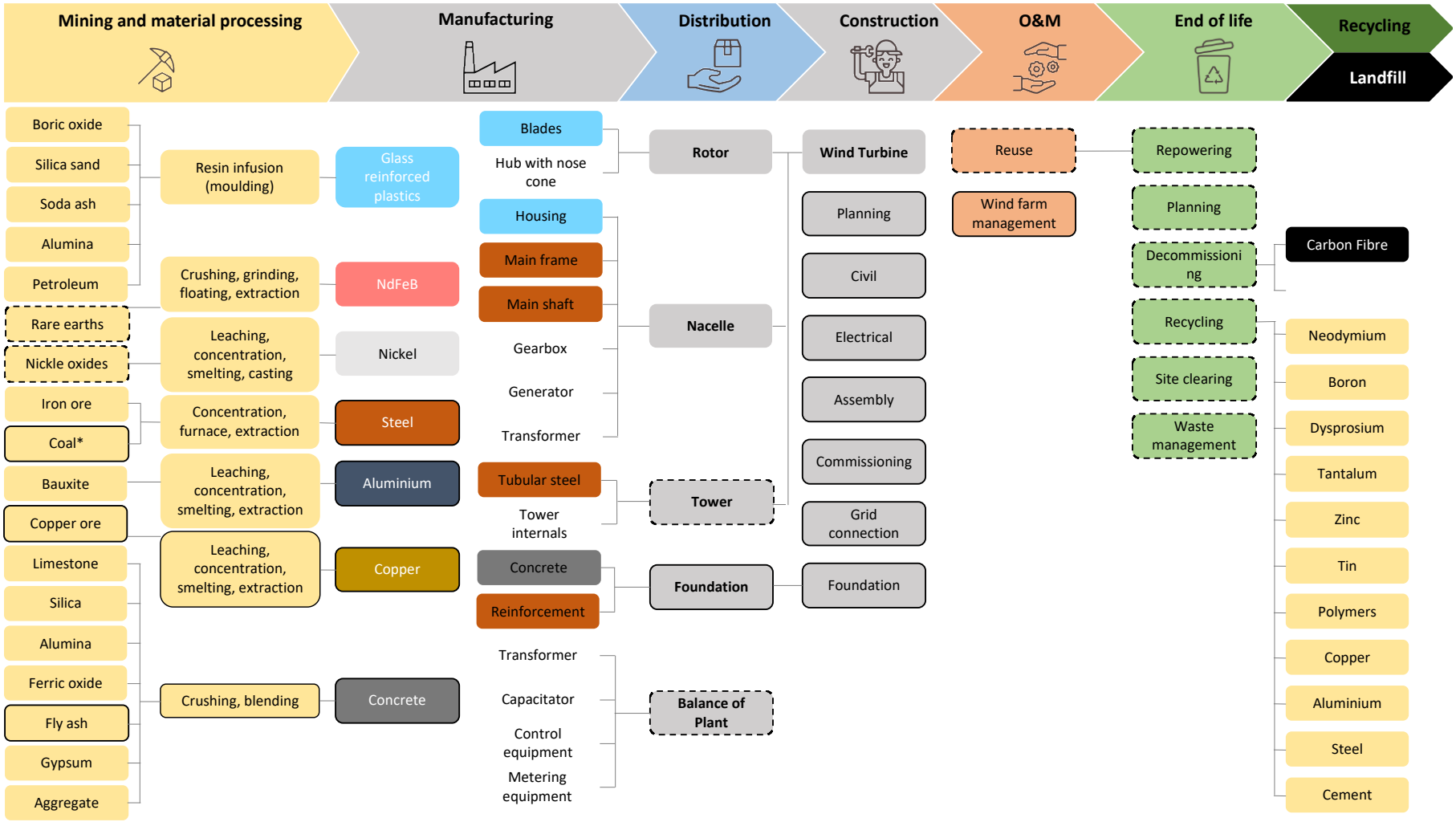
In identifying opportunities to increase local industry involvement upstream and downstream in the supply chain from the construction and operations and maintenance phases, this report identifies the stages and components of supply chain from cradle to grave for wind, solar, pumped hydro storage, batteries, and transmission lines.

We have mapped the supply chain for each technology upstream from mining through mineral processing to manufacturing and downstream to include end-of-life and recycling. Within each supply chain map, we identified material inputs as well as areas where there is existing NSW industry and areas where there could be opportunities to develop NSW industry.

3.2 Wind supply chain map

Sector	Summary
	The wind supply chain (Figure 15) focuses on utility scale onshore wind farms. Wind turbines are large and heavy structures that require a large reinforced concrete foundation and are typically assembled onsite. They are composed of a tower, a nacelle and a rotor, built from a range of materials: steel, fiberglass, resin or plastic, iron or cast iron, copper and aluminium. Concrete and steel are the most prominent materials required for wind turbines and foundations. Manufacturing of the main components of the wind turbine requires specialised equipment such as that used for welding, lifting and painting in other industries such as construction and aeronautics. The foundations require specialised equipment for rolling, drilling and welding. Special equipment is also needed to move these big structures. Wind turbines convert kinetic energy of moving air to electrical energy, with incoming air flow activating the rotation of rotor blades that in the gearbox transfers to higher speeds spinning the electricity producing generator. There are several variations in the designs of wind turbines and consequently the material requirements. One of the main distinctions is between geared and gearless converters, with further variations within each of the options. Gearless generators offer greater reliability and require less maintenance but are bigger and heavier (for example, the nacelle of a direct drive synchronous generator is approximately one third greater than that of a geared generator). However, the weight of the gearless generator can be significantly reduced with the use of the rare earth elements (Neodymium, Praseodymium, Dysprosium, Terbium). It is estimated that wind turbines require around 200 kg/MW of rare earths, which have been a driving force for innovation in wind technology due to an increase in rare earth prices. Lighter nacelles also have lower material requirements for the tower and foundations. WA holds significant rare earths reserves but there are also rare earths reserves near Dubbo and Nurraburra, NSW. (NSW Government, 2018) Most of the components of the wind turbine are manufactured overseas. Some are unlikely to develop a market in Australia but there are opportunities for local manufacturing, especially where components are already being manufactured in Australia (e.g., towers, transformers). At the end-of-life, most of the materials used in the wind farm can be re-used (for the same function), repurposed (applied to another function) or recycled (material recovered). However, the blades and nacelle housing that are made from carbon or glass fibre are hard to recycle and often end in landfill. The supply chain of offshore installation would have similar stages and components but with higher requirements for quantities of steel that is seawater resistant (including chromium).

Figure 15 Wind technology supply chain



**Currently coal is used to make steel, which is anticipated to be replaced with renewable hydrogen in the next decade, an opportunity for NSW.*

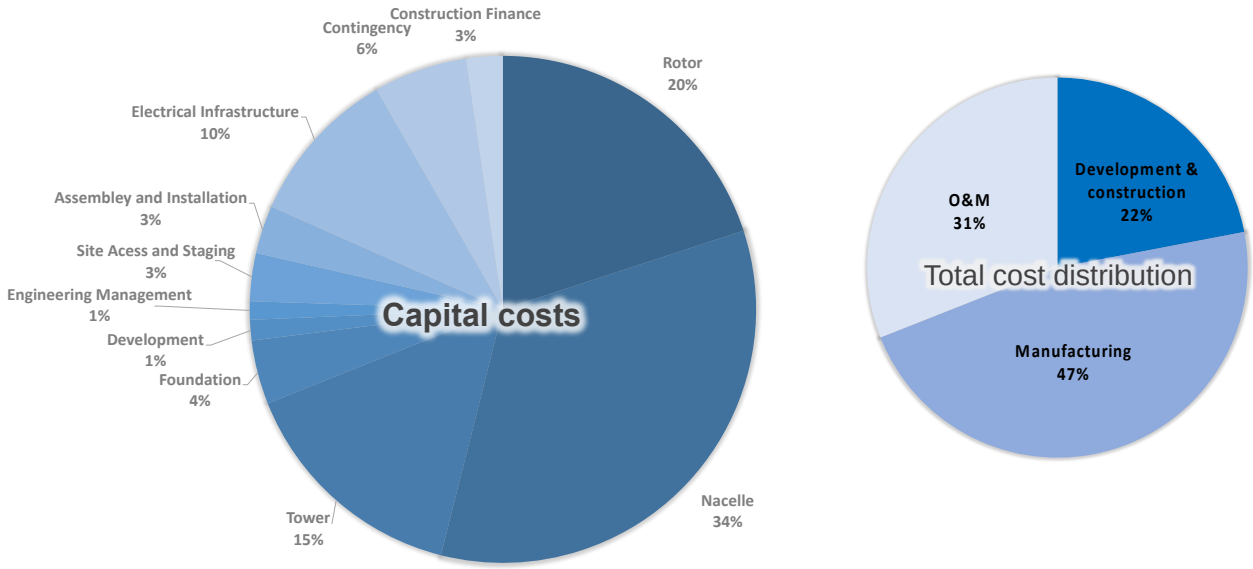
Flow diagram Key

NSW capacity | NSW Opportunity | Materials forming components

Figure 16 illustrates the value distribution for a wind farm including the operational and management costs over the predicted 25-year life span as estimated by the National Renewable Energy Laboratory (NREL, 2019a). The most significant costs occur in the manufacturing of the nacelle that hosts the generator, gearbox and transformer; and for the replacement parts (which would mostly be in the nacelle). Other significant costs are the rotor, which includes the blades, and the tower. The wind towers account for approximately 15% of capital expenditure (capex) and 10% of the total cost. The wind tower is predominantly made of steel, which is 50% of the cost of the tower. The nacelle and blades account for 55% of capex and 40% of total cost (once O&M is included). Development and construction represent a bit more than 20% of the project cost. For operation and management, a third of the project cost, the main cost is in the replacement parts (61%), while other material and services represent 26% and labour costs 13%.

Onshore wind prices have decreased globally in the last year by 13%, following the trend that has been occurring over the last decade due to technological improvements (lowering installation costs and operation and maintenance costs), economies of scale, increased competitiveness and maturity of the sector. The year-on-year decline in 2020 has been largely attributed to the reduction of wind turbine price and balance of plant cost reduction (10%). (IRENA, 2020)

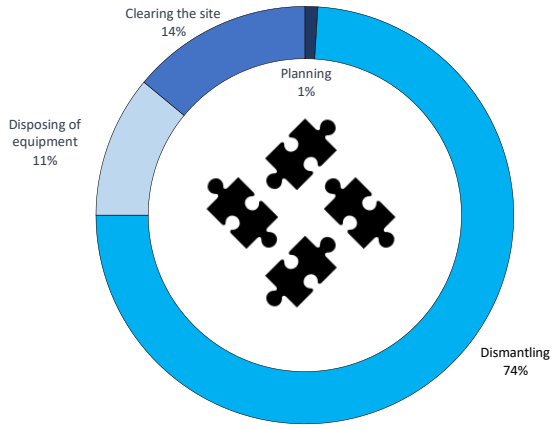
Figure 16 Value distribution for a wind farm (capital cost and total project cost)



Source: NREL, 2019a *Cost of Wind Energy Review*

At the end of wind farm life, there are several valuable resources that can be captured for re-use or recycling. Figure 17 illustrates the cost distribution for the end-of-life for a wind farm, where the cost of dismantling is by far the highest cost (74%). Notably, dismantling requires the same skill set as the wind farm construction and will therefore be an employment opportunity in future.

Figure 17 End-of-life cost distribution for a wind farm



3.3 Solar supply chain map

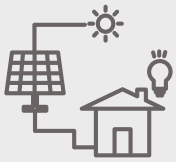
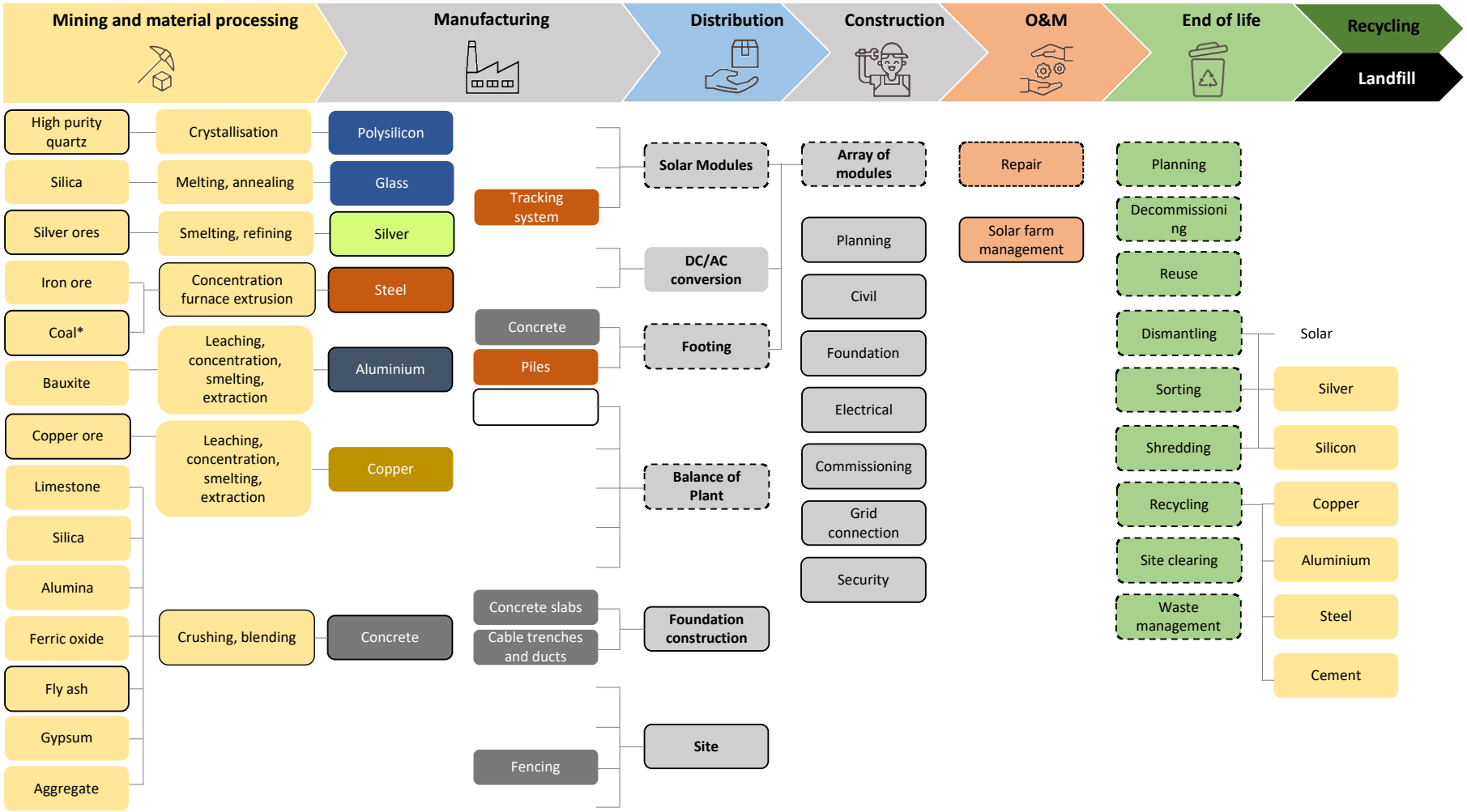
Sector	Summary
	The supply chain of a solar farm is represented in Figure 18. A utility scale solar farm consists of an array of solar modules (PV panels) arranged in strings. Modules include cells organised in a series on the panels. There are different cell types (such as monocrystalline cells, polycrystalline cell, thin-film cells etc.) using different materials. Solar panels are imported from overseas and are either mounted on fixed angle frames or a sun-tracking system. The tracking system is integrated in Australia but the components are predominantly manufactured in China. The mounting structures and the foundation piles, typically fabricated from steel or aluminium, are also predominantly imported. Inverters used to convert the DC electricity produced by the modules to the AC electricity compatible with the grid are manufactured overseas. Manufacturing inverters requires sophisticated technology which could be a barrier for overseas companies establishing manufacturing facilities in Australia. Solar farms use two types of transformers: a distribution transformer (installed with inverters) and substation transformer used to set up voltage for transmission. Transformers are housed in metal containers and placed on concrete foundations. Electrical equipment, combiner boxes and cables and conduits are imported; however, the cables and conduits could be supplied from Australia. Other components such as monitoring systems, security systems and weather stations are all manufactured in Australia. Steel fencing with concrete footings and site facilities are produced locally. Solar farms in Australia use only minimal quantities of concrete due to the use of driven piles instead of concrete foundations; concrete is predominantly used in foundations for the substation construction. The main materials used in solar farms by weight are glass (33%), steel (27%), concrete (22%), aluminium (9%), silicon (3%) and copper (3%). Most components of the solar farm last the lifetime (15-25 years), except for the inverters and other electrical devices (10-15 years). The current end-of-life approach to solar panels in Australia is to shred the panels and separate glass, copper, steel, aluminium, and plastics that are sent for recycling. This is an emerging field with local industry opportunity for establishing the recycling process and PV stewardship program developed by government in partnership with industry.

Figure 18 Utility-scale solar farm supply chain



Note: Currently coal is used to make steel, which is anticipated to be replaced with renewable hydrogen in the next decade, an opportunity for NSW.

Flow diagram Key

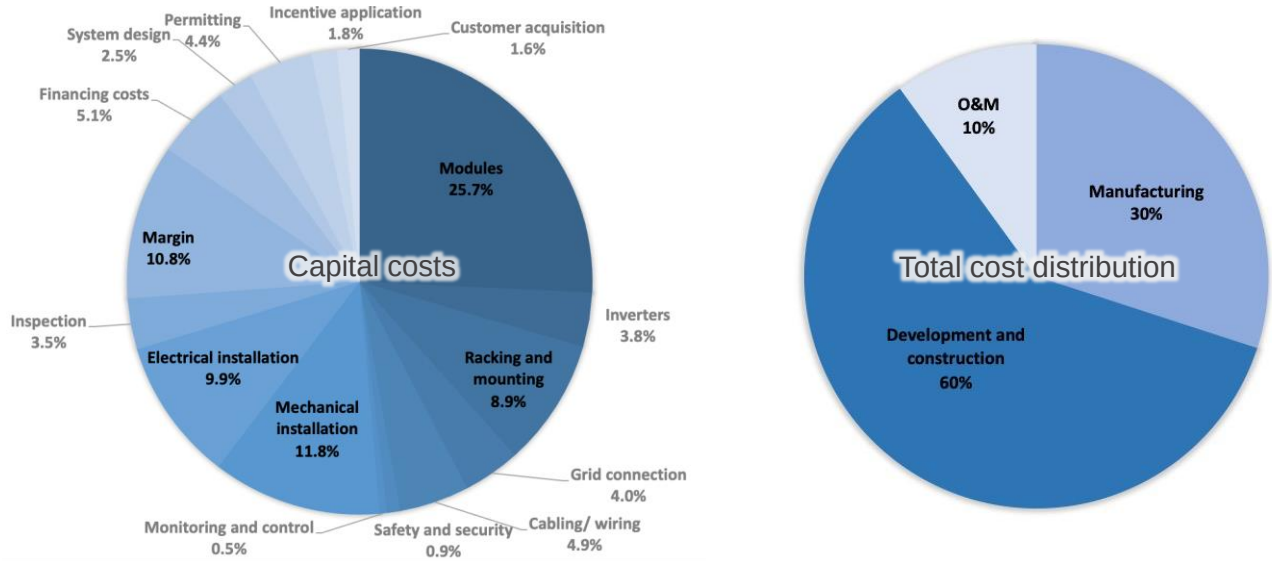
NSW capacity | NSW Opportunity | Materials forming components

The highest value in the value distribution of solar farms is in solar panels and silicon cells specifically, followed by the steel racking system. In the solar cell value breakdown, the main cost is attributed to silicon cells (74%) and the rest of components to glass (10%), ethylene vinyl acetate (7%) and back-sheet (5%) (NREL, 2019b). Electrical components - such as the junction box, inverter, conduit, and transformer - generally represent about a third of the cost.

For Australian solar farms (Figure 19), when the installation and soft costs are included, the cost of modules represents 26% and inverters 4%, while the rest of the balance of solar hardware is around 19%, installations 25% and soft costs 26%. The installation cost includes mechanical, electrical installation and inspection. Soft costs include margin, financing costs, system design, permitting, incentive application and customer acquisition, as shown in the Figure 19.

A solar farm project cost analysis in Australia conducted by ARENA (2018) estimated the operational expenditure (opex) component to be 9-21%.

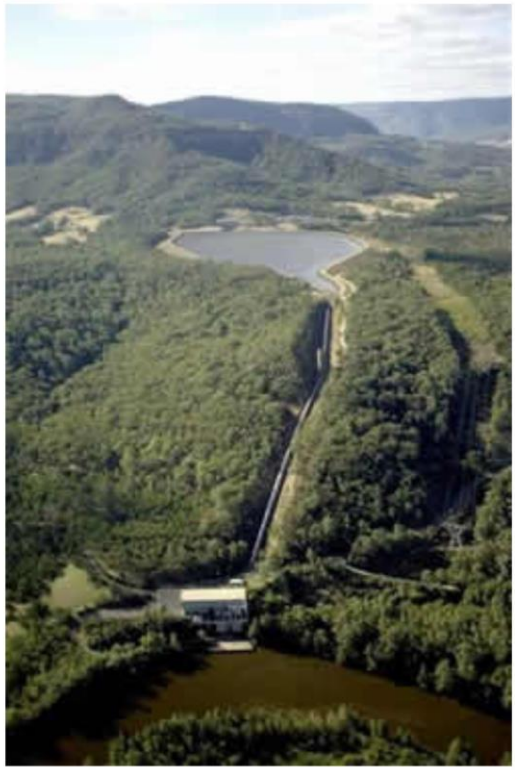
Figure 19: Cost distribution for Australian solar farms



3.4 Pumped hydro energy storage supply chain map

Sector	Summary
	Pumped Hydro Energy Storage (PHES) is important in energy management when coupled with a renewable generation technology such as wind or solar (or 'firming' intermittent renewable energy). PHES is particularly important when a longer duration supply of six hours or more is required from storage technology. Hydro technologies are well established, but the design varies depending on the geographical features of the site. Often, PHES is suitable in naturally occurring reservoirs. Other factors such as penstock height to length ratio, underground location of the pipes or power station (requiring excavation and additional lining of the underground chambers or tunnels) also impact the material requirements and cost of the project. Figure 20 illustrates examples of different reservoirs and penstock setups in pumped hydro systems around the world, demonstrating the range and variety of construction designs and use of materials due to the different levels of complexity and structures. The pumped hydro storage supply chain is illustrated in Figure 21. The main components of PHES are the storage system, penstock, power system and grid connection. The storage system consists of the two reservoirs (upper and lower), which generally utilise the naturally occurring material for lining but also might require lining material and concrete. The penstock, including pipes and valves (either buried or on surface), are predominantly built from steel and concrete. The power system housed in a powerhouse consists of turbines, pumps and generators or motors, which also require high quantities of steel and concrete. Similarly, the grid connection that requires inverters and transformers are built from steel and placed on concrete slabs. Therefore, steel and concrete are by volume the most important materials in building the PHES. While the concrete used in building the PHES would be sourced locally, the large quantities of steel required to build turbines or pumps would be counted within the manufacturing process. Other materials such as aluminium and copper are used in manufacturing of the electrical components and cables. When lining is used in reservoirs it is often manufactured from high density polyethylene. The lifespan of hydro technologies is 50 years or more and in this timeframe the power and generation equipment will require repairs and refurbishment. Due to the long lifetime span, the end-of-life is hard to consider at the design/build stage as recycling processes for the materials used to build the PHES may change. However, the main materials used to build the PHES, concrete and steel, are recyclable today. Spoil that occurs during the construction stage of PHES due to excavations is utilised on site (e.g., to build roads), though a proportion of it is disposed to landfill.

Figure 20 Examples of reservoir and penstock construction setups for pumped hydro systems around the world.



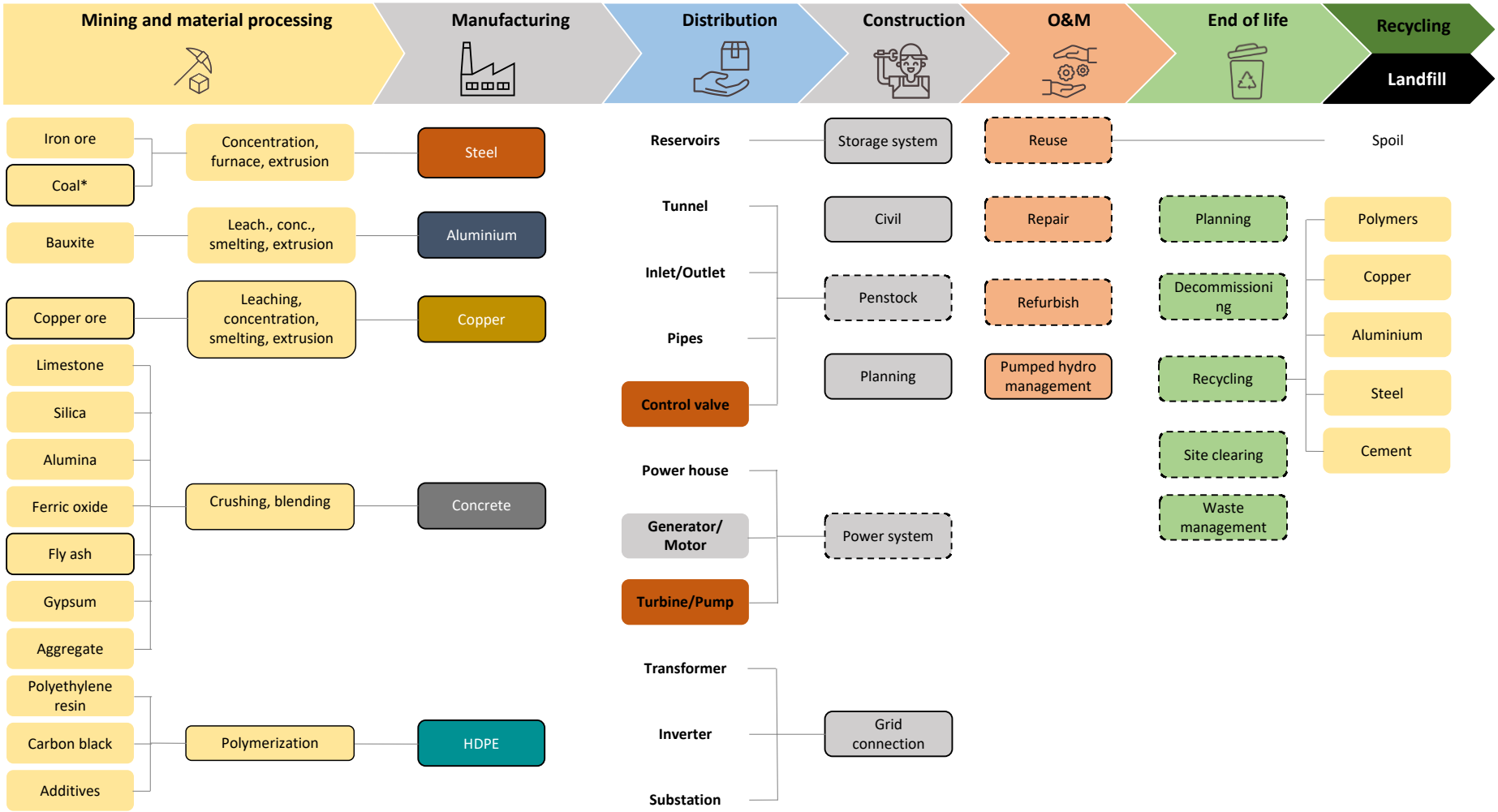
Shoalhaven Scheme – Bendeela Pondage, Australia

Turkey nest type PHS systems – Goldisthal, Avce, Dlouhé Stránë, Tianhuangping, Turlough Hill, Coo-Trois-Ponts, La Muela, Seneca, Ludington, Taum Sauk.

Yanbaru seawater PHS plant on Okinawa Island, Japan

Tumut-3 power station in the Snowy Mountains, Australia

Figure 21 Pumped hydro energy storage system supply chain



Note: Currently coal is used to make steel, which is anticipated to be replaced with renewable hydrogen in the next decade, an opportunity for NSW.

Flow diagram Key

NSW capacity | NSW Opportunity | Materials forming components

The cost of the PHES project depends on the pumped hydro storage capacity and ranges from $1m to $3-5m/MW (Table 6) and varies from project to project. Additional equipment such as treatment of seawater (e.g., Cultana PHES, SA) adds to project cost.

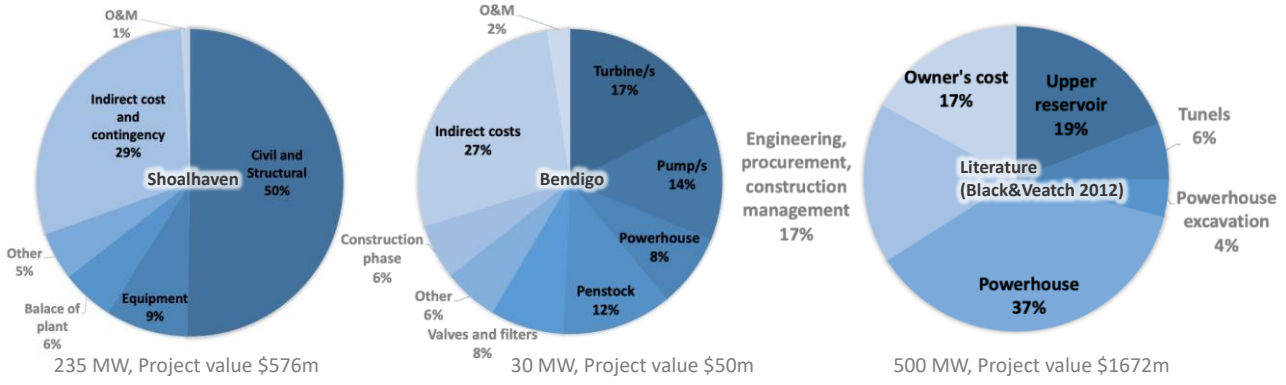
Table 6: Example costs for different pumped hydro storage capacity projects under consideration to build in Australia.

	Central-West (NSW)	Cultana sweater (SA)	Lake Echo (TAS)	Cethana (TAS)	Rowallan (TAS)	Poatina (TAS)
Capacity [MW]	325	225	200	600	600	600
Storage [h]	8 h	8 h	8 h	11 h	24h	31
Cost [$m/MW]	1.54	3.4	2.7	1.5	1.65	1.79
Project cost [$m]	500	790.5	540	900	990	1075

The value distribution for the supply chain and different components varies considerably between projects, depending on the extent of civil and construction works required. Figure 22 illustrates the cost and value distribution for three projects. In the first project example, (Shoalhaven) the highest cost are the civil and structural costs. The cost for construction is significantly lower in the second project example, Bendigo PHES. In the third, drawn from a study (Black & Veatch, 2012), civil works make 46% of the capital costs even though the lower reservoir already existed. The three examples illustrate the variation in project costs, predominantly due to the characteristics of the geographical location.

Indirect costs include preliminaries and general, design and approval, and owner's cost and contingency and are more consistent across the three projects, representing almost a third of the costs. The O&M costs are estimated to be 1-2% of the total cost per annum and include maintenance of the plant and cost of staffing. Cost of the equipment (pumps, turbines and balance of power) increases in smaller capacity projects.

Figure 22 Value distribution for pumped hydro energy storage (including O&M)



3.5 Battery storage supply chain map

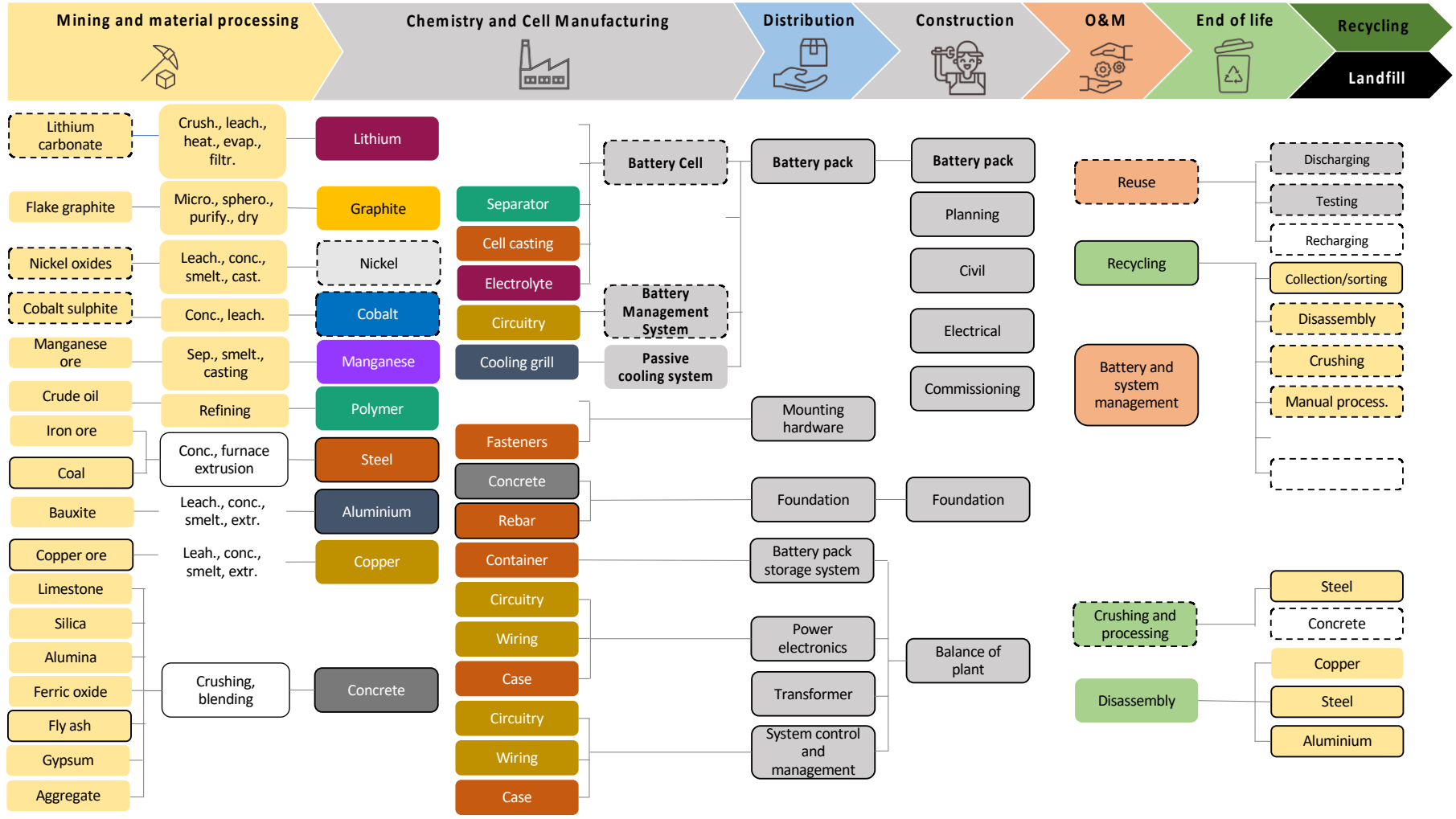
Sector	Summary
	A range of battery chemistries could be applied to the stationary energy storage market, including lithium-ion, lead-acid and flow batteries. However, due to the significant market share, availability of research, and projected growth in both electric vehicle and battery energy storage system (BESS) applications, the lithium-ion battery is the focus of this supply chain analysis (see Figure 23). **Mining and materials processing:** a range of minerals are used for lithium-ion batteries. Within NSW, mining capacity in nickel, coal and copper is already established and each material includes varying degrees of material processing downstream of extraction. Opportunities have been identified within NSW in both lithium mining, in the form of lithium deposits, and in cobalt mining and processing via the proposed Cobalt Blue mining and processing facility. For materials to be suitable for battery chemistries, they must be processed to a highly pure battery grade. The Cobalt Blue and Sunrise Energy Metals facilities in NSW are proposing to process cobalt to a battery grade. **Manufacturing and assembly:** Battery manufacturing can be broken down into three main stages: • **Electrochemical manufacturing:** the mixing of battery materials into slurry form and application onto battery cell sub-components such as the anode and cathode. • **Battery cell manufacturing**: Sub-components are then assembled into battery cells made up of anode, cathode, electrolyte, separators, and cell casing materials. • **Battery pack assembly**: Battery cells are then assembled into the battery packs in combination with balance of plant components. The Renaissance One battery manufacturing facility, proposed for Tomago, is the first in NSW and will assemble lithium batteries for Australian and international markets (Energy Renaissance, 2021). Our interviews indicate potential to extend into lithium cell manufacturing via the Renaissance Two facility, currently at development stage. Our survey identified nine businesses in NSW who contribute to the manufacturing or assembly of components for batteries. **Balance of plant:** Supporting infrastructure for battery packs include the storage system for housing batteries and systems (in many cases a repurposed shipping container with concrete or bitumen foundation), power electronics (temperature and condition monitoring for the battery system), and system control and management (monitoring the flow of energy between battery and grid). Our desktop research identified some NSW businesses acting as distributors for components in these areas. Our survey identified 10 businesses supplying secondary equipment, and 13 contributing to electrical balance of plant at the construction phase. **Distribution and construction:** We found that businesses already contribute to the distribution, installation and electrical commissioning of BESS components. Our survey identified six businesses in warehousing or distribution, 7 businesses in transport and 42 businesses in the construction phase (most of which contributed to project management). **O&M:** The management of BESS systems is predominantly done remotely by system control and management components and service providers - a small proportion of O&M will require onsite assessment and maintenance. The degree to which onsite servicing of BESS is required is not well understood. We found service companies that perform remote monitoring, often located in major urban centres such as Sydney and Newcastle. Our survey identified eight businesses undertaking BESS O&M in NSW. **End-of-life:** Lithium-ion battery life cycles are estimated at between 3-9 years and depending on the condition at end-of-life and the available facilities, reconditioning is possible. However, collection facilities and repowering facilities are not well established for lithium batteries. A lithium industry could look to the lead-acid supply chain in NSW for potential process design for end-of-life collection. Businesses may be operating at the end-of-life stage for the battery supply chain; however, we didn't identify any in our survey. Another alternative for batteries at end-of-life is recycling, which involves several steps: collection, sorting, disassembly, crushing, manual separation of materials and further pyrometallurgy or hydrometallurgy to extract battery grade materials for re-use in the manufacturing process. NSW benefits from a well-established lead-acid battery waste management system, where batteries are collected through council waste facilities. Energi Power Storage processes lead-acid batteries and the lithium battery market could look to integrate waste streams with lead-acid batteries. However,

identification of battery chemistries during the collection and sorting process is a current issue affecting lithium battery waste streams (Zhao, et al. 2021).

An opportunity exists for balance of plant items that contain steel, aluminium, and copper such as steel shipping containers, foundations, copper wiring and accessories to be re-used (via disassembly and reassembly) or recycled (via the blast furnace and smelting stages). In Australia, the percentage of recycled material in new manufactured products varies from between 25% - 60% for steel (ASSDA, 2005) and up to 75% for aluminium (AAC, 2021). Concrete recycling varies depending on the proximity of the decommissioning site to aggregate crushing facilities. In regional areas, mobile processing facilities have been used where insufficient concentration of materials has resulted in a lack of permanent facilities (QLD Department of Environment and Resources Management, 2011).

A thorough lithium-ion BESS supply chain breakdown and analysis of known opportunities is explored in the supply chain diagram below.

Figure 23 Lithium-ion battery energy storage system supply chain



Note: Currently coal is used to make steel, which is anticipated to be replaced with renewable hydrogen in the next decade, an opportunity for NSW.

Flow diagram Key

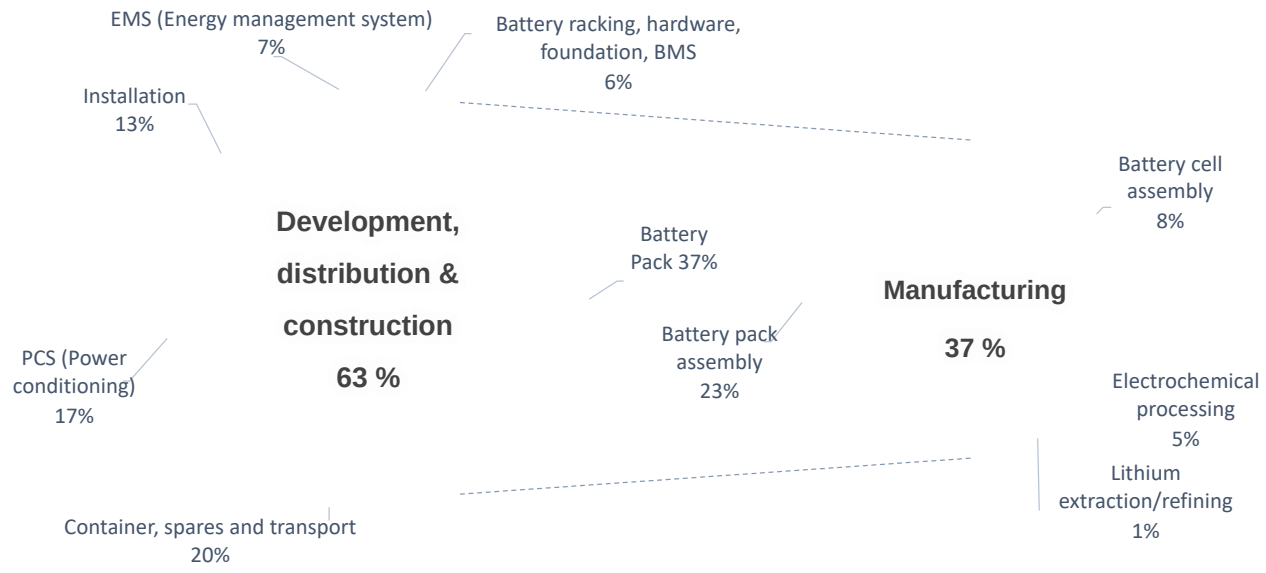
NSW capacity | NSW Opportunity | Materials forming components | Recycled content

Battery storage supply chain value breakdown

A value breakdown of battery manufacturing and balance of plant components in Figure 24 is based on a combination of sources from the US and Australian market and are considered broadly equivalent to the NSW context. As a relatively new technology, cost reductions and efficiencies are likely to shift the distribution in coming years.

Although the battery pack is the single biggest contributing component (37%), balance of plant items account for a substantial share of the value distribution. The largest cost item is container, spares and transport at 20%, closely followed by power conditioning (17%) and installation costs (13%). The largest share of battery manufacturing costs is battery pack assembly (23%), where battery cells are assembled into banks of batteries in packs. The remainder of battery manufacturing costs are associated with battery cell manufacturing (8%) and electrochemical processing (5%). One study focused on the value opportunity at the end-of-life stage (Zhao, et al., 2021), which we have not explored thoroughly due to its focus on repowering electric vehicle batteries. However, the waste stream of electric vehicle battery cells could be repurposed for stationary energy storage uses in future, with average refurbishment costs (battery purchase, plant, insurance, testing, repowering) at 35% of potential resale values. Further research into the viability of this opportunity is needed to understand the applicability for BESS.

Figure 24 Lithium battery manufacturing and construction cost distribution.

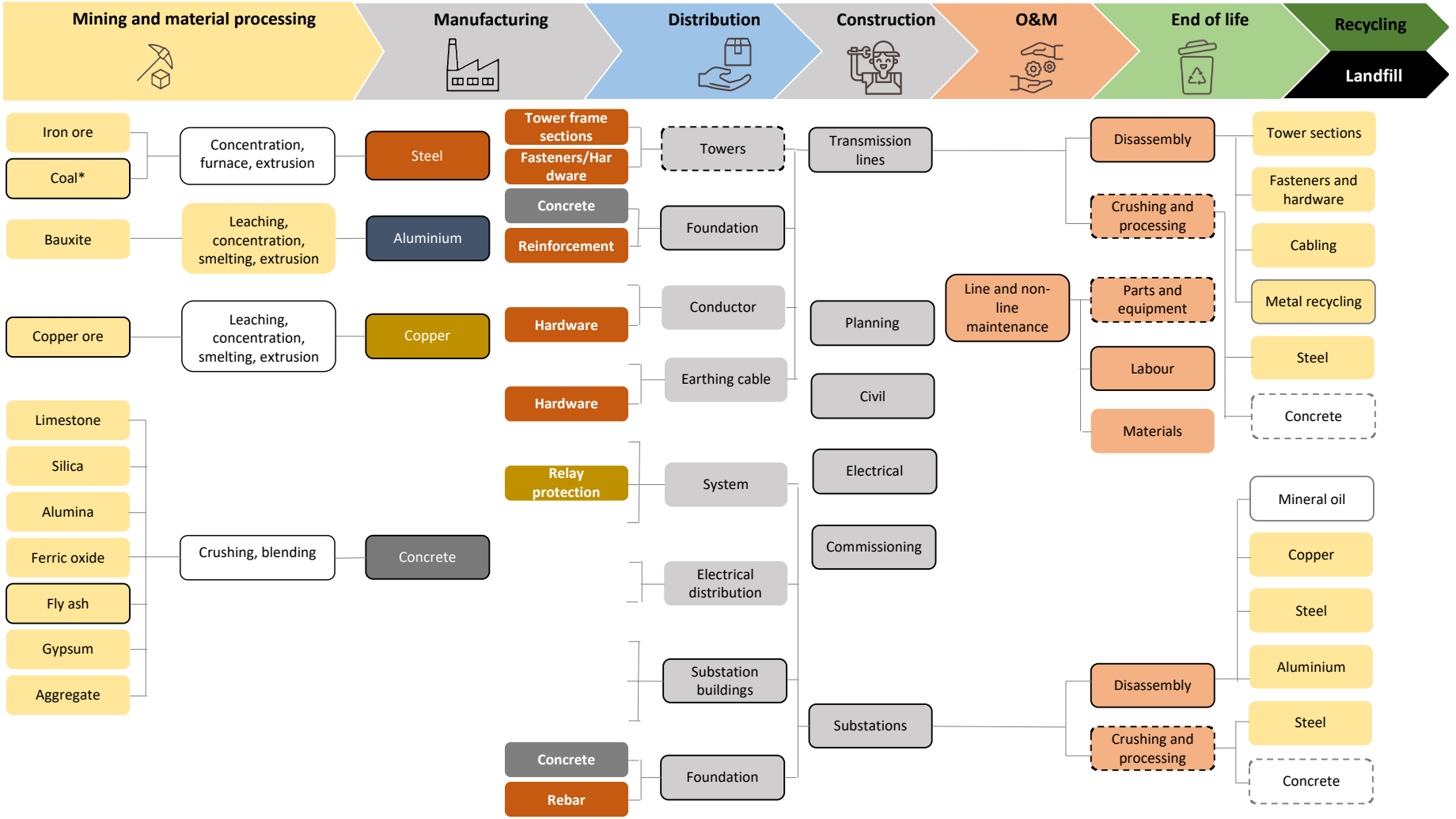


Source: Scandia National Laboratories, 2016 and Zhao et. al, 2021

3.6 Transmission supply chain map

Sector	Summary
	Transmission infrastructure can be divided into many different asset types. For example, transmission lines consist of low, medium or high voltage; single or double circuit; end of the line, turning point or midline position; and steel lattice or steel pole. Components vary based on the geographical location, grid location, voltage and design requirements. To simplify this supply chain analysis, we aggregated transmission infrastructure asset categories into transmission lines and substations. Transformers could also have been a category on their own as they are the single biggest component that could be installed as a standalone asset outside of substations. However, these components are included as part of a substation (see Figure 25 for supply chain diagram). **Mining and materials processing:** Of the minerals used, mining capacity in coal and copper ore are already established in NSW. These materials flow into processing stages and onto cast and extruded metals for the transmission sector. Capacity to manufacture extruded metals does exist – to some degree - within NSW. Potential opportunities for future manufactured components could include copper wire for cabling, steel rebar for foundation reinforcement, steel sections used for transmission towers and steel sections used in substation buildings for framing. **Manufacturing and assembly:** • **Transmission towers** can be assembled as steel poles or lattice towers. Both applications are used in NSW; however, lattice towers are prominent in high and medium voltage applications. Most assembly happens onsite but there is potential for partial assembly offsite. NSW has steel manufacturers for lattice and pole designs. • **Substation** configurations can vary significantly, yet they comprise key elements – foundation, buildings that house electrical equipment, control and security systems, electrical distribution equipment such as transformers and system equipment (e.g. capacitors, relays, switchgear and communications). NSW currently has suppliers/distributors for all components, however the only known manufacturer for transformers (Wilsons Transformers) is in Victoria. • Steel reinforcing is required for tower and substation **foundations** and manufactured locally, as is concrete. **Distribution and construction:** There are four construction phases for both asset types: planning (engineering, environmental approvals, pre-project management), civil works (site clearing, foundations and building works), electrical works (tower erection and line stringing with cranes and/or helicopters and electrical equipment installation), and electrical commissioning (testing and connection to grid). NSW already has established capacity to contribute to the planning, distribution and construction phases of the transmission tower and substation supply chains. However, the scale of construction required may result in constraints for the transmission sector if the specialised construction and electrical commissioning skills required are in short supply. **O&M:** Maintenance of transmission lines and non-line equipment is performed routinely to specified maintenance schedules by truck crew and/or helicopter in remote areas. Transmission corridor maintenance keeps lines clear of surrounding bushland. Further stakeholder engagement is required to understand the types of maintenance procedures performed at substations; however, one source reports regular replacement of mineral oil found in transformers (Benzoil, 2021). We identified some NSW capacity in this area. **End-of-life:** There is little information available on the end-of-life stage for transmission and substation components. Given the high percentage of metals embedded we assume most components would be scrapped at metal recyclers and reprocessed via the blast furnace/smelting stages of metal production. In Australia, the percentage of recycled material in new manufactured products varies from between 25% - 60% for steel (ASSDA, 2005) and up to 75% for aluminium (AAC, 2021). Concrete recycling varies depending on the proximity of the decommissioning site to aggregate crushing facilities. In regional areas, mobile processing facilities have been used where insufficient concentration of materials has resulted in a lack of permanent facilities (Qld Department of Environment and Resources Management, 2011). Stakeholder engagement could explore opportunities for supply chain components such as transmission towers, or electrical equipment to be decommissioned, reconditioned and re-used in new transmission infrastructure.

Figure 25 Transmission line and non-line supply chain



Note: Currently coal is used to make steel, which is anticipated to be replaced with renewable hydrogen in the next decade, an opportunity for NSW.

Flow diagram Key

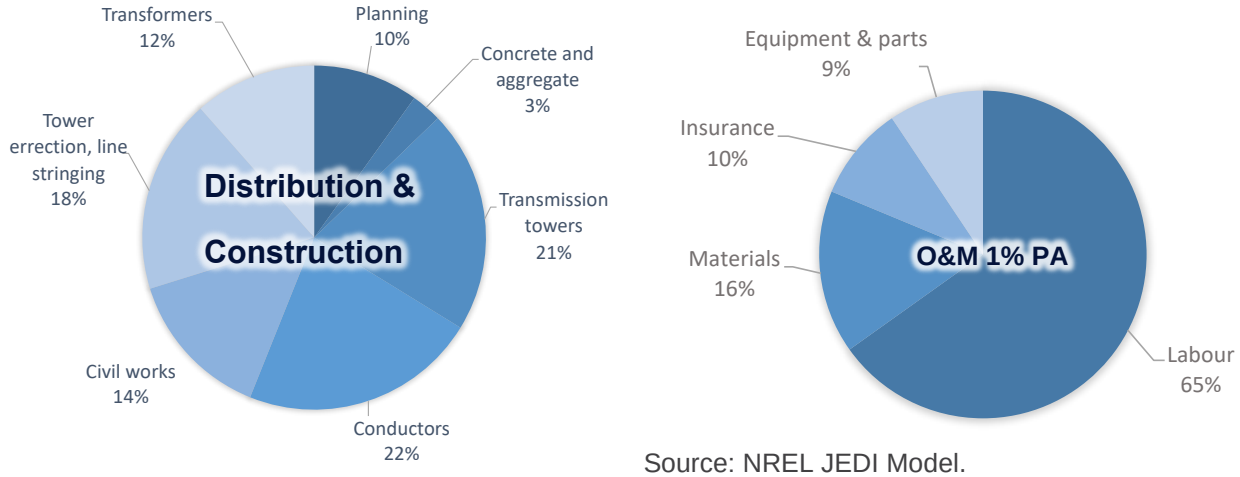
NSW capacity | NSW Opportunity | Materials forming components | Recycled content

Transmission line construction and O&M value breakdown

A value breakdown of transmission line and non-line infrastructure is provided below. Line value breakdown is provided by the NREL's JEDI transmission cost estimation model, based on the US market. This cost breakdown provides more detail for lines than estimates provided in AEMO's ISP inputs and assumptions workbook based on the Australian market. AEMO's cost breakdown did, however, provide more detail in non-line assets; therefore, we used AEMO figures for substations.

Conductors are the highest cost component of transmission lines (22%), closely followed by transmission towers (21%) and tower erection (18%) respectively. Values were also provided for the O&M phase at 1% of construction costs per annum. This is a significantly lower amount per km than the construction phase, reflected in the self-sustaining nature of transmission lines once complete. However, this value is likely to increase into the future as a result of climate change induced weather events.

Figure 26 Transmission line supply/distribution of components, construction, and O&M cost distribution.

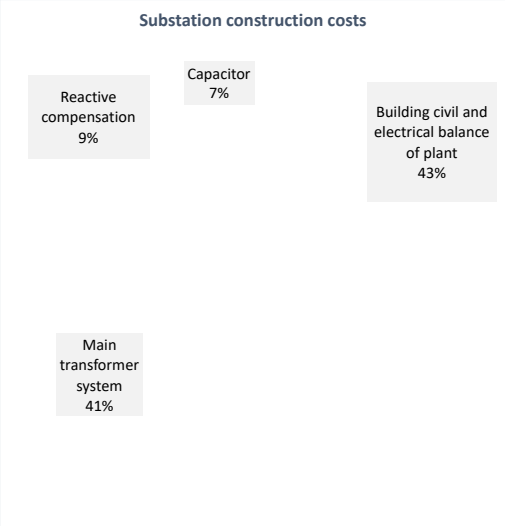


Source: NREL JEDI Model.

Transmission non-line construction value breakdown

AEMO (2020) figures inform the value breakdown of substation construction costs, AEMO figures provide a high-level breakdown only and a large amount of supply chain components have been aggregated into the building, civil and electrical balance of plant making up 43% of total installation costs. The main transformer system follows closely, accounting for 41% of total substation costs. O&M figures were not provided for substation components.

Figure 27 Transmission non-line (substation) construction cost distribution.



Source: AEMO (2020)

3.7 Existing supply chains in REZs and NSW regions

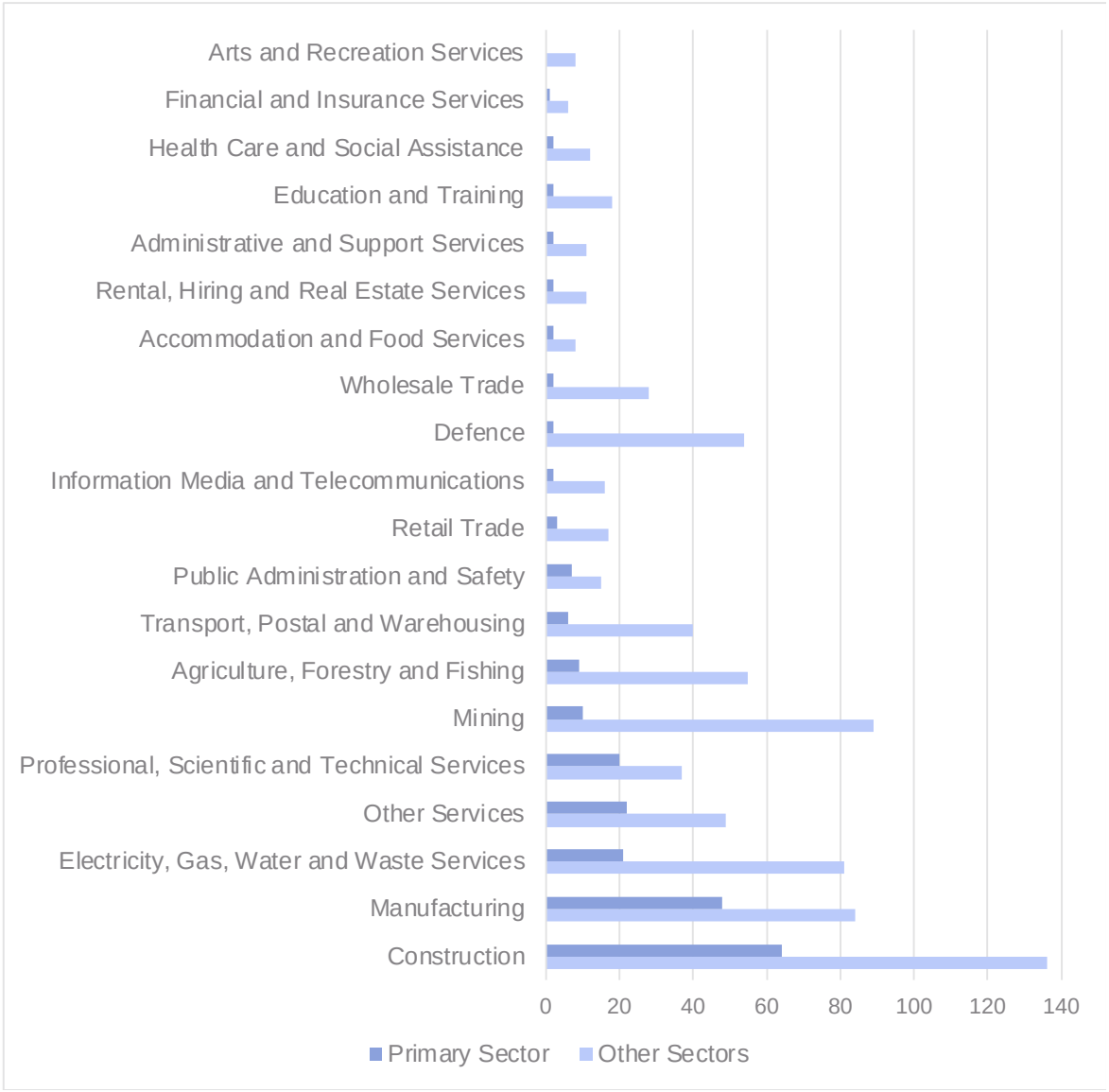
The level of information about businesses in renewable energy supply chains is low. Renewable energy does not have its own classification in the Australian and New Zealand Standard Industry Classification and businesses are distributed across various classifications. We used an online survey to investigate the existing supply chain capacity.

We distributed the survey through organisations with business networks and members (e.g., ICN) in July 2021 with around 265 businesses filling out part of the survey and 200 businesses fully completing the survey (see Appendix 3 for results). The survey covered businesses operating across each of the REZs and regions.

3.7.1 Interconnections between sectors

We found a high level of interconnection between sectors amongst businesses operating in renewable energy supply chains. Most businesses identified construction as their primary sector, followed by manufacturing, electricity, gas, water and waste services and professional, scientific and technical services.

Figure 28 'Primary' and 'other sector', NSW Business Survey



More than 83% of the respondents have operations in sectors besides their primary sectors. This is illustrated below, where the inner circle shows the primary sector for businesses and the outer circle shows how many of those businesses also have operations in other sectors.

Figure 29: Interconnection between construction, mining and manufacturing within renewable energy supply chains

- Construction businesses (primary) are also involved in electricity, gas, water and waste (38%), manufacturing (25%) and mining (38%).
- For manufacturing, the range is 40% for electricity, gas, water and waste to 60% (mining and construction)
- For electricity, gas, water and waste, the range is 30% (mining, manufacturing) to 70% (construction).
- For mining businesses, 60-70% operate across each of these other sectors (noting this is a small sample of 10 businesses).

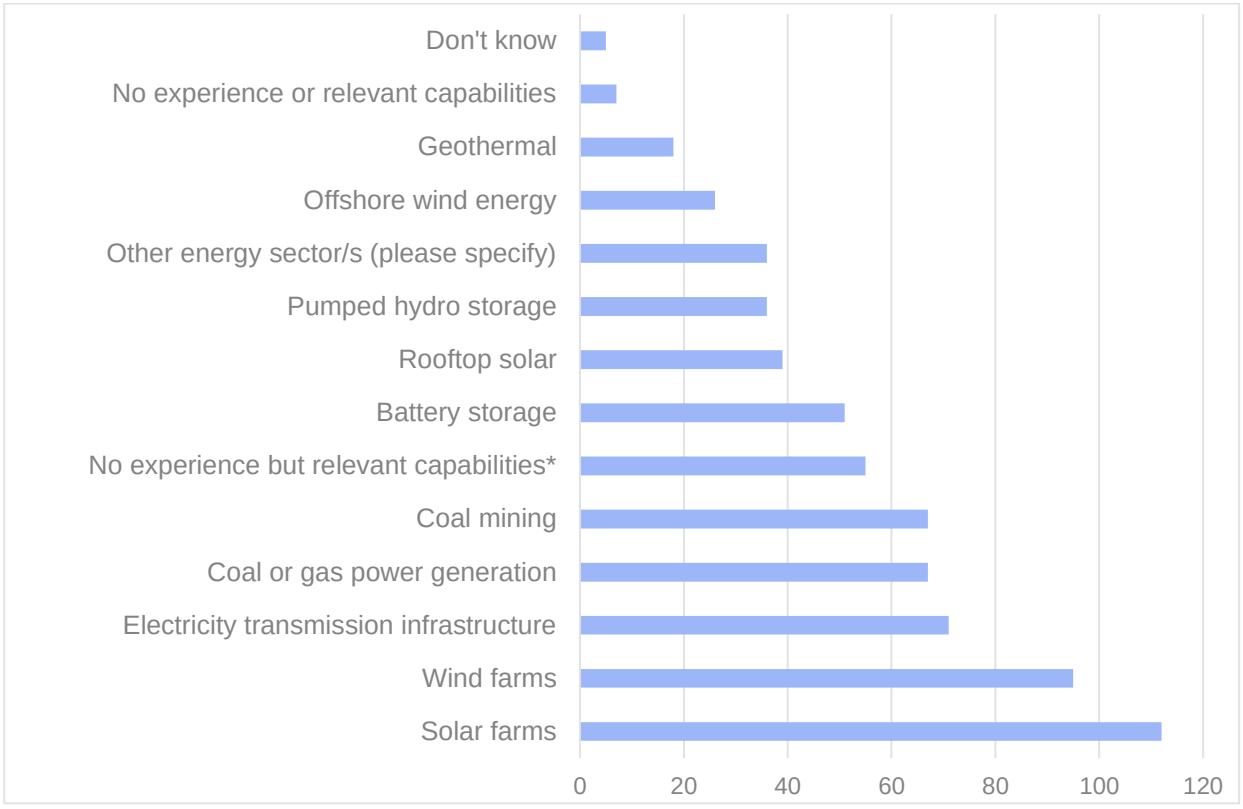
The survey reveals intertwined sectors with businesses operating across supply chains.

3.7.1 Experience and capabilities

We asked businesses about their experience and capability for each technology, phase and detailed activities (e.g., posts for solar farms). The list of activities was primarily derived from the Victorian Solar and Wind directory (Victorian Government 2019) for compatibility.

Most surveyed businesses have some experience in renewable energy, particularly solar or wind farms. Around half of respondents have experience in solar or wind farms, around one-third have experience in transmission, coal or gas generation, or coal mining respectively and one-quarter had experience in battery storage.

Figure 30 Energy sector experience among surveyed businesses



*These businesses recorded that while they had no experience in the listed sectors, they had relevant capacities (e.g., civil construction, electrical, manufacturing etc)

Almost a quarter of the businesses did not have experience in the renewable energy space but had relevant capabilities (mostly in project management, civil site works or manufacturing, assembly and supply of components).

Looking at the different phases of the supply chain by technology (Figure 31), the major concentration of businesses is in construction and manufacturing for solar and wind farms. There is also some distribution experience that includes secondary equipment supply, transport, logistics, infrastructure, warehousing, etc. Note there were no major differences between businesses located inside and outside the REZs.

Figure 31: Business experience across the supply chain

Note: each figure reflects the number of businesses which responded they have experience and/or capability at different phases of the supply chain. Around 265 businesses filled out part of the survey and 200 businesses fully completed the survey

Looking across the value chain (Figure 32), we found:

- The largest experience pool is in civil construction for solar farms followed by wind farms.
- Project management and manufacturing experience is moderate. Manufacturing experience is particularly strong for metal work.
- Moderate levels of O&M experience are seen across the different energy sectors. O&M capabilities range from a full wrap service to specialised equipment repair and change outs, from equipment and vehicle hires to security and surveillance services.
- Only a handful of businesses deal with electrical balance of plant and other secondary equipment supply for the different sectors
- Aspects of the value chain where experience is very limited include end-of-life, transport and warehousing.

Figure 32 Business experience in different energy sectors in REZ regions

	Wind farms	Solar farms	Battery	Pumped hydro	Trans-mission	Other energy
Project management						
Civil construction						
Secondary equipment						
Manufacturing or assembly						
Electrical BoP						
Infrastructure						
O&M						
Transport & Logistics						
Warehousing & Distribution						
Mining						
Mineral processing						
Recycling, re-use or circular economy						

Key: Red indicates no experience and the gradation towards green indicates increasing experience; grey – no data was collected

Full details of the findings below are in Appendix 3.

For solar farms:

- Most capability is in civil construction and project management.
- For manufacturing, the highest number of businesses were involved in metal work (posts, racks, mounts, etc.), followed by electrical components.
- Most of the electric balance of plant capabilities are in hardware like HV, LV and MV cables, panels and switchgear.

For wind farms

- Construction and project management being the strongest capacities.
- Manufacturing capabilities primarily in steel and metal work.
- Some experience in electrical balance of plant but much lower for other components.

For transmission:

- Overall, businesses in electricity transmission infrastructure are moderate.
- Electricity transmission infrastructure shows the same trend as seen in wind and solar, but with fewer businesses having capabilities across the different activities.

For battery storage:

- Most expertise is in project management, moderate in manufacturing, equipment supply, civil work and electrical balance of plant.
- There is a small amount of experience in upstream activities like mining and mineral processing.
- None of the surveyed businesses reported end-of-life management capabilities.

For PHES:

- Overall, among the sectors, experience in pumped hydro storage is very limited.
- Most of the recorded capabilities are in manufacturing, followed by project management, secondary equipment supply and civil works.
- There are limited capabilities in other activities across the supply chain.

04: NSW REZ baseline data

4.1 Introduction

This section reports on our understanding of the wider economic context and examines the existing structure and performance of the regional economy in each REZ. We identify industry and occupational composition of each region, as well as education and regional economic development strategies (REDS).

We drew on data from Australian Bureau of Statistics SA1 boundaries, best matched to the REZ boundaries. While these SA1 boundaries do not perfectly align, they are the best fit for the purpose of census data collection and analysis. Each of the regions are shown with the REZ boundary overlaid with the SA1 boundaries.

4.2 Summary of regional economic profiles

The existing regional economic structure and workforce in each REZ is a key determinant for successful development and local benefits. If a region has an available workforce with applicable experience and skills the development of a REZ will be more straightforward. Policy actions can overcome workforce and skill barriers if identified early. In regions with declining employment opportunities and a lack of new economic development and growth, the REZs present an opportunity to revitalise regional economies.

The following overview of the economic performance and structure, availability of a workforce, existing skills and education assets of each REZ can be seen in more detail in the appendix.

Central-West Orana

The economy of the Central-West Orana REZ has grown at a slower rate over the past decade than state and national rates. In terms of structure, primary production (mining and agriculture) collectively accounts for most income generated in the regional economy.

While there are planned solar and wind energy projects, the labour force largely reflects agriculture and mining. These occupations are somewhat relevant to the development of the REZ, with many technicians and equipment related tradespeople working in the area. Programs for skills development or re-skilling would allow residents to engage in certain aspects of the renewable energy supply chain. The university profile in the region does not appear to align with the opportunities presented by the REZ in terms of direct skills.

Population growth is projected to be relatively strong, which will contribute a larger local workforce.

Stakeholder inputs from workshops, interviews and surveys pointed to various constraints, including skills and labour shortages, and the ability to attract and retain staff. The training sector (including TAFE) has been constrained, and there is a gap in the training of electricians. The lack of affordable housing makes it difficult to attract workers.

The Central-West Orana experiences barriers within the local supply chain. Transport bottlenecks and disruptions are common and access to construction materials an issue. Businesses struggle with planning processes. Community engagement around the REZ was low and there is uncertainty regarding the social benefits of the REZ within the community.

Finally, a lack of coordination between different levels of government and sharing local knowledge is an ongoing barrier to good economic development outcomes.

New England

The economy of New England has generally grown at a slower rate than the NSW economy over the past decade. Agriculture is the biggest contributor the local economy, making up 25% of GRP in 2020. Interestingly for a regional area, education is the second largest contributor to GRP, due in part to the University of New England in Armidale, and related ancillary services. The economy is also more diverse than many regional areas in NSW, resulting in a more diverse labour force and range of skills.

However, these diverse skills are not directly compatible with the REZ and manufacturing activities. Stakeholders identify skill and labour shortages as a barrier and reported that a lack of skills is compounded by the lack of relevant training courses. The area's educational assets could be a platform for local courses to better align with the REZ.

Attracting, retaining and embedding new staff and residents requires investment in training, community services and infrastructure, particularly roads and rail. Local councils are resource constrained in procurement and community engagement and require support to capture the benefits of the REZ.

Despite land availability for residential development, housing affordability for key workers is another barrier to local workforce development.

South-West

The economy of the South-West REZ has generally grown at a slower rate than the NSW economy over the past decade. The REZ is typified by agricultural production. The labour market and skill profile will need to be developed to meet the REZ opportunity. There is no major university located in the region , but TAFEs can support skill transition processes.

Stakeholders identify labour shortages as the key barrier given the competition for labour with other industries. The housing shortage constrains the ability of industry to attract new staff. The lack of certainty around the government's renewable energy objectives is another barrier, particularly to SMEs who find it challenging to remain updated on procurement opportunities and any regulatory changes.

Hunter-Central Coast

The Hunter and Central Coast's economy has broadly outperformed the NSW and national economy since 2013. The economy is more metropolitan with high rates of employment and residential density. While mining remains a large part of the economy, construction and manufacturing also contribute large shares.

There is a broader skill profile in the Hunter-Central Coast compared to other REZs. The existing manufacturing capability presents a good base to support renewable related manufacturing operations. The region's proximity to Newcastle also means that highly skilled workers are more likely to be attracted to this REZ. Combined with the depth of the existing workforce, and the major infrastructure and education assets (such as the University of Newcastle), there are good conditions for the development of the REZ.

Stakeholders report that although there is a large and skilled labour force, there are still skill shortages. Local supply chain shortages also exist. Poor timing of projects and a lack of transparency regarding planning would be a barrier to success. Transparent planning is essential for industry to understand required skills for the appropriate project to then transfer or develop skills to match. A lack of communication, collaboration, transparency and consistency across areas of policy makes it challenging to plan for the future.

A limited capacity to expand manufacturing is reported, linked to limited land availability. The supply of land may increase as mining land is remediated, though the ecological impacts and the utility of those lands are not yet known.

Illawarra

The economy of Illawarra has generally grown at a slower rate than the NSW economy over the past decade. The economy is more diversified compared to more remote REZs. Illawarra is near Canberra and Wollongong, resulting in a greater share of knowledge-intensive and population-serving employment. There are also strengths in agriculture and mining. While manufacturing at a regional level is not a significant economic contributor, steel production at Port Kembla is a significant specialisation in the region. This, coupled with a large labour market, tertiary institutions and proximity to other areas where renewable energy assets are located such as the Southern Highlands, all create good conditions for the Illawarra REZ.

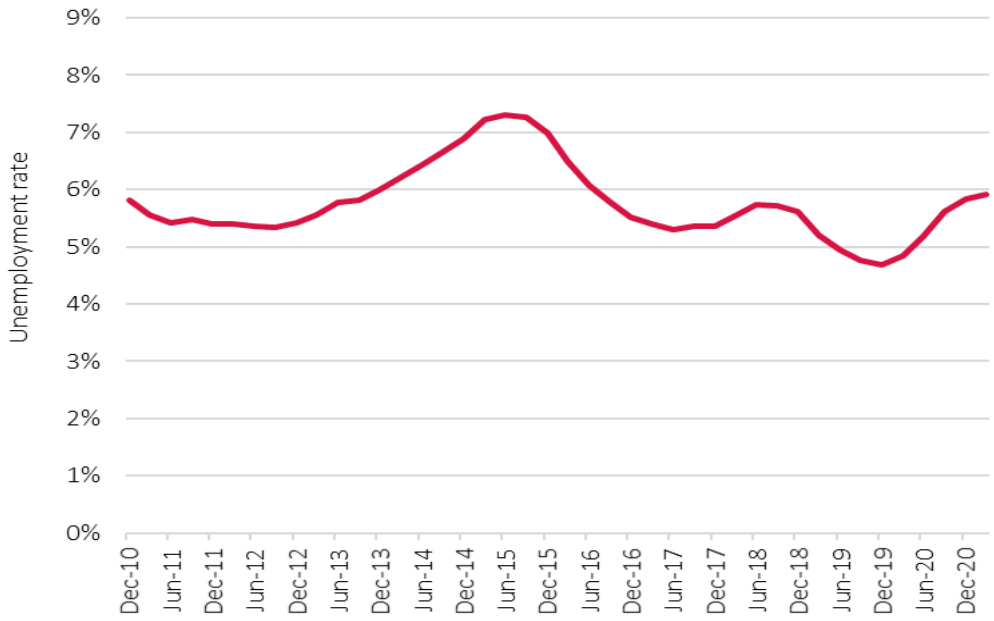
Stakeholders note significant skill and local supply chain shortages, and a lack of funding and resources for TAFE to develop and deliver the appropriate courses. There is a barrier regarding land use conflict with increasing residential encroachment and densification. A hydrogen industry is being developed locally, which

will increase the need for infrastructure upgrades and competition for workers. Stakeholders also identify the pace of government funding approvals as a barrier.

4.3 Regional NSW unemployment

While we have drawn from 2016 Census data, we note this is now five years old and labour markets can change within that period. We provide a time series of unemployment across Regional NSW in Figure 33, showing how the unemployment rate has fluctuated over the past decade. Recent impacts including COVID-19, bushfires and flooding have increased unemployment rates since December 2019. The average unemployment rate for regional NSW is now around half a percent higher than it was when the 2016 Census was undertaken.

Figure 33: Regional NSW unemployment rate



Source: ABS, Small Area Labour Markets, March Quarter 2021

Figure 34 shows trends in underemployment over the past five years. The NSW and the Australian average level of unemployment are closely aligned. The ABS defines underemployment as those who work part time but would like to work more hours, and full-time workers that worked part time in the survey period due to economic reasons (such as being stood down or insufficient work being available).

Since the onset of the COVID-19 pandemic in March 2020, the underemployment rate has risen in NSW. This peaked at around 14% in April 2020 and recovered slowly over the following year. This recovery was halted and the underemployment rate again rose sharply upon the onset of another set of lockdowns in June 2021. As a result, workers in affected industries saw reduced hours.

Data for underemployment is not available at sub-state geographies, and as a result there is no clear picture of underemployment in REZs (the figure below shows the NSW rate compared to Australia). Most REZs have a higher proportion of workers in full-time employment than the regional NSW average, possibly pointing to underemployment being less of an issue in the REZs.

Figure 34 Underemployment, all NSW and Australia, 2016 to 2021

Source: ABS Labour Force Data, October 2021

4.4 Summary of regional economic development strategies

Each REZ is subject to economic development activities, with councils, regional authorities and communities having economic visions, strategies, and ambitions that can be built on. As shown in Table 7, those ambitions, as captured in the regional economic development strategies (REDS), align with the development of the REZs including stated support for the development of renewable energy, the manufacturing sector and workforce skill development.

Table 7: Alignment of REDS with the development of the REZs

Regional Economic Development Strategies (REDS)	Renewable Energy Zone	Renewable energy	Manufacturing	Agriculture & food manufacturing	Tourism	Construction	Mining	Logistics
Central Orana	Central-West Orana	■	■	■	■	■	■	■
Castlereagh		■		■	■			
Mid-Western			■	■	■		■	
Northern New England High Country	New England	■	■		■			
Southern New England High Country	New England	■	■	■	■			
Western Murray	South-West	■		■	■	■	■	
Murray	South-West			■	■			
Western Riverina	South-West		■	■				
Hunter	Hunter-Central Coast	■	■	■	■		■	
Central Coast & Lake Macquarie	Hunter-Central Coast		■		■		■	

While most REDS emphasise renewable energy or manufacturing, in the South-West, only one the Western Murray RED focuses on renewable energy and only the Western Riverina focuses on manufacturing. The economic opportunities of the REZs could be more strongly embedded into the South-West's economic development focus.

4.5 Insights from REZ profiling

Our profiling of the five REZs have identified the following insights:

- Agriculture is the dominant industry and contributor to productivity in many regions. It is also volatile, with production and productivity influenced by climatic events and international markets. Opportunities to smooth out this volatility include greater industry diversification to reduce reliance on one industry and investment in industries with a more consistent economic output that are less impacted by broader climatic and market issues.
- The transfer of labour and skills is likely to be strongly linked to agriculture and mining. Mining already has many engineering-related skills that could be transferable to related engineering aspects of renewable energy. The transfer of skills from agriculture to renewable energy may be more challenging, and may require concerted and regionally-specific programs. However, we heard from maintenance firms that relevant technical skills can be drawn from the agriculture sector.
- Different regions have different strengths and opportunities. The presence of the Parkes SAP in the Central-West Orana Region and the Wagga Wagga SAP adjacent the South-West REZ provide opportunities for large scale manufacturing or assemblage. Both REZs feature road and rail freight connectivity, which benefits the importing and exporting of product.

- Regions close to large population centres (like the Hunter and Central Coast's proximity to Newcastle, Wollongong in the Illawarra and Wagga Wagga in the South-West) can also leverage the depth of labour to support higher knowledge-intensive industries related to the establishment of the REZs – particularly important for jobs in engineering, law etc. Both Newcastle and Wollongong also have port access with land available to support adjacent industries. Port Kembla has critical steel production facilities adjacent and both have access to both onshore and future offshore wind farms.
- Many of regional areas have disproportionately older workforces than state or national averages. This is a recurrent issue in regional Australia, driven in part by reduced employment opportunities that force younger people to cities, and exacerbated as fewer young families stay to raise children who may otherwise enter the regional workforce. Many REZ jobs may be targeted at younger people yet an older workforce presents limitations. An older workforce may also be less able or willing to transition to new industries, particularly if close to retirement. This presents difficulties for new businesses to build long-term skills capability.
- Unemployment rates vary across regions. Current levels of unemployment in regional NSW hover around 6%, following COVID-19; prior to the pandemic they were below 5%. We heard that in several regions, such as the Central-West, unemployment levels are low, or access to labour is constrained. Where this is the case, there is less labour capacity to direct towards new projects, which may result in labour shortages and cost increases.
- Almost uniformly, First Nations unemployment is significantly higher than non-First Nations unemployment. This is a deep-seated social issue across Australia, but presents an opportunity to use the REZ process to drive up First Nations participation through skills pathways, targeted apprenticeships etc.

4.6 Employment projections and skill shortages

The projected capacity within each of the REZs shown in Figure 35 reflects modelling provided for this report and can be adjusted through the actual delivery program for each REZ (see Section 2.2 for a description of the source data). The installed capacity for the Hunter reflects the current pipeline and not AEMO modelling for the ISP, and it is noted that these projects may not all proceed. The employment demand for each REZ is presented in Figure 36.

The employment demand by key occupation based on installed capacity for each REZ is illustrated in Figure 37. This is employment demand generated by the generation and transmission construction associated with the renewable infrastructure expansion, and not a projection of employment within each REZ.

In the Central-West Orana, New England and South-West REZs, there is a peak of employment of between 1,000 and 5,000 jobs associated with renewable project construction spread over three to four years, and occurring between now and 2031. Following the construction period, operations and maintenance provide between 200 and 1,000 jobs in each REZ. The Hunter-Central Coast REZ has a very different profile, dominated by the installation and maintenance of high levels of utility scale batteries, particularly in the early years.

Figure 35 Total capacity, NSW REZ Scenario, 2021–2036

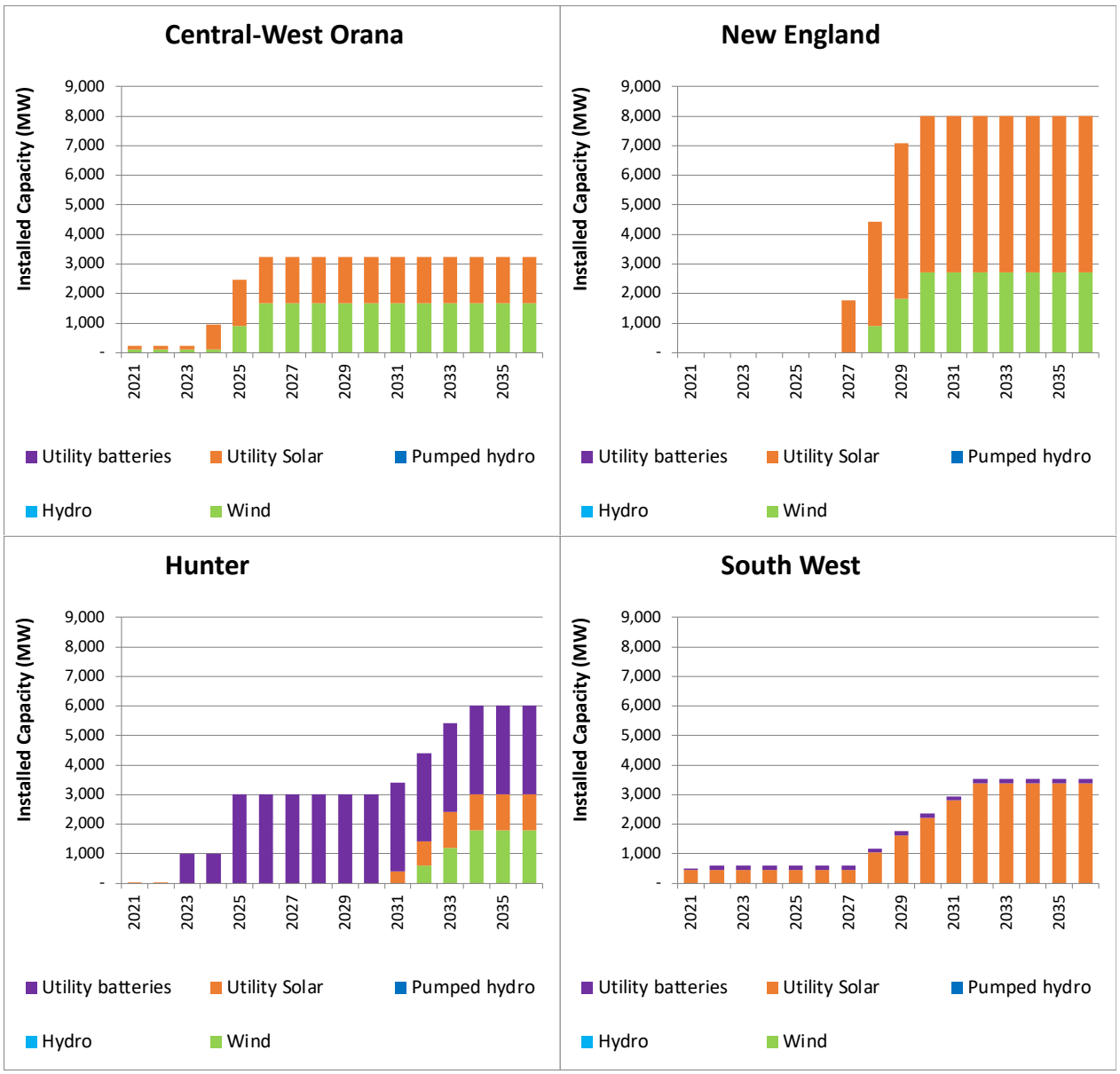


Figure 36 Employment by REZ, renewable electricity generation, 2021–36 (NSW REZ scenario)

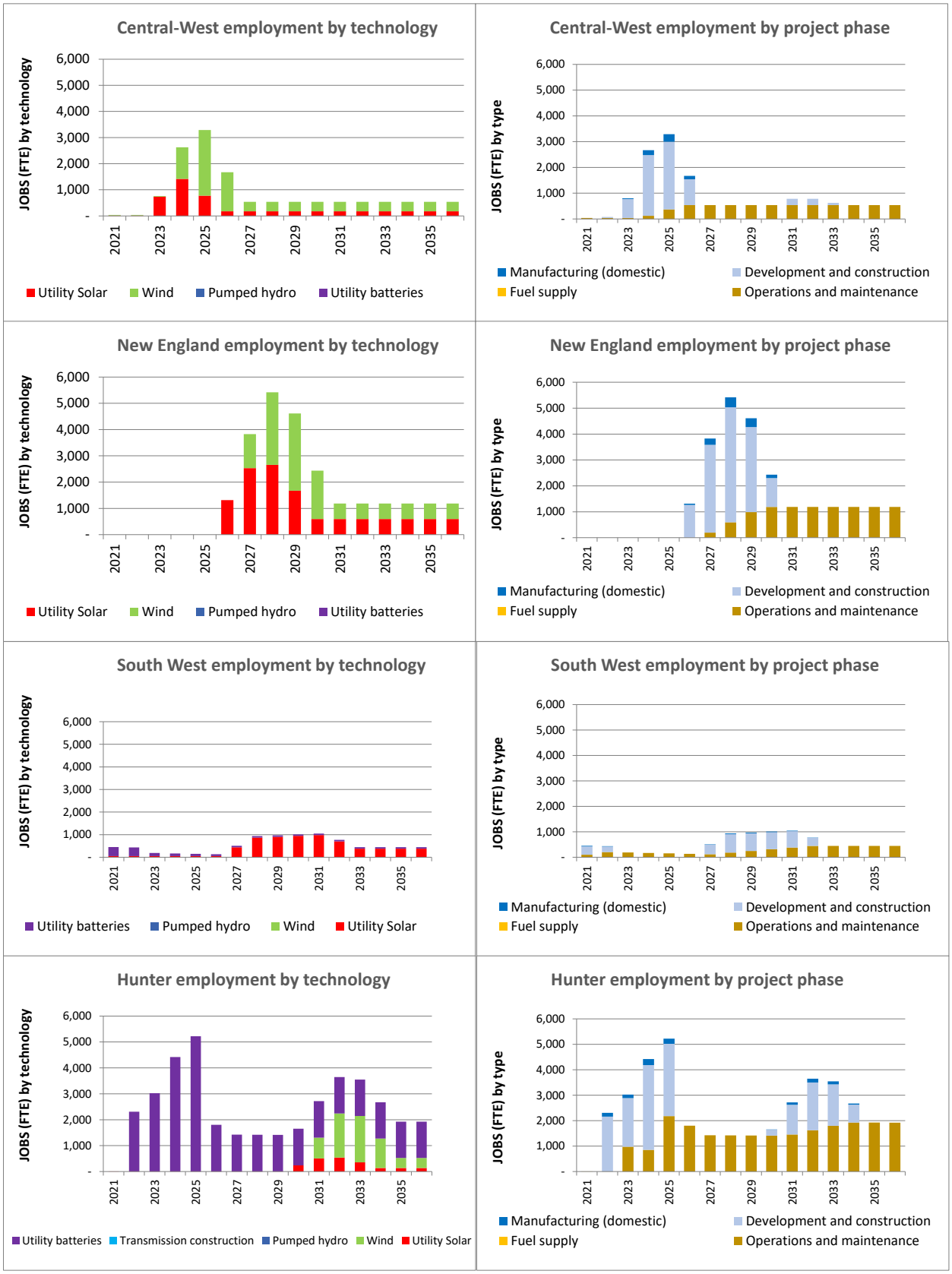


Figure 37 Average employment demand, key occupations by REZ, 2021–2036

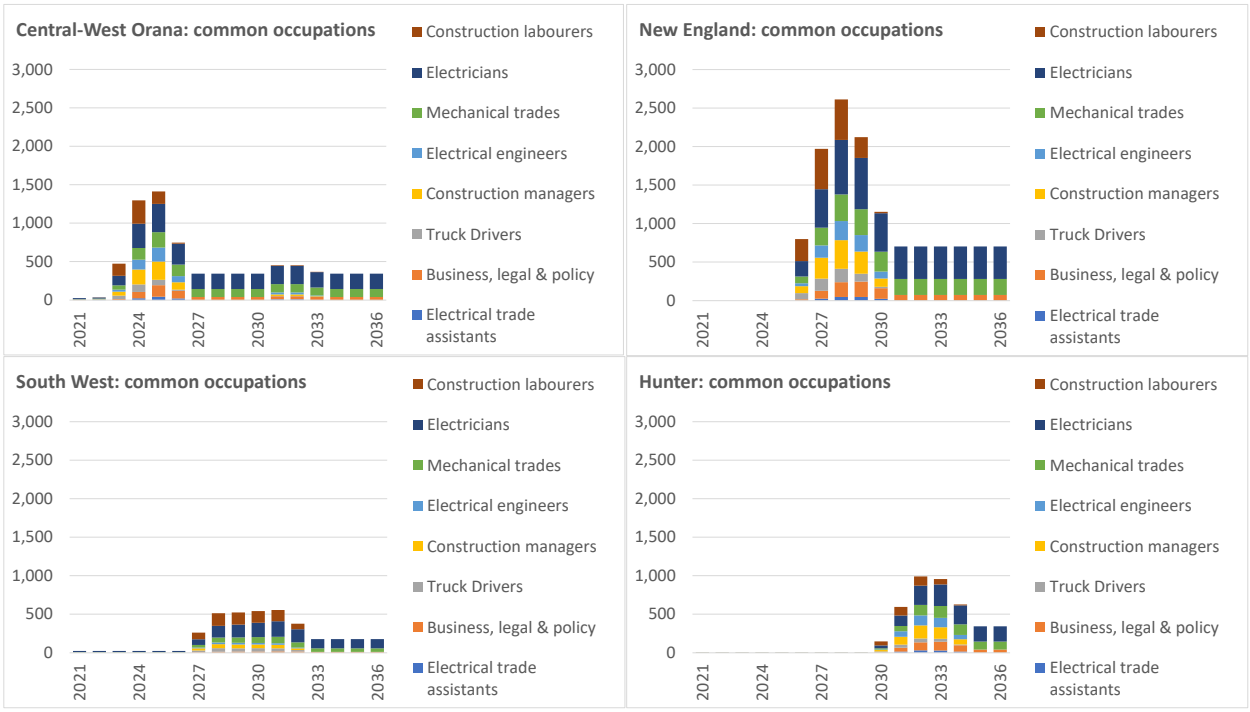
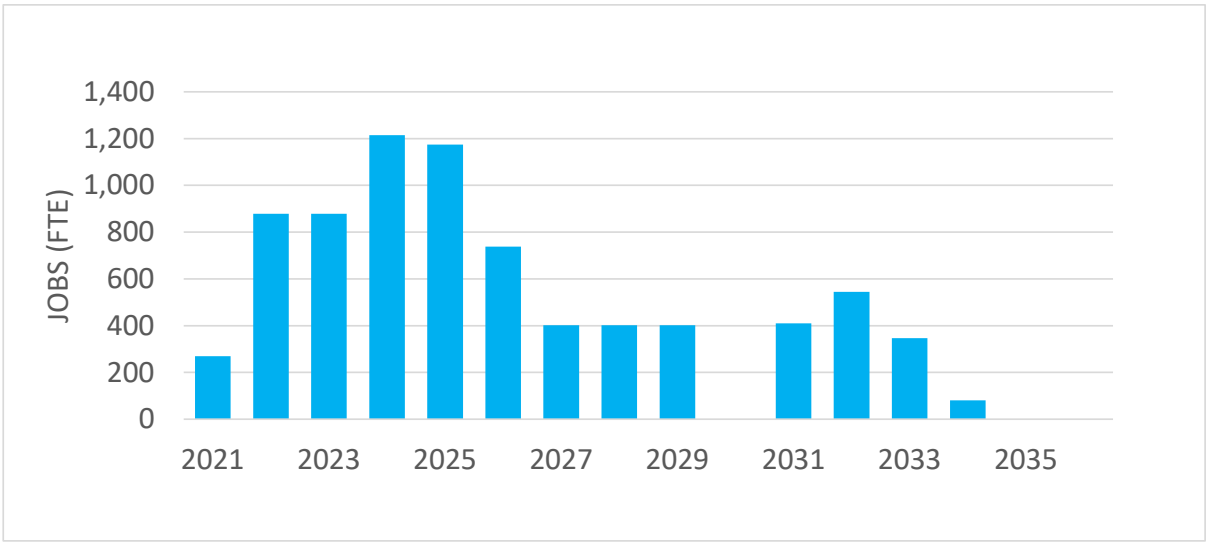


Figure 38 NSW transmission construction employment, NSW REZ scenario, 202–-2036



As noted in section 2.2, skill shortages – or 'recruitment difficulties' – are experienced for construction managers, engineers, electricians, mechanical technicians, transmission line workers and riggers, drillers and crane operators, making each a priority for skills and training.

Employment in NSW transmission construction scales up to a peak of 1,200 employees in the next few years (Figure 38). While the source of transmission construction employment is likely to be at least state-wide, if not Australia-wide, the requirement for labour creates both opportunities and risks for the development of the NSW REZs.

Building the supply of local lineworkers and riggers is an urgent priority due to the training lead-times:

- The transmission roles involve specialised skills with a long lead-time to train new workers: training a Certificate 3 lineworker usually takes 4 to 5 years, but some EPCs said in practice workers require much longer periods of on-the-job training.

- Electrical distribution workers can be trained in around 12 to 18 months (a distribution worker may hold as many as 14 out of 17 units for a Certificate 3 transmission lineworker qualification).
- Electricians take longer to train as lineworkers than distribution workers because they generally hold much fewer of the 17 core units for a Certificate 3 lineworker qualification and due to shortages of electricians this is not likely to be a common pathway.
- For substations, on-the-job training and upskilling can be an option for electricians but electrical commissioned is a specialised role that can take between 1 and 3 years of retraining.
- For construction labourers (e.g., riggers, crane operators), the ability to use construction labourers from other sectors varies depending on the project characteristics. Civil construction workforce on foundations can move quite quickly across if they are working on greenfield site away from lines. Riggers require 1 to 3 years depending on experience level.

NOTE: The Illawarra REZ has not been included in the analysis of employment above and labour gaps below. At the date of publication, the Illawarra REZ is in the early stages of planning. As noted in 4.2, the REZ has good renewable energy resources including offshore wind, and benefits from existing power stations, electricity network infrastructure, port and transport infrastructure and a skilled workforce. The REZ could also include emerging technologies such as green hydrogen, ammonia production and electrification of industrial processes. The NSW Government is exploring these opportunities and engaging with local community and stakeholders on the design and delivery of the REZ. This work may need to be updated as more information on the Illawarra REZ becomes available, such as the network capacity, geographical area and any new project developments in the region.

4.7 Labour gaps: NSW and the REZs

REZ labour market analysis: workers required and labour shortfall

We have considered how labour market conditions in the REZs compare with the demand for labour from both construction and operation. The following charts compare occupational employment forecasts (as defined through the work detailed in previous sections) to the current supply of labour in these occupations in the relevant REZs. This factors in demand through both the construction and O&M phases of development.

This analysis maps the existing occupational profile to projected demand from investment in renewable energy. In practice, current jobs in each region are likely to be able to cover some proportion of future demand resulting from this investment. What is most instructive is where the gap between current supply and additional demand narrows, or is exceeded, as this is where labour shortages in key occupations related to construction and O&M are likely to be most keenly felt.

New England – wind

For wind generation in New England, construction activity is expected to begin in 2027, and current occupation supply is expected to be able to cover needs for all years except between 2028 and 2030. Demand over these years nearly doubles due to the focus on construction, with a significant shortfall of more than 1,000 workers across the labour market during 2028 and 2029. During the operations and maintenance phases period from 2031 onwards, labour demand will be more easily met.

Figure 39: Wind generation, current labour supply vs demand, New England, construction and operation

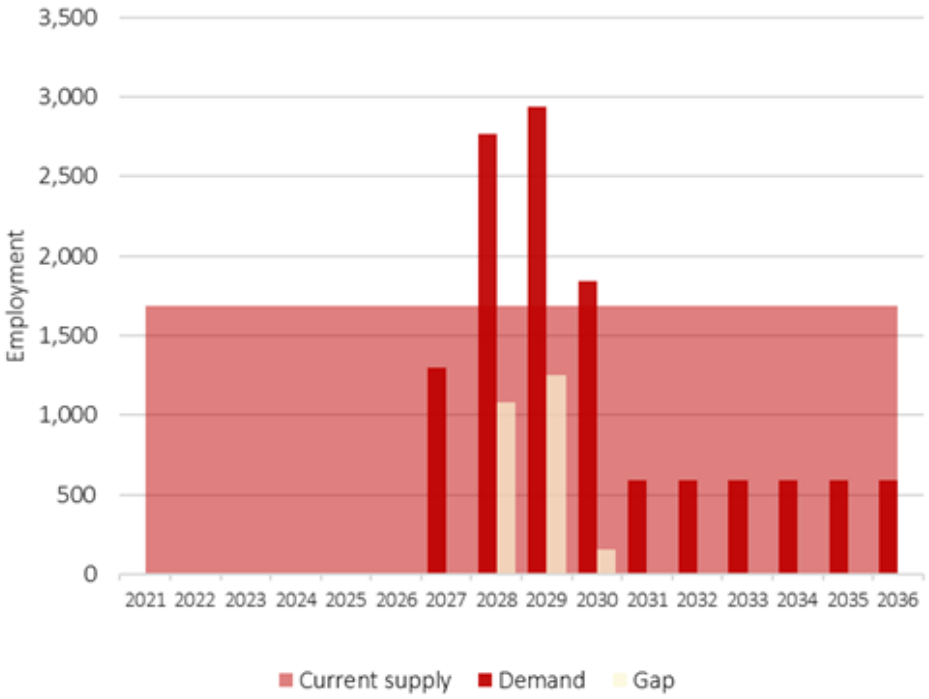


Chart sources: ISF 2021, ABS census data, 2016, SGS Economics and Planning

At an occupational level, the undersupply of labour in the peak year of demand (2029) is likely to occur most acutely with managers, professionals and to a lesser extend administration staff and labourers. There appears to be a fine balance between trades and technicians, but we need to recognise those currently in employment are satisfying other pre-existing demand for services.

Figure 40: Wind demand vs supply by occupation, New England

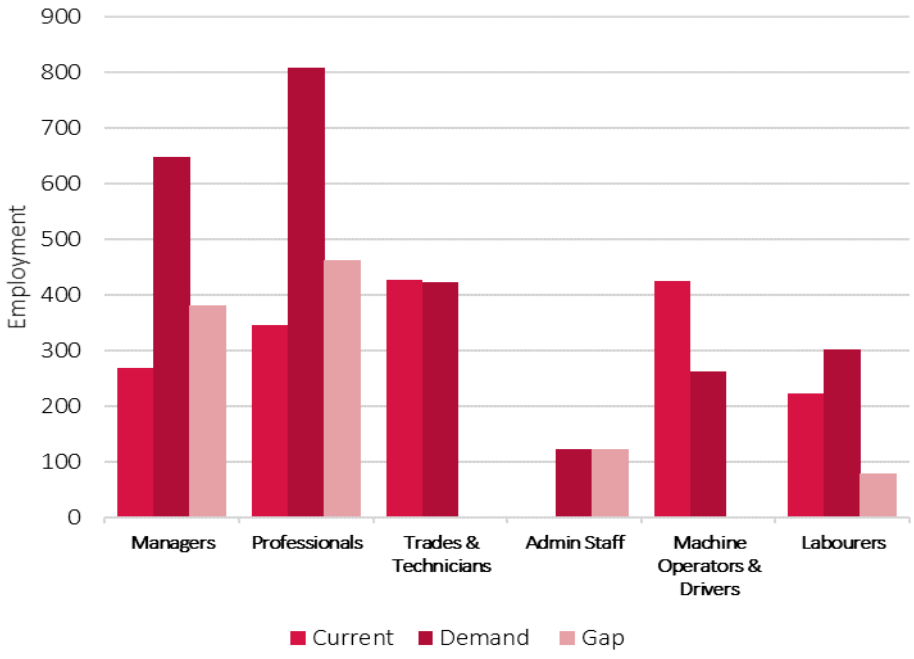


Chart sources: ISF 2021, ABS census data, 2016, SGS Economics and Planning

New England – solar

For solar generation in New England, construction activity is expected to ramp up in 2026, with demand for jobs exceeding those available in the REZ during the anticipated construction phase from 2027 to 2029. During the O&M phase from 2030 onwards, labour demand will be more easily met. There appears to be a large gap between demand and supply at this point, indicating that there may be capacity in the labour market within the relevant occupations to meet the needs of this phase.

Figure 41: Utility solar generation, current labour supply vs Demand, New England, construction and operation

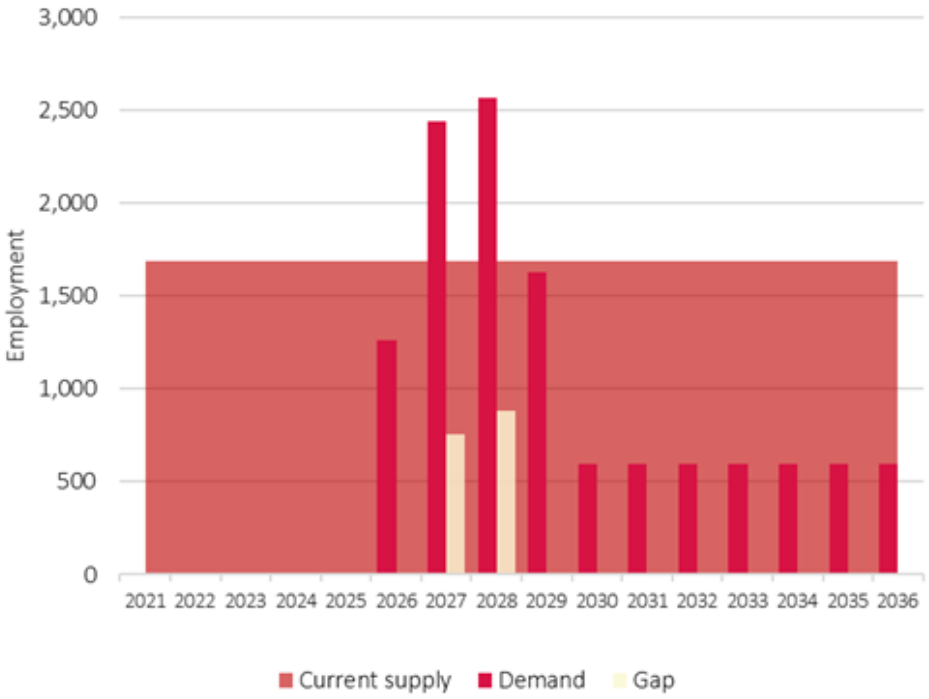


Chart sources: ISF 2021, ABS Census data, 2016, SGS Economics and Planning

At an occupational level, the undersupply of labour in the peak year of demand (2028) is likely to be spread across most occupations, but most acutely with managers. professionals, trades and technicians. Administrative staff and labourers are all expected to be under-supplied, although machine operators and drivers may have capacity, suggesting an opportunity to focus on skills translation.

Figure 42: Solar demand vs supply by occupation, New England

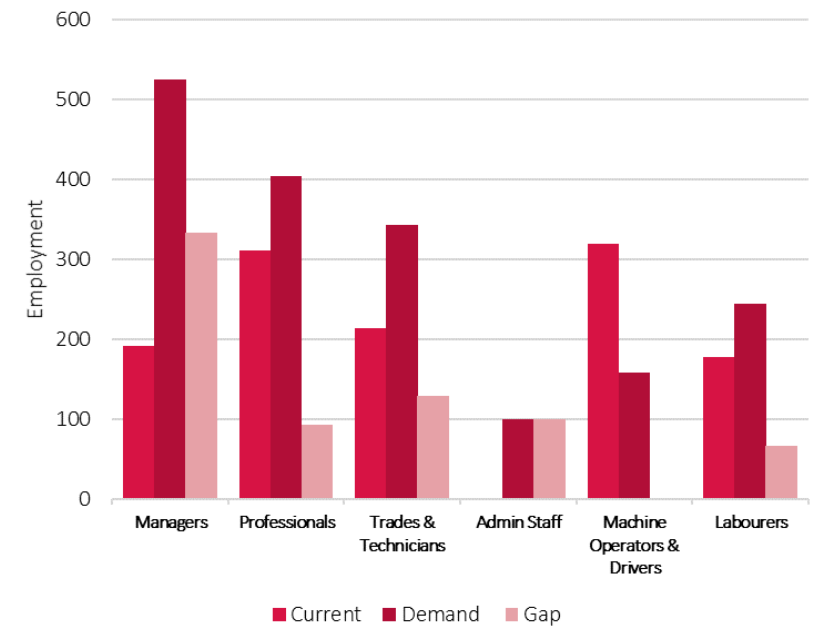


Chart sources: ISF 2021, ABS Census data, 2016, SGS Economics and Planning

South-West – solar

For solar generation in the South-West, construction activity is expected to ramp up in 2027, with demand for jobs exceeding those available in the REZ during the anticipated construction phase from 2028 to 2032. During the O&M period from 2033 onwards, labour demand will be more easily met. However, it is still considered tight as demand for these services will continue from other sectors elsewhere in the region.

Figure 43: Utility solar generation, current labour supply vs demand, South-West, construction and operation

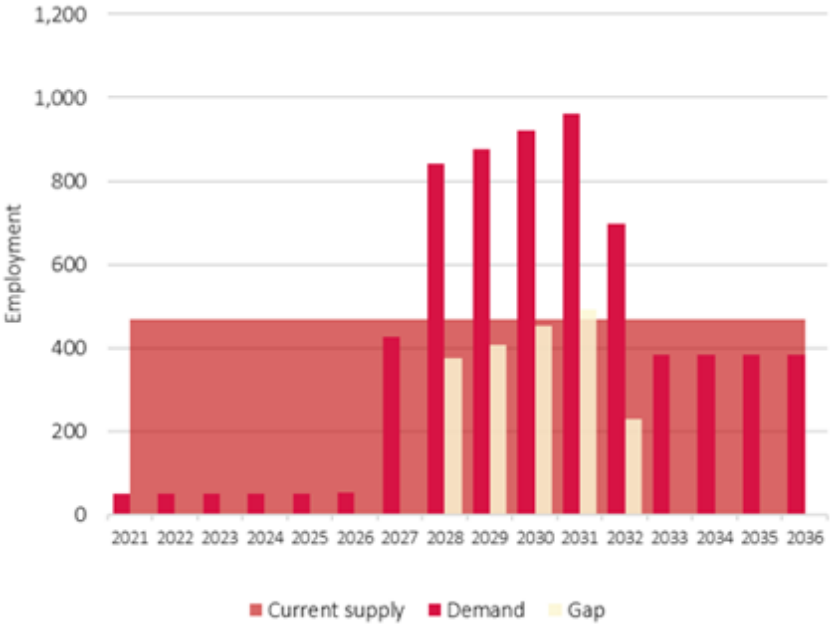


Chart sources: ISF 2021, ABS Census data, 2016, SGS Economics and Planning

At an occupational level, the relatively small size of the labour market highlights large labour supply gaps in the peak year of operation at 2031. Only machine operators appear to be in surplus from this point.

Figure 44: Solar demand vs supply by occupation, South-West

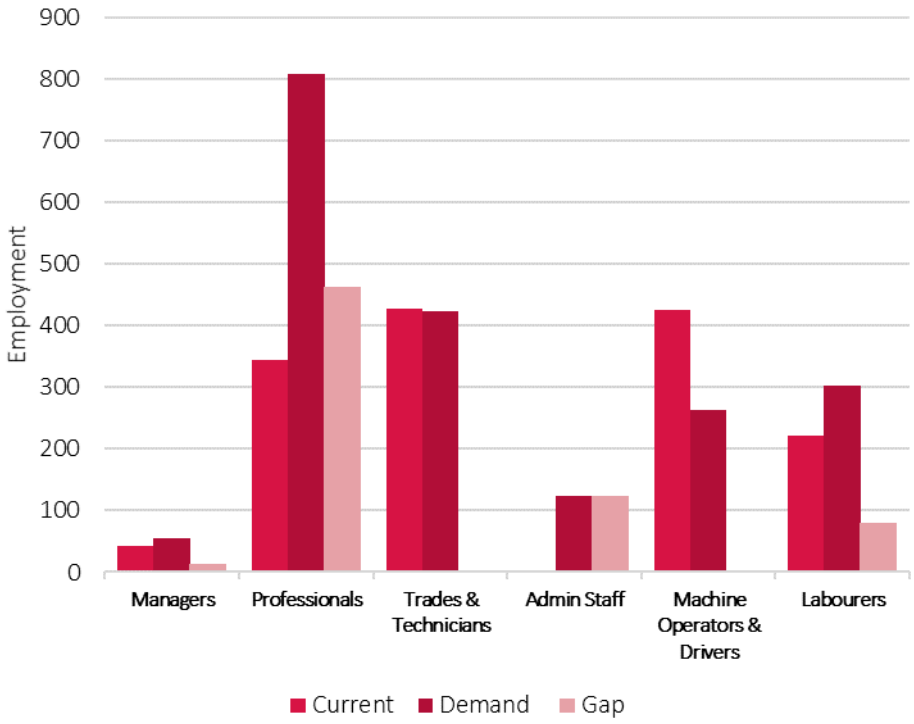


Chart sources: ISF 2021, ABS Census data, 2016, SGS Economics and Planning

Summary

Our analysis identifies where specific pinch points may exist in each region. If demand far exceeds supply in certain occupations, we need to better understand which skills can be transferred from other occupations, or, alternatively, plan for growth through job attraction.

For occupations with sufficient capacity or where there is a fine balance between supply and demand, we need to recognise that existing jobs are already meeting local needs and that the injection of more work may impact labour supply. This highlights the importance of sequencing infrastructure to minimise labour supply bottlenecks.

For New England, where both wind and solar are proposed, this could further exacerbate labour shortages in key occupations if not carefully managed.

05: Opportunity evaluation

5.1 Introduction

We have scoped opportunities to increase local employment, apprentices and trainees and supply chain involvement through our existing knowledge and research, additional desktop research and interviews with stakeholders. The report also draws on research undertaken for other recent projects, primarily:

- *Employment and Material Requirements for Energy Generation and Transmission Construction* (Infrastructure Australia): surveys with transmission EPCs and a workshop with industry, TAFE and training providers in the first half of 2021 (Briggs et. al., 2021).
- *The Potential for Offshore Wind Energy in Australia* (ISF and CSIRO, funded by the Blue Economy CRC and the MUA, ETU, ACTU, AMWU): a study into the feasibility of offshore wind in the first half of 2021 which included interviews and consultation with offshore wind developers (Hemer et. al. 2021).
- *Renewable Energy Employment in Australia* (Clean Energy Council): a survey of employment in 2019-20 (Briggs et. al., 2020).

5.2 Evaluation framework

We used three categories of criteria for evaluating opportunities.

- **Viability for NSW**: these criteria evaluate the likelihood of the opportunity becoming a reality in NSW, the advantages of local supply, advantages for NSW, the scale of the relevant local workforce and market, and market entry barriers (see Table 8).
- **Value of the opportunity:** these criteria include the overall scale in employment and revenue, its long-term sustainability, the proportion of net new jobs, multiplier effect, and the potential to reduce unemployment in the long term (see Table 9).
- **Cost of opportunity:** these criteria evaluate the impact on renewable energy project delivery costs, the level of investment required to support associated population growth, and the cost to government (see Table 10).

Table 8 Evaluation criteria - viability for NSW

Viability for NSW					
Criteria	How significant are the advantages of local supply and proximity?	Are there local sources of comparative advantage or resources?	Can the industry and workforce be scaled to realise the opportunity?	Is the scale of local market sufficient to support new investment?	Are there market entry barriers?
Description	Are there advantages inherent to local proximity that provide a competitive advantage, such as existing industry specialisation, infrastructure that reduces time to market, supply chain resilience and risks, expertise, quality etc.?	Are there other local sources of comparative advantage in NSW such as resource endowments, labour market depth, infrastructure, etc? How does the cost of local supply compare to imports?	Does local capacity to scale production and/or the workforce exist or will there be capacity barriers or constraints? e.g. material supply such as steel, skilled labour supply etc.	Does market volume exist for a viable and/or efficient local supply? e.g. is market demand sufficient to support new investment in a production facility, investment in new training capacity etc	e.g. established global supply chains

Table 9 Evaluation criteria – value of opportunity

Value of opportunity					
Criteria	What is the scale of the opportunity (employment, revenue)?	Is it likely to be a sustainable, longer-term source of employment?	How many jobs will be net additional to existing jobs in the region?	What are the multiplier effects for other industries in the region?	What is the potential to reduce unemployment over the longer term?
Description	What is the employment and market size?	Are there longer-term employment and industry opportunities with a higher value and can these be prioritised?	What opportunities will create net additional jobs rather than simply reallocate labour? Will there be any short-term reallocation of labour impacting longer-term health of regional labour markets, industries and communities?	Are there industry development opportunities with higher multipliers or flow-ons for associated industries and supply chains?	Are there opportunities to create jobs suitable for the unemployed and disadvantaged or under-represented labour market groups?

Table 10 Evaluation criteria – cost of opportunity

Cost of opportunity			
Criteria	What is the scale of impact on renewable energy project delivery costs?	What level of investment in supporting regional social infrastructure, housing or skills is required to support population growth?	What is the cost to government?
Description	Assessing potential impacts of initiatives to increase local industry participation on electricity prices is important to avoid unintended consequences. For example, to avoid impacts on the opportunity to use clean energy as a source of competitive advantage in energy-intensive industries and wider impacts on other sectors. It is also important that requirements for projects within the REZs do not outweigh the benefits and increase costs relative to projects outside the REZs. Assessment of the implications of increases in project cost for electricity prices is complex. Indicative estimates of potential impacts on project costs will be assessed. Note this criteria does not assess the implications for electricity prices, as the relationship between project cost and electricity prices is complex (see box).	Will realising the opportunity also require investment in other forms of infrastructure? If so, what types of infrastructure? Will other investment be needed to support population growth if that is required?	Will the opportunity require funding or support from government with costs?

Project cost and electricity prices

The RESB's plan will aim to increase local employment without significant impacts on electricity prices, which could impact wider economic opportunities. Where data is available or reported, we provide information on the potential impact on project costs. While in theory, renewable energy project cost increases should flow through to electricity prices, in practice this is more complex. There are four pathways by which an increase in project costs for renewable energy projects can increase electricity prices.

- **Wholesale market electricity prices:** increased project costs for renewable energy projects could flow into spot market prices. In practice, non-hydro renewable energy projects are almost always price-takers and coal, gas and hydro are the price-setters (see AEMO 2021, p14). This may change over time, although dispatchable resources may remain dominant, but at present the link is weak. It is reasonable to expect modest project cost increases are unlikely to flow through into wholesale electricity prices.
- **PPAs between a project and electricity user:** Increased project costs could flow into higher strike prices between a project and a specific off-aker.[3] For large creditworthy offtakers, significant competition between projects is likely with varying capacity to pass-through costs.
- **PPAs between a project and an electricity retailer:** Increased project costs could flow into higher strike prices between project and retailer which are passed onto customers. Electricity purchase costs typically range between 20 to 25% of retail electricity charges and electricity retailers purchase from a range of sources.
- **LTESAs for the REZ:** Proponents can bid for LTESAs, an option agreement to a fixed strike price for their output. LTESAs are intended as a last-resort option with incentives to reward parties that negotiate PPAs. An LTESA strike price could either be 'over' or 'under' the wholesale electricity price and therefore incur savings or costs which would flow into distribution charges (noting energy-intensive industries may be excluded as has been the practice for environmental instruments such as renewal energy targets). Any liability through the LTESAs will be paid by the NSW electricity customers through distribution charges. LTESAs will be awarded periodically through competitive tender process.

[3] In general, an offtaker is the buyer of the product or service produced by a project. In this case it refers to the electricity purchaser that signs the PPA.

5.3 Opportunity summary

We identify two primary types of opportunities to increase regional and state employment:

- **Increasing local employment in project phases currently done within regions**: A proportion of project development, transport and distribution, and the entirety of construction and O&M are carried out locally. However, the workforce will frequently live elsewhere and travel to the region for the relevant periods. This may include O&M, which can be done on a FIFO basis. Workforce recruitment also occurs at different scales – international, national, state and local/regional.
- **Increasing local industry involvement across the supply chain**: Local content up and down the supply chain in mineral processing, manufacturing, offsite maintenance is low internationally. The end-of-life sector with recycling and re-use is also an emergent opportunity. These opportunities are likely to be statewide, rather than specific to each REZ region.

The workforce for renewable energy generation and transmission projects is assembled at local, regional, interstate and international scales. Table 11 summarises the scale at which recruitment occurs for different types of labour and the risks for project labour supply. Consequently, there are opportunities to increase employment within regions and local to sites, and to reduce some of the labour supply risks for projects for the construction and O&M phases. This analysis informs the individual evaluation of opportunities.

Table 11 Recruitment strategies and labour supply risks for renewable energy generation and transmission

Scale	Demand	Supply options	Risks
Local & regional	Jobs sourced local to the project site vary depending on location and local labour market – but generally labourers, some trades and technicians, some construction managers and site administrators can be recruited locally. At a regional level, trades, technicians and labourers are sourced from larger towns, regional centres or capital cities and then move from project to project once they have experience.	Recruitment from within the industry	• Labour availability as industry scales • Intra-sector competition • Retaining workers between projects
		Recruitment from other sectors	• Tight infrastructure labour markets • Competition with higher-paying sectors
		New entrants (e.g., apprentices, traineeships)	• Risks of not recouping investment • Attracting and retaining candidates
		Workforce training from adjacent sectors	• Attracting candidates • Risk of not recouping training investment • Length of time to retrain relative to project • Lack of training resources (e.g., trainers) • Funding to scale up training
		Upskilling of workers on-the-job (e.g., electrician into substation specialist)	• Capacity to undertake on-the-job training in context of high competition and tight project deadlines • Retraining or relocating experienced workers to do conduct training
		Internal workforce redeployment and training (regional)	• Length of time to retrain relative to project • Willingness to relocate, exiting workers (e.g., retirement, changing employers) • Availability of training resources.
National	Recruitment for managers, professionals, experienced and skilled trades and technicians and machine operators.	As above	• Additional risk of border closures • Barriers to inter-state movement (e.g. different licencing requirements for electricians, lineworkers). • Different training funding rules across states

Scale	Demand	Supply options	Risks
International	Specialist skills that are in short supply in Australia. Recruitment occurs not just for managers and professionals but also trades, technicians and labourers.	International skilled migration. On-the-job training for local workers from international recruits	Border closures due to COVID-19 or other limitations on skilled migration.

Note: the classification of recruitment strategies is based on surveys and discussion with electricity generation and transmission industry stakeholders. The above table is reproduced from Briggs et. al. (2021).

Table 12 summarises the list of opportunities and the overall assessment for each opportunity as detailed in Section 5.4.

Table 12 Opportunity assessment summary

Opportunity for NSW	Viability	Value	Cost
Wind tower manufacturing			
Transmission tower manufacturing			
Wind farm manufacturing (non-tower)			
Battery energy storage supply chain			
Solar farm infrastructure			
Electrical balance of plant			
Transmission construction workforce			
Solar construction workforce			
Wind maintenance technicians			
End-of-life			
Mining and minerals			
Offshore wind			

5.4 Opportunity evaluations

5.4.1 Wind tower manufacturing

- Stakeholders are interested in the opportunity to develop wind tower manufacturing. NSW has steel manufacturing capacity, but investment would be required in a new wind tower factory. There are some local advantages (e.g., industry reports 7.5-10% lower cost than Victoria due to co-location with steel supply) and there could be additional opportunities to supply onshore towers to neighbouring states, offshore wind and to produce hydro pipes.

- The minimum viable scale for investment in a new factory is approximately 250MW per annum and the optimal scale around 350MW per annum for 6 years – 1,500MW (minimum) or 2,100MW (optimal). If half of the 12GW target is assumed to be wind (6GW) that represents one-quarter (minimum) to just over one-third (optimal) of new capacity built across the REZs.
- Based on an adjusted range for the cost differential of approximately 10% to 35% to account for savings in shipping costs and lower NSW production costs, the cost impact would be ~0.25% to ~0.9% (minimum scale) to ~0.35% to ~1.2% (optimal scale)
- A wind tower factory would employ 175 to 200 workers directly. Based on modelling commissioned by Bluescope Steel (Oxford Economics 2020), 3,000MW of wind towers would lead to just under 2000 direct jobs in steel manufacturing and associated industries.

Table 13 Opportunity evaluation: wind tower manufacture

Viability for NSW		• OEMs prefer global supply chain and there is a cost-premium for local production. Under the Victorian renewable energy target (VRET), the cost-differential for local production was estimated to be 20/25% (manufacturer) to 50% (renewable energy industry), noting manufacturing stakeholders consider the upper-end estimate 'unrealistic'. • There are benefits of local supply such as speed to market and reduced supply chain risks, which have increased significantly with rising shipping costs and times. • Co-location with steel in NSW can significantly reduce production costs relative to Victorian manufacturing and reduce product damage. • There are no major barriers to scaling workforce or local manufacturing capacity. • Minimum scale for new facility is approximately 250MW p.a. and optimum scale is approximately 500MW p.a. over at least 6 years.
Value of Opportunity		• There could be 175-200 jobs (tower factory) and a major boost to local steel supply chain (just under 2,000 direct jobs based on modelling commissioned by Bluescope Steel by Oxford Economics 2020). • It is likely jobs will be sourced from the local workforce who can be trained through a mix of TAFE and accredited on-the-job training. • Semi-skilled jobs could reduce local unemployment. • There is potential for longer-term build-out in wind turbines and associated opportunities in pumped hydro tubes, offshore wind and potentially onshore to other states.
Cost of Opportunity		• Towers account for ~10% of total wind farm cost and 15% of capex. • Estimates on the cost-differential under VRET ranged from 20/25% to 50%. Adjusting range for increased shipping costs (5%) and savings from co-location, cost differential is ~10% to 35%. • Bluescope has land available for co-location. • There are no major public infrastructure requirements identified but to facilitate investment, local content requirements or an equivalent mechanism would be required for certainty on project pipeline.

5.4.2 Transmission tower manufacturing

- Transmission towers have been imported to date, mainly from China, which has purpose-built fabrication plants.
- The Roadmap's large-scale transmission build-out creates the potential for local manufacturing. A factory is being established in South Australia by Ferretti International (FI) to integrate fabrication and galvanisation of transmission towers co-located with a steel mill. A modern, automated facility that integrates fabrication/processing and galvanisation removes additional handling and transport cost.
- The Australian Steel Institute has more than 85 steel fabrication members in NSW, of which 12 have indicated via member profiles they have capability to manufacture transmission towers.

Table 14 Opportunity evaluation: transmission tower manufacture

Viability for NSW		• Established supply chains can represent a barrier to local suppliers. • There are significant local advantages from proximity such as reduced transport costs and the capacity to provide local assembly offsite – but even with those factors industry sources estimate a cost differential of around 20-25% against imported content. • A feasibility study for the FI facility in South Australia found that an automated factory reduced the cost from $2800/t to $2200/t which was comparable to the imported price (2019 prices). • Bluescope production facility can manufacture steel for a monopole design but not a lattice tower design. Tower design varies depending on site conditions but lattice is the dominant tower type. Liberty Primary Steel/Infrabuild Steel have capacity for lattice tower designs. • We did not identify industry or workforce capacity issues in our interviews. The skill sets used in the factory being established by FI include logistics and handling, chemical controls, electronic and mechanical maintenance.
Value of opportunity		• Transmission towers are a mid-level opportunity in terms of production and employment. • We project 211,000 tonnes of steel throughput will be required across Australia and 79,000 tonnes under the ISP from 2020 to 2035 under current scenarios. • Direct employment in an automated tower manufacturing facility is ~80 according to FI plus 20 jobs in transport and logistics. Based on modelling commissioned by Bluescope, the volume of steel processed could create ~ 300 direct jobs in steel manufacturing. • Transmission tower construction will occur over the next 15 years at least. Other fabrication activities can be undertaken in the same facility. There will also be an ongoing requirement for distribution towers.
Cost of opportunity		• FI says with the operation of a purpose-built facility transmission towers will be cost-competitive with imported towers. • FI states a $60 million capital upgrade was required for the establishment of the new factory. They received a Commonwealth grant and are applying for a State loan to cover almost 50% of funding. The balance will be from commercial financing tools. Bluescope has land available for a facility. • The lack of a testing facility may be an issue. Some have noted international manufacturers have local access to a testing facility. FI notes towers are made against established standards so only minor testing should be needed. It would cost ~$1 million if international testing was required unless there were major issues. Consequently, their view is a local testing facility is preferable but in the context of a major project costs of international testing are modest.

5.4.3 Wind farm manufacturing (non-tower)

The other manufacturing opportunities discussed by stakeholders are:

- **Wind blade manufacturing**: Blade manufacturing accounts for 20% of the capex and 15% of total wind farm project cost so it is a high-value opportunity. However, Australia does not have any blade manufacturing facilities and a new facility would require a scale beyond NSW.
- **Wind assembly manufacturing**: Nacelle componentry manufacturing is highly unlikely to occur within Australia but assembly manufacturing occurred under VRET.
- **Reinforced steel and concrete foundations, anchor cages**: The Australian Steel Institute notes there is some imported product but considers the local product to be cost competitive.
- **Wind technology maintenance**: A survey for the Clean Energy Council (Briggs et. al. 2020) identified a NSW gearbox manufacturer undertaking maintenance on turbine gearboxes.

In general, there are barriers to the expansion of manufacturing in most of these areas but there could be opportunities for local industry development with concerted industry engagement, procurement incentives and other forms of government support.

Table 15 Opportunity evaluation: wind farm manufacturing (other than towers)

Viability for NSW		• For **wind blades**, there are variations in design between different types of blades. This is a major barrier to the scale required for local manufacturing (although there was one known international firm that manufactures multiple blades identified). • VRET includes NSW as 'local'. Stakeholders discussed the potential for market engagement by the NSW and Victorian governments to pool demand with a facility on the border to stimulate industry interest.
		• For **nacelle manufacturing**, firms are often co-located with fine divisions of labour for different componentry. Nacelle componentry manufacturing is unlikely to be viable for Australia. • Local assembly could be viable. Drive train and hub assembly occurred under VRET and multiple stakeholders identify assembly as a potential opportunity for NSW, most likely co-located with ports and existing manufacturing capability.
		• For **maintenance**, there is growing onshore maintenance but major components are generally serviced in global repair centres offshore with specialised expertise and equipment that requires scale to be cost effective. Consequently, some local growth in repairs and maintenance can be expected but will be limited due to the scale and specialisation required.
Value of opportunity		• There is significant value in these manufacturing opportunities. • Around 34% of the capex is in nacelle manufacturing and around one-quarter of the project cost. Based on NREL (2019) analysis in the US, around two-thirds of the value in nacelle manufacturing is in assembly functions – nacelle structural assembly (5%), drivetrain assembly (9%), nacelle electrical assembly (8%), yaw assembly (2%). Even securing an assembly function such as drive-train assembly would notably increase local content.
Cost of opportunity		• Stakeholders suggest collaboration between projects could support assembly through tender criteria and more ambitious opportunities such as blade manufacturing would require inter-state collaboration and engagement.

5.4.4 Battery energy storage system (BESS) supply chain

The Future Battery Industries Cooperative Research Centre (Accenture 2021a) found Australia has an opportunity to develop an integrated battery supply chain that could be a $7.4 billion market opportunity with 34,000 jobs to 2030.

- **Australia has sources of competitive advantage in mineral resources**: Australia is the only nation with all the local mineral deposits necessary for BESS manufacturing and higher political stability than most other nations with relevant mineral deposits. From this foundation Australia can develop mineral mining, mineral refining and materials processing (minerals go through various processing stages to reach high purity battery grade 'active' materials) capacity.
- **Australia has one of the largest domestic markets**: Australia is ranked fifth in the world by market size for BESSs with demand forecast to reach 40-52GWh by 2030, the third largest market globally.
- **Australia can be competitive in battery manufacturing**: Labour costs are a lower proportion of production costs (10%) than traditional manufacturing and Australian wages are comparable in the higher-skilled occupations required for advanced battery manufacturing. As material inputs account for 55% of the cost, developing an upstream supply chain can be a major source of competitive advantage in manufacturing. Accenture (2021) notes "availability of skill labour is likely to be a bigger barrier than cost".
- **Development of end-of-life sector:** This can enhance the environmental performance and competitiveness of a battery supply chain by looping back into mineral processing.
- **Economic security drivers**: A series of OECD nations (e.g. US, UK and EU) are establishing sovereign supply chains for economic and national security considerations (e.g. emerging supply chain capacity constraints, operational security concerns such as network cyber-security with international technology).

The figure below is reproduced from Accenture (2021a) and summarises their assessment of competitiveness along the supply chain.

Australia can expand its presence throughout the value chain, with some opportunities being more immediate than others

There are prospective opportunities for Australia in every step of the value chain, but the nature and size of those opportunities varies.

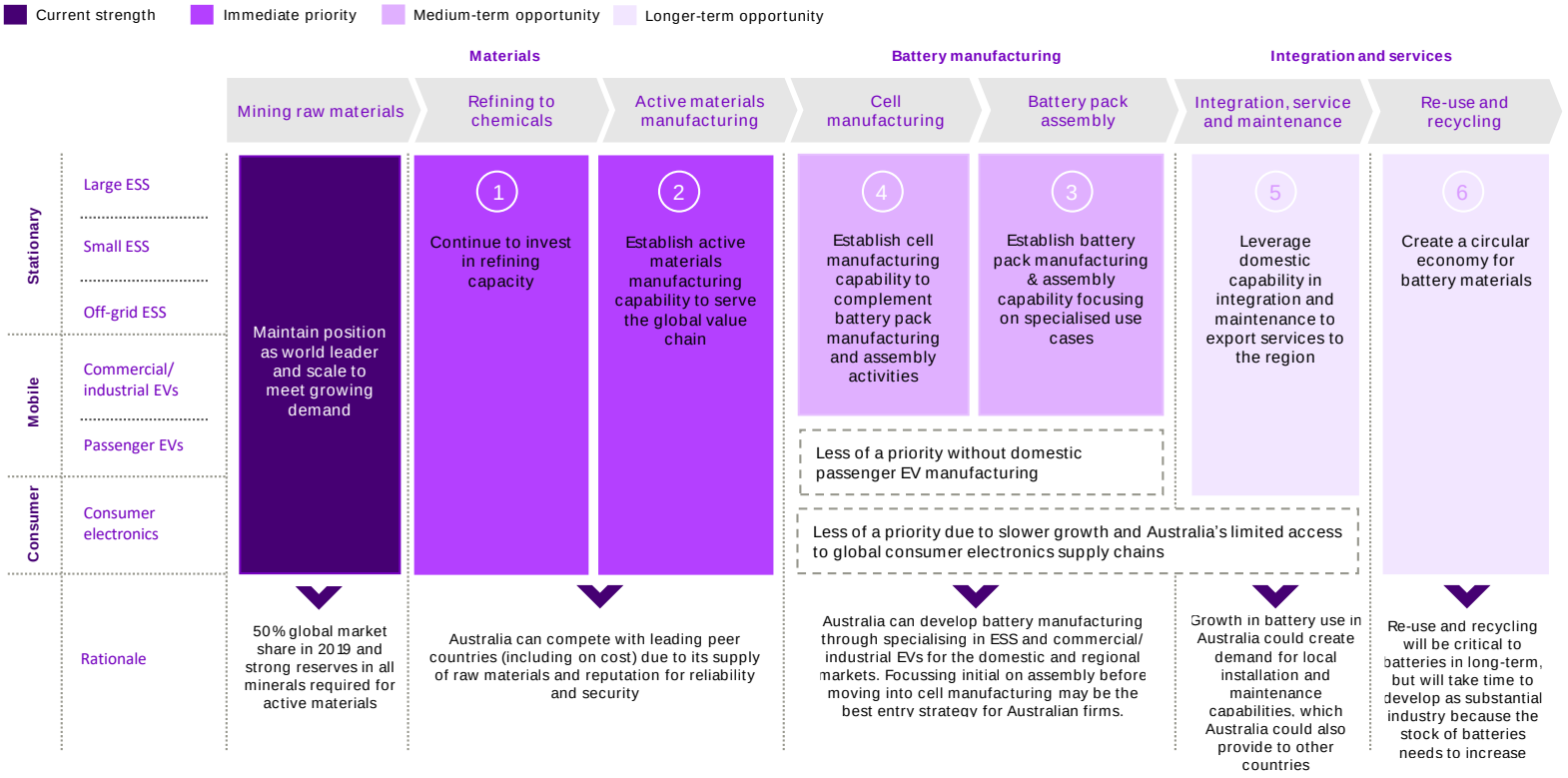
Immediate priorities for Australia include segments that Australia can enter more readily (for example, those that leverage Australia's raw materials strengths or build on existing activity and investment).

Medium-term opportunities are those that can still have a significant impact on the Australian economy, however they may require longer to mature and additional support to grow as they are not an existing domestic strength.

Longer-term opportunities are less accessible today and likely to develop later in the decade, but where Australia has a strong potential to compete in the long-run.

While these opportunities appear most prospective based on fundamental criteria, the industry environment is evolving rapidly and Australia's strategy needs to remain dynamic.

Exhibit 18: Australia's opportunities for future battery industries by 2030



Source: Accenture analysis.

NSW has project development at all stages of the supply chain. In addition to upstream supply chain development in mining and mineral processing (e.g. Sunrise Metals) and emerging logistics capacity in Central West NSW, NSW has manufacturing facilities under development in battery pack assembly and cell manufacturing (Energy Renaissance, Tomago).

Table 16 Opportunity evaluation: battery storage supply chain

Viability for NSW		• Supply chain security and risk is an important consideration. • Major sources of competitive advantage from co-location between mineral processing, manufacturing and end-of-life circular economy. • NSW contains the largest deposits of nickel and cobalt outside the Democratic Republic of Congo, essential materials for lithium battery manufacturing. • NSW has emerging project interest at all stages of the supply chain – mining in cobalt, nickel, lithium, mineral processing, two manufacturing facilities (Renaissance 1 battery cell assembly facility, Renaissance 2 battery cell manufacturing facility at Tomago), end-of-life (lead acid battery recycling that could be expanded to include other battery types, Enirgi Power Storage). • Accenture (2021b) notes that diversification into manufacturing will need to address capital availability and expand workforce and supply chain capability due to the small manufacturing base. Electricity costs are a factor that can be addressed through low-cost renewable energy.
Value of opportunity		• The Australian opportunity for manufacturing, integration and management services is in the magnitude of $2.1 billion value added and 12,100 (direct) ongoing jobs (Accenture 2021a). • Energy Renaissance reported 700 to 800 jobs at the Tomago battery manufacturing facility, Sunrise 1,200 full-time equivalent jobs for the construction period and 350 FTE roles during operation. • Recycling revenue projections of between $603 million and $3.1 billion in Australia by 2036 (FBI CRC). As a battery manufacturing hub, NSW would be well placed to make the most of this opportunity (Zhao et. al. (2021).
Cost of opportunity		• Accenture (2021a, 2021b) concludes that Australia and NSW could be cost-competitive in a range of energy storage applications. If a local battery supply chain can be established, it is likely to reduce the risks and costs of local energy storage. • The development of a local battery supply chain is likely to require proactive industry development by the NSW Government (in collaboration with other levels of government). A range of actions would support the development of a local supply chain including strategic procurement, infrastructure support, workforce development.

5.4.5 Solar farm infrastructure

- Solar panels are imported from overseas and are either mounted on fixed angle frames or sun-tracking systems. The tracking system is integrated in Australia, but the components are predominantly manufactured in China. The mounting structures and the foundation piles, typically fabricated from steel or aluminium, are also predominantly imported.
- A range of supporting infrastructure for solar modules could be locally supplied such as steel foundation piles, mounting structures and trackers (tubes and backing frames), component assembly (e.g. inverters) and telecommunications equipment.
- The VRET local content criteria led to infrastructure such as piles, trackers and cabling being sourced locally. Local supply of solar farm infrastructure in NSW (excluding panels) is currently low and only

includes concrete, fencing (steel), some trackers and frames and miscellaneous products (e.g. hold-down bolts). Consequently, there is an opportunity for local industry development.

Table 17 Opportunity evaluation: solar farm infrastructure manufacturing

Viability for NSW	• Established global supply chains are likely to be cheaper for most types of solar infrastructure. • Local supply is quicker to market, more responsive to changes in project schedules and can reduce exposure to risks in global supply chains (e.g. EPCs note risks around pricing and timing of contracts with Chinese suppliers, the cost and availability of transportation). • Local conditions lead to some innovations on piles (e.g. hollow steel tubes for sandy soils) and frames (e.g. 5b, frame manufacturer). • Local industry is actively evaluating and positive about opportunities for expansion. Variations in design need to be reflected in production capacity. • Our survey identified significant local capability in steel and metal products, although limited experience.
Value of opportunity	• Racking and mounting is just under 9% of the project value. Cabling and wiring is 5%. Inverters are 4%. • We project that 1.55 million tonnes of steel would be produced for solar farms in NSW between 2020 and 2035. • There could be opportunities for ongoing employment in manufacturing frames and local steel products such as posts.
Cost of opportunity	• Local supply is generally 20 to 30% more expensive for VRET. Steel industry stakeholders question this figure and whether supply is compliant with trade and production standards. • There may be role for government in facilitating and supporting local SMEs but we did not identify any infrastructure requirements.

5.4.5 Electrical balance of plant

Solar and wind farms use a distribution transformer (installed with inverters) and a substation transformer used to set up voltage for transmission. Transformers are manufactured in NSW and Australia. Electrical equipment, combiner boxes and cables and conduits are imported, but the cables and conduits could be supplied from Australia.

Table 18 Opportunity evaluation: electrical balance of plant

Viability	• Local supply is quicker to market, more responsive to changes in project schedules and can reduce supply-chain risks. • Beyond the advantages of proximity, there are no local sources of comparative advantage in balance of plant, which is currently mostly imported. • New investment is unlikely in balance of plant manufacturing – activity is likely to be expansion of existing suppliers in areas like cabling and inverters, assembling or Victorian transformer manufacturing (if included in definition of 'local').
Value of opportunity	• Balance of plant is a generally in the order of 5-10% of the value for renewable energy technologies. • There are also significant opportunities for smaller businesses in the supply chain. In response to the business survey, there were 10-15 businesses that indicated they had capability in electrical balance of plant for solar, wind and battery storage.

Cost of opportunity		• There is a cost premium for local supply but we did not receive data from stakeholders we interviewed. • We did not identify any major infrastructure requirements for the NSW Government. • If the NSW Government wanted to pursue investment in other balance of plant manufacturing beyond transformer manufacturing, that would likely require significant engagement and support.

5.4.7 Transmission construction workforce

- A significant expansion in the transmission network is scheduled through AEMO's ISP and the Roadmap over the next decade and beyond.
- There are skill shortages in various categories of engineers (electrical, structural, mechanical, civil, telecommunications), construction managers, site supervisors, electrical commissioning specialists, lineworkers and riggers.
- Reliance on international recruitment is a risk factor, especially in times of COVID-19. Maintenance on specialised equipment is typically undertaken by international workers due to low volumes. Consequently, there is an opportunity for local job creation in transmission construction and maintenance and a strategic priority to de-risk transmission construction.
- There are opportunities to create jobs for First Nations workers. Project EnergyConnect has a minimum requirement of 2.5% of total project spend on First Nations participation in the workforce, with at least 30% of this minimum target being spent on the contractor's First Nations employees, apprentices and trainees.

Table 19 Opportunity evaluation: transmission construction workforce

Viability for NSW		• Local supply would increase the resilience of the supply chain and reduce risks associated with transmission construction. • The extent to which a local workforce can be developed in time is unclear. It usually takes four years to train a Certificate 3 lineworker. Depending on the qualifications already held, electricians, distribution lineworkers and riggers can transition in 1-3 years. • Transgrid has training facilities in Wagga Wagga and could expand to train for the wider market across NSW and the National Electricity Market.
Value of opportunity		• We project a peak workforce of 2,500 across the National Electricity Market and more than 1,000 in NSW by 2024. NSW has the largest share (40%+) of the National Electricity Market transmission construction jobs. • Cross-sector opportunities could be developed for lineworkers (rail, distribution) and electrical commissioning specialists (transmission, generation). • There are opportunities to create pathways for school leavers into professional roles and disadvantaged labour market groups into labouring and trade roles.
Cost of opportunity		• Local workforce development and recruitment should have a modest positive impact on project costs. • Additional social infrastructure may be required (e.g., a transmission EPC reported difficulties in finding housing for staff in the South-West REZ). • There is also likely to be funding required to expand training facilities.

5.4.8 Solar construction workforce

- There are opportunities to increase the volume and quality of employment in solar farms during the construction phase, particularly civil construction, local electricians and lower-skill assembly roles to reduce the level of imported and FIFO employment.
- Best-practice examples of solar farms have achieved high levels of unemployed and First Nations workers. For example, 15% of the Bomen Solar Farm construction workforce in Wagga Wagga are First Nations people and of the 300 construction workers engaged for Karadoc solar farm (Victoria), 90 were long-term unemployed, 38 First Nations workers and 70% of the workforce had not previously worked on a solar farm.
- While the jobs are short-term construction roles (often 4-8 months), there are opportunities for longer-term employment either through redeployment to other projects or as bridge to other construction projects for the unemployed. Consequently, there is an opportunity to increase local employment and address social disadvantage through better employment practices.

Table 20 Opportunity evaluation: solar farm construction workforce

Viability for NSW		• A FIFO workforce will generally have more experience working on solar farms, but there are sufficient cases to demonstrate the viability of training up a local workforce. For remote projects, there may be limits to the capacity to employ locals but building up a regional workforce that moves between projects will still enable better outcomes than a FIFO workforce. • Regional unemployment levels are low in some areas. Remote solar farms may also not have sufficient population catchment. • Generally, there is sufficient volume of workers who are unemployed, workers in low-skill jobs or school-leavers for the civil construction and assembly jobs.
Value of opportunity		• There will be a peak construction workforce of 500 to 600 across REZs • A local workforce will improve the social licence and alleviate persistent complaints about FIFO workforces in regional communities by solar farms. • While there are opportunities with higher volumes of employment and the jobs are often short term, solar farms present a valuable opportunity to target disadvantaged labour market groups and reduce long-term unemployment.
Cost of opportunity		• There is a modest improvement to project costs. • No major infrastructure is required. • Hiring practices that engage local workforces could be incentivised through procurement guidelines, industry engagement and information sharing. There may be some funding support for initiatives to develop training capacity.

5.4.9 Wind farm maintenance technicians

- Over time, the number of wind farm maintenance technicians will increase across the fleet of wind farms. Wind farm maintenance requires a mix of electrical and mechanical technicians to maintain turbines, electricals and blades. Wind farm maintenance technicians are good quality, ongoing blue-collar jobs with salaries of $90,000+ before overtime.
- The wind industry reported skill shortages for wind turbine and blade technicians and the use of international recruitment during 2019-20 to fill gaps. O&M contractors reported difficulties sourcing local workers as blade technicians. One O&M contractor stated:

  > *We have to try and get people from other industries and train them ourselves on the job and put them through the basic safety courses which is time consuming and expensive … if there were basic courses tailored for the wind industry it would make it easier to employ local people. We could take*

people who have a background in composites and repair and do a short course and get them on-board … there are more technicians coming out to Australia every year to do blade technicians tasks than there are locals. There's opportunity for much more local jobs here.

Table 21 Opportunity evaluation: wind maintenance technicians

Viability for NSW		• Industry preference is for local workers due to cost savings, connection with community and logistics of workforce management. • Mechanical technicians can be recruited from a variety of industries in regional areas (e.g., fitters and turners, agricultural workers with a mechanical background) with add-on training (e.g. working at heights). • There are wider skill shortages for electricians in regional areas but there is sufficient time for these to be addressed for wind farm maintenance.
Value of opportunity		• There are ongoing jobs over the lifetime of wind farms that require regular maintenance. Contractors often service a group of wind farms. • If wind farms are refurbished with new turbines, the jobs would continue beyond the life of the existing turbines (~20 years). Mechanical technicians can be recruited from a variety of industries in regional areas (e.g., fitters and turners, agricultural workers with a mechanical background). • There are opportunities for quality, long-term blue-collar jobs ($90,000+).
Cost of opportunity		• A local workforce would modestly reduce O&M costs. Workers from out of the region are more expensive due to allowances ($700-$800 per week quoted by an industry source) and other recruitment costs. • There is no major infrastructure requirement, • New training infrastructure may be required, although there is potential to leverage investment in blade apprenticeship and training facilities in Victoria that are addressing the training and skills gap. The course is designed with block training to make it easier for interstate workers to attend.

5.4.10 End-of-life

- There are circular economy opportunities to extend the life of renewable energy technology, reduce costs and minimise waste through repairing, servicing and replacement. Recycling rates will become important for exports with the EU mandating labelling on recycled content for batteries.
- Local supply chain capability in re-use/repowering also results in long-term employment opportunities in O&M. Skills could be transferred from the manufacturing sector to the assembly and disassembly of renewable energy technologies, while ensuring the highest value recycling.
- Until 2025, it is anticipated that PV waste will be from distributed systems and geographically located in Sydney, the Central Coast, and northern coastal regions. By 2035 both utility and distributed will be generating a large share of waste.
- There are opportunities within REZs for co-location of local recycling, materials processing and manufacturing facilities with efficient logistics of distribution, collection and transfer of components/materials. This could occur through integration with SAPs and established recycling collection and processes (e-waste in particular).
- However, specialised equipment is required to fully process solar panels and scale up. Market certainty on volumes is required to justify capital investment. The National PV Product Stewardship Scheme is being developed to provide certainty in investment and infrastructure, R&D and increase participation in PV recycling.

Table 22 Opportunity evaluation: renewable infrastructure end-of-life

Viability for NSW		• Projected renewable energy waste will provide the volumes to develop recycling at scale for PV and battery storage, with an opportunity to combine existing e-waste collection schemes, infrastructure and processing. • Establishment of local steel manufacturing capability for transmission towers would also facilitate better end-of-life handling of transmission line infrastructure and production to Australian standards. • Skills can be transferred from assembly during construction of renewable energy technology to decommissioning, disassembly and refurbishment.
Value of opportunity		• We anticipate 10,000t/y by 2025 and 63,000 t/y by 2035 of PV waste generation in NSW. With low value recovery, only aluminium ($1,000/t) and copper ($5,000/t) are recovered and glass is stockpiling. With higher value recovery, silicon ($12,963/t) and silver ($533,000/t) are also recovered but the recovery process still in its infancy. Energy storage batteries will be at 6,500-8,200t/y by 2035. • 9.2 jobs are created per 10,000 t of waste recycled (400 new jobs) compared to 2.8 jobs per 10,000 t of waste disposed (120 new jobs).
Cost of opportunity		• The collection, transfer and recycling processes for renewable energy technologies will need to be established. • The estimated costs for PV recycling is: – low value pathway: capex: $1.5 million for 1,500 tonnes per annum, opex: $650/tonne, gate fee, $15/unit – high value pathway: capex: $7 mil for 4,500 tonnes per annum, opex: $1120/tonne, gate fee: $15/unit. • Several grants for development of end-of-life management can be leveraged including NSW Circular Solar ($10 million), ARENA R&D rounds and CEFC Australian Recycling Investment Fund ($100 million).

5.4.11 Mining and minerals

- NSW and Australia have opportunities in mining and to extend into mineral processing for battery storage.
- A report for the Future Battery CRC found Australia can compete with leading peer countries (including on cost) due to its supply of raw materials and reputation for reliability and security (Accenture, 2021). Downstream purchasers are increasingly looking to source battery materials from mines with sustainability certification. Producers expect net zero emissions to become a supply chain requirement.
- NSW contains the largest deposits of nickel and cobalt outside the Democratic Republic of Congo, which are essential materials for lithium battery manufacturing. NSW also has small deposits of lithium.
- There are projects under development for processing facilities, co-located with new nickel and cobalt mining operations in NSW, which significantly reduces the cost and waste associated with transporting bulk unprocessed ore material. Unique cobalt deposits in NSW have attracted investment in innovative materials processing technologies with better environmental outcomes (Cobalt Blue proposed facility).
- There are circular economy opportunities for minerals processing facilities with co-location (e.g. Parkes SAP) that have the ability to reprocess recycled cathode chemistries.

Table 23 Opportunity evaluation: mining and minerals

Viability for NSW		• Australia is a global leader in battery materials supply, with export markets sufficiently mature and growing rapidly in scale. • There is emerging investment in NSW battery material mining and processing capacity. However, new mineral processing operations are capex intensive and securing an offtake agreement to underwrite investment is a barrier. • In general, projects seek offtakes from international producers but there could be scope for a domestic offtake via local manufacturing for government procurement. • No major workforce skills issues are identified but there is competition for labour within each region.
Value of opportunity		• There could be 9,500 FTE jobs Australia wide in material processing by 2030 with a diversified supply chain according to the CRC Report (Accenture, 2021). • There is a $1.9 billion Australia wide value-added opportunity in refining and active materials processing/manufacturing. • This could employ workers from declining industries such as coal mining. • Materials processing facilities have the potential to reprocess recycled material.
Cost of opportunity		• There are some supporting infrastructure requirements including oversized route upgrades to transport large processing and manufacturing infrastructure during construction. • Government could support investment attraction, local content requirements in procurement, uptake of renewable energy, achievement of net zero emissions and certification.

5.4.12 Offshore wind

- Offshore wind was not originally included in the REZs by AEMO but was included in the 2021 Input, Assumptions and Scenario report. The development of offshore wind globally, increasing scale and falling costs and new floating wind turbines that can open access to deeper waters are combining to improve the viability and interest in offshore wind in Australia. Several early stage projects total more than 10GW under development off the coast of the Hunter-Central Coast and Illawarra REZs.
- Offshore wind is more expensive than onshore wind and solar, which will dominate new generation in coming years. However, the National Hydrogen Strategy notes the volume of electricity required for hydrogen production is as high as 4.5 times the size of the current National Electricity Market (COAG Energy Council 2019, p. 87) and AEMO states modelling for offshore wind should be expanded for hydrogen superpower scenarios.
- Construction and O&M are local but as with other types of renewable energy there could be variations in the level of imported workers depending on local workforce skills and supply.
- Supply chain opportunities include tower manufacturing, port facility development and operations, vessels (e.g. primarily smaller survey and maintenance vessels), electrical balance of plant and steel manufacturing (towers and other smaller elements e.g. ladders).

Table 24 Opportunity evaluation: offshore wind

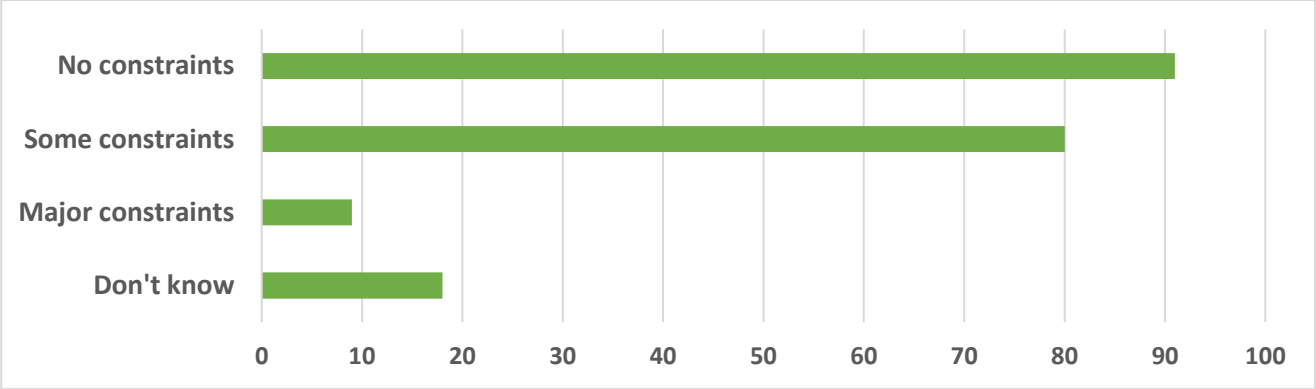
Viability for NSW		• A locally-based construction and maintenance workforce has cost and social licence advantages. Co-location with port facilities will be advantageous. There are benefits for local production of towers. • It is likely that supply chains will develop significantly in South East Asia in response to a large project pipeline, which will be an attractive option for offshore wind projects in Australia. More detailed analysis will be required to understand the opportunities at a more granular level. • A new wind tower facility can be future-proofed to make thicker towers for offshore wind projects but new investment would be required in steel manufacturing processes. Developing supply chains for onshore wind could increase the local content of future offshore wind projects.
Value of opportunity		• Our employment modelling for the Blue Economy CRC report found that employment across Australia scales up to between 3,000 to 4,000 jobs annually from 2030 and in the higher scenario to 5,000 to 8,000 jobs each year. • Major international pathways for the workforce have been from offshore oil and gas, energy industries and cross-sector skills (e.g. finance). Opportunities should exist for transition of the coal workforce within the Illawarra and Hunter-Central Coast REZs.
Cost of opportunity		• It is too early to assess any implications without consideration of detailed local content mechanisms. It is likely that similar considerations will apply as in onshore wind.

06: Barriers

This section analyses the barriers to opportunities identified mainly through stakeholder engagement in interviews, workshops and where relevant, survey results. The research identified barriers that relate directly to the remit of the RESB and wider contextual barriers that need to be addressed to support RESB plans.

At the level of individual businesses, the survey results are encouraging. Around half of businesses say there were no constraints. A similar proportion identified some or major constraints on their ability to take advantage of opportunities. However, very few see major constraints (noting some were unsure of constraints). Businesses that perceived major constraints were mainly in the rental, hiring and real estate, mining, manufacturing and utilities sectors.

Figure 45 The primary constraint on the capacity of NSW businesses to realise opportunities



Source: Survey results, responses to the question: "To what extent are there constraints on the capacity of your business to take advantage of the opportunity for increased business from renewable energy and electricity transmission projects?"

Despite the survey results, many stakeholders identified barriers to realising the opportunities. We have analysed the following barriers:

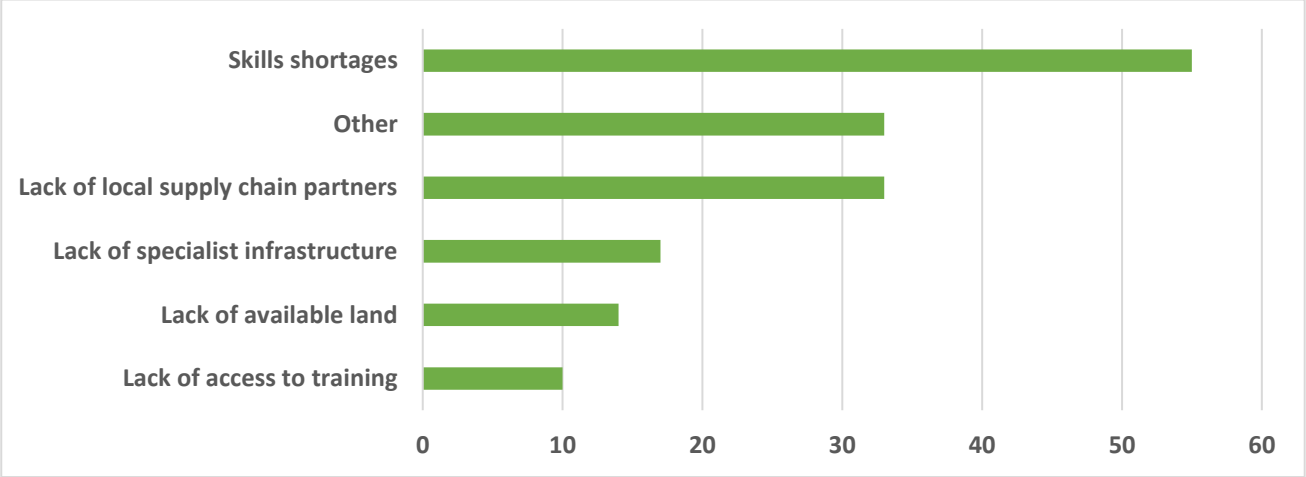
- skills shortages
- training market and system capacity
- supply chain
- infrastructure
- regulation, planning and policy.

Stakeholders identified barriers that directly impact opportunities to increase local content and jobs (e.g., skills, training and supply chain) and broader contextual barriers that impact opportunities more indirectly (mainly in the categories of infrastructure, regulation, planning and policy).

6.1 Skills shortages

Industry experts and regional stakeholders identified critical skills shortages in key sectors and regions (also supported by survey data). Shortages are driven by a range of factors including systemic labour market issues and more specific renewable energy sector drivers.

Figure 46: Primary constraints on businesses to realise opportunities from renewable energy and transmission projects



Source: Survey results, responses to question on what constrains the business from taking advantage of the opportunity for increased business from renewable energy infrastructure

Many stakeholders identified critical **skill shortages for specific trades and professions** as a major barrier. Around a third of respondents nominated skill shortages as the primary barrier (and some of the 'other' responses also related to skill shortages).

Stakeholders note shortages for electricians, which industry representatives believe could be a "massive problem" for the REZs and others consider a problem for infrastructure projects more broadly. Shortages are noted for wind farm maintenance personnel, transmission lineworkers, fitters, carpenters, engineers and site supervisors that can train staff on the job and pass on knowledge.

We heard that it will be difficult to train enough electricians within the timeframes required given that training takes 3-4 years, which highlights the importance of investment early in the delivery of the Roadmap. Stakeholder observations are supported by survey data – respondents experience or anticipate most skill shortages in mechanical and construction jobs (trades, technicians, labourer, mangers), and project management professionals.

6.1.1 General drivers of skills shortages

- Multiple stakeholders identify the **shortage of skilled regional labour**, along with skills leakage from regional areas, in part due to loss of regional VET. Some regions, such as Dubbo, have low unemployment rates which could contribute to local workforce shortages. Stakeholders in Central-West Orana, New England and Illawarra REZs also note labour shortages. Many regional areas have lower numbers of younger residents and an older workforce. Conversely, COVID-19 has driven many workers to live in reginal areas, which could increase availability of local labour.
- Stakeholders identify **competition for skills and labour within regions with other industries** in the context of tight labour markets as a barrier, with mining and manufacturing being examples. **Competition for skills between states** suggests that national collaboration on training may be required.
- Stakeholders in several regions reference a **lack of transferrable skills**. The need to upskill workers for renewable energy applications, even in areas with local capability such as civil works, can be a challenge for local content requirements. Several stakeholders note **challenges with engaging with low-skilled labourers to upskill** and reluctance to undertake training and apprenticeships in some demographic cohorts.
- Stakeholders question the **ability to attract workers to live and work in regional areas in the long term**. This hinders investment in training as it reduces the return on the investment if workers leave after a few years. REZs near major centres such as Newcastle may be more viable for long-term relocation.
- Stakeholders note the current **decline in migrant labour due to COVID-19** and that migrants often need additional training for Australian standards.

6.1.2 Renewable energy drivers of skills shortages

- Short-duration projects and the mobility of labour is one reason why the renewable energy sector is not a coordinated industry sector. An example offered by stakeholders is that workers do not receive portable employment entitlements that require continuity of service (e.g. annual leave), which is available in the building construction industry. It is unclear who will fund an industry-wide uplift of training and skills in the absence of these arrangements. There is a lack of renewable energy industry pooling to contribute to industry levies and training funds – the cost to develop the industry is not being shared by the sector.
- **Short timeframes** of construction phases, **uncertainty** around projects going ahead and a **lack of transparency** regarding the timing of projects limit the ability to take on apprentices for longer contracts (especially solar projects which are typically 12 months) and to investment in training. The lack of longevity of work leads to contractors hiring the cheapest labour they can and is a general workforce barrier in the regions. Upskilling for single projects is not a good return on investment.
- **Labour and product supply bottlenecks** are a concern when major infrastructure is delivered concurrently, rather than sequentially, reducing the ability for local labour to move between projects and for local supplier content to be maximised.

6.2 Training and market system capacity

A series of reviews at Commonwealth and NSW level have identified structural issues with the VET sector (Commonwealth of Australia (2019), the Gonski and Shergold review (2021), NSW Productivity Commission (2021), Federal Productivity Commission (2021)) and we heard similar views in our interviews

6.2.1 Low demand and supply for training in renewable energy and transmission

- The **Australian market is small and renewable energy is a 'thin market'** (i.e. in regional areas, there is low demand for training spread across regions) which makes the economics of specialised training challenging. The low demand in regional areas makes it less attractive for private RTOs or TAFEs to offer training in the context of competitive markets and limited resources. Lack of demand leads to lack of supply and it can be difficult for contractors to identify training providers.
- **Low enrolments** in relevant units of competency leads to rationalisation and cutting back on training packages that might be used. Some qualifications may not be useful and workers are likely to upskill in other ways, such as through global qualifications. This does not apply across the board; there is plenty of demand for electricians who can be trained by RTOs.
- **Specialist training is expensive to set up** and capex on associated new equipment is high (e.g, hydrogen supply chain). With some higher-risk specialised skill sets there are commercial barriers to collaboration such as companies wanting to retain internal training and skills to ensure quality and competitiveness. SMEs see investment in training as a relatively high-risk activity due to proportionately high upfront costs and uncertain return on investment.
- There may **not be enough demand for the specialised courses** in each REZ (e.g., wind maintenance technicians), so a coordinated approach to skills and training between regions or states may be required to pool demand.
- A core base of skills is needed to build the more specialised skills, but **trades and VET have become less attractive** relative to university education for school-leavers and young people.
- There has been a **loss of big companies and 'supply authorities' training apprentices**. Only the largest employers have inhouse apprenticeships, and many apprentices are missing relevant skills because they are not getting on the job training.
- **Trainers are getting older** and attracting new trainers is challenging. There is high skills demand within the industry and a considerable salary differential between industrial and training employment.
- Several stakeholders referred to **under-resourcing of TAFE**. Increased funding and collaboration between government, industry and the educational sector will be required to overcome this challenge.

6.2.3 Training packages

There were divided views on training packages (units of competency, skill sets and qualifications):

- Industry representatives note they are unsuitable and would not be used by the industry. They see training providers as confused about what is needed with no policing of standards. One regional workshop noted a lack of effective RTOs and the inability of the VET sector to respond quickly.
- Training packages can take a long time to change and widespread change is needed in training if every qualified electrician needs the ability to work on renewables, for example. Processes to approve new and innovative qualifications can be slow.
- Unions and training providers believe the knowledge of many in the industry on the content of the training packages is limited outside major companies with specialists employed, and that a jobs advocate or initiatives to raise better awareness of RTOs and training packages should be a priority. They feel the training packages are broadly suitable with some gaps (e.g. blade maintenance). A more general observation from a training specialist is that training packages are often misunderstood. Packages can be flexible and used as inputs to training content, and micro-credentials are often embedded in training packages in units of competency.
- The problem is less about training packages than creating the infrastructure, resources and people to deliver training in the context of under-resourced TAFEs and private RTOs in thin markets and considerable salary differentials between industrial and training employment.

6.3 Supply chain

Stakeholders identify a range of supply chain-related barriers.

6.3.1 Market constraints

- **Compressed delivery timeframes** undermine the ability for local content providers to scale up (particularly when domestic capability is limited, such as for wind tower manufacturing) **and increases the pressure to source products internationally** even though production capability could exist domestically.
- Interviewees note that **lack of sufficiently sized offtakers** (e.g., for minerals), is a barrier for local producers.
- **Over-reliance on imports**, particularly by overseas owners of solar and wind farms, is a barrier to local supply chain development. For example, in the wind sector, turbine producers often drive the procurement of parts and have varying policies on local sourcing. Some procure everything from overseas, even where materials (such as concrete) could easily be sourced locally. Other barriers include project specifications that favour overseas suppliers. Past failures to retain elements of manufacturing or moving them to Australia, such as wind turbine blades and cabling, speak to the need for a steady pipeline/sufficient scale for local manufacturing to be viable.

6.3.2 SMEs/regional suppliers

- Survey respondents believe unreasonable liquidated damages, retentions and contract terms for small businesses, as well as uncertainty in tender processes are key issues relating to **contracts and tenders**.
- Businesses identify a **lack of knowledge of the market** and the services/products required as a constraint, as is a lack of market and procurement contacts and lack of awareness of opportunities.
- **Limited organisational capacity** and significant existing workloads are constraints as is the limited capacity of local suppliers to engage with renewable energy project developers and absence of industry-led consortia or associations to handle supply chain issues.
- Stakeholders believe **large capex will be needed** to scale up and get projects off the ground and this is a major barrier for SMEs, particularly where there is concern around the longevity of investment returns. For SMEs, issues such as lack of equipment are a constraint and volatility in materials pricing can make

it hard to commit to long term projects. Some suggest financial support will be needed for local business to diversify into REZ opportunities.

6.3.3 Manufacturing, technology and cost competitiveness

- There are mixed views on cost competitiveness and the potential for cost competitiveness varies by component. Some interviewees see the potential for NSW to be cost competitive on production although it has been historically difficult to source higher value products locally. COVID-19 may have improved cost competitiveness for local producers because of global supply chain disruptions. However, for some products it remains cheaper to import and there can be differences between costs of local and overseas manufacturing.
- **Local employment standards** contributes to higher costs compared to overseas suppliers, with stakeholders observing imported products do not always have to comply with equivalent standards. Other significant costs arise from **transport and energy** and **WTO rules**.
- Some stakeholders note **technology barriers to local production**. For example, the increasing size of wind towers may require larger, new facilities to produce related products such as base plates.
- One stakeholder considered this was more a **perception barrier** about Australia's ability to manufacture at competitive prices. This does not reflect the reality of advanced manufacturing in which relatively low labour costs (due to high levels of automation) and proximity to materials gives a competitive advantage.

6.3.4 Local production versus lowest cost

- **Local economic development needs to be balanced with renewable energy being competitive** in the market and not making development in the REZs more/too expensive. Additionally, policies mandating local content may have unintended consequences including job losses if costs are too high.
- **Overseas supply also creates risks** such as waiting for supply, currency risk and price increases due to increased global demand. One interviewee notes sovereignty of supply as a major security issue for batteries. Not knowing the provenance of battery software for grid connected utility scale batteries is a cyber security risk.
- There is an inherent **tension between competitive tenders to secure a low strike price versus increased industry development opportunities** that could arise from greater consolidation through a single or fewer proponents. Consolidating tenders and the scale of the auction would encourage bidders to offer more local industry development but ongoing auctions are considered likely to get a lower strike price for the electricity supply.
- **Lack of consideration of wider economic benefits** compared with financial value when considering investment means the value in capacity building of regional economies and labour markets is not priced into the financial appraisal. Procurement practices tend to favour lowest prices.

6.4 Infrastructure

Short-term construction may adversely impact local communities, putting pressure on local infrastructure and services (e.g., childcare, health, roads), particularly accommodation. Local infrastructure constraints may present barriers during construction. There are concerns that regions will experience short-term pain but not longer-term benefits. Several the regions are at capacity with existing projects pushing services to their limit.

6.4.1 Accommodation

- A specific concern is **worker accommodation**. Additional accommodation and facilities will be needed for construction, some of which may also be needed to house workers for large-scale maintenance. Combined with local shortages of suitable housing stock, this could cause **issues with local housing affordability** in some regions. This is also an issue for apprentices on low pay in overheating markets during construction booms.
- However, some stakeholders see potential opportunities to work with government to find **alternative uses for purpose-built accommodation** that would otherwise be mostly vacant post construction. For

example, projects could be built with affordable housing outcomes for lower socio-economic groups, after the construction phase.

6.4.2 Local infrastructure constraints

Regional stakeholders identify local infrastructure constraints and particularly the **need to upgrade shared infrastructure**. Issues include:

- transport bottlenecks and disruptions, rental vehicle availability, out-of-hours transportation movements, transport to/from job locations
- issues with local roads (including bridges and tight corners) that may not be adequate for construction and maintenance phase
- limitations in regional rail networks
- lack of warehousing facilities
- lack of suitably zoned land
- land use conflict and competition, including issues regarding urban sprawl, rezoning of industrial land, pressures on agricultural land and the need to balance carbon and biodiversity offsetting and protections
- lack of raw materials for construction.

6.5 Regulation, planning and policy

Stakeholders identify some deficiencies in coordination, regulation, planning and policy as well as local councils' capacity to manage the scale of the infrastructure tasks.

6.5.1 Coordination, clarity and transparency

- Multiple stakeholders refer to the **lack of joined up thinking and coordination** by government – different people, departments or agencies are working on jobs, exports, investment attraction etc. Competition rather than coordination between states is identified as a constraint, along with a lack of coordination and transparency regarding alignment of projects (including REZ phasing), and community needs. We found a lack of an integrated economic and investment framework at a regional NSW level - multiple precincts competing for investment across a range of different regional initiatives (SAPs, Clean Manufacturing Precincts, REZs etc) but not recognising fully the interdependencies and not fully aligning with local housing and social infrastructure supply planning.
- Some stakeholders referred to general uncertainty, lack of transparency and lack of clarity around plans for REZ development (particularly around timing and phasing in some regions. Challenges include perceived lack of industry and community engagement and benefit sharing especially relating to social benefits. There is a risk of community backlash.

6.5.2 Policy constraints

- Stakeholders identified an overall **absence of consistency** of policy, direction and support from the Commonwealth and NSW governments, compounded by short-term thinking and past policy positions that have contributed to a cautious approach to investment by business. Current Commonwealth Government policy is noted as hindering investment in renewables.
- Additional specific policy deficiencies include the absence of a national stewardship scheme for PV panels, and a lack of policy to keep manufacturing jobs in the country

6.5.3 Regulation and local planning constraints

- Several stakeholders refer to issues relating to statutory **planning and zoning requirements**. It is suggested that land use rules and regulations are not written with new technology in mind and a major review is needed.
- Stakeholders note **capacity constraints for local suppliers and councils** to be able to keep up to date with and manage the impact of regulatory changes. It is suggested that councils will need additional

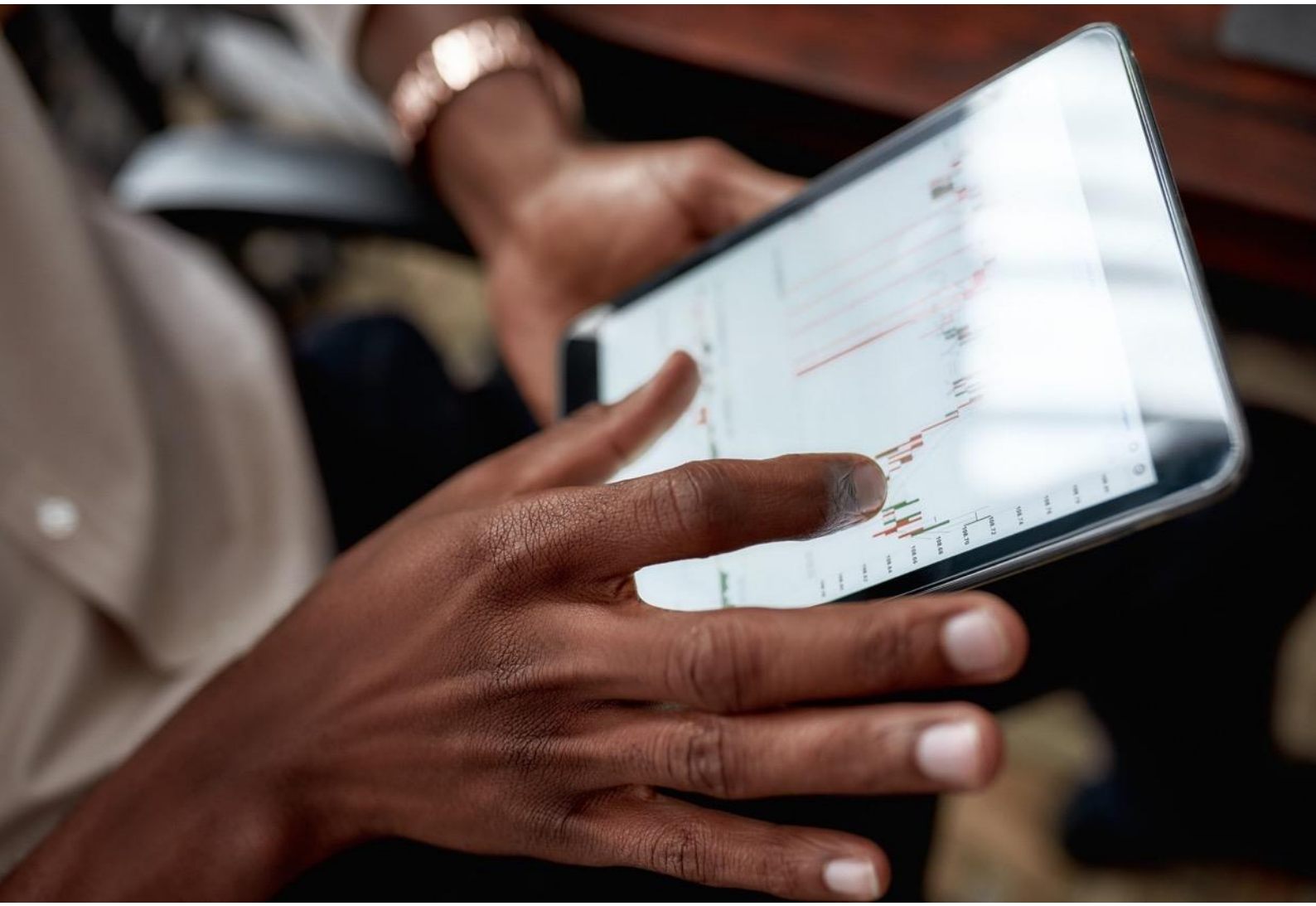
capacity to manage planning and development of community infrastructure for increased local populations. Tension between regional job opportunities and housing supply is considered a major barrier to attracting workers to regional communities and this is a challenge for councils to address due to limits on financial and other resources, and limited abilities to deliver large-scale infrastructure. Additionally, there is a lack of capacity and resources in some councils to plan for wider economic development opportunities for inward investment, particularly if such investment will come quickly but be temporary (e.g., growth due to construction-phase activity).

- Stakeholders identified the need for **regulation to support whole of life** material recycling and rehabilitation of sites.

6.5.4 Economic development, finance

Although economic development and financing concerns featured less prominently, we note the following observations from some stakeholders:

- It is suggested that faster and more agile processes would be needed for approval of public funding – **slow processes are leading to missed opportunities** and competitive disadvantage compared to other states.
- Stakeholders in the **Hunter** note that **investment is shifting away from regional industries** and that the region is currently outcompeted by other states or regions, or overseas, for investment attraction. The scale of individual investment opportunities is small and they may need to be aggregated to attract capital inflows. For the Hunter, it is suggested that the competitive advantages of new sectors are less clear cut than for current and historic sectors.



07: Actions

AREA: Procurement				Owner	Customer Trustee (tender), DPIE, ICN	
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
✔	✔	✔	✔	✔	✔	All technologies

ACTION 1A

Require all tenders under the Electricity Infrastructure Investment Act 2020 to submit a local industry participation plan to be evaluated against merit criteria.

Rationale

Tender criteria issues include the design question of target-based vs outcomes-based approaches. A mix of minimum targets underpinned by detailed research and outcomes-based approaches is recommended in the report by MBB; consequently, we have not revisited these issues of tender criteria.

Instead, this action builds on the MBB report and highlights additional areas to be considered for local industry participation plans (or equivalent) submitted to satisfy local content tender criteria for LTESAs. This action is also based on the assumption that local content criteria will be weighted at a significant level (e.g. 20 or 25%), but lower than price criteria to balance impacts on electricity prices with local industry development and employment.

MBB's report and our consultation note a range of other clear conditions for maximising local content that will not be elaborated on, including:

- early notice for developers and EPCs
- visibility of the project pipeline
- sequencing of projects to avoid boom-bust cycles.

Description

Each proponent should submit a local industry participation plan stating the minimum percentage of local content they will achieve, their target percentage and how they will satisfy specific criteria that reflects the NSW Government's industry development objectives.

The Consumer Trustee should, in setting criteria with specified weightings for the LTESA tenders, establish:

- **targets and incentives** for local content in the supply chain for construction and O&M, but also specific merit criteria with weighting for local manufacturing
- options to **disaggregate large contracts** into smaller value work parcels – where feasible – to facilitate greater SME participation and level the playing field for regional operators
- incentives within the criteria for the **establishment of local facilities** within REZs and NSW, noting the success of ACT reverse auction being a stipulation that the criteria would reward the establishment of new, local facilities consistent with the ACT's Renewable Energy Industry Development Strategy – a companion NSW strategy would create a signal for proponents
- recognition for **group industry development** proposals that can achieve greater impact and economies of scale by pooling investment in local capacity
- incentives for investment that can support ongoing development of First Nations employment and economic participation **exceeding compliance with the NSW APP, with reference** to the *Guidelines for Consultation and Negotiation with First Nations Communities* that are being developed

- a requirement to publish a **monitoring and evaluation plan** backed by legal penalties to ensure higher local content. The Victorian Government notes an ongoing dialogue with renewable energy project developers and adjustments to how local content agreements are met as market conditions change and that this is important to compliance. In South Australia, an industry advocate monitors compliance. Clear requirements for reporting on outcomes, barriers, supply chain gaps and mitigating actions will help inform local industry and government on opportunities for further development of local capacity and adjustment of targets for auctions.

AREA: Procurement						OWNER	Customer Trustee; Department of Education and Training.
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES	
	✔	✔			✔	All technologies	

Action 1B

Require all tenders under the EII Act 2020 to submit a workforce development and training plan to be evaluated against merit criteria.

Rationale

Tender criteria are a proven mechanism for increasing industry investment in training. The requirement for a Workforce Development and Training Plan within the VRET has been well received. The Victorian Government reports that projects have exceeded targets. This requirement could be standalone or incorporated within a Local Industry Plan should attract a criteria weighting.

A consortium of wind farms in partnership with Federation TAFE has established the first blade apprenticeship in Australia and training facilities under the VRET. This occurred informally through outreach from the TAFE. Formalisation of group proposals to invest in training facilities or ongoing programs could be encouraged by recognition in merit criteria.

While the focus of skill shortage discussions often focuses on trades, there are critical shortages in engineers. In its Market Capacity report, Infrastructure Australia (2021) finds engineers are the primary shortage in the sector. Initiatives to increase local employment also often focus on trades and labourers with firms using city-based workforces for professional roles. Supporting the growth of local professionals such as engineers could have positive spillovers to other sectors. Weighting for priority occupations might be considered to encourage training opportunities for local professionals.

Description

Each proponent should be required to submit a workforce development and training plan including the minimum level and targets for hour-based engagement of apprentices, trainees, cadets and interns. The criteria for evaluating Workforce Development and Training Plans should:

- evaluate the number and total labour hour targets (i.e. percentage of labour hours) for the engagement of apprentices, trainees, cadets and interns
- recognise the development of ongoing training capacity (e.g. courses and equipment that can be used to train other workers such as the Federation TAFE development) and encourage group proposals between projects
- recognise programs or commitments to engage unemployed persons, increase gender diversity, and increase First Nations participation
- recognise mechanisms to support career paths and workforce deployment internally and externally post-construction
- recognise programs to engage local professionals (e.g. engineering interns) as well as trades.

To support investment in training capacity and longer-term programs, access fee criteria should include scope for and recognition for employment and training initiatives with ongoing benefits. The Victorian consortium emerged from an informal partnership, but the NSW Government could encourage this type of initiative by formalising in criteria.

A monitoring and evaluation plan should be published, with proponents required to report on training outcomes and actions.

The Hunter-Central Coast and Illawarra REZs are not yet included for this action as there are no tenders scheduled for electricity generation.

AREA: Procurement						OWNER	Customer Trustee (tender), DPIE, Local Councils, large anchor businesses in the REZ supply chain
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES	
	✔	✔	✔	✔	✔	All technologies	

Action 1C

Reduce barriers for SME participation in renewable energy procurement opportunities, particularly in regional areas

Rationale

SMEs find it challenging to participate in procurement processes for large projects due to scale, their lack of specialised expertise in procurement processes, and inability to access project information.

Increasing opportunities for SMEs can direct wealth back into regional economies and place control and benefits into the hands of local people. Referred to as community wealth building, these projects are undertaken by local authorities with their large anchor institutions (like hospitals or universities) and large businesses to develop local supply chains and localised procurement policies. REZs can be a community wealth building anchor with economic benefits enhanced if a greater share of income and wealth can be captured in regional economies.

DPIE can be involved in implementing these ideas and create strategies to support the early establishment of local supply chains so SMEs can take advantage of the opportunities.

Many regional economies are undergoing economic transition and need new industry development and economic opportunities. Without action the economic, business, employment, training and wealth benefits won't be captured locally, but instead flow to major cities or internationally.

Description

This action includes several sub-actions:

- Undertake a business and skills mapping project to understand where opportunities for SME participation align with local capability
- Develop a single consolidated registry and Renewable Energy Supply Chain Business Directory (Action 4D) by with details of SMEs by expertise, region, and capacity where SMEs can register interest in future projects.
- Identify and work with businesses who could participate in the development of the REZs and promote the opportunities early, giving SMEs time to invest in their capabilities so they can participate
- Provide tailored financial support (grants/loans etc.) for SMEs to upgrade technology and processes to overcome barriers to participation
- Provide capacity-building training and information to registered or interested businesses, drawing on government support and renewable energy and industry business networks

- Require bidders at REZ auctions to demonstrate how they are implementing SME-friendly measures in their bids
- Support the early involvement of ICN in procurement processes to increase opportunities for SMEs.

AREA: Procurement						OWNER	NSW Government, Department of Education and Training
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES	
✔	✔	✔	✔	✔	✔	All technologies	

Action 1D

Use a procurement portal for the REZs to streamline the procurement process across the state

Rationale

There will be many projects with associated equipment, goods and services procured in the coming years to deliver new renewable energy infrastructure. A one-stop portal to assist the renewable energy industry and other stakeholders will:

- reduce transaction costs
- support the achievement of social and environmental outcomes
- centralise communications to the market and
- create consistent application and approvals processes.

The ICN has an existing portal that can be used for LTESA project proponents to advertise opportunities.

Description

Sub-actions include:

- Improve the portal so it provides a streamlined and simple service to enable access to tender information, submission of tenders and dissemination of communications to the market regarding renewable energy projects
- Develop a publicly available implementation timeframe to provide clarity around when certain regions are likely to see investment so that the business community can appropriately plan
- Link the portal to the Renewable Energy Supply Chain Business Directory (Action 4D)
- Consider the linking the portal to the recommendation proposing online platforms to support workforce redeployment (Action 2C)
- Provide educational resources on how to access grants and other assistance to get workers into regions, for pre-employment training and how to engage apprentices.

AREA: SKILLS AND TRAINING						OWNER	NSW Department of Education and Training, Jobs Advocate
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES	
	✔	✔	✔	✔	✔	All technologies	

Action 2A

Establish a Skills and Workforce Development Working Group in each REZ for energy, resources and infrastructure

Rationale

One of the key barriers to skills development and increased local employment is an effective mechanism for coordination, communication and planning between industry, government and training organisations. For example:

> *The industry does not have a collective vision … there is a need for an organised, long-term and unified approach with strategies and actions that are supported by industry … a collaborative system to education, training with industry playing a part in guiding course development and providing spaces for workplace experience is necessary to support workforce development.' (Tasmanian Energy Industry Workforce Development Plan 2020).*
>
> *We want to have that partnership at regional level to be able to attract staff … there is incredible scope for the long-term opportunity to develop workforce – but it needs a holistic view. A collaborative approach to industry and training workforce. We have a highly fragmented workforce in Australia. An additional layer of consideration is project work within a fragmented industry – people try to stitch together careers or otherwise we seek the international workforce. (Transmission, EPC, survey respondent).*

Energising Tasmania reports that a cornerstones of their programs is a mechanism for dialogue, problem-sharing and planning between stakeholders within and outside the training system. In addition to skills and training planning, stakeholders identify a need for regional information-sharing on the project pipeline and labour demand and a coordinating mechanism for workforce redeployment. Building the capacity of industry and training organisations to more systematically plan and manage skill and workforce development is essential to reduce skill and labour shortages.

The scope of the working group should extend beyond renewable energy to include other related sectors:

- Renewable energy is part of an ecosystem: mining, manufacturing and infrastructure have overlapping workforce requirements. There is a high inter-relationship across sectors between supply-chain businesses and we frequently heard the issue of competition for labour and overlapping skills.
- Labour supply and demand need to be managed across the regional ecosystem to reduce skill shortages and counterproductive competition for labour. Workforce redeployment is required to manage labour demand in the context of tight labour markets within REZs.
- Renewable energy construction is short term: establishing career paths and attracting and retaining labour into regions requires movement between renewable energy and other sectors.
- Renewable energy is a thin market: investment in training capacity and workforce development will be more effective across a group of sectors.

Description

These working groups should support the development and implementation of a strategy comparable to the model of Energising Tasmania to develop a workforce with nationally-accredited qualifications able to be deployed across the renewable energy, construction, resource and manufacturing sectors.

Each working group would contain representatives from government, industry, regional development groups, unions and training organisations (public and private). Working group activities could include:

- information sharing on project pipeline and forward labour demand to assist with sequencing and smoothing of demand
- skills mapping and auditing local training capacity
- identifying local workforce training needs for the REZ: the importance of upgrading local training capacity was a key theme from the workshops and local stakeholder input will be important to shape investment
- developing and implementing mechanisms for workforce redeployment
- monitoring and evaluation of implementation of training strategies within the REZ.

The focus of the working groups will vary between the REZs. Renewable energy generation and storage construction will be a larger focus for the inland REZs whereas for the REZs in traditional energy and heavy

industry regions (Hunter-Central Coast, Illawarra) will see a greater focus on skills mapping in declining industries and workforce transition.

Stakeholders note that implementation would need to be carefully considered to make resource commitments manageable and create effective decision-making (e.g., limiting participation to decision-makers, establishing sub-groups to develop and implement actions).

AREA: SKILLS AND TRAINING				OWNER	NSW Government, Department of Education and Training;	
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
✔	✔	✔	✔	✔	✔	All

Action 2B

Dedicate funding to increase training system capacity for clean energy workforce development

Rationale

There have been a series of inquiries into the vocational education and training system in NSW and Australia in recent years such as the Joyce Review (Commonwealth of Australia 2019), the Gonski and Shergold review (2021) and by the NSW Productivity Commission (2021) and Federal Productivity Commission (2021). 'Chronic skill shortages in the trades' (NSW Productivity Commission 2021) have been highlighted with a wide range of recommendations across leading reviews such as:

- Increasing the attractiveness of apprenticeships: new marketing campaigns, improving the breadth and quality of VET in school to balance the focus on university entrance and incentives to increase the flexibility of course delivery (e.g., after-hours, intensive learning) for apprenticeships.
- Broadening access to the trades: creating alternative pathways to trades qualifications alongside apprentices and incentives to place them on an equal footing. Apprenticeship uptake has been declining for some years. Alternative pathways are required in addition to school leavers for mid-career entrants which recognise they are unlikely to spend 3-4 years in a low-paid position to transition.
- Improving occupational mobility
- Extending Smart and Skilled subsidies to micro-credentials

There are related reforms underway in NSW such as:

- the establishment of a Trades Skill Pathways Centre (to create more flexible trade pathways)
- Job Trainer: subsidised training and personalised assistance for displaced workers to get VET training targeted at vulnerable cohorts (e.g., young people, long-term unemployed). The NSW Productivity Commission has recommended a continuation and expansion of the Job Trainer program.

While addressing skill and training issues within renewable energy is intertwined with these broader reforms to the training sector, there are also issues specific to the renewable energy sector. In our interviews and the regional workshops (especially Central-West Orana and New England), stakeholders held views similar to those in other states:

- Skill shortages are the number one constraint in our survey of supply-chain businesses.
- There are inadequate training offerings due to a combination of factors such as TAFE resourcing and 'thin markets' which do not create incentives for RTOs.
- Other structural barriers include a shortage of trainers.

Other state governments are implementing funds to develop clean energy training market and system capacity, which should complement other initiatives and cost-sharing arrangements. The Victorian

Government is establishing a $10m fund to support the Clean Energy Workforce Development Strategy. The *Energising Tasmanian* initiative has a joint Federal and Tasmanian Government fund of $16.1m.

In Tasmania, the Energising Tasmania Initiative involves a partnership agreement with the Federal Government for $16.1 million to develop the workforce for the 'Battery of the Nation' initiative and renewable energy more broadly. The Energising Tasmania program is an innovative model currently being implemented to address the same set of issues being considered by the REZ. Energising Tasmania initiative is a cross-sectoral regional initiative which aims to develop a workforce that can move across wind, hydro, transmission, hydrogen, civil construction and advanced manufacturing. The goal is to build a workforce with nationally accredited qualifications that reflect the project pipeline of the next 10 years and build career paths for workers that can move across sectors. The rationale is both to try and avoid skill shortages for industry and to create long-term employment with career paths.

Description

The employment purpose funding earmarked in the Electricity Infrastructure Investment could play an equivalent role to funds being established in other states to address skills and training issues.

Some of the key elements that could be considered for inclusion:

- Train the trainers: there is an issue with both the volume and currency of knowledge amongst trainers identified by the Tasmanian and Victorian Government and the Clean Energy Council. Barriers include lower earnings for people with industry experience to become trainers and the time and cost of acquiring training qualifications. Trainers are aging and getting trainers with contemporary industry knowledge is challenging. Energising Tasmania has provided grants for 12 experts to become trainers.
- Funding for RTOs to expand subsidised training offerings
- Training market development, particularly targeting priority occupations, to include:
  - development of new qualifications where needed
  - innovative delivery methods (e.g. mobile training units)
  - development and piloting of training for skill sets and micro-credentials, especially for mid-career workers and to create transition pathways from declining industries.
  - funding for industry associations or partnership initiatives to create new training capacity through for example transferring on-the-job skills and knowledge towards accredited qualifications. Examples from Energising Tasmania include Certificate 2 level pathways into industry for recent school leavers/unemployed for electrician and construction roles and mid-level engineering management training.
- Group Training Organisations: GTOs will be critical to enabling increased levels of apprenticeships and there are examples of successful initiatives but equally reports that uptake is not as high as it could be. Developing locally available GTOs should be a key priority for developing training market capacity.
- Engage with TAFE NSW to identify opportunities to align skills requirements with existing initiatives e.g. TAFE's proposed Specialist Advanced Training Centre (SATC) in the Western Sydney Aerotropolis, with a focus on advanced manufacturing skills
- Investigate with TAFE NSW and other RTOs the potential for training and innovation hubs and consider establishment in NSW: training hubs or centres have been established in other states and should be supported where they can be proven to be an efficient way of supporting training and innovation.

Any actions need to be aligned with wider reforms. This action also links with specific recommendations on the establishment of REZ Workforce and Skills Development committees and actions for priority occupations (electricians, solar construction workforce, transmission construction workforce).

AREA: SKILLS AND TRAINING				OWNER	NSW Government, Department of Education and Training;	
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
✔	✔	✔	✔	✔	✔	All

Action 2C

Develop frameworks and platforms to facilitate workforce redeployment within the renewable energy sector and across other sectors

Rationale

- Improving workforce redeployment within the renewable energy sector and between renewable energy and related sectors is important to address the risk of labour shortages and enhance career paths for workers.
- Overlapping workforce requirements between the renewables, transmission, mining, manufacturing, and infrastructure sectors creates opportunities for workforce redeployment.
- There are platforms and frameworks that could be established to facilitate worker redeployment.

Description

Frameworks and platforms should be developed to facilitate workforce redeployment including:

- A ‘digital passport’ in NSW for recognition of skills and qualifications of the renewable energy and transmission sector workforce. Industry stakeholders say a digital passport is operating in Victoria but not NSW.
- Establish on-line ‘talent community’ platforms for each REZ with jobs and apprenticeship listings. There are existing platforms used by industry. Identifying a platform that is required to be used by the industry can reduce transaction costs
- A micro-credentialling framework, offerings and pilots that target identified skills shortages. There are common foundational skill requirements, but workers may require specialised skills. An updated model of credentialling options is needed to ensure that skills supply can evolve alongside industry demand.
- There may be an opportunity to leverage existing funding streams through the Smart and Skilled program, new institutions such as the NSW Institute of Applied Technology and new models of VET delivery to roll out short courses and test a digital passport.

The Skills and Workforce Development working group would also be a mechanism for information-sharing and coordination.

Establishing portability of entitlements for workers would also reduce disincentives for workers to transfer between jobs (see recommendation 4F on improving job quality in the renewable energy sector).

AREA: SKILLS AND TRAINING						OWNER	NSW Government, Department of Education and Training; Transgrid
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES	
✔	✔	✔			✔	Transmission	

Action 2D

Federal-State co-funding to establish Transgrid as the national trainer for the construction and a training strategy to increase the local transmission construction workforce

Rationale

There is a current and growing shortage of transmission construction workers. A training strategy is required to increase the supply of workers to avoid shortages that could impact on the delivery and cost of transmission construction and to increase local employment and provide opportunities for disadvantaged labour market groups.

Several barriers need to be addressed:

- There is an urgent need to increase the supply of transmission construction workers to address skill shortages and reduce the risks of reliance on international recruitment for the delivery of critical infrastructure.
- Training capacity is inadequate. Training packages are currently being updated by the ESI Transmission, Distribution and Rail Group. There are very few registered training organisations that can deliver the training. One EPC noted this had been a constraint on plans to increase training. Another EPC summed up the situation as follows:

  'The training market is neither mature nor organised. Can it mature itself quick enough to deliver workers? There are TAFE system issues and only a couple of city-based RTOs.'

- Market uncertainty limits forward training investment by industry. Neither Transgrid nor the EPCs can be sure about either the volume or timing of future projects and workforce requirements, partly due to energy policy uncertainty but also regulatory processes and competitive tendering.
- Construction project timeframes present challenges for the engagement of apprentices, as apprenticeships often extend beyond the lifetime of construction projects.
- There is competition for lineworkers for the transmission sector with rail and electricity distribution line projects which can be more attractive because they can often offer more ongoing employment in urban or major town settings. Transmission projects are more likely to be remote.
- Transmission construction is a 'thin market' for training, with few training suppliers, due to volume of employment.
- The pool of experienced staff that can pass on skills and knowledge on-the-job is stretched, and a lack of site supervisors in particular has been identified by industry sources.

Without a coordinated training strategy, it is likely there will be ongoing shortages and reliance on international recruitment for jobs that are long term and could be filled locally.

Description

It is recommended that Transgrid and the Department of Education and Training develop a training strategy in consultation with Transmission EPCs and ESI Transmission, Distribution and Rail. As the cornerstone of this training strategy, it is recommended that co-funding be provided by the NSW and Australian Government for Transgrid to scale up its training to increase the supply the transmission construction workforce across the National Electricity Market :

- Transgrid has established training facilities at Wagga Wagga which can be leveraged. At a workshop run by ISF for a project for Infrastructure Australia, it was noted by several industry participants that an

efficient solution to transmission construction skill development, in view of the relatively low volume of workers required, would be for NSW and Transgrid to take on a national training role instead of each state developing facilities. NSW has the largest share of transmission construction jobs projected (43% overall). MBB's supply chain report also noted an opportunity for NSW to train the workforce in other states.

- A central organisation training for the entire sector is a proven model, and similar to the role played by Transgrid (and other public sector institutions) in the past. Whilst EPCs should contribute to the pool of skilled labour and have important roles in transmitting skills and knowledge through on-the-job training and experience, it is unlikely that relying on the private sector will generate a timely response.
- The reason for co-funding between the Federal and State governments is to enable Transgrid to increase training to supply transmission projects across the National Electricity Market . There is a strategic imperative for both national and state governments to expedite the development of the workforce for the build-out of transmission infrastructure. As a precedent, the Federal Government has provided training funding to support the Energising Tasmania initiative as part of the Marinus Link upgrade and 'battery of the nation' project.
- Transgrid is already playing a pro-active role in workforce development for the sector (one EPC noted Transgrid had offered to take on apprentices if the EPC found they had insufficient work, increasing their capacity to engage apprentices). The recommended approach would remove the barriers to scaling up that role and the training provision.

A training strategy should be developed by Transgrid and the Department of Education in consultation with key stakeholders.

As the cornerstone of this training strategy, it is recommended that co-funding be provided by the NSW and Australian Government for Transgrid to become the **national trainer for transmission** – and train beyond its organisational requirements for key shortages (e.g., engineers, lineworkers and electrical commissioning specialists) across the sector.

Other elements recommended for consideration are:

- Transgrid and Essential Energy investigation of initiatives to increase the redeployment of workers between the transmission and distribution networks. There are shared competencies between key occupations such as lineworkers but additional competencies are required for distribution lineworkers to work on transmission projects. Funding could be provided for a program to accelerate worker upskilling and increase mobility between the distribution and transmission workforces as the quickest way to develop a local transmission workforce, including workforce skill mapping and training. The development of shared engagement of apprentices would enable workers to gain qualifications in both transmission and distribution, increase the flexibility of their career paths, and increase the ability to redeploy between sectors as needed.
- Inclusion of targets for the engagement of apprentices and trainees for transmission construction projects in tender criteria
- Initiatives to engage unemployed and First Nations community members (e.g. Certificate 2 training as a pathway into the sector) including targets within transmission construction project tender criteria;
- Initiatives to increase female participation in the sector
- Development of internship partnerships for engineers between universities, Transgrid and EPCs
- Funding for the development of site supervisor courses to support on-the-job training of trades workers for renewable energy generation and transmission construction.

Illawarra and Hunter REZs are not included in this action as new transmission infrastructure will be constructed to connect new generation in the other REZs and interconnectors with other states.

AREA: SKILLS AND TRAINING				OWNER	NSW Government (Department of Education and Training), Jobs Advocate
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
	✔	✔	✔	✔	✔	All technologies

Action 2E

To develop a training strategy to increase the regional supply of electricians

Rationale

Electricians are the largest occupational group in renewable energy. Shortages of electricians in regional areas is a general issue, as well as shortages of electricians with skills and experience in renewable energy, transmission and storage projects.

There are a range of identified issues or barriers (including sometimes conflicting views):

- Relative pay rates: electricians can often earn higher rates in other sectors such as mining.
- Training resources: some stakeholders consider existing training resources to be adequate and the problem to be a lack of industry awareness, use and appropriate structuring of apprenticeships. A more common view is well summarised by the Tasmanian Energy Workforce Development Plan (2020, p.31):

  > *Concerns remain with the current electrical qualifications: the qualification is considered too long (to complete) … the qualification is seen as inflexible and does not meet local industry needs. Training needs to be customisable: there is potential to look at basic electrical skills, with potential cross-sector application, plus on-the-job training as a model to address real needs.*

- As a longer-term solution, industry would prefer to see renewable energy incorporated into both electrical training packages and standard courses. There are other issues such as a lack of appropriate courses on offer in TAFE and RTOs and a shortage of trainers and equipment within RTOs for delivering training.
- Disincentives for engaging apprentices: construction project timeframes present challenges, as apprenticeships extend beyond the lifetime of most projects, and most construction is undertaken by EPC firms. Electrical apprenticeships also require domestic onsite experience which EPCs cannot provide. Clients only pay for qualified labour, so EPCs only recoup investment once a worker is fully qualified.
- Group Training Organisations: GTOs can be a vital component for enabling apprenticeships between employers. A thorough review was not possible in the context of this project but there were different views expressed about how well they are currently functioning. There were some positive cases (e.g. Western Victoria) but also industry comment that take-up was not as high as it could be.
- Young people and women are not attracted to work in the energy sector: with no clear visibility of career pathways or programs in school, and little attention to gender equality, there is low interest in working in the energy sector.

Description

Some the measures to increase the supply would be part of wider training reform initiatives – but due to the importance of electricians it is recommended that increasing the supply of electricians is a key priority.

- VET in schools: a program for VET in schools should be developed for clean energy and transmission.
- Use of procurement guidelines to increase the use of apprentices by renewable energy, transmission and storage projects.
- Enhancing the uptake and completion of apprenticeships and electrical training by girls and young women in both schools and industry programs by active promotion and mentoring.
- Enhance the operation of Group Training Organisations: review the operation of GTOs to identify any barriers to uptake by the industry and where required fund initiatives to enhance GTO capacity.

- Initiatives for the redeployment of electricians between renewable energy and other sectors (e.g. micro-credentials or bridging courses) and within renewable energy (e.g. digital passport). Cross-sector movement has been identified as a key priority for the Tasmanian Energy Workforce Development Plan (2020: 31-32).

    The confluence of a range of pipeline projects will likely create a bottleneck for key occupations such as electricians. TasNetworks is seeking cross sector collaboration, with consideration for working together on pooling resources and developing specialist skills. An opportunity exists to look at core skills in renewable energy that cut across solar, wind and hydro to address the entire industry.

Stakeholders reported successful transition of workers across from oil refinery closures in WA as an example. Other stakeholders said coal workers prefer to 'wait it out' until they get a redundancy due to the wage differential and then work out their future.

As training new electricians takes 3-4 years, strategies for transitioning electricians or providing current apprentices with training is essential if the local workforce is to be increased. Strategies to increase the supply of electricians could be piloted in CWO through the Workforce and Skill working group. Not only is the CWO REZ the first REZ but tight labour markets have been observed and there is an acute risk of shortages within renewable energy and other related sectors.

AREA: SKILLS AND TRAINING						OWNER	NSW Government (Department of Education and Training), Jobs Advocate
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES	
	✔	✔	✔	✔	✔	Wind	

Action 2F

To develop a training strategy to increase the supply of wind farm maintenance technicians

Rationale

A shortage of wind farm maintenance technicians has been identified in surveys and industry consultations. A regional training strategy for these technicians could increase the supply of ongoing jobs for the local workforce, create transition pathways for workers from other sector with mechanical and electrical skills, and reduce ongoing project costs.

Description

There are economic incentives for the sector to address this skill gap which can be complemented by tender guidelines, but the NSW Government should also engage with the sector on a training strategy for wind farm technicians.

There are three key types of training required, safety, blade technicians, and turbine technicians:

- **Safety training** to compliance with Global Wind Organisation standards. There are a range of RTOs that can deliver this training including the Canberra Institute of Technology.
- **Blade technicians**: Federation TAFE is establishing an apprenticeship which is an extension of the Certificate III of Engineering (Composites). The blade technician apprenticeship includes 1-month in-person blocks at the beginning and middle of the year, supplemented by on-line training.
- **Turbine technicians**: post-trade training to extend skills with a 6-month program. The training involves 5-months of in-person training and a one-month internship as a bridge to employment.

The focus of NSW Government action should be to determine the extent to which existing fee-for-service training capacity in Victoria could be leveraged or is there supporting infrastructure required to be established in NSW.

The Victorian training capacity has been established with a view to servicing inter-state training requirements. In particular, the blade technician training requires only 1-month in person attendance, although a 5-month block for turbine training may not be attractive.

New training capacity could be established in regional NSW with investment in equipment (towers, nacelle etc). The costs of new equipment may be able to be leveraged from or shared with the wind industry (e.g. a tower for training purposes). Victoria and Queensland have each invested in a tower for training facilities. Industry consultation through the tender process is required to determine if NSW-specific investment is required.

AREA: SKILLS AND TRAINING				OWNER	NSW Government (Department of Education and Training), Jobs Advocate
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
	✔	✔	✔	✔	✔	All technologies

Action 2G

To develop a training strategy to increase the supply of engineers

Rationale

- There are shortages of engineers across a range of disciplines for renewable energy and adjacent sectors.
- Infrastructure Australia's market capacity report identified engineers as one of the major shortages across the infrastructure sector. Infrastructure Australia noted that an unprecedented boom in public infrastructure is planned for coming years with the peak of investment ($52 billion) in 2023 at a level that has never before been delivered.
- Engineers were identified as the occupations 'at most risk of shortage' with an additional 41,000 positions required across a range of disciplines including civil, structural and geotechnical engineers. As the report notes: *'engineers are in the highest demand. Approximately 57,000 FTE jobs in engineering are required in 2021-2022. Demand for civil engineers is the largest at 30% of total engineering demand. This is closely followed by structural engineers at 20% … rapid engineering demand is difficult to source. This is largely driven by long training periods and hyper-unique skill sets to particular sub-sectors … the hyper-bespoke nature of these engineering disciplines underscoring the importance of long-term workforce planning (Infrastructure Australia 2021: 53)*
- In the survey conducted for the Clean Energy Council in 2019-20, electrical and grid engineers were one of the leading shortages identified by respondents (Briggs et. al. 2020).
- Local content and training strategies sometimes focus on trades and labourers without a strong focus on professionals. It is important that NSW Government strategies include engineers.
- This is also an opportunity to develop regional professionals. Renewable energy firms rarely engage and develop professional staff in regional areas local to projects, utilising city-based staff or recruiting interstate and internationally. There is a high reliance on international recruitment in particular for electrical and network engineers.

Description

It is recommended actions be developed to increase the supply of engineers for the renewable energy and transmission sector including:

- The NSW Government facilitating partnerships between universities and renewable energy and transmission projects for internships and graduate programs. Partnership arrangements could also be extended to include other energy market organisations and renewable energy firms to expand the experience of the pool of engineers.

- Creating incentives for partnerships for internships between renewable energy projects and regional universities through recognition in procurement guidelines
- Clean energy VET in schools' initiatives to include a focus on engineers

AREA: Strategic Planning and Infrastructure				OWNER	NSW DPIE	
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
✔	✔	✔	✔	✔	✔	All technologies

Action 3A

Develop and implement a circular economy framework for the REZs to build an end-of-life sector for renewable energy

Rationale

- Large-scale investment in renewable energy technologies is creating new problematic, accelerating waste streams. However, the industry is at a very early stage of development (e.g. There are only 4 solar PV recycling businesses in Australia and 1 in NSW). As the sector develops, end-of-life can create workforce transition opportunities from construction. Based on current data, it is estimated recycling creates around 3.5 times as many jobs as landfill disposal. Increasing recycling will also become increasingly important for participation in global supply chains (e.g. The EU is passing a law to require labelling of batteries on recycling content) and reducing costs.
- The NSW electricity infrastructure roadmap is an opportunity to develop an onshore end-of-life sector and incorporate circular economy principles at the design phase. Not only is this most environmentally impactful, developing end-of-life sectors will take time. A circular economy framework for the REZs is required which encompasses infrastructure, innovation, skills and engagement to develop local end-of-life sectors.

Description

Engage with relevant levels of government, stakeholders, the renewable energy industry, local communities and First Nations people to develop a circular economy framework that can be applied across all the REZs. Actions should include:

- Investigating the use of regulation, procurement and planning regulations to **create and expand end markets** for recycled materials from renewable technologies. For example, applying and extending product stewardship schemes and increased standards in NSW procurement (e.g. Increased proportion of recycled crushed glass in road construction).
- Addressing **information gaps** by establishing a renewable energy directory with industry data on type, location and age for installed technology to enable efficient repair and end-of-life collection and processing.
- Investigating the optimal **investment in waste management processing infrastructure** including:
  - Shared infrastructure investment with neighbouring states for recycling to benefit from economies of scale (s-w and n-e REZs)
  - Opportunities for recycling hubs to integrate with hydrogen hubs and the saps
- **Access to grants** (e.g. Waste and recycling infrastructure fund – circular solar trials) to support industry compliance with regulation and participation in local schemes for collection, transfer or waste processing.
- Engaging with recycling and re-use businesses to **identify workforce and skill requirements** and to identify opportunities to transition re workers to end-of-life industry over time (very little is currently known.

AREA: Strategic Planning and Infrastructure						OWNER NSW DPIE
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
	✔	✔	✔	✔	✔	All technologies

Action 3B

Develop a coordinated inter-regional implementation plan for the Electricity Infrastructure Roadmap which aligns with other regional infrastructure delivery programs

Rationale

Across regional NSW, significant investment is being made in transport and community infrastructure, economic development and industry transition. Ensuring that these major projects complement each other will ensure better outcomes in terms of building local skills and supply chains. For example, industry and local stakeholders noted the provision of road infrastructure, education facilities and affordable housing are essential enablers for developing, attracting and retaining local workforces in the REZs

There is a need for an integrated implementation framework to enable existing efforts to complement each other. The plan could coordinate across multiple agencies and local councils and allow co-planning for investment, to ensure service and infrastructure development where it will be most needed.

Description

Sub-actions include:

- Develop a statewide implementation plan to ascertain where potential infrastructure gaps may exist (including transport infrastructure, affordable housing and education institutions). This should include a refinement to the statewide employment forecasts (transport for NSW produced TZP19 forecasts) to reflect likely employment distribution and timeframes
- Engage with relevant stakeholders to understand housing supply challenges and address constraints to local job growth forecasts from the REZ and SAP development. Develop a strategy for longer-term use of temporary accommodation built for construction workers.
- Align infrastructure and services planning to match seasonal and resident population growth in and around the REZs through a regional statewide schedule of works
- Analyse labour demand in state significant project (SSP) approvals to ensure that the right skills are identified and sourced locally where possible.
- Engage with councils early to understand their internal capabilities and capacity to help deliver renewable energy infrastructure (for instance, planning approvals and utilities capacity)
- Work with local government officers to ensure that land use and strategic planning is supportive of investments in the renewable energy supply chains (for example, serviced land for manufacturing components locally).

AREA: Strategic Planning and Infrastructure						OWNER NSW DPIE
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
✔						All

Action 3C

Investigate opportunities for collaboration between states to maximise local content

Rationale

NSW is just one state that is focusing on developing a renewable energy sector with local supply chains. Collaboration between states can support local content in a range of ways such as:

- Increasing the scale of the procurement opportunity for businesses who can then invest with greater certainty with a greater demand achieved across states
- Shared investment in infrastructure
- Shared investment in skills and training infrastructure

As the definition of 'local' in VRET includes Australia and New Zealand, NSW is implicitly included in the local content criteria within VRET.

There were several opportunities raised in the course of the project for collaboration between NSW and Victoria and/or Queensland:

- Establishing manufacturing facilities in cross-border locations for opportunities that require greater scale (e.g. Blade manufacturing)
- Investing in waste management infrastructure in cross-border locations
- Specialising in skills and training investment to develop a national workforce where it could be inefficient for each state to invest separately

Description

The NSW government should investigate opportunities for collaboration between states where they can enhance investment attraction, procurement, infrastructure investment and skills and training.

There are existing forums for state collaboration which may be able to incorporate renewable energy local content (or via a sub-group) or alternatively a new forum may need to be established.

AREA: Economic Development						OWNER NSW DPIE
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
	✔	✔	✔	✔	✔	All technologies

Action 4A

Build the capacity of local manufacturing businesses to participate in transmission and generation manufacturing

Rationale

Increasing local content in manufacturing for the renewable energy sector will reduce supply chain risks and increase the economic benefits for the NSW Electricity Infrastructure Roadmap.

The inclusion of criteria to increase local content will be an important driver but it may not be sufficient to facilitate investment in new manufacturing capacity. It is notable that VRET led to expansion of existing capacity in tower manufacturing, solar infrastructure and the temporary establishment of nacelle assembly in an automotive factory - not to new capacity.

The NSW Electricity Infrastructure Roadmap offers a larger project pipeline but, depending on the level of certainty provided by tender criteria, additional engagement, support and capacity-building may be required to attract new investment. There were also differing views amongst stakeholders on optimal siting of new manufacturing, especially between port facilities and inland locations such as Parkes and Wagga Wagga SAP.

Description

Sub-actions include:

- **Market sounding** with OEMs and investors on major opportunities, which could include the manufacture of parts for renewable energy technologies.
- **Identify and develop supply chain and workforce development opportunities for offshore wind**: for e.g. ensuring any new wind tower and steel manufacturing facilities are 'future-proofed' for onshore wind. A NSW project developer (Oceanex) is currently undertaking a supply chain assessment which could be a platform for engagement between the industry, ICN and DPIE. Skills mapping for the coal sector workforce should incorporate assessment of transition pathways into OSW.
- **Establish an International Manufacturing Exchange** that aims to attract foreign investment and international partnerships with local manufacturers. Initially this could be through a pilot scheme (e.g. a hub at the facility earmarked by Bluescope Steel).
- **Use a portion of REZ access scheme fees to reinvest in local manufacturing pilot programs, grants and loans** with a focus on building capacity, facilitating international partnerships, and scaling local businesses. In regions with strong mining labour forces, this could be deployed with a focus on skills transition programs.
- Undertake a detailed cost-benefit analysis and work with key stakeholders (e.g. NSW Ports and Port Authority of NSW, Bluescope Steel, major manufacturing businesses such as Keppel Prince, OEMs) to understand the **optimal location for new manufacturing** from a whole of NSW Economy perspective. Identify any additional facilitation measures needed based on the optimal location.
- Undertake a **transport feasibility study** to identify any upgrades that are required. (e.g. transporting wind turbine blades along road networks due to increasing size).
- **Work with Investment NSW to incorporate manufacturing investment needs in the REZs with existing business attraction efforts**.
- Investigate scope for a national testing facility for transmission and wind towers to support local manufacturing

AREA: Economic Development				OWNER	NSW DPIE (energy, investment attraction)	
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
✔	✔			✔	✔	Battery supply chain

Action 4B

Establish a Battery Energy Storage System innovation taskforce to coordinate industry development opportunities across the supply chain

Rationale

The Future Battery Industries CRC (Accenture 2021a) have identified a $7.4 billion market opportunity for Australia (gross value-added) from the development of a diversified supply chain in battery energy storage systems. Australia is well-placed to develop a battery supply chain as one of the few nations in the world that has all the relevant minerals. Australia is historically known for its competitiveness at the mining stage of the battery life cycle – but as identified by the Future Battery Industries report there are opportunities across the supply chain from mineral processing to manufacturing and end-of-life management. Accenture (2021) notes

workforce availability is 'likely to be a bigger barrier than cost' to the development of an integrated battery supply chain. In addition to the economic opportunity, a range of nations (the United States, United Kingdom, Germany and France) have identified battery storage as a strategic technology and are developing local battery supply chains to ensure energy and national security.

NSW is also attracting investment interest and project development across the supply chain. The unique cobalt deposits found in NSW have attracted investment in innovative materials processing technologies with better environmental outcomes (Cobalt Blue, proposed facility). Downstream purchasers are increasingly looking to source battery materials from mines that can assure a sustainable product, prompting the mining industry to invest in sustainability certification readiness. NSW, in combination with other mineral endowed states such as Western Australia, could play a major role in providing a blueprint for a sustainable, circular, battery supply chain, reducing the environmental and social impacts of production.

In addition to battery materials processing (cobalt and nickel for Lithium BESS chemistries with sulphur bi-products for lead acid chemistries), other opportunities exist in battery pack assembly, cell manufacturing, system integration services, and end-of-life recycling and re-processing of battery materials (particularly cobalt and nickel).

One of the key barriers to realising supply chain development opportunities for battery technologies is improved coordination between government, industry, research, and training organisations. It is notable that the focus on hydrogen, for example, is much stronger than battery storage where there is currently no industry development strategy. Several mutually beneficial value-added opportunities exist across supply chain stages; however, the sphere of influence is limited for individual stakeholders and industry reports that government departments can be siloed in their approach to procurement, regulatory, planning and funding initiatives across the supply chain. Better coordination, knowledge sharing between supply chain stakeholders and policy development is needed to develop local supply chain capacity at the speed required to harness the opportunity.

Description

Accenture (2021b) has noted Australia could benefit from a national battery strategy. Our recommendation is that the NSW Government establish a taskforce to coordinate NSW battery supply chain development, develop an industry strategy and advocate for the development of a national strategy. Coordination between REZs and the NSW Special Activation Precincts would be a mutually beneficial starting point for the taskforce and supply chain stakeholders.

The following initiatives are a combination of suggested government actions from the FBI CRC reports on supply chain development, and recycling and re-use, the Australian Government's Technology Investment Roadmap discussion paper, and insights from stakeholder workshops and interviews for this project.

There are five main areas that could be the focus of a NSW battery supply chain taskforce:

- **Coordinated procurement strategy** to support demand for domestic production and investment by continuing to electrify state infrastructure and local content requirements – which could support local industry gain offtake agreements or expand operations.
- **Facilitating renewable energy power purchase agreements**: one of the major barriers identified by industry is the cost of electricity and requirements for net zero emissions. Action 4c covers this issue but it should be part of the scope of a taskforce.
- **Investment attraction and engagement** to support local projects secure finance (e.g. materials processing facilities)
- **Workforce and skill development:** the companies interviewed for this project did not identify any major workforce or skills issues but the FBI CRC report identified actions including:
    - ensuring university and VET **courses** are suitable for producing skilled graduates ready for an advanced manufacturing battery supply chain:c ritical gaps in the scope and specialisation of engineering degrees for the battery supply chain, particularly in mechanical, chemical, and industrial engineering.

  - Early **engagement with graduates**, clear identification of critical skills, and support for career pathways for graduates by linking industry, universities, and RTOs through battery innovation hubs. Innovation hubs will enable opportunities for funded industry focused research projects, collaboration on cutting edge issues and technologies, and better graduate understanding of industry skills requirements resulting in effective course selection.

- **Investigate and support other barriers and opportunities** for supply chain development which may include but are not limited to:
  - Co-location of processing, battery manufacturing, and end-of-life facilities where feasible or securing transport routes for the effective connection of facilities,
  - Establishing shared oversized transport routes to assist with transporting equipment during the construction phase,
  - Future research into opportunities for better circular integration of battery supply chain stages for more effective end-of-life treatment.
  - **Support battery material mines to achieve best practice sustainability certification**, currently IRMA, in order to maximise export opportunities and ensure readiness for future supply chain certification, and ensure all new batteries facilities plan for best practice supply chain certification from conception.

New England and Illawarra REZs were not included in this action as to the best of our knowledge there is no industry development or mineral sources within these REZs.

AREA: Economic Development				OWNER NSW DPIE		
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
✔	✔	✔	✔	✔	✔	

Action 4C

Broker PPAs for renewable energy supply chain businesses to enhance local content and international competitiveness

Rationale

There are several barriers to increasing local participation in renewable energy supply chains which relate to electricity:

- electricity costs: mining and manufacturing businesses reported electricity costs were a significant barrier to international competitiveness.
- Net zero emissions: mining and manufacturing businesses also reported that net zero emissions will increasing be a requirement for operating in renewable energy supply chains. The European Union is introducing mandatory reporting for battery imports on sustainability including emissions and recycled content which could be the precursor to regulatory requirements.

Amongst the businesses interviewed or that participated in workshops there were several that registered interest in corporate renewable energy power purchase agreements (PPAs) or onsite renewable energy to lower costs and emissions. A number of businesses also hoped the REZ would open up opportunities for supply from local projects. PPAs between renewable energy projects and local businesses will assist with social licence for the REZs.

In consultation with the officers from the Net Zero Industry program, there is also high interest in clean energy solutions that can reduce emissions and costs amongst potential participants in clean energy manufacturing precincts being established.

- One battery industry business stated:

"After raw materials, the biggest cost is power – it's a huge hurdle. We are putting on as much solar as we can. It (business activity) is enormously power heavy and that will also be true of any mineral processing … that is something which can be shared if you could tap into a 500MW solar field. We would sign up to a PPA with that in a second — if government can help we would sign onto it in a second … the biggest enabler is power so that would be a smart play."

LTESAs are being designed to encourage corporate renewable energy PPAs (e.g. recognition in the tender criteria for bidders that already have offtake agreements).

However, there is often limited understanding and capacity amongst businesses on how to negotiate renewable energy purchase agreements. Whilst there has been a growth in the maturity of the PPA market and the range of offers available, there is no standardised, off-the-shelf model and there is significant complexity to navigate.

Description

The NSW Government should consider playing a role in brokering or facilitating PPAs for battery supply chain businesses and clean manufacturing precincts.

There are several pathways for the NSW Government to broker renewable energy PPAs including:

- On-selling PPA capacity by the financial vehicle managing the LTESAs: in a discussion paper released on the REZs (DPIE 2020), it was noted that the financial vehicle may on-sell PPAs to manage risk.
- Take the role of 'anchor buyer': the NSW Government could invite or coordinate other buyers to join a PPA negotiated for its own electricity requirements. There are several precedents in the private sector (e.g. Telstra invited other buyers to join to a PPA it had negotiated) and the public sector (e.g. City of Melbourne buyer group, Melbourne Renewable Energy Project). By negotiating a PPA for some of the output of a project and inviting other businesses to join the PPA, the NSW Government would be reducing the transaction costs, potentially lowering the cost of the PPA by improving credit-worthiness and sending a signal to the industry, investors and regional communities of its support for the sector.

The Victorian Government is currently undertaking a market sounding with industrial buyers for this model under VRET.

As well as directly brokering PPAs, the NSW Government could also support activities to increase awareness and develop the capacity of buyers to make PPAs.

AREA: Economic Development				OWNER	NSW DPIE	
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
✔	✔	✔	✔	✔	✔	

Action 4D

Develop a renewable energy supply chain business directory/registry

Rationale

The level of knowledge about NSW businesses and their experience and capabilities to undertake work along the renewable energy supply chain is relatively low. A survey was conducted for this project in part to gather more information on local capacity. Improving the level of knowledge of local and regional capacity amongst project developers, original equipment manufacturers and EPCs is one step towards increasing local content. Victoria has developed a business directory for solar and wind farms with a detailed breakdown by types of activity across the supply chain.

Description

- Develop a renewable energy supply chain business directory modelled on the Victorian solar and wind directory in partnership with the Industry Capability Network. The Industry Capability Network is the

organisation best placed to support information gathering and to use and implement the directory through engagement with renewable energy project developers and EPCs.

- The survey undertaken for this project was designed to match the Victorian directory and contact details were collected with the consent of businesses to enable follow-up should the NSW Government decide to develop a directory.
- The directory could cover all technologies from the start or be phased by starting with solar and wind and including battery storage, transmission and pumped hydro at a later stage.
- The directory should ensure that SMEs identified in Action 1C are listed.

Notes:

- The directory should collect information for businesses across NSW and not just the REZs.
- The procurement portal (Action 1D) should link to the Renewable Energy Business Directory.

AREA: Economic Development				OWNER	NSW DPIE	
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
✔	✔	✔	✔	✔	✔	All

Action 4E

Develop a strategy to improve First Nations employment and economic participation in the renewable energy and transmission sectors

Rationale

The Roadmap presents a significant opportunity to increase employment and economic participation amongst First Nations people. The labour market profiles of the REZs show First Nations people account for a significant portion of the unemployed in several key regions, notably Central-West Orana, New England and, to a lesser extent, the South-West REZs. We identified several promising initiatives by some transmission and renewable energy companies but there scope for improvement.

The APP contains minimum standards for employment and economic participation. The Electricity Infrastructure Investment Act requires the Consumer Trustee to take account of the Guidelines for Consultation and Negotiation with First Nations Communities ('the Guidelines') in carrying out its functions (sections 4(4) of the EII Act). A parallel project is underway to develop the Guidelines.

Description

Sub-actions include:

- **Incorporate the NSW APP** within tender criteria and evaluate projects against performance which was done for Regional Rail Jobs, Skills, Industry Participation. The effect should be to create incentives for achievement of employment and economic participation targets that are above the minimum standards in the NSW APP for workers and businesses.

  Proponents could be provided with the option to include their supply chains to meet targets as regional variations may make it hard to achieve targets within the construction phase and there could be opportunities to create more ongoing employment in transport and distribution and manufacturing.

  An effective monitoring and evaluation regime is also important to ensure compliance. There is a monthly reporting template for the APP that could be used.

- **Establish networks for information sharing and best practice** on First Nations engagement and employment across the renewable energy, storage and transmission sectors and within each REZ. Develop resources and contacts to support engagement with First Nations communities by renewable energy, storage and transmission projects

- Enable **long-term economic development and training initiatives** for First Nations people in community benefit funds: this will need to be determined through consultation with First Nations communities as priorities vary.
- Fund training and engage with the renewable energy, storage and transmission sectors to support **best-practice recruitment practices, pre-employment training and qualifications** that create bridges for unemployed First Nations people into work – especially for solar farms and transmission
- Investigate opportunities for **project origination and development on First Nations-owned land** including mandating a proportion of developments.
- **Engage with the renewable energy and transmission sector to develop associated employment opportunities** such as cultural exchange (e.g. cultural tours for workers at the outset of projects) and landscape protection and rehabilitation.
- The **strategy to increase SME participation** (1c) should include a component that specifically targets increased participation and capacity amongst First Nations-owned businesses.

AREA: Economic Development				OWNER	Jobs Advocate; NSW Industrial Relations	
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES
✔	✔	✔	✔	✔	✔	All

Action 4F

Implement measures to improve job quality in the renewable energy sector

Rationale

Well-paid, secure employment, with good training and advancement pathways, is a cornerstone of economic and community development. There are community concerns about the quality of renewable energy jobs in regional NSW. The quality of employment in renewable energy has been a subject of debate with reference to the level of labour-hire/short-term employment, union membership and relative pay rates.

Improving job quality in the renewable energy industry is important for improving regional economic and social outcomes and for the sector to attract and retain labour. Specific measures to improve the quality of jobs will complement actions in the procurement and skills and training domains, which will also improve job quality (for example, by enhancing career paths).

Description

Sub-actions include:

- **Supporting the establishment of industry-level arrangements** such as the development of portability of entitlements within the sector as applies in some other construction sectors. Given the incidence of short-term employment, greater use of industry-level entitlements would improve employment conditions, reduce loss of employees from the sector and facilitate greater labour movement within the sector.
- **Avoiding 'social dumping'** from manufacturers with lower standards through tender requirements to comply with environmental, sustainability, and governance (ESG) standards, international labour standards, and anti-slavery standards across the supply chain.
- **Improving information on employment quality** e.g. tenders should include requirements for proponents to provide information on a range of measures of job quality and workforce composition and report outcomes
- Engage with the sector to support the **setting of targets and delivery of programs to improve gender equity and diversity** within the renewable energy and the transmission and distribution workforce which is currently low

AREA: Economic Development						OWNER	DPIE, Investment NSW, NSW Training Services
NSW	CWO	New England	Illawarra	Hunter	South-West	TECHNOLOGIES	
✔			✔	✔		Offshore wind	

Action 4G

Facilitate the development of an offshore wind industry in NSW

Rationale

NSW is blessed with a large volume of high-quality on-shore solar and wind resources, but offshore wind is now viewed by the International Energy Agency as one of the 'big three' clean energy generation sources. Offshore wind technology has reduced costs rapidly, increased scale and new floating turbine designs are emerging which can access more locations off the coast of NSW. Offshore wind could play an important role in NSW's energy transition. NSW has the ability to install large projects (2GW+) that connect into the strong parts of the electricity network, complement on-shore wind and solar generation and supply power to heavy industry (including green hydrogen). It would also provide alternative employment in the Hunter Valley and Illawarra.

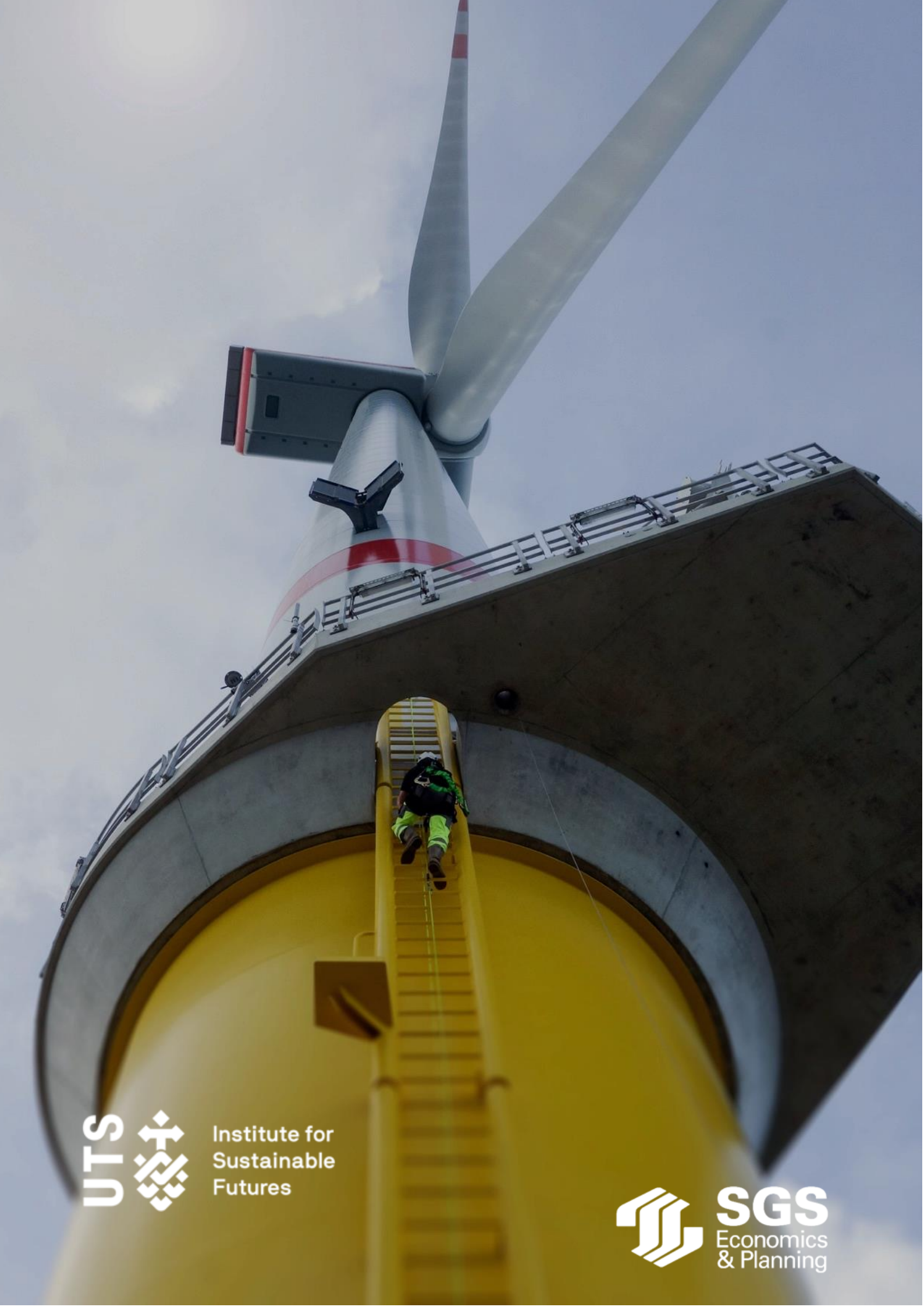
Over 10 GW of offshore wind projects are currently under development off the coast of the Illawarra and Hunter Valley REZs. Offshore wind is a new, emerging sector in NSW and Australia and there are a range of actions that NSW could undertake to support its development.

These actions build on the recommendations in the Blue Economy CRC report undertaken by ISF and CSIRO.

Description

Sub-actions include:

- **Advocating for the inclusion of local content criteria to apply to the licencing of offshore wind projects by the Commonwealth Government**: offshore wind projects require a licence from the Commonwealth Government. The licencing process creates an opportunity for competitive tenders including local content criteria to develop the local supply chain. Whilst this is occurring for the LTESAs, these are focussed on the on-shore REZs in the immediate future.
- **Identifying and developing supply chain and workforce development opportunities**: there are opportunities to develop the supply chain and workforce in coming years as the sector develops. For example, ensuring any new wind tower and steel manufacturing facilities are 'future-proofed' for onshore wind. A NSW project developer (Oceanex) is currently undertaking a supply chain assessment which could be a platform for engagement between the industry, ICN and DPIE. Skills mapping for the coal sector workforce should incorporate assessment of transition pathways into offshore wind.
- **Incorporate offshore wind into NSW REZ planning**: the emergence of offshore wind is a new development and the large volume of potential capacity should be considered in future planning for the NSW REZs e.g. further assessment is required to understand the extent to which offshore wind resources can complement onshore renewable energy and offset storage requirements.
- **Advocating for funding through ARENA and the CEFC for offshore wind**: innovation funding for the demonstration of floating wind technologies could accelerate the development of offshore wind in NSW. Local content development could be incorporated into innovation funding criteria.
- **Investigate options for efficient grid connection**: as projects develop, the NSW Government could support feasibility assessments on the most efficient grid connection solution. If a joint connection point between projects emerges as the most efficient solution, there may be a further coordination role for the NSW Government akin to the onshore REZs.



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