ARTICULATION AND QUANTIFICATION OF LOCALISING RENEWABLE ENERGY SUPPLY CHAINS

FINAL REPORT

Prepared for The Office of Energy and Climate Change by Accenture

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1. EXECUTIVE SUMMARY

The purpose of this report is to articulate and quantify the strategic benefits of localising renewable energy supply chains in NSW, to inform the work of the Renewable Energy Sector Board (Sector Board). This report is intended to complement existing work done by the Sector Board.

NSW has an ambitious renewable energy plan. In November 2020, the NSW Government released the NSW Electricity Infrastructure Roadmap (the Roadmap). The Roadmap will support the private sector to deliver a minimum of 12GW of new renewable electricity generation and 2GW of long-duration storage by 2030.[1] The build-out of the electricity infrastructure is expected to attract at least $32 billion of investment and require 1.6 Mt of steel, 110 kt of aluminium and 60 kt of copper.[2] This level of activity presents a significant opportunity for businesses involved in renewable energy supply chains.

However, the renewable energy roll out faces key risks in project delivery that, in some instances, can be mitigated by localisation. The roll out will require coordination across projects, exacerbating susceptibility to project delivery risks including supply of materials, supply of labour, supply of energy, opposition or objections and governance challenges. Localisation is well placed to reduce the risks of supply of material, supply of labour and opposition or objections (including impact to regulatory approvals).

There are key points in the renewable energy supply chain that can be localised. Australia already manufactures many of the key materials required in the roll out – steel, aluminium, copper and concrete. However without intervention, the bulk of these (excluding concrete) are expected to be sourced from overseas.[3] Australia does not produce much of the componentry required in renewable energy technologies, such as photovoltaic cells, solar inverters and wind turbines and towers, meaning these are expected to be imported.

This report aims to articulate and quantify the strategic benefits of localising supply chains. The traditional economic benefits of localisation (sourcing content from Australia and New Zealand) have already been analysed by the Sector Board. These are significant, with up to 23,200 additional employee years in NSW between 2020-21 and 2040-41 and an increase to gross state product of up to $1.3 billion.[4] This report aims to identify and quantify the strategic benefits of localising renewable energy supply chains. Strategic benefits include reduced risks of delays to the roll out through reduced exposure to supply chain disruptions and reduced social risks and reduced embodied emissions.

The strategic benefits of localising renewable energy supply chains have the potential to be impactful at a system-wide level. Delays greater than a month that are caused by supply chain disruptions could be reduced by 35-46%. At a system-wide level, the probability of a 6-month delay to the roll out could be reduced from 10% to 1%.

Localising renewable energy supply chains could also build social licence for projects. In the US, up to 14% of projects are delayed or cancelled due to a lack of social support. While localisation can be a key enabler of social licence, localisation alone does not resolve all the

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[1] NSW Electricity Infrastructure Roadmap (2020)
[2] SGS and UTS ISF (2022)
[3] Ibid.
[4] ACIL Allen (2022)

potential sources of community opposition. Localisation will also reduce the incidence of modern slavery in the supply chain, which otherwise would be heavily reliant on inputs from the Xinjiang Uygur Autonomous Region, where forced labour of the Uyghur people is rife.

Bringing key manufacturing processes to Australia would reduce the total emissions of these processes by 38%. The reduction in emissions is driven by NSW's relatively cleaner grid and more environmentally friendly industrial practices, as well as reduced shipping and logistics.

Case studies from peer countries illustrate approaches to unlocking strategic benefits of localisation. NSW has already implemented several best practice tools to encourage localisation, including the long-term energy service agreements, local content requirements and identification of Renewable Energy Zones which support clustering of supply chains. Further efforts could focus on R&D specific local content requirements and capacity building support.

To unlock strategic benefits and achieve localisation, there are key challenges to overcome. Levers that could be deployed to increase localisation include production subsidies, local content requirements, increased R&D, training and incentives for developers. Levers should look to address the three key localisation challenges; cost, capacity and capability. Alongside the economic and strategic benefits of localisation, localising supply chains could come at a short-term cost estimated by ACIL Allen to be up to $4.7 billion. This cost could be passed on to consumers in the short term as developers look to recoup lost margins. NSW business capacity will need to be grown significantly before localisation is possible. Local suppliers will need support to build the capacity required to meet the volumes of materials and components required in the roll out. Furthermore, significant shortages of critical skills required for the energy transition will need to be addressed. Any efforts to increase localisation will need to also increase the supply of skilled workers in NSW, to avoid drawing from existing industries, further exacerbating skills shortages. Beyond the modelled economic and strategic benefits, overcoming the cost, capacity and capability challenges to enable increased localisation could have longer-term benefits to Australia due to diversifying the industrial base and increasing economic activity

This report extends prior work by SGS Economics & Planning and the University of Technology Sydney (UTS) Institute for Sustainable Futures (ISF) and Acil Allen on the opportunities stemming from NSW's five REZs. Commissioned by the Sector Board, the previous reports examined employment and industry development potential, identified growth areas like wind tower manufacturing and photovoltaic recycling hubs, and recommended policy initiatives in areas such as procurement and local content. Concurrently, ACIL Allen, tasked by the Department of Planning and Environment, modelled the costs, benefits, and public acceptance of local content requirements for the modernisation of NSW's electricity system.

2. NSW'S PLAN TO GROW ITS RENEWABLE ENERGY SECTOR

2.1. NSW aims to provide 12 GW of renewable electricity generation and 2 GW of long-duration storage by 2030

The NSW Electricity Roadmap (the Roadmap) is the state's 20-year plan to transform the electricity system. The Roadmap will coordinate investment in transmission, generation, storage and firming infrastructure as ageing coal-fired power plants are retired from 2023. The state is targeting a minimum of 12 GW of renewable energy generation and 2 GW of long duration storage to be constructed by 2030 (see Figures 1 and 2).

To achieve these targets, five Renewable Energy Zones (REZs) have been established to drive integrated and coordinated investment in large-scale energy infrastructure.

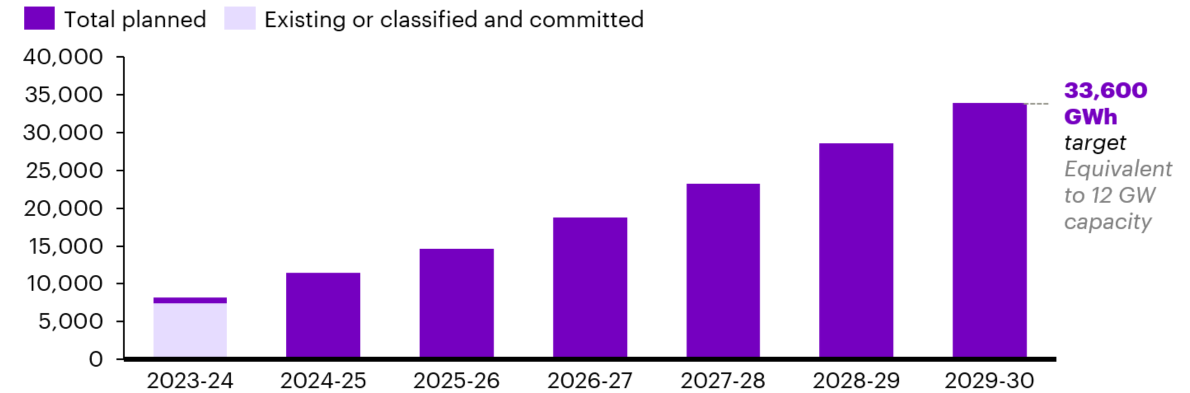
The Electricity Infrastructure Investment 2020 Act (the EII Act) embeds the objective of the Roadmap and prescribes the roles and responsibilities of the entities involved in delivering the Roadmap. AEMO Services Limited (AEMO Services), the Consumer Trustee, appointed under the EII Act is responsible for conducting long-term planning to achieve the infrastructure investment objectives, also defined in the EII Act. AEMO Services runs competitive tender processes to offer Long-Term Energy Service Agreements (LTESAs) to project developers. LTESAs provide minimum revenue certainty for private investment in new renewable energy generation, firming and long-duration storage, to help secure finance for project construction.[5] All tender bids must include information about how the proposal will create employment and support industry in NSW, as part of the electricity infrastructure investment safeguard.[6]

The Renewable Energy Sector Board (the Board) is appointed by the Minister for Energy. The Board has prepared a plan for the NSW renewable energy sector that focuses on maximising the use of locally produced and supplied goods and services, employment of local workers and opportunities for apprentices and trainees for the projects under the Roadmap.

[5] NSW EnergyCo (2023)
[6] Electricity Infrastructure Investment Act 2020 No 44

Figure 1: NSW cumulative development pathway (generation)

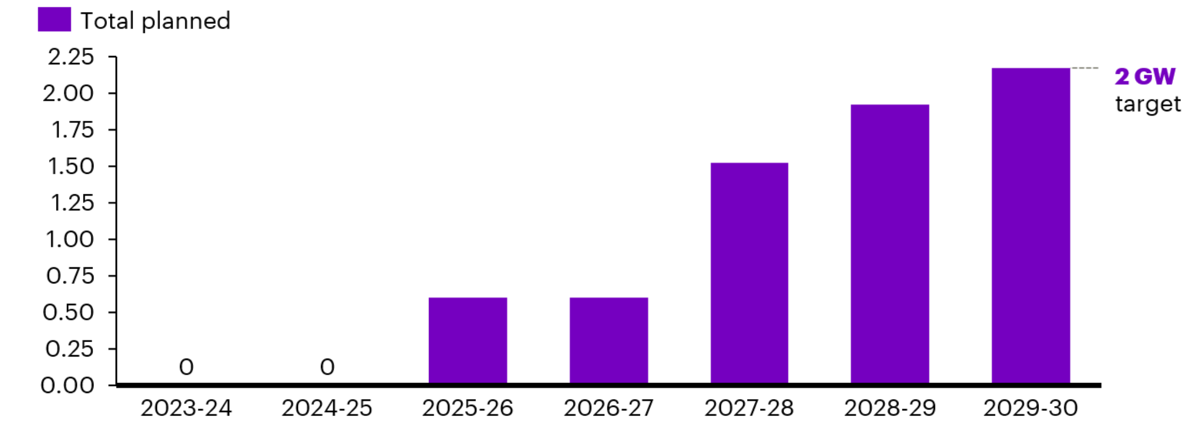
Target renewable energy generators (GWh)



Note: Estimated amount of electricity in GWh that is equivalent to 12 GW of capacity, per 2020 Integrated System Plan. Generation is technology and location neutral.
Source: AEMO Services 2022 IIO Report (2022)[7]

Figure 2: NSW cumulative development pathway (long-duration storage)

Target long duration storage (GW)



Source: AEMO Services 2022 IIO Report (2022)

2.2. Five REZs have been established

The NSW Government has established REZs in Central-West Orana, New England, South-West, Hunter-Central Coast and Illawarra. The REZs will enable the retirement of coal-fired power stations in the state, whilst ensuring reliable electricity is delivered to all NSW consumers.[8]

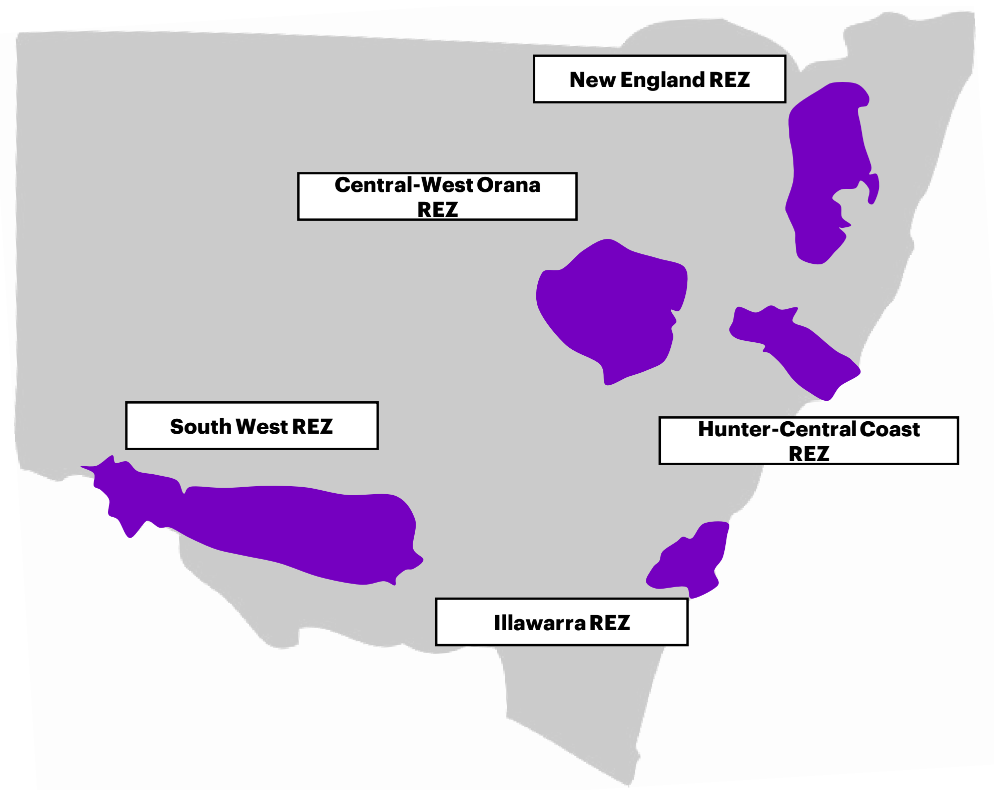
The REZs are the equivalent of modern-day power stations. They combine new renewable energy infrastructure, storage and high-voltage transmission infrastructure. The REZs aim to

[7] The 2023 IIO report will be released in December 2023.
[8] NSW EnergyCo (2023)

deliver cheap, reliable and clean energy for homes and businesses in NSW.[9] The REZs group and coordinate generation, storage and network infrastructure (see Figure 3), although the focus of each REZ zone will differ based on existing and planned technology in the region, as described below.

1. The Central-West Orana REZ is electrically close to the Sydney load centre and has existing wind and solar resources. This REZ has been identified as the pilot for NSW.
2. The New England REZ has existing wind and solar resources near the 300 kV network. Additional generation includes large scale solar, onshore wind and pumped hydro.
3. The South West REZ has existing utility-scale solar projects already operating within the REZ, and as such there is no additional capacity. Rather the focus of development will be on network augmentation towards the greater Sydney load centre.
4. The Illawarra REZ has been identified due to its major energy, port and transport infrastructure. The region also has the potential for offshore wind development, but plans for offshore development are still in initial stages.
5. The Hunter-Central Coast regions have been identified as a REZ. These regions have great renewable energy resources, electricity network infrastructure, port and transport infrastructure and a skilled workforce. There is also a potential for offshore wind development in the future.

Figure 3: Map of NSW REZs and intended additional network capacity



Note: Intended network capacity for REZ zones in Figure 3 factors in the inclusion of projects outside of the REZ zones such as grid forming battery technologies which will be required as network augmentation occurs.
Source: EnergyCo Renewable Energy Zones (2023), Appendix for 2022 ISP (2022)

[9] NSW EnergyCo (2023)

2.3. AEMO have developed a 10-year tender plan to build the REZ infrastructure

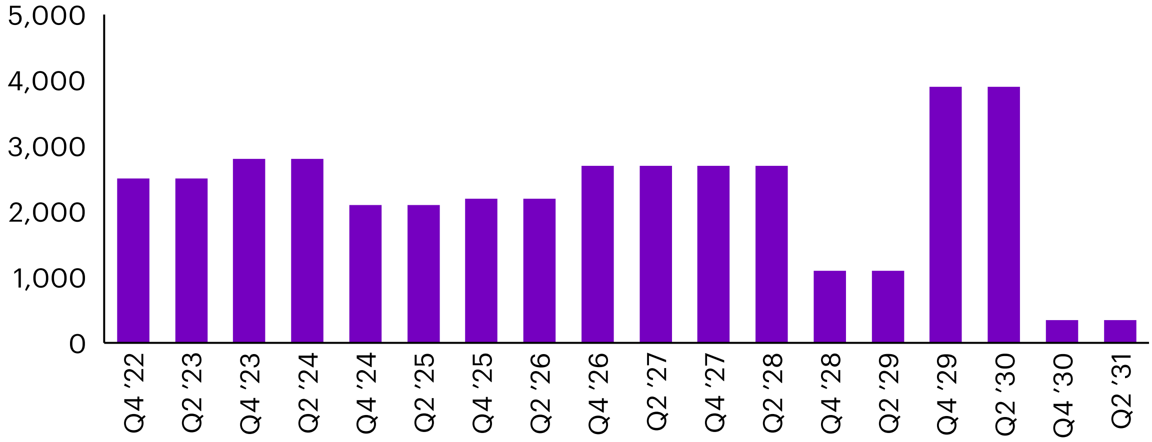
The 10-year tender plan lays the foundations for the tendering of generation and long duration storage infrastructure for LTESAs. Over the next 10 years over 40,000 GWh of electricity is planned to be delivered by generation tenders (see Figure 4) and 2 GW of confirmed long-duration storage (see Figure 5).[10]

To be eligible for the LTESAs, projects must meet project merit criteria: impact on electricity system, pathway to commercial operation, organisational capacity to deliver project, land use considerations, community engagement and benefits, and regional economic development. In addition to this, a project must meet the financial value merit criteria which assesses financial value and commercial departures.[11]

The Sector Board's Plan aims to enhance the production and supply of goods and services within the local area, foster employment for qualified local workers, and generate prospects for apprenticeships and trainees.[12] The local content requirements (LCR) are incorporated in the project merit criteria for tenders in the form of an Industry and Aboriginal Participation Plan. The plan covers LCRs for supply chain inputs, employment skills and knowledge transfer, First Nations participation, fair and ethical practice, and environmentally sustainable procurement.

Figure 4: 10-year tender plan (generation)

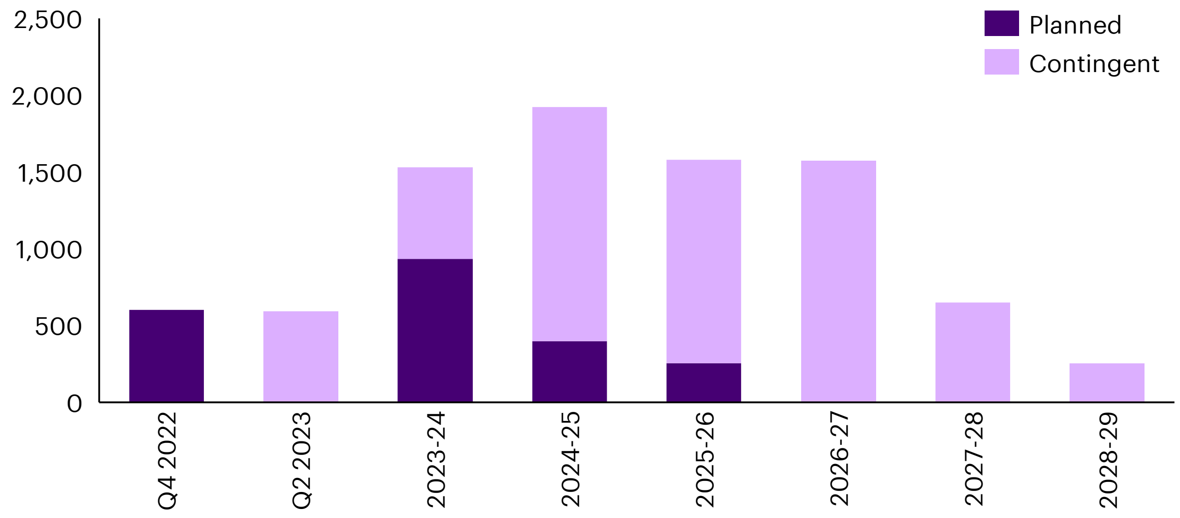
Size of annual tenders for renewable energy generation (GWh)



Source: AEMO Services 2022 IIO Report (2022)

[10] AEMO Services 2022 IIO Report (2022), Accenture analysis
[11] AEMO Services NSW Electricity Infrastructure Tender Guidelines (2023)
[12] NSW Sector Board's Plan (2022)

Figure 5: 10-year tender plan (long-duration storage)
Size of annual tenders (planned and contingent) for long-duration storage (GW)



Source: AEMO Services 2022 IIO Report (2022)

2.4. Australia's current role in renewable energy supply chains

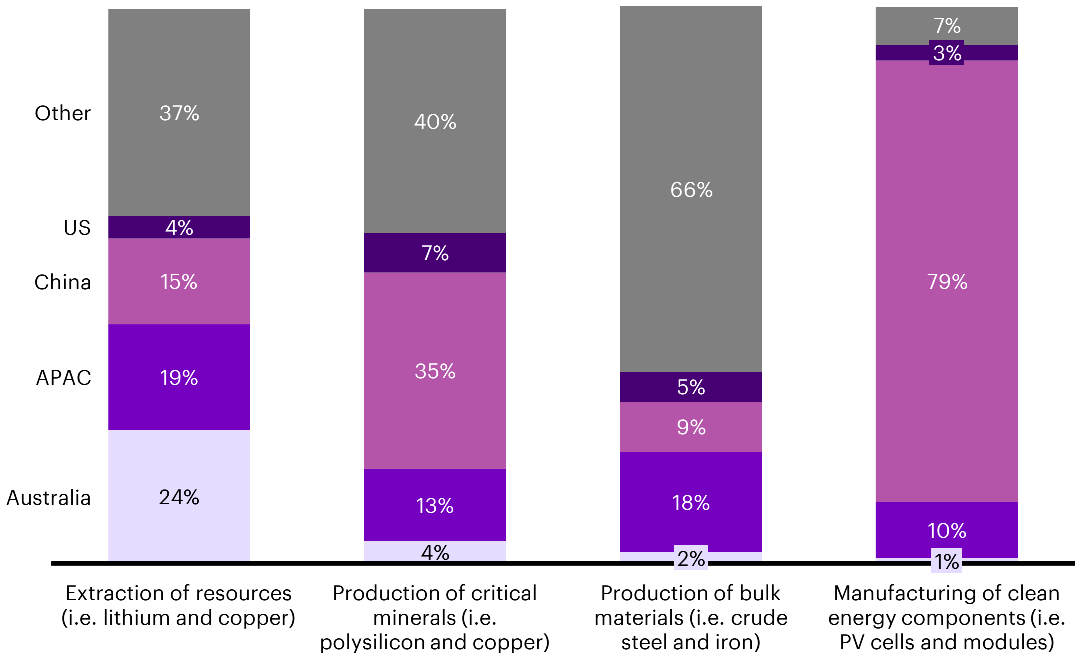
Australia plays a large role in the mining of raw materials that are critical to the electricity infrastructure roll out, in particular lithium and copper. However Australia's role diminishes in the refining and production of critical materials for the renewable energy supply chain. Australia's role in the manufacturing phases of the renewable energy value chains is currently very small (see Figure 6).[13]

Across the various renewable energy technology supply chains, China is the main producer of key technologies, controlling at least half the output.[14] In solar PV, China has 97% market share in wafers, 85% in cells and 74% of the market for modules (see Figure 7).

[13] IEA (2023)
[14] IEA (2023)

Figure 6: Regional shares of key inputs to renewable energy technologies

Share of key inputs per region across the value chain (%)

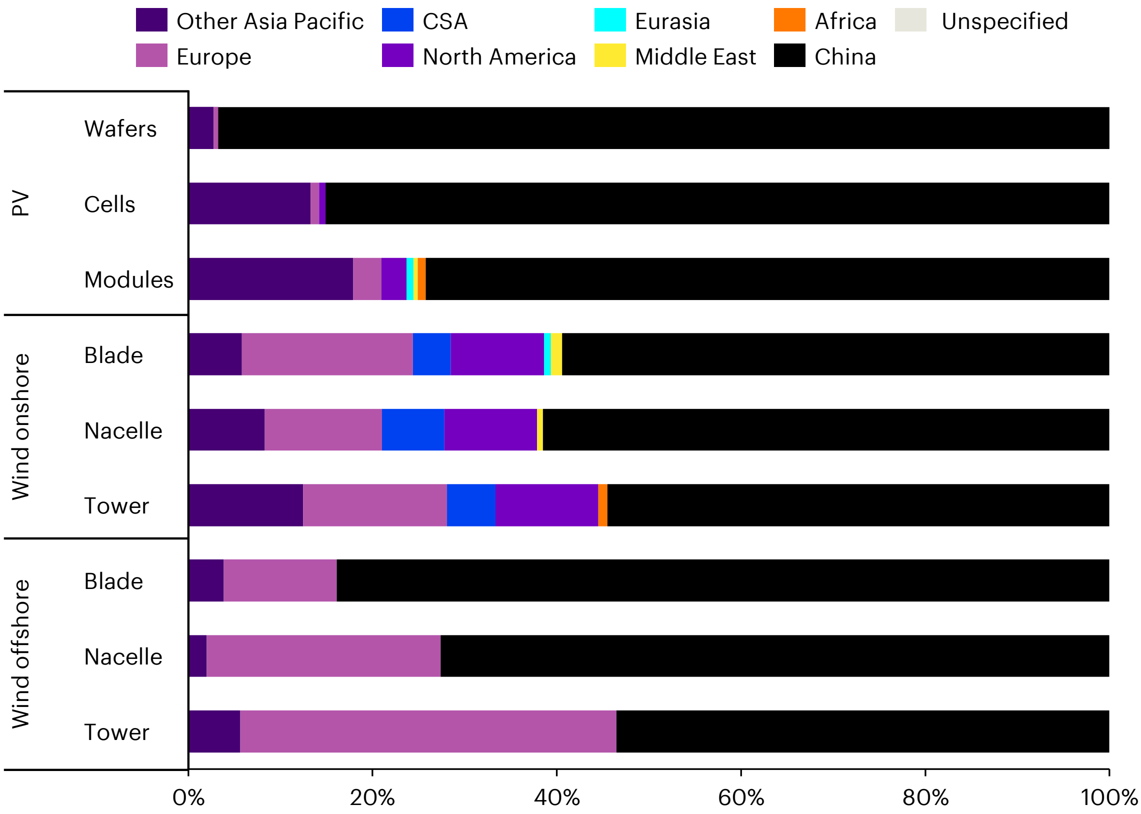


Note: Extraction of resources include aluminium, steel, magnesium, platinum group metals (PGM), silver, rare earth elements (REE), lithium, copper, nickel and cobalt. Production of critical minerals includes polysilicon, REE, lithium, copper, nickel and cobalt. Production of bulk materials includes high-value chemicals, plastics, alumina, aluminium, clinker, cement, iron and crude steel. Manufacturing of clean energy components includes PV wafers, cells and modules and onshore and offshore wind blades, nacelles and towers.

Source: IEA (2023), Accenture analysis

Figure 7: Regional shares of manufacturing capacity for selected clean energy components

Regional share of manufacturing capacity, 2021 (%)



Source: IEA (2023)

3. LOCALISATION CAN MITIGATE KEY RISKS TO RENEWABLE ENERGY PROJECTS

3.1. Localisation can reduce three key risks to renewable energy project delivery

The renewable energy roll out faces several key risks in project delivery. The roll out will require coordination across projects, exacerbating susceptibility to project delivery risks. There are a number of levers, beyond localisation, to mitigate these risks throughout the roll out, and there is no silver bullet. However, localisation of supply chains can mitigate some risks including supply of materials, supply of labour and opposition to projects (see Figure 8).

Figure 8: Impact of localisation on the key risks to project delivery

Risk to project delivery	Scale of contribution to delay in project delivery	Reduced by localisation?	Commentary
Supply of material	◕	✓	Accessing materials, particularly inputs on the critical path, have a significant contribution on delays
Supply of labour	◕	✓	Accessing available and trained people for project workforces has been a significant challenge for RE projects
Supply of energy	◔	—	Sufficient supply of energy to manufacture and deliver RE projects has not been found to drive delay in project delivery
Opposition or objections (including impact to regulatory approvals)	◕	✓	Opposition or objections to RE projects has been found to be a significant driver of delays or failure in project delivery
Governance challenges	◔	—	Governance challenges have not been found to be a significant driver of delay or failure in project delivery

Localisation could reduce exposure to global supply chain risks and disruptions by, in some instances, replacing complex global supply chains with shorter domestic supply chains. Global supply chains are vulnerable in part due to the dependency on geographically concentrated suppliers, logistical challenges and trade restrictions.[15]

Localising supply chains could also reduce the risk of disruption due to supply shortages. Stakeholder interviews have revealed that facilities producing key inputs into renewable energy supply chains are at capacity as global demand accelerates as countries transition to renewable energy sources. Furthermore, Australia – due to its size and isolation – has limited purchasing power compared to larger nations and OEMs that stockpile goods.

[15] Productivity Commission (2021)

Localisation does however raise the risk of exacerbating some categories of risk. Localisation can lead to perverse outcomes such as increased labour shortages, exposure to domestic supply chain issues and failing to deliver certain expected socio-economic outcomes. These concerns should be considered and mitigated where possible in the shift towards localisation.

3.2. Supply chain risks and benefits

Australia's current involvement across the various renewable energy supply chains is concentrated upstream, focusing on extracting and refining raw materials, and further downstream, providing some final components for construction.

Previous work by SGS Economics & Planning and the University of Technology Sydney (UTS) Institute for Sustainable Futures (ISF) mapped supply chains for solar, wind, batteries, and hydro projects. This work identifies existing capacities within NSW and opportunities to develop additional capacity and industry to feed into the renewable energy supply chains.

Work in this report builds on the UTS ISF and SGS analysis. Criteria have been developed and applied to the combined list of capacity and opportunities to assess if each would be likely.

For each industry, the following criteria were considered:

- if there is an existing capacity in NSW and the size of this capacity compared to the needs of the Roadmap,
- if there is an advantage or differentiation available for a local manufacturer to create a component for NSW project,
- a component or process' proximity on the critical path for a typical project, and
- if a component or process is vertically integrated within an incumbent's ecosystem.

Two scenarios have been developed for the purpose of this report (see Table 1):

1. existing strengths: further develop existing or planned capabilities and industries, and
2. new opportunities: existing strengths plus enter industries that Australia is not meaningfully involved in currently.

Table 1: Key opportunities for localising in NSW along supply chains

	Scenario	Resource extraction and material processing	Manufacturing	Construction
Solar	Existing strengths	- High purity quartz - Steel smelting - Coal extraction - Copper extraction - Silver extraction - Fly ash - Concrete pre-processing	- Steel manufacturing - Aluminium manufacturing - Concrete production - Silver manufacturing	- Transformers - Concrete footings - Foundations - Balance of plant (electronics)
	New opportunities		- Solar modules	- Array of modules
Wind	Existing strengths	- Steel smelting - Coal extraction - Copper extraction - Copper smelting - Fly ash - Concrete pre-processing	- Steel manufacturing - Copper manufacturing - Aluminium manufacturing - Concrete production	- Turbine foundations - Tower - Balance of plant (electronics)

	New opportunities	- Rare earth extraction - Nickel extraction		- Tower assembly
Battery	Existing strengths	- Steel smelting - Coal extraction - Copper extraction - Fly ash - Concrete pre-processing	- Steel manufacturing - Aluminium manufacturing - Concrete production	- Balance of plant (electronics) - Mounting hardware - Transformers
	New opportunities	- Lithium carbonate processing - Nickel extraction - Cobalt extraction - Cobalt processing		- Battery cell manufacturing - Battery pack assembly
Hydro pumped storage	Existing strengths	- Steel smelting - Coal extraction - Copper extraction - Copper smelting - Fly ash - Concrete pre-processing	- Steel manufacturing - Aluminium manufacturing - Copper manufacturing - Concrete production	- Penstock - Power system
	New opportunities	- Polyethylene polymerisation	- High density polyethylene production	

Source: UTS ISF and SGS opportunity and local capacity analysis, Accenture analysis

Some materials – particularly in the manufacturing stage – are common across the renewable energy supply chains, therefore providing a significant opportunity. In Australia, wind, solar, and hydro-powered energy storage are likely to be the three most significant sources of renewable energy generation accompanied by a significant transmission roll out. To build these, the three most significant raw inputs are steel, copper and aluminium. Under the Roadmap, between 2023 and 2035, NSW will need:

- ~1.6 megatonnes of steel for wind towers and anchor cages, solar panel mounting frames and structures, and transmission towers,
- ~110 kilotonnes of aluminium for frames for solar panels and solar inverting casing, and
- ~60 kilotonnes of copper for electrical wiring and transmission.[16]

3.3. Localisation can reduce the risk of material shortages through lowering exposure to international supply chains

3.3.1 GLOBAL EVENTS REVEALED VULNERABILITIES IN RENEWABLE ENERGY SUPPLY CHAINS

The vulnerabilities in renewable energy supply chains were exposed by the COVID-19 pandemic due to production shutdowns, border closures and increased hygiene controls.[17] Manufacturing was brought to a halt due to forced lockdowns, with the effects felt globally. The COVID-19 shock to was exacerbated and extended by the further supply chains disruptions caused by the war in Ukraine.[18] The disruption to supply chains had a profound impact on Australia's

[16] SGS and UTS ISF (2022)
[17] OECD (2021)
[18] OECD (2022)

renewable energy sector, just as it did in other sectors.[19] Delays in utility-scale renewable energy projects were initiated due to manufacturing shutdowns in China and exacerbated by domestic border closures limiting the movement of labour.[20] Renewable energy project timelines were substantially delayed over this time with examples of delays more than six months attributable directly to the pandemic disruptions.[21] During the pandemic, Australian renewable developers were forced to seek alternative suppliers, in some cases pivoting to local manufacturers. As a result, Australia's only solar panel manufacturer, Tindo Solar, experienced record sales in March 2020.[22] Similarly, locally made transformers spiked in sales due to factory closures in China. Developers noted that using local suppliers was more costly but improved their ease of doing business.[23]

Since the pandemic, weaknesses in supply chains have continued to be exposed through other global events. Economic sanctions on Russia have impacted the supply of critical raw materials produced in Russia, including aluminium, nickel, palladium and vanadium.[24] Growing tensions and shifts to economic nationalism amongst global powers are also shifting and disrupting supply chains.[25]

3.3.2 LOCALISING SUPPLY CHAINS COULD REDUCE PROJECT DELAYS

While there are many potential sources of project delays for renewable energy projects, the following analysis focuses on the opportunity to reduce delays caused by supply chain logistics, through localisation. The threshold for a major delay has been set to one month, as a one-month delay to the delivery of materials or components to a project is sufficient to have a cascading effect on the overall project timeline (for example impacting regulatory approval or labour availability and further delaying overall project delivery).[26]

Localisation can help to reduce the length of supply chains by decreasing the physical distance and shipping legs between manufacturing and consumption points. A 2022 survey found that of the 62% of respondents who had made significant changes to their supply chains over the past 24 months, 55% had moved their supplier footprint closer to their operations and 47% nearer to their customers to reduce supply chain risk.[27] However, localisation only guarantees a shorter supply chain when the entire supply chain is localised. While steps throughout the value chain are still occurring overseas, localisation could have the effect of lengthening the supply chain, for instance if cobalt from the Democratic Republic of Congo was shipped to Australia to be refined then exported for manufacturing then re-imported for use. Focusing on the manufacturing phase of the value chain will eliminate the final international shipping leg for delivery of components.

Statistical analysis of theoretical supply chain disruptions found the largest driver of reductions is further localisation of steel production and manufacturing. The diverse uses of steel across renewable energy projects means it provides significant opportunities for strategic benefits, notably across both the solar and wind supply chains, through shortening and de-risking logistics of steel components.

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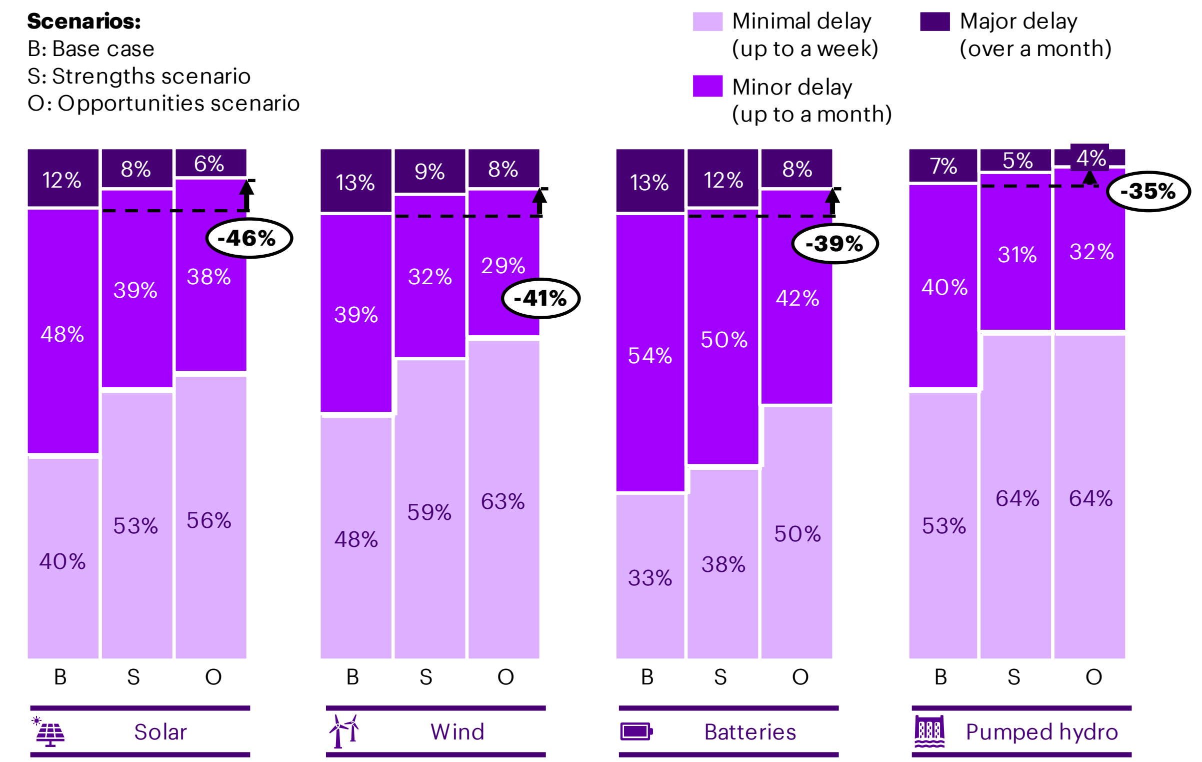
[19] WWF (2020)
[20] National Energy Resources Australia (2021)
[21] Stakeholder interviews
[22] WWF (2020)
[23] Stakeholder interviews
[24] OECD (2022)
[25] Ndukwe, C. V., Chan, T., Gao, S. & LIU, J. (2021)
[26] Stakeholder interviews
[27] Ernst & Young (2022)

3.3.3 LOCALISATION COULD REDUCE MAJOR DELAYS CAUSED BY SUPPLY CHAIN DISRUPTIONS BY 35 TO 46%

The impact of localising supply chains on disruptions is shown in Figure 9.

Figure 9: The impact of localisation on renewable energy projects



Note: Percentages in the ovals represent the reduction of significant delays between the base case and opportunities scenario. See Appendix for full methodology.
Source: Accenture analysis

The impact is greatest for solar projects. Solar projects see the greatest benefit from localisation due to the complexity of the supply chain with polysilicon in particular driving delays. The localisation of steel drives benefits in solar projects as steel is an input for 13 of 17 initial manufacturing steps and is notably critical for mounting frames and tracking systems.

- The probability of a major delay (over a month) almost halves between the base case and new opportunities scenario.
- The average delay for a solar project reduces by 31% between the base case and new opportunities scenario.

Wind energy projects and batteries projects see similar benefit from localisation with regards to supply chain disruptions. Steel is required at scale across 12 of the 16 initial manufacturing steps for wind projects and drives the 38% reduction in the likelihood of major delays. Delays in the battery supply chain are driven by the complexity of materials feeding into the cathode side of battery cell manufacturing

- For wind projects and batteries projects, the probability of a major delay drops by around 40% from the base case to the new opportunities scenario.
- For wind projects, the average delay caused by supply chain disruptions reduced from 13.6 days to 8.5 days in the new opportunities scenario. The average delay for a batteries project reduces from 15.6 days to 11.2 days.

The impact of localising supply chains is lowest for pumped hydro projects. The possible reduction in delays through localisation would be largely driven by localising the construction of penstocks and building upon existing capacity to manufacture high density polyethylene (a key material in pumped hydro infrastructure).

- The probability of a major delay reduces by around a third (36%) between the base case and new opportunities scenario.

3.3.4 LOCALISING THE SUPPLY CHAIN CAN ALSO REDUCE THE RISK OF DELAYS TO THE PACE OF THE OVERALL ROLL OUT

Supply chain delays not only pose a risk to individual projects but have the potential to cascade between projects and delay the overall roll out. Delays in one project can cascade to another when there is overlap in the labour pool or use of common infrastructure. Furthermore, all projects are interconnected by their regulatory approval processes and share the same collection of staff and resources from regulatory agencies. While generation delays risk accumulating, transmission project delays will immediately have system-wide consequences.

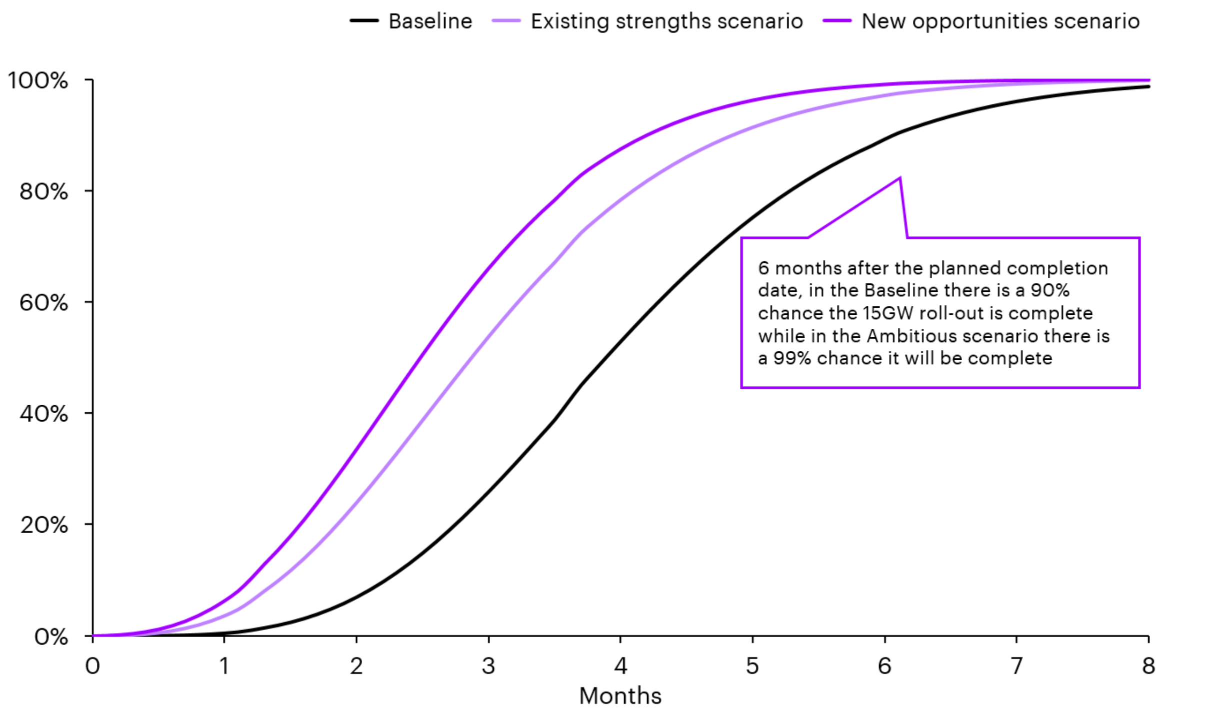
Analysis of the interconnectivity of projects occurring in similar timeframes in the same REZ allows a study of the cumulative effects of supply chain disruptions. The roll out of 14.8 GW of solar and wind projects across NSW through to 2030 in the AEMO 2022 ISP (Step Change) was used to model the mix and timeline of wind and solar projects in each REZ. The localisation scenarios were applied to this roll out and the potential for supply chain disruptions between projects modelled.

The accumulation of supply chain delays outstanding at the end of 2030 is modelled to centre around a mean delay of 3.9 months in the baseline, 2.9 in the existing strengths scenario and 2.5 in the new opportunities scenario. The distribution of this accumulated delay was also analysed and the chance of a 6-month delay is plotted in Figure 10. In the base case there is an 11% chance of the six months of supply chain disruptions at the end of the 6-year Roadmap (which represents a 9% overrun of the schedule). This probability decreases to 3% in the existing strengths scenario and further reduces 1% in the new opportunities scenario.

The bottom-up accumulation of supply chain delays in this analysis may underplay the impact of systemic risks to the supply chain which is explored in the next section.

Figure 10: Localisation impact on system-wide roll out

Probability of completing 15 GW of solar and wind roll out described in AEMO's Step Change scenario, *n* months after planned date



Source: Accenture analysis

3.3.5 SYSTEMIC RISKS POSE AN INCREASED THREAT TO GLOBAL SUPPLY CHAINS

The impact of low probability but high severity risks is more difficult to quantify – though are increasingly relevant. These risks can be classified as systemic as rather than impacting one node of a supply chain, they can impact the entire supply chain (or multiple supply chains). Localisation provides a means to mitigate these "unpredictable" risks as well.

Examples of systemic risks include:

- **Global pandemic**: restrictions to the movement of people and goods as part of the response to a pandemic can significantly impacted global trade. During the height of the COVID-19 pandemic, less than 10% of global shipping ran to schedule and renewable energy projects in Australia were delayed by over a year due to supply chain collapse.
- **Natural disasters**: a natural disaster impacting a key area, transport line or port. In 2010, a volcanic eruption in Iceland grounded planes across large parts of Europe and caused global supply chain disruption, lasting long after the airspace was reopened.[28]
- **Trade disruption**: geopolitical forces blocking or disrupting trade pose an ongoing risk to supply chains, particularly for the raw materials and components related to energy and the renewable transition. Recent examples include countries restricting exports of

[28] Kelmen et al. (2023)

key materials for the energy transition including China (rare earths) and Indonesia (nickel).

- **Other unforeseen events**: events including accidents, terrorism, recession and cyberattacks all also pose threats to global supply chains. In 2021, the Suez Canal was blocked for six days by a container ship, which added 2-3 week of delay to an eighth of global trade. The cost was estimated at $US 10 billion per day.[29]

Localisation can insulate Australian renewable energy projects from the impacts of these systemic supply chain risks.

Conversely, localisation would increase exposure to concentration risk. For instance, following flood events on in 2022 on the east coast of Australia, 70,000 tonnes of construction freight could not be delivered and 245,000 tonnes were rerouted, costing $2.3 million. Concrete was the worst impacted commodity with 45% not reaching its destination.[30] In the event of a local supply chain disruption, developers would still be able to access international supply chains, however this would add time and cost to projects.

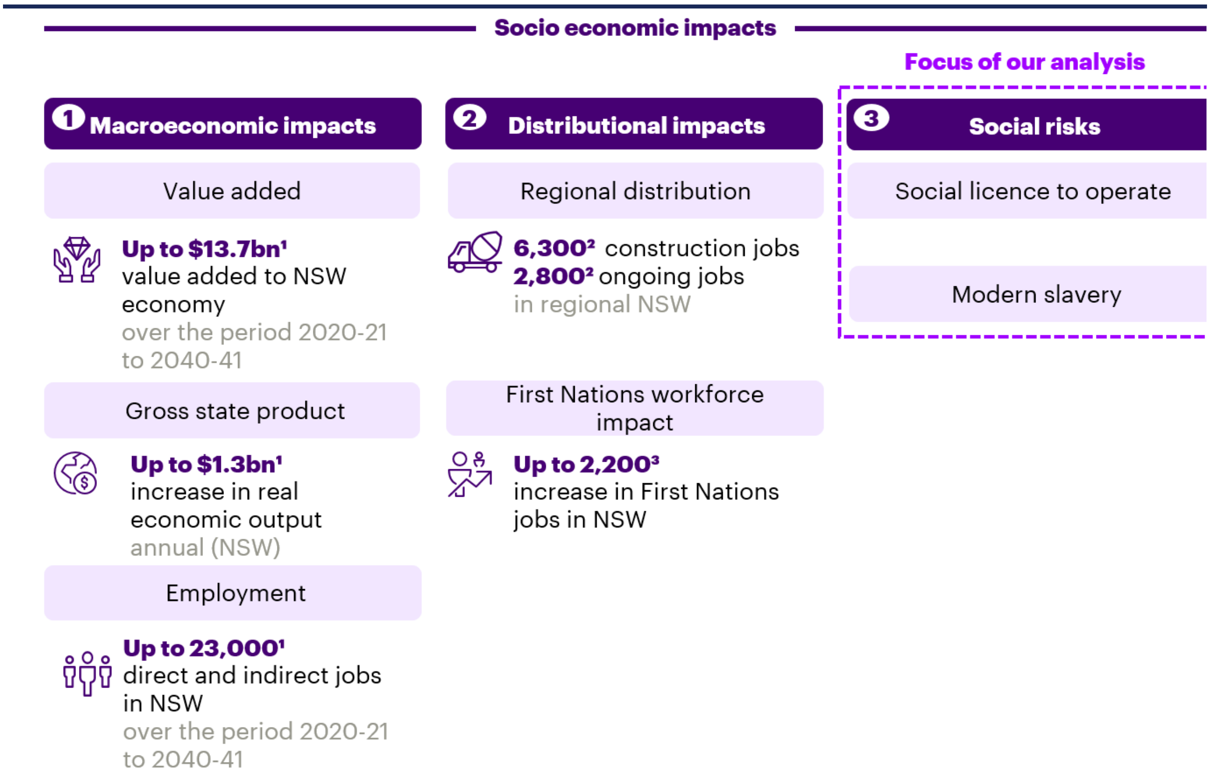
3.4. Socio-economic risks and benefits

3.4.1 LOCALISING RENEWABLE ENERGY SUPPLY CHAINS WILL DELIVER THREE KEY SOCIO-ECONOMIC IMPACTS

There are three key socio-economic impacts of localisation; macroeconomic impacts, distributional impacts and social risks (see Figure 11). The Sector Board has previously commissioned ACIL Allen to quantify the macroeconomic and distributional impacts of localising renewable energy supply chains. As the highest drivers of social licence, employment and economic impacts can reduce sources of objection and opposition to renewable energy projects and lead to a reduction in project delays. This report builds on ACIL Allen's analysis by quantifying the reduction of two key social risks; social licence to operate and modern slavery.

[29] El Pais (2023)
[30] Infrastructure Australia (2022)

Figure 11: Socio-economic framework



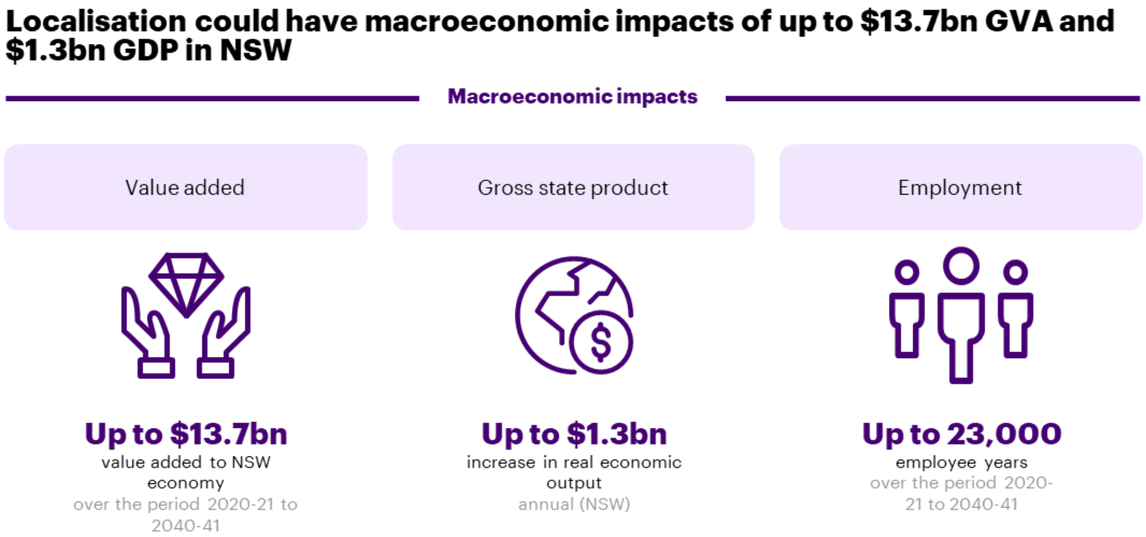
Sources: framework adapted from IRENA (2014), ACIL Allen (2022), NSW Electricity Infrastructure Roadmap (2020), NSW Sector Board's Plan (2022), Accenture analysis

3.4.2 MACROECONOMIC IMPACTS OF UP TO $13.7BN GVA, $1.3BN GSP AND 23,000 EMPLOYEE YEARS IN NSW COULD BE DELIVERED BY LOCALISATION

Under ACIL Allen's ambitious local content scenario, localisation could increase real economic output by up to $1.3 billion annually for NSW and up to $0.7 billion annually for the rest of Australia. In terms of value added to the economy, up to $13.7 billion is projected during the construction phase. This is comprised of a direct contribution of $843 million, production-induced contribution of $7.8 billion and consumption-induced contribution of $5.1 billion. Furthermore, localisation could add up to 23,000 employee years in NSW over the period of 2020-21 and 2040-41 (see Figure 12).[31]

[31] ACIL Allen (2022)

Figure 12: Macroeconomic impacts

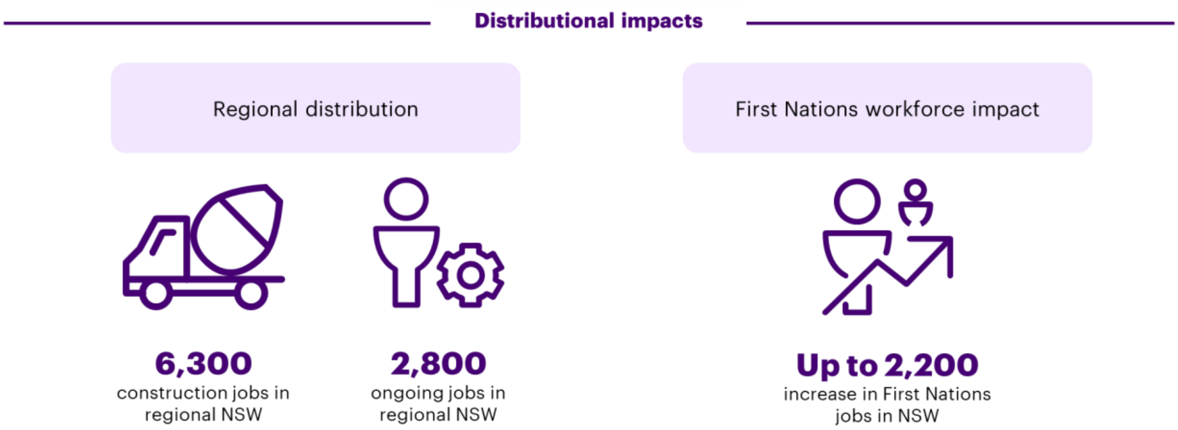


Notes: 1. All ACIL Allen figures included are reflective of the ambitious local content scenario which aligns with the stretch goals in the Sector Board's Plan
Source: ACIL Allen (2022)

3.4.3 DISTRIBUTIONAL IMPACTS OF UP TO 9,000 REGIONAL JOBS AND 2,000 FIRST NATIONS JOBS IN NSW

Localisation will support jobs, growth, and diversification of regional communities. The REZ roll out is projected to create 6,300 construction jobs and 2,800 ongoing jobs across regional NSW (see Figure 13). In addition, there are opportunities to create jobs for First Nations communities, with an estimated minimum of 2,200 additional jobs based on the ambitious local content requirements, however this number could be much higher.[32]

Figure 13: Distributional impacts



Notes: 1. All ACIL Allen figures included are reflective of the ambitious local content scenario which aligns with the stretch goals in the Sector Board's Plan; 2. Distributional figures have been calculated for this report using previous analysis and local content requirements in the Sector Board's Plan

[32] ACIL Allen (2022), Accenture analysis

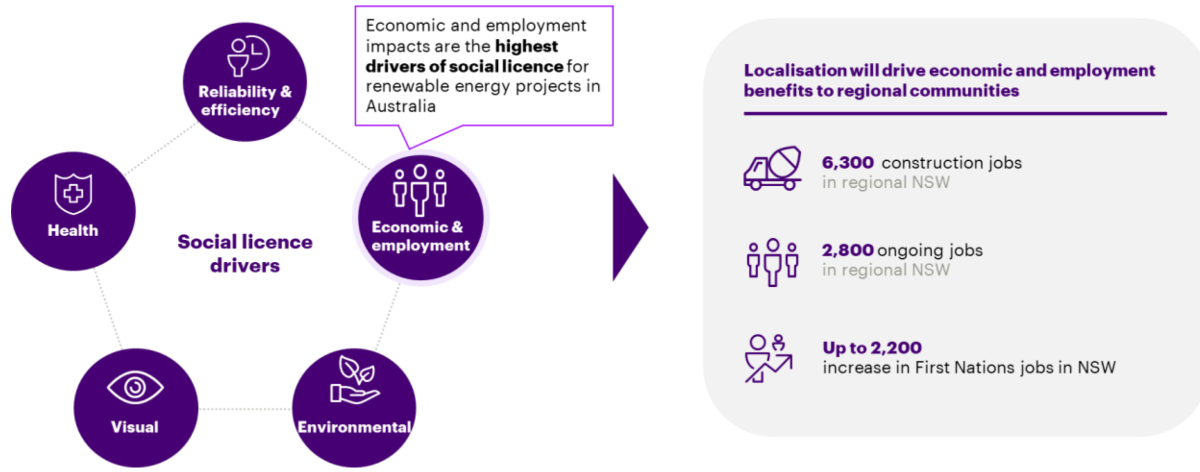
Source: ACIL Allen (2022), NSW Electricity Infrastructure Roadmap (2020), NSW Sector Board's Plan (2022), Accenture analysis

3.4.4 LOCALISATION CAN INCREASE SOCIAL LICENCE

Localisation can help build social licence for renewable energy projects. A 2016 study identifies five drivers of social licence: reliability and efficiency, visual impacts, environmental impacts, economic and employment impacts, and health impacts (see Figure 14).

Localisation can ensure the benefits of the transition are felt in communities, by strengthening the economic and employment impacts of the activity. Localisation could create 6,300 construction and 2,800 ongoing regional jobs.

Figure 14: Localisation drives increased social licence through economic and employment benefits to regional communities



Source: ARENA (2016), NSW Electricity Infrastructure Roadmap (2020), Accenture analysis

Social licence is becoming increasingly relevant to renewable energy projects

Social licence issues are increasingly faced by the energy infrastructure sector in Australia.[33] Building and maintaining a social licence in the community can enable renewable energy projects to utilise resources more effectively and reduce delays or obstructions to operations.[34] As such, social licence has been identified as a critical factor to enable the NSW REZ roll out and more broadly, the growth and development of the renewable energy sector in Australia.[35]

In contrast, failure to maintain social licence and therefore the support of local communities in which infrastructure projects take place can be significant. Over the past decade, it is estimated that over $20 billion worth of infrastructure projects in Australia have been delayed or cancelled due to community opposition.[36] In a national survey conducted by the University of Melbourne,

[33] IPA (2020)
[34] ARENA (2016)
[35] CEC (2018)
[36] University of Melbourne (2017)

political lobbying by community members accounted for approximately 70% of strategies used to oppose infrastructure projects.[37]

Furthermore, social licence issues have driven up costs and resulted in year long delays to a number of Victorian transmission projects, including the Western Renewables Link and Western Victorian Transmission Network.[38] In NSW, existing renewable energy projects in the Central-West Orana are already facing social licence issues with public complaints ranging from visual amenity, construction impacts, land use conflicts with agriculture and disruption of community cohesion.[39] Failure to achieve social licence has been acknowledged as one of the greatest risks to the REZ roll out in NSW.[40]

There is limited data on this topic in the Australian renewable energy sector. However an MIT study analysed the drivers of opposition of over 50 renewable energy projects in the US. These projects have either been paused, delayed or cancelled due to opposition and conflict between 2008-21. Seven key drivers of opposition to renewable energy projects are identified in the study: environmental impact, financial viability, lacking public participation, tribal rights to consultation, health and safety concerns intergovernmental issues, property value concerns.[41] Four of these drivers impact social licence; environmental impact, lacking public participation, tribal rights and health and safety. Based on this grouping, social licence is the leading driver of renewable energy project delays in the US, responsible for almost 90% of conflict or opposition related project delays (see Figure 15). This equates to about 50 projects (14%) of the 366 renewable energy projects currently underway in the US being either delayed, paused, or cancelled due to social licence issues.[42]

Assuming that social licence plays a similar role in in Australia as it does in the US with regards to project delays, solving social licence issues could benefit up to 14% of the projects in the roll out (or $4.5 billion of the expected investment).[43] [44]

However, it is important to note that not all social licence issues will be resolved through localisation. There are a range of issues that contribute to social licence (or lack thereof) that localisation will not solve for, including environmental concerns, health and safety concerns and visual impact.

Furthermore, localisation will only lead to improvements in social licence if jobs or economic impact occur in the same area as the development. For these benefits to be realised, it is essential for aspects of supply chains to be co-located in and around the NSW REZs. Stakeholder interviews have highlighted that the cost of transport, particularly for wind projects whereby towers of large stature will need to be transported is a key consideration for suppliers. For example, an Australian steel supplier has considered the location of potential fabrication facilities for wind towers in closer proximity to the REZ zones.[45]

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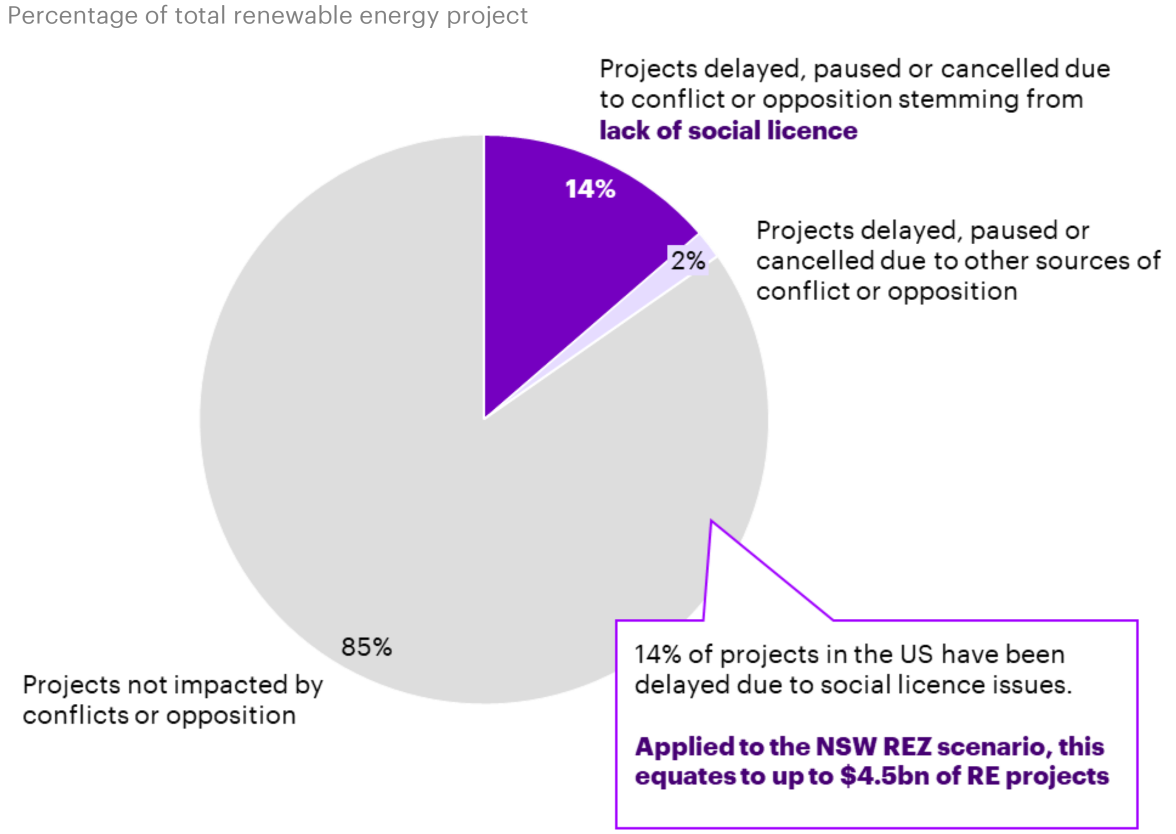
[37] Ibid.
[38] Energy Grid Alliance (2022)
[39] RE Alliance (2021)
[40] Ibid.
[41] MIT (2023)
[42] Ibid.
[43] NSW Electricity Infrastructure Roadmap (2020)
[44] Indicative value given the value of projects will vary so 14% of projects being impacted by social licence may not mean 14% of value is impacted.
[45] Stakeholder interviews

Figure 15: Renewable energy project conflicts and opposition in the US 2008 – 2021



Note: 1. Four of the seven drivers of social licence have been classified under the topic of social licence: environmental impact, lacking public participation, tribal rights to consultation and health and safety concerns. 2. Assumes the role social licence plays in project delays in Australia is similar to the US. The 14% equates to $4.5bn worth of the $32bn investment expected to be delivered by the NSW Roadmap.
Source: MIT (2023), PV Magazine (2023), Accenture analysis

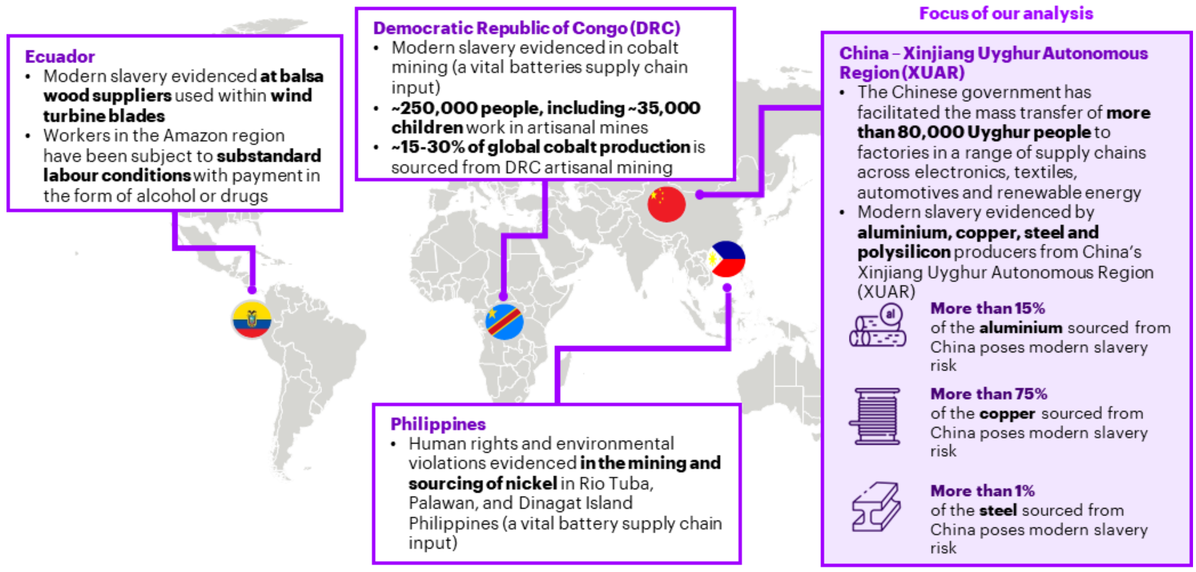
3.4.5 LOCALISING COULD REDUCE RISKS OF MODERN SLAVERY

Modern slavery is a growing risk in global renewable energy supply chains

Renewable energy supply chains are complex and are expanding to support growing global ambition. Whilst renewable energy supply chains are a source for the growth of employment, there is also growing evidence of modern slavery. Renewable energy supply chains in China, Domestic Republic of Congo (DRC), Ecuador and the Philippines have all been linked to instances of modern slavery (see Figure 16).[46]

[46] Clean Energy Council (2022)

Figure 16: Evidence of modern slavery across global renewable supply chains



Source: Clean Energy Council (2022), Sheffield Hammond University (2022), Business Human Rights (2023), Amnesty International (2021), Accenture analysis

Localising will reduce modern slavery risk in renewable energy

The risk of modern slavery in China, DRC, Ecuador, and the Philippines outweigh modern slavery risk in equivalent supply chains in Australia. There are over 3.8 million people living in conditions of modern slavery in China, a prevalence of 2.8 victims for every thousand people.[47] By comparison, Australia is estimated to have 15,000 people living in conditions of modern slavery, a prevalence of 0.6 victims for every thousand people.[48] China, DRC and the Philippines are among the top ten countries in the world with the largest estimated numbers of people in modern slavery.[49]

Australia has some of the most stringent modern slavery regulations and was the second country globally to introduce anti-modern slavery laws.[50] Since 2018, two pieces of legislation specific to modern slavery have been introduced; the Modern Slavery Act 2018 (Cth) and the National Action Plan to Combat Modern Slavery 2020-25. NSW has taken a strong stance against modern slavery as the first state or territory in Australia to legislate against modern slavery under the Modern Slavery Act 2018 (NSW).

The Modern Slavery Act 2018 sets out reporting obligations for Australian entities or those carrying business in Australia with a minimum annual consolidated revenue of $100 million.[51] The reporting criteria in Australia is mandatory, with reporting entities required to provide a reasonable basis for any opinions expressed in their modern slavery statement. Under the Act, modern slavery encompasses slavery, servitude, child labour, forced labour, human trafficking, debt bondage, slavery like practices, forced marriage and deceptive recruiting for labour or

[47] Walkfree (2018)
[48] Walkfree (2018)
[49] Walkfree (2018)
[50] Reuters (2018)
[51] Modern Slavery Act (2018)

services.[52] The National Action Plan to Combat Modern Slavery provides a strategic framework for Australia's response to modern slavery from 2020 to 2025. The purpose of the plan is to target current modern slavery practices and prevent future occurrences.[53]

Renewable energy supply chains in the Xinjiang Uyghur Autonomous Region (XUAR) have been directly linked to modern slavery

There is limited reliable data about the full extent of modern slavery in renewable energy supply chains. However, there is data available on forced labour in XUAR, where key metals used in renewable energy are produced. Therefore, this analysis focused only on XUAR due to the widespread impact of the region on renewable energy supply chains and availability of data. The full extent of modern slavery in renewable energy supply chains is expected to be much higher.

Since late 2017, the Office of the UN High Commissioner for Human Rights has received increasing allegations that members of the Uyghur and other predominantly Muslim ethnic communities have been missing from XUAR in China. From 2018 onwards, reports of enforced or involuntary disappearances and the introduction of "re-education" camps in XUAR have increased.[54] The Chinese government have detained and "re-educated" more than 1 million Uyghurs and other Muslim ethnic and religious minorities in XUAR to secure and control the population. More than 80,0000 of these people have been forced as part of labour transfer programs to work in factories across a range of supply chains including electronics, textiles, automotives and renewable energy.[55]

A 2022 study into forced labour and exploitation in XUAR for the automotive industry identified evidence of labour transfer participation across manufacturers of steel, aluminium, and copper operating in the region.[56] The following analysis focuses on producers noted as high risk or at evidence of participation in labour transfer programs in XUAR. The estimates of modern slavery risk are therefore conservative as they do not consider instances of modern slavery in China or elsewhere.

1. **Aluminium**
   China is responsible for approximately 58% (38.8 million tonnes) of global aluminium production. XUAR aluminium production capacity represents almost 20% of China's total production capacity. Eight key aluminium producers are identified as operating in the XUAR. This includes two of the largest aluminium producers in the world – Xinfa Group and East Hope. All eight of these producers have been identified as participating in forced labour transfer. Xinfa Group has approximately 50% of their aluminium production in XUAR. Some Australian companies are closely linked to Xinfa group, including Rio Tinto and Metro Mining through bauxite contracts.[57]

   At least 15% of aluminium sourced from China relies on modern slavery. This is a conservative estimate based on the combined capacity of eight aluminium producers in XUAR where labour transfer participation has been evidenced.[58]

[52] Norton Rose Fulbright (2022)
[53] Australian Government (2020)
[54] OHCHR (2022)
[55] Australian Strategic Policy Institute (2020)
[56] Sheffield Hammond University (2022)
[57] Ibid.
[58] Accenture analysis

2. **Copper**
   China smelts 50% (10 million tonnes) of the world's copper and refines 41% (8 million tonnes).[59] Some of the largest miners and processors of copper operate in XUAR, including Zijin Mining Group which holds 75% of China's copper reserves and Xinjiang Nonferrous Metal Industry Group. Both companies have been identified as participating in forced labour transfer. Xinjiang Nonferrous Metal Industry Group has been identified as playing a major role in the XUAR government's labour transfer programs.[60]

   At least 75% of copper sourced from China relies on modern slavery. This is a conservative estimate based on the Zijin Mining Group's presence in the XUAR region.[61]

3. **Steel**
   China produces over 50% (943 million tonnes) of the world's steel.[62] Baowu Group is the largest steel producer in the country, responsible for 12% of China's steel capacity. A subsidiary of the group, Xingjiang Bayi Iron and Steel, operating in the XUAR has been evidenced to prolifically employ labour transfers, linking 9% of the Group's total steel production to modern slavery.[63] In 2019, Baowu Group reported that 23.91% (86,578 tonnes) of steel products exports were to East Asia and Australia.

   At least 1% of steel source from China relies on modern slavery. This is a conservative estimate based on the capacity of three steel producers and Xingjiang Bayi Iron and Steel operating in XUAR.[64]

Whilst Australia's leading aluminium, copper and steel producers report some exposure to modern slavery risk, these risks are minor

Australian companies are more transparent in the disclosure of supply chain risks and in the instance of modern slavery, Australia's leading aluminium, copper and steel producers all disclose data in publicly available modern slavery statements.

1. **Aluminium**
   Rio Tinto is a global leader in Aluminium production, delivering 5% of the world's aluminium with 3 million tonnes produced in 2022.[65] In Australia, they are responsible for three of four aluminium smelters located in Tasmania, Queensland, and NSW. Rio Tinto's Slavery and Human Trafficking Statement 2021 reveals that aluminium production was responsible for 20% of 100 third-party due diligence reports that were escalated to human rights specialists for review. In 2021, the organisation did not identify any "very high" risk suppliers in relation to modern slavery, however, 15 human rights-related "high" risk ratings from TPDD reports were identified in relation to nine direct suppliers.[66]

[59] Based on total global copper mine production of 20.6 million tonnes in 2020
[60] Sheffield Hammond University (2022)
[61] Accenture analysis
[62] Bloomberg (2022)
[63] Sheffield Hammond University (2022)
[64] Accenture analysis
[65] Rio Tinto (2022)
[66] Rio Tinto (2021)

2. **Copper**

Australia is responsible for 4% of the world's global copper production with 0.9 million tonnes produced in 2021.[67] Though Australia has limited copper refining activity, BHP's Olympic Dam Mine in South Australia produced an estimated 205.3 kilotonnes of copper in 2021 and operates a copper smelter and refinery on site.[68] BHP's Modern Slavery Statement (2022), cites that most of the total procurement spend for FY2022 occurred in low or medium risk countries. This reflects the fact that all of BHP's operated assets are in low or medium risk countries.[69]

3. **Steel**

Australia's largest steel producer, BlueScope reports on modern slavery in the supply chain in their modern slavery statement (2022). In this statement, the organisation acknowledges risks within certain aspects of the supply chain where there are victims of human trafficking, particularly in the ASEAN region, where some goods and services are sourced. In addition, the organisation reports risk due to debt bondage/bonded labour in South Asian countries such as India and Pakistan, however, the risk is minor with only 2% of direct suppliers sourcing goods from India. Greater than 80% of BlueScope's supplier spend takes place in low or medium risk countries globally. 37% worth of this supplier spend takes place in Australia and is classified as low risk. [70]

3.5. Environmental risks and benefits

The renewable energy roll out is one component in a broader movement towards more environmentally sustainable practices. Renewable energy projects themselves can raise environmental concerns such as land use, impact on the environment and biodiversity where they are installed, and emissions associated with the material inputs. Localisation of supply chains cannot address all of the potential impacts of the roll out, localising the production of certain high embedded carbon inputs can reduce the associated emissions.

3.5.1 CURRENT INPUTS INTO RENEWABLE ENERGY SOURCES ARE HIGHLY EMISSIONS INTENSIVE

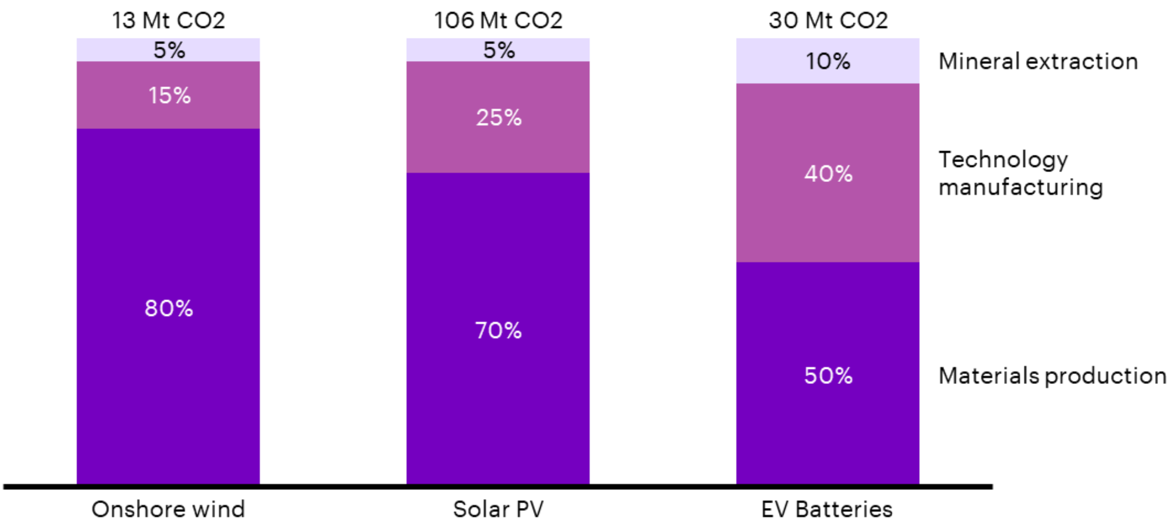
The key inputs for renewable energy projects that NSW has capability to localise are steel, aluminium and copper. These inputs are highly emissions intensive to produce. Figure 17 illustrates the significant share of emissions that material processing is responsible for across onshore wind, solar PV, and EV batteries.

For the volume of materials required for the NSW roll out, a minimum of 5,500 ktCO_2e are expected to be embedded as demonstrated in Figure 18. This value reflects the emissions associated with the stages of the value chain that could be localised: steelmaking for steel and smelting for aluminium and copper. It is worth noting that this value is likely larger if the full value chain were to be considered.

[67] WEF (2022)
[68] Global Data (2021)
[69] BHP (2022)
[70] BlueScope (2021/22)

Figure 17: Total CO_2 emissions from the production of renewable energy sources by source and supply chain step

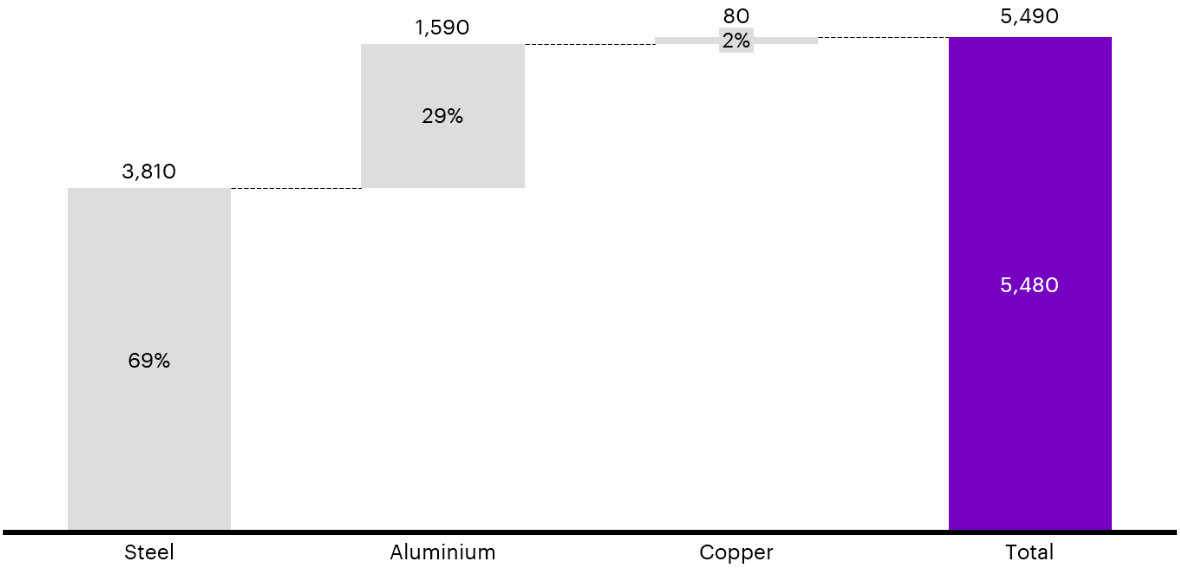
Relative emissions by supply chain step and total emissions (% and Mt CO_2)



Source: IEA (2023)

Figure 18: Embedded emissions from the key input materials required for the renewable energy roll out in NSW[1]

Embedded emissions ktCO_2e



Source: Accenture analysis
Note: Totals may not sum due to rounding

Embedded emissions in steel are the largest contributor (69%) to emissions, largely driven by the high volumes of the material required (1.6 million tonnes). Embedded emissions in aluminium are the second largest contributor (29%) to emissions, largely driven by the highly intensive energy process which drives an emissions factor of up to 16 tCO_2e/t. Embedded emissions in copper, while a key input, represents a very modest share of both volume of metal and emissions at the refining and smelting stage.

3.5.2 LOCALISING THE PRODUCTION OF INPUTS ACROSS RENEWABLE ENERGY SUPPLY CHAINS COULD REDUCE NSW'S CUMULATIVE EMISSIONS BY ~38%

To assess the possible reduction in emissions, the emissions from the incumbent producer (China) have been compared with the emissions if produced in Australia. Table 2 includes the key data points for the three metals of interest, including the stage of production considered, the emissions factor ranges and the volume requirements as modelled by UTS ISF and SGS. See Appendix for full methodology.

Table 2: Key data points for the three key metal inputs

Metal	Production stage	Emissions factor Aust. (tCO_2e/t)	Emissions factor China (tCO_2e/t)	Material requirements cumulative 2023-35 (t)
Steel	Steelmaking	0.7	2.4	1,600,000
Aluminium	Smelting	13	16	110,000
Copper	Smelting	1.4	1.4	90,000

Localising the production of energy-intensive and high embedded emissions inputs of the renewable energy supply chains in NSW could reduce embedded carbon emissions in those production processes cumulatively by ~38% (~2 million tCO_2e) by 2035 (see Figure 19). Emissions will be lowered through:

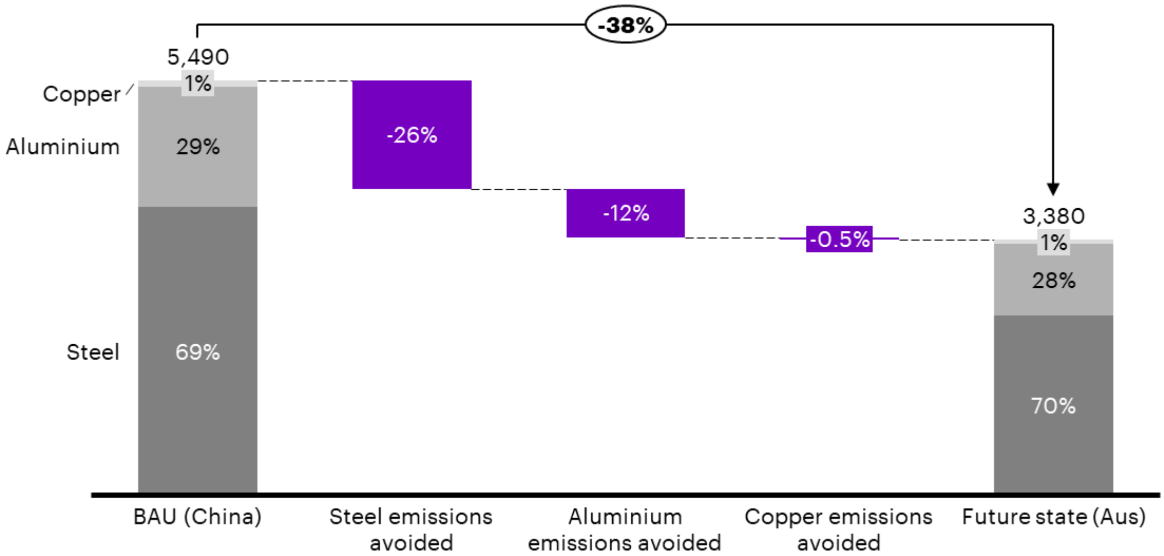
- Scope 1 emissions (all direct emissions from the activities of an organisation or under their control),
- Scope 2 emissions (indirect emissions from electricity purchased and used by an organisation), and
- transport emissions (which are a contributor to Scope 3 emissions).

Steel, aluminium, and copper are three highly carbon-intensive inputs into wind turbines, solar panels and solar farm infrastructure, and transmission infrastructure. Australia has the greatest opportunity to reduce embedded emissions through localising the energy-intensive production of these three metals. NSW has been identified to have production capacity/opportunity for all three inputs.[71] Further detail on the selection of these three inputs and their production processes can be found in the Appendix.

[71] SGS and UTS ISF (2022)

Figure 19: Cumulative reduction in embedded emissions by metal, China compared to Australia

Embedded emissions ktCO2e, 2023-2035



Source: Accenture analysis

BAU emissions in Figure 19 are based on current emissions factors for existing manufacturers of these materials. This value represents the volume of emissions embedded within the metals required for the renewable energy roll out as calculated by UTS ISF and SGS. In Australia, most renewable energy inputs are imported from and manufactured in China. Therefore, the calculations utilise expected emissions from manufacturing these materials in China.

These estimates for emissions reduction assume a continuation of current practices except where commitments have been made for future changes. For example, the emissions intensity of electricity in Australia is reduced according to the increase in renewable energy in the grid as projected by AEMO.[72] However, for industrial practices, such as what method of steelmaking is used, it is assumed the current practices continue where no future commitments have been made. Therefore, if new energy-efficiency or low-carbon manufacturing practices were introduced, these emissions savings could be even greater. However, given these emissions savings are calculated against a baseline, for Australia to achieve a reduction in emissions compared to China, these technologies would need to be adopted in Australia before they were adopted in China. Conversely, if Australia lags China either in failing to adopt low-emission technology while China does or failing to increase its share of renewables as projected, it risks producing greater emissions than the BAU case.

It is further worth noting that comparing the expected emissions from each of these three metals between Australia and China is challenging due to the variation in industrial process and energy source by geography. For example, across China there will be factories that adopt newer, cleaner processes and others that are laggards using outdated and emissions intensive

[72] AEMO, 2022 Integrated System Plan (ISP) (2022)

processes. For this analysis, we have taken the approximate average as determined in the literature to represent a typical plant and expected emissions outcome. This may under- or over-estimate when compared to a specific plant in China.

These estimates consider only the quantity of materials required by NSW for the planned roll out through to 2035. This represents only a subset of the total quantity of material required by Australia more widely. Greater emissions savings by volume could be achieved if Australia were to localise the production of an even greater quantity of renewable energy inputs.

Box 1: Production-based versus consumption-based emissions accounting systems

Production-based emissions accounting considers the total emissions of a country based on the emissions produced in that country. This is currently the traditional system used to understand and count emissions. Using this accounting system, China is considered the greatest global emitter. Conversely, an alternative accounting system is based on the goods consumed in a country and the emissions 'embedded' in those goods, i.e. the emissions produced to produce the goods. According to this accounting system, many of China's emissions should be accounted for by the countries that consume the goods that China produced because the countries that imported the goods are consuming and benefitting from them.

From a production-based emissions accounting approach, Australia's emissions would increase since currently the materials are produced elsewhere and localising them here would add to Australia's produced emissions. However, when considering a consumption-based approach, Australia is already consuming these goods and therefore there is an emissions savings when accounted according to a consumption approach.

3.5.3 LOCALISING IMPACTS THE EMBEDDED EMISSIONS ACROSS SCOPE 1, 2 AND 3

The emissions savings for each metal can be understood according to the changes in Scope 1, Scope 2, or Scope 3 emissions. Scope 1 includes all direct emissions from the activities of an organisation or under their control. Scope 2 includes indirect emissions from electricity purchased and used by an organisation. Scope 3 includes any other emissions as part of the supply chain not included in Scope 1 or 2.[73]

When comparing across Australia and China, there are several key variables that differ:

A. the chemical process of producing the metal,
B. emissions factors of the electricity grid, and
C. the efficiency of the plant producing the metal.

Scope 1 emissions are impacted by A and C. Scope 2 emissions are impacted by B and C. Therefore, it is most consistent to consider how the Scope 1 and 2 emissions collectively are reduced by localising, given the interconnectedness of the variables (see Table 3). Sections 3.5.4 – 3.5.6 explore how these variables impact the emission reduction for each metal.

[73] Teske et al. Scopes 1, 2, and 3 Industry Emissions and Future Pathways (2022)

Table 3: Key data points for the reduction of emissions by metal

Metal	Primary source of emissions	Driver of reduction
Steel	Scope 1 for Blast Furnaces (BF) Scope 2 for Electric Arc Furnaces (EAF)	- Increased use of EAF compared to BF - Increase share of renewables in grid (for EAF) - Greater plant efficiency
Aluminium	Scope 2	- Increase share of renewables in grid to lower the emissions factor - Greater plant efficiency
Copper	Scope 2	- Increase share of renewables in grid to lower the emissions factor - Greater plant efficiency

3.5.4 LOCALISING THE STEEL PRODUCTION PROCESSES COULD SEE A CUMULATIVE REDUCTION OF EMISSIONS BY 37%

Localising steel production in Australia could avoid up to 37% of steel production emissions, equal to ~1.4 $MtCO_2e$ between 2023-30. As shown in Figure 20, these savings are driven by a significant reduction in Scope 1 and 2 emissions and a smaller reduction in transport emissions (a contributor to scope 3 emissions). The primary drivers of Scope 1 and 2 savings in Australia are the higher share of scrap-fed electric arc furnaces paired with a higher share of renewable energy in the grid across the timeframe, as well as greater energy efficiency in Australia's blast furnaces. The emissions from transportation decrease by 220 $ktCO_2e$ when steel is produced locally.

Steel manufacturing is highly emissions intensive, responsible for between 0.7 – 2.4 tCO_2e for every tonne of steel produced. There are two methods for steelmaking: via a blast furnace (BF) and via an electric arc furnace (EAF). These two methods have different emissions profiles: varying both in the total emissions intensity of producing a tonne of steel and of the source of the emissions, between Scope 1 and Scope 2.

Steelmaking using a BF is responsible for higher emissions, the majority of which are Scope 1 during the steelmaking itself. Steelmaking using an EAF can achieve a lower emissions intensity depending on the feedstock (scrap metal, direct reduced iron, or pig iron). Table 4 displays the range of emissions intensity values for these two methods. The emissions intensity ranges based on several factors such as facility infrastructure, energy source, method of iron reduction, and share of scrap steel.

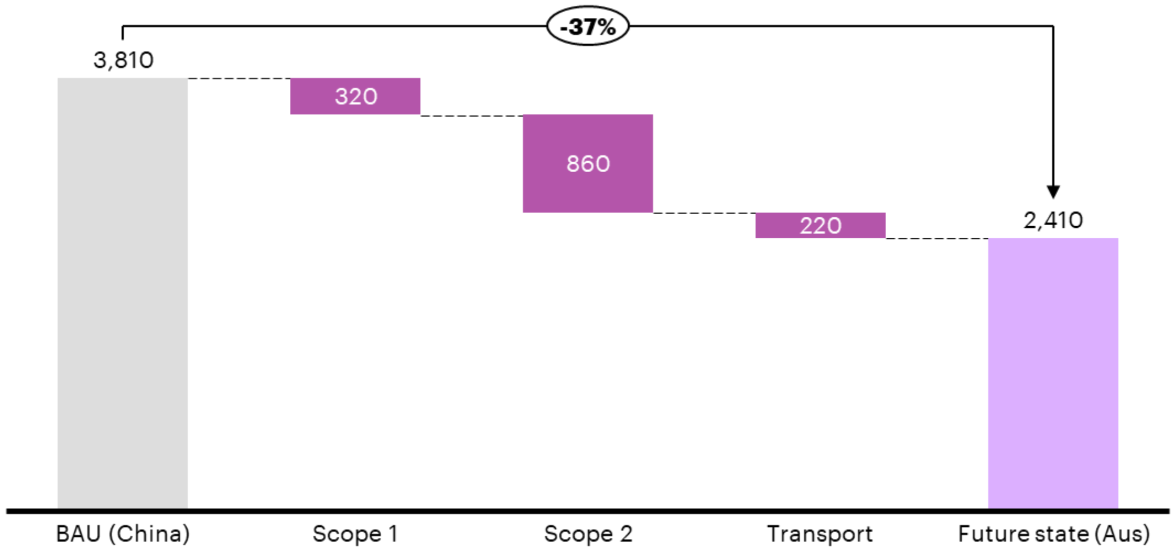
Table 4: Range of emissions intensity for steelmaking processes globally by method[74]

Steelmaking method	Emissions intensity range (tCO_2e/t)
BF	1.6 – 2.9
EAF	0.3 – 1.5

[74] A. Hasanbeigi, *Steel Climate Impact: An International Benchmarking of Energy and CO2 Intensities* (2022)

Figure 20: Cumulative avoided embedded emissions in steel, BAU (China) compared to Australia

Embedded emissions $ktCO_2e$, 2023-2035



Source: Accenture analysis

3.5.5 LOCALISING THE ALUMINIUM PRODUCTION PROCESSES COULD SEE A CUMULATIVE REDUCTION OF EMISSIONS BY 41%

Localising aluminium production in Australia could avoid up to 41 of emissions, equal to ~650 $ktCO_2e$ between 2023-30. As shown in Figure 21: these savings are driven by a significant reduction in Scope 1 and 2 emissions and a smaller reduction in Scope 3 emissions. The primary driver of this emissions reduction is a decrease in Scope 2 emissions driven by greater plant efficiency and a higher share of renewable energy in the grid across the timeframe. Producing aluminium locally results in a reduction of transportation emissions by 15 $ktCO_2e$.

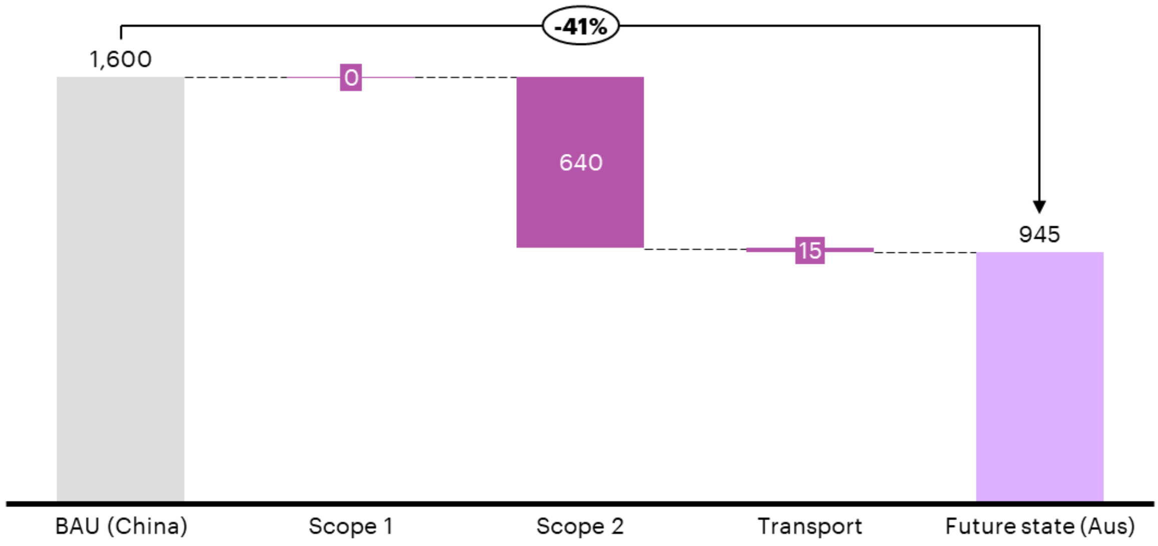
Aluminium smelting has the highest emissions factor of all the metals analysed, between 13-16 tCO_2e for every tonne of aluminium produced. The smelting process is highly energy intensive and accordingly most of the emissions in producing aluminium are Scope 2. Scope 2 emissions are directly impacted by the plant efficiency and the share of renewable energy in the grid.

Australia is projected to have a more rapid renewable energy uptake than existing suppliers from China, driving a significant reduction in emissions. Further, emissions reporting from the Australian Aluminium Council suggests slightly greater plant efficiency than China.[75]

[75] Australia Aluminium Council (2022) *Sustainability*

Figure 21: Cumulative avoided embedded emissions in aluminium, BAU (China) compared to Australia

Embedded emissions $ktCO_2e$, 2023-2035



Source: Accenture analysis

3.5.6 LOCALISING THE COPPER PRODUCTION PROCESSES COULD SEE A CUMULATIVE REDUCTION OF EMISSIONS BY 37%

Localising copper production[76] in Australia could avoid up to 37% of emissions, equal to ~30 $ktCO_2e$ between 2023-30. As shown in Figure 22, these savings are driven by a significant reduction in Scope 1 and 2 emissions and a smaller reduction in Scope 3 emissions. Similar to aluminium, the primary driver of this emissions reduction is a decrease in Scope 2 emissions driven by greater plant efficiency and a higher share of renewable energy in the grid across the timeframe. Local production of copper results in a reduction from transportation emissions by 8 $ktCO_2e$.

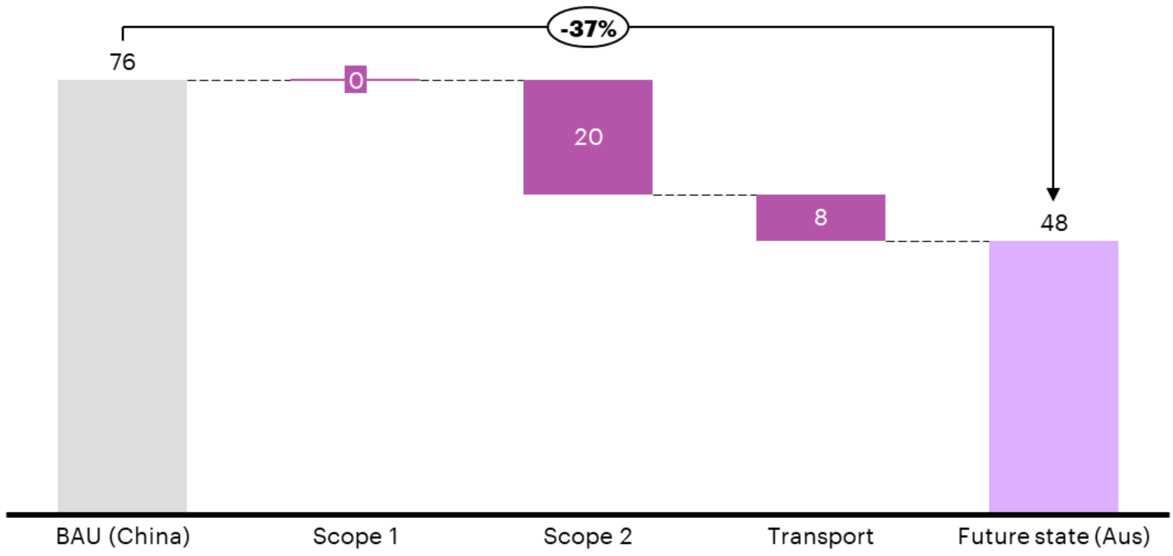
The full value chain of copper production from ore to wire can be heavily emitting and raise pollution concerns based on the chemicals used in the early stages of the value chain. This analysis considers only the refining and smelting stage of copper based on previous analysis finding local capability for this stage. There are additional embedded emissions from earlier stages in the value chain not modelled here.

The total volume of emissions for Copper is relatively low given the comparatively small volume of copper required compared to the other metals considered here and the comparatively low emissions factor.

[76] Only including smelting. Embedded emissions are ~4x higher when other stages of the value chain are considered.

Figure 22: Cumulative avoided embedded emissions in copper, BAU (China) compared to Australia

Embedded emissions $ktCO_2e$, 2023-2035



Source: Accenture analysis

4. GLOBAL APPROACHES TO LOCALISATION

4.1 Global best practice approaches

Five key learnings from global best practice have been highlighted in the case studies below. Case studies were selected based on their relevance to NSW in terms of the political environment and market size, as well as their demonstration of enabling policy levers and conditions. The recommendations might not be within the remit of the Sector Board, and therefore include potential recommendations from the Sector Board to the Minister or the NSW Government.

1. **Gradually ramping up local content requirements to the maturity of industry**
   Global case studies where local content requirements (LCRs) have successfully been employed to localise supply chains reveal the need for a gradual increase in LCRs to enable local capacity to build in accordance. Identifying targets for LCRs that accurately reflect current and future supplier capacity is challenging. If targets are set too high and without sufficient capacity building support measures in place, local industry growth may stagnate.[77] Conversely, a gradual increase of LCR targets enables benefits to be assessed over time and percentages adjusted accordingly, as demonstrated in Norway's oil and gas industry whereby requirements were gradually increased and ultimately lifted when local industry reached maturity (see section 4.4).[78] The Sector Board recommends LCRs in its plan, and must review its plan at least every two years. The LCRs were set to be realistic and achievable, to reflect market capacity.

2. **Supporting domestic R&D enables sustained competitive advantage**
   Consistent government support and investment related R&D serves to both improve the long-term competitiveness of local industry and instil investors with confidence. Political commitment and investment in R&D were key enablers for the successful establishment of local supply chains in all five global case studies that have been analysed (see chapter 7). In particular, minimum R&D targets within local content requirements in Norway's oil and gas industry were instrumental in the facilitation of knowledge transfer between international oil companies and local industry (see section 4.4).[79] Additionally, in the UK's offshore wind industry, the government's establishment of a dedicated innovation and research centre for offshore renewable energy has demonstrated their commitment to accelerating innovation in offshore wind (see section 4.3).[80] The NSW Sector Board's plan currently includes minimum LCRs specific to R&D, although there are no numerical requirements.[81] Furthermore, the NSW Government offers $75 million worth of grant funding support for the development of innovative renewable energy projects within the NSW Emerging Energy program and electrification and energy systems is a priority area for support through the $195 million Clean Technology Innovation programs.[82]

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[77] Stakeholder interviews
[78] Columbia Center on Sustainable Investment (2016)
[79] Columbia Center on Sustainable Investment (2016)
[80] Renewables UK (2021)
[81] EnergyCo (2022)
[82] NSW Government (2019)

3. **Reducing the cost of capital reduces investor risk**
   Cost is a key barrier to establishing a localised supply chain. This includes cost of capital, which is a critical aspect of overall project cost and therefore creates significant development risk. As demonstrated in the offshore wind industries in Denmark and the UK, mechanisms such as contracts for difference can effectively incentivise local supply chains by reducing cost of capital and therefore investor risk (see section 4.2 and 4.3).[83] [84] The NSW Roadmap includes similar financial mechanism to contracts for difference, the LTESAs.

4. **Capacity building support is instrumental to enable local industry to meet demand**
   Capacity is a key barrier to establishing a localised supply chain. LCRs alone are not sufficient to successfully establish a localised supply chain. Appropriate capacity building support is necessary to enable local suppliers to meet the volumes of goods and services required to meet demand. In a number of global case studies capacity building support measures have been used by governments to strengthen local industry. For instance, in Australia's defence industry, a global supply chain program pairs SMEs, universities and research organisations with multinational defence prime contractors to provide mentoring, and greater opportunities to Australian companies (see section 4.6).[85] In addition, supply chain support programs have been instrumental in building local supplier capacity and improving the position of local suppliers to win offshore wind tenders in the UK (see section 4.3).[86] The Sector Board's plan includes a recommendation to build the capacity of the local manufacturing sector.

5. **Clustering supply chain activities in centralised locations maximises strategic benefits**
   The clustering of supply chain activities in specific locations encourages innovation, collaboration and partnerships increasing competitiveness of the local market.[87] Aside from the clear benefits of industry participants working in closer proximity, clustered supply chains enable greater economic and employment benefits to surrounding communities. For example, Denmark has developed offshore wind clusters in regional ports where significant aspects of the wind supply chain have been established. At Port Esbjerg in Denmark manufacturers, operation and maintenance providers and developers have co-located to create a hub of collaboration and industrial expertise. This has led to the acceleration of local industry growth and consequently stimlulated the local community through the creation of jobs and increased economic activity (see section 4.2).[88] NSW REZs have the potential to provide benefits akin to locational clusters, if supply chain participants choose to co-locate with the generation and storage projects operating in the REZs.

[83] Columbia Center on Sustainable Investment (2016)
[84] Renewables UK (2021)
[85] AMC National Defence Roadmap (2021)
[86] Offshore Wind Sector Deal (2020)
[87] Stakeholder interviews
[88] Wind Denmark and Danish Energy (2020)

4.2 Denmark's offshore wind localised supply chain

Denmark pioneered offshore wind with the installation of the world's first offshore wind turbine in 1991. Since then, the country has focused on establishing a supply chain and network that spans component wind turbine manufacturing, development and operations and maintenance (O&M) dominated by Ørsted (development) and Vestas and Siemens Gamesa (wind turbine manufacturing) and LM Wind Power (rotor blade manufacturing). The raw material and commodities required for offshore wind, including steel, copper, nickel, and rare earth elements are largely sourced outside of Europe. A first mover advantage and government policies to support industry were instrumental in the development of the local supply chain with a skilled workforce of ~33,000 direct employees and a further ~63,000 in adjacent industries as of 2019. Denmark has achieved strategic benefits including economic and employment growth, regional job creation, investment in skill and development and increase quality of input materials.

How did Denmark localise the offshore wind supply chain?

1. **Political commitment and R&D investment**
   Denmark's sustainable energy policy, 'Energy 2000' established in 1990, introduced both R&D and industrial policy which enabled the regulated development of wind turbine technology. The Danish government strengthened the competitiveness of the offshore wind industry with long-term R&D investment and a feed-in-tariff for wind electricity generation. Ambitious electricity consumption targets established domestic demand for wind and a need to develop local industry.

2. **Governance and Contracts for Difference**
   The Danish Energy Agency (DEA) acts as the single point of contact over the end-to-end offshore wind value chain, from planning to commissioning and operation. They are responsible for planning and permitting for offshore wind projects, which reduces the cost and risk of pre-consent work for developers. The DEA were responsible for introducing a Contract for Difference (CfD) subsidy scheme which reduces development risks and lowered capital costs for investors in offshore wind.

3. **Partnerships and hubs**
   Companies across the value-chain exist in proximity, encouraging collaboration, knowledge sharing and partnerships. Services and products are pooled, with companies delivering complete or packaged solutions to supply chain players such as wind turbine manufacturers of farm owners. For example, Port Esbjerg (Europe's leading port in offshore wind construction) has over 200 local companies specialised in offshore wind – representing the majority of the supply chain across R&D, manufacturing, transport, pre-assembly, installation and O&M.

What were the strategic benefits of the localised supply chain?

1. **Macroeconomic benefits**
   - Increased employment opportunities for oil and gas workers in Denmark due to the transferability of skills. Localisation of offshore wind development adds over 2% of private employment in Denmark with around 33,000 direct employees. The sector contributes over 13.8 billion DKK (AU$ 3 billion) of taxes to the Danish Government.
2. **Distributional benefits**
   - Economic and employment benefits for regional communities due to the location of ports.
   - Ongoing regional jobs created in the installation and O&M phase within and around ports.
3. **Investment in skill and development leading to world class R&D facilities**
   - The localisation of R&D for wind energy in Denmark have resulted in a highly skilled workforce, supported by innovative testing facilities.
   - As a result, companies from across the globe have centralised R&D operations in Denmark.
4. **Higher quality of input materials due to quality assurance methodology**
   - Quality assurance has been standardised by APQP4Wind as a result of cross-industrial collaboration between leading companies (Vestas, Gamesa and Siemens).
   - APQP4Wind developed common quality assurance methodology for the global wind industry, reducing risk and lowering costs associated with poor quality.

Key learnings for NSW:

- **End-to-end governance of renewables value chain** via a governing body allows for maximum local control and ease of business.
- **Local ownership model** fosters increased social licence and local communities have 'buy-in' to renewables projects. To the extent possible, encouraging local 'buy-in' can help to reduce delays due to community opposition.
- **Contracts for Difference** are a strong mechanism to incentivise investment in renewable projects as they lower risk and capital costs. Note that NSW has already employed LTES agreements to the same effect of CfDs.
- **Locational clusters of supply chain activities** encourage collaboration, partnerships increasing competitiveness of the local market. Economic and employment benefits to the community can be maximised by clustering supply chain activities as observed in the case of Denmark's Port Esbjerg.

Source: Danish Energy Agency (2022), Danish Shipping, Wind Denmark and Danish Energy (2020), State of Green (2021), State of Green (2021), (2022), Poulsen and Lema (2017), Afewerki and Steen (2022), IRENA (2013), van Est (2022), QBIS Denmark (2020)

4.3 UK's offshore wind localised supply chain

The UK's offshore wind capacity is second only to China, attributed to both to weather conditions with high winds and shallow seas and industry development policy, including targeted local content policies. Offshore wind directly employs ~20,000 people in the UK, with a large concentration of these in maintenance. According to the Offshore Wind Industry Council, by 2030 this could increase three-fold, with many the jobs in regional locations such as Grimsby, Hull and Teesside. Early strategic benefits have been identified regarding industrial capability and profitability and future skill development, however, there is still a significant reliance on content outside of the UK for key offshore wind components such as monopiles, towers and some turbines.

How did the UK localise the offshore wind supply chain?

1. Political support and R&D investment
Offshore wind in the UK has received consistent political support, which has fostered confidence across industry in R&D investment, supply chain and skills. Investment in offshore wind gained backing with Britain's Climate Change Act in 2008. Subsidies were provided to early large-scale wind farms due to reduce capital intensity and encourage development.

2. Long term contracts and introduction of Contracts for Difference
Long term contracts provided greater certainty for companies to invest in offshore wind projects and for companies like Siemens Gamesa and Ørsted to set up shop in the UK. In addition, Contracts for Difference have successfully been employed to support large scale renewables projects, including offshore wind. These contracts can deliver a reduction of 10-21% of total project costs.

3. Local content requirements as part of the Offshore Wind Sector Deal
The Offshore Wind Sector Deal is a partnership between the UK government and the offshore wind industry which set the target of 40 GW of offshore wind capacity by 2030. This included a total lifetime UK content target of 60% for projects commissioning from 2030 onwards. The deal also provided more visibility over future for Contracts for Difference rounds with support of update to £557 million.

4. Supply chain growth support schemes
Establishment of organisations and programs to support new entrants into offshore wind, from the growth of new SMEs to other well-established organisations in adjacent sectors such as oil and gas, subsea, automotive and aerospace. One example is ORE Catapult Offshore Renewable Energy, established as an innovation and research centre for offshore renewable energy. UK's Catapult network aims to drive innovation between industry and research, similar to Australia's Cooperative Research Centres. ORE Catapult have a number of supply chain support programs including Offshore Wind Growth Partnership which promotes collaboration across the supply chain and facilitation of shared growth opportunities between developers and suppliers and Fit 4 Offshore Renewables program which focus on businesses improvement and capability building to prepare organisations for bids.

What were the strategic benefits of the localised supply chain:

1. **Macroeconomic benefits**
   - Estimated 90,00 jobs to be created in UK offshore wind by 2030.
   - Increased export opportunities, particularly in floating offshore wind where the UK is a global leader in pipeline capacity.
   - Increased employment opportunities for oil and gas workers in the UK due to the transferability of skills to the clean energy sector, specifically within offshore wind.
   - Although there are not yet clear examples of these benefits, the UK government have developed a people and skills plan to shift people from existing oil and gas roles to the renewable energy sector.
2. **Faster and more efficient deployment**
   - Lower cost and time to deployment as UK companies are awarded environmental survey contracts due to local knowledge.
   - Environmental survey contracts take up 1/10 of the total offshore wind project costs.

Key learnings for NSW:

- **Long term project pipelines** are key to securing investor interest in the renewables market. Note that NSW is already delivering on this with the 10-year tender schedules for generation and long-duration storage.
- **Contracts for Difference** are a strong mechanism to incentivise investment in renewable projects as they lower risk and capital costs. Note that NSW has already employed LTES agreements to the same effect of CfDs.
- **Partnerships between industry and government bodies** are crucial to jointly solve supply chain issues and deliver sustained investment as evidenced by the UK's Offshore Wind Sector Deal and the Offshore Wind Industry Council, established to drive the growth of the offshore wind sector in the UK by bringing together developers, manufacturers and government.
- **Supply chain growth support schemes** are necessary to build local capacity from small SMEs to large international corporations. Support should be focused on the facilitation of knowledge sharing between existing developers and suppliers in the form of productivity improvement programs as well as support to prepare and build capability for new entrants to the industry.

Source: Offshore Wind Sector Deal (2020), The Economist (2022), Tony Blair Institute for Global Change , Renewables UK (2021), ORE Catapult (2023)

4.4 Norway's oil and gas localised supply chain

Norway has a skilled and internationally competitive petroleum supply chain, developed over decades of petroleum activities. In 2008, Norwegian suppliers represented nearly 30% of the total sales in the oil and gas industry[1]. Government policies, specifically local content requirements were instrumental in establishing a localised supply chain and enabling self-sufficiency. LCRs were first introduced with Norway's 1985 Petroleum Act and focused largely on the development of industry and transfer of knowledge and capabilities and remained in place until Norway joined the European Economic Area in 1994 and the World Trade Organisation. Norwegian petroleum activities cover most of the supply chain. Norway have achieved strategic benefits due to the investment in skill development and focus on knowledge transfer.

How did Norway localise the oil and gas supply chain?

1. **Separation of government and industry**

   In 1972, the Norwegian government developed a new structure which separated out policymaking (Ministry of Petroleum and Energy), technical control and resource management (Norwegian Petroleum Directorate) and commercial participation (Statoil, GassCo, and Petero). These commercial participants that were 100% state owned, pushed for the use of suppliers based in Norway.

2. **Local content requirements focused on purchase of local goods and services**

   Norway's Petroleum Act (1985) introduced a local content plan to be approved by the Ministry of Petroleum and Energy prior to licences being assigned to international oil companies (IOCs). Key requirements set the local content target for the development of petroleum fields at 50-60% and operations and maintenance was 80%. The local content requirement was initially set at 50% in the

Act, this requirement gradually increased to 60% in 1994 and to 70% in 2001. The intention behind these increases was to promote the development of a robust domestic industry, stimulate job creation, and enhance technology transfer within Norway's oil and gas sector.[2]

3. **Local content requirements focused on localising R&D**
Policies focused on the transfer of knowledge between IOCs and local Norwegian companies via training and employment of Norwegian personnel. In addition, IOCs required at least 50% of R&D activities to be performed in Norway. As a result, Norway is a technological leader in several supply chain aspects: subsea, drilling, seismic, offshore services and equipment.

What were the strategic benefits of the localised supply chain:

1. **Macroeconomic benefits**
   - Investment in skill development greatly benefited Norwegian research communities, with a large number of petroleum-related technology developed in Norway due to R&D requirements.
   - Norway established competitive advantages in subsea, drilling, seismic, offshore services and equipment.
2. **Reduced logistics emissions**
   - Norway is world leading in low carbon production as a result of the integration of power from shore via renewables allow for increasing carbon neutral oil cargoes.
   - State-controlled Equinor is targeting carbon-neutral operations by 2030, and full carbon-neutrality by 2050.

Key learnings for NSW:

- **LCRs with a focus on transfer of industry knowledge** as opposed to local ownership enables self-sufficiency and sustainable job creation.
- **Gradual introduction of LCRs** is recommended so that benefits can be assessed and LCRs can be flexibly adjusted over time**.**
- **Flexible procurement frameworks and general principles** as opposed explicit local content laws to enable fast changes.

Source: Brazilian Petroleum, Gas and Biofuels Institute (2016), Columbia Center on Sustainable Investment (2016), Fitch Solutions (2023)

4.5 Australia's localised oil and gas supply chain

Australia's localised oil and gas supply chain contributes $38 billion value added to the economy. Approximately 70% of the value of the goods and services that support extraction of oil and gas are added in Australia, with the remaining imported. Local suppliers have captured a significant share of value within the operations and maintenance phase of the oil and gas value chain, however, have historically failed to capitalise on construction. The industry supports 80,000 direct and indirect jobs and between 2016-2017 provided a $27 billion boost to the economy through the purchase of goods and services from local businesses[2]. The demand for LNG in global energy markets is attributed to the growth in Australia's natural gas sector, however, there are also a number of levers pulled by state governments, specifically Queensland and Western Australia that can be attributed to the growth of local supply chains. Some strategic benefits have been achieved, including regional and Indigenous job creation and the spill over impact of investment in skills and development.

How did Australia localise the oil and gas supply chain?

1. **Global demand for LNG and resource abundance**
In 2018, worldwide LNG exports grew by 27 mega tonnes, with half of the growth coming from Australia, where local extraction largely look place in Queensland and Western Australia. This growth has created demand for a larger localised supply chain.

2. **Local Content Requirements**
Local content requirements are based on the key principle to offer 'full, fair and reasonable' access to employment and tendering opportunities to Australian firms and individuals. However, local content requirements in the construction phase of Australian oil and gas projects have been historically lower due to gaps within the Australian supply chain across manufacturing and capital

servicing as well as the inability for companies to compete with lower cost international service providers.

3. **Coal seam gas innovation and investment**
Eastern Australia hosts large reserves of coal seam gas that can deliver gas to well-bores faster than coal reservoirs. Queensland has played a major role in pioneering the use of coal seam gas to produce LNG. Over $200 billion of new investments have been proposed for LG and CSG developments in Western Australia and Queensland. The Queensland Government promoted the use of CSG for electricity via the Queensland Gas Scheme.

What were the strategic benefits of the localised supply chain:

1. **Distributional impacts**
    - Australia's O&G industry has spurred economic activity across the energy vale chain within regional Australia due to the location of oil and gas hubs.
    - Ichthys LNG Project is set to engage more than 1,100 Aboriginal and Torres Strait Islander peoples in Northern Australia through business contracts and employment between 2012-2050.[3]
2. **Macroeconomic impacts**
    - In Western Australia, the development of remote offshore gas resources and mega-scale LNG facilities has established the region as an important global centre for offshore LNG research and innovation.
    - Spill over impact from Environmental impact assessments, environmental offset packages and CSR investments have been instrumental to the sciences and knowledge of Australia's biodiversity.
    - Spill over impact to commercial services in support of O&G industry, evidenced in the development of city service hubs in Perth and Brisbane.

Key learnings for NSW:

- **Invest in areas of R&D** that play to Australia's strengths as evidenced with CSG and development of remote offshore gas resources.
- **Maximise strategic benefits** with the centralisation of supply chain activities, resulting in the development of support hubs.

Source: APPEA (2020) (2021) , NERA (2020), Austrade (2022), ACIL Allen (2017), AER (2009), Esteves, AM & Barclay M. (2012)

4.6 Australia's localised defence supply chain

Australia's defence supply chain spans across maritime and antisubmarine warfare, key enablers, strike and air combat, land combat and amphibious warfare, air and sea lift an ISR, EW, Space and Cyber. Australia's key manufacturing strengths in defence include naval vessels, aircraft components, armoured vehicles and components, sustainment of gas turbines, jet engines and tank engines, special military equipment. In the past decade, there have been a number of programs established to support the localisation of defence supply chain, specifically via growth in small to medium-sized enterprises. From 2020, in response to the COVID-19 pandemic and the related global supply chain issues, Australia has set new strategies with the expected benefit of increased local supply chain resiliency.

How did Australia localise the defence supply chain?

1. **Global Supply Chain Program (GSCP)**
Program introduced in 2009 to increase the number of small to medium-sized enterprises, universities and research organisations embedded in the global supply chains of multinational defence prime contractors, including BAE Systems, Boeing, Lockheed Martin, Northop Grumman, Raytheon, Rheinmetall and Thales.

2. **Australian Industry Capability Program (AIC)**
Program introduced in 2016 aimed towards building a robust, resilient, and internationally competitive Australian defence industry. The program identified 14 sovereign capabilities that must be developed or supported by Australian industry. The Sovereign Industrial Capability Priority Grant Program, eligible only to Australian SMEs with grants of $50 thousand - $1 million for up to 50% of a project that builds sovereign capabilities.

3. Investment in manufacturing capabilities

The Government has recognised the importance of these capabilities and announced $270 billion in funding for new and adjusted Defence capability to 2030, some of which will span manufacturing opportunities in Australia[1]. This unprecedented level of investment represents opportunities for Australian manufacturing firms, and secure, long-term employment for Australian workers.

What were the strategic benefits of the localised supply chain:

1. **Investment in R&D**
   - Investment in R&D for defence has potential spill over impacts to regarding technology exchange to several other industries such as space, medical products, clean energy, resources technology and critical minerals processing.
   - For example, the Australian Defence Force supported the growth in local manufacturing of medical equipment during the COVID-19 outbreak.
2. **Regional job creation and the spill over impact**
   - Defence makes a significant contribution to regional Australia by the location of bases and personnel.
   - Regional workforce equates to 31.8% of the total Defence personnel located in Australia.
3. **Supply chain resiliency**
   - Defence SME jobs were more resilient than the average Australian business in 2020.
   - Australian defence SMEs added ~32 thousand jobs over the past five years.
   - Defence firms are significantly more resilient, resulting in greater job security.

Key learnings for NSW:

- **Supply chain capacity building support** focused on SMEs and utilising international companies to do so is key to developing local activities across the supply chain.
- **Identify high priority areas of the supply chain** to focus on building capabilities and leverage policy to incentivise the use of local manufacturing.
- **Dedicated focus on industry skilling** to identify needs, risks and pathways forward for workers.

Source: AMC National Defence Roadmap (2021), AMC Defence National Manufacturing Priority Roadmap (2021), AIA Group Defence Council (2022), Defence Ministers Media Release (2020), Accenture Analysis

5. KEY CHALLENGES TO ACHIEVE LOCALISATION

5.1 There are three key challenges that need to be overcome to localise points in the renewable energy supply chain: cost, capacity, capability

5.1.1 COST

Localising supply chains will come at a cost. This is due to several factors including a lack of economies of scale in Australia, higher input costs and higher construction costs. ACIL Allen has estimated the total additional cost to be $1.9 billion in a modest local content scenario and $4.7 billion in an ambitious local content scenario.[89] Anecdotally, it appears that the costs of responsible procurement outweigh the benefits for developers, as their final product – electricity – is commoditised.[90] Localised procurement could increase the total investment for renewable energy projects. This could impact the profitability of the project and result in higher electricity costs.[91] The additional costs will be passed on to consumers, with the estimated average increase to retail electricity bills between FY24 and FY41 to be 0.6% or 1.6% in a modest and ambitious local content scenario, respectively (see Table 5).

Table 5: Average estimated increase in retail electricity bills, FY24 – FY41

Type of customer	Modest local content scenario	Ambitious local content scenario
Residential	0.5%	1.3%
Small business	0.5%	1.4%
Medium C&I	0.7%	1.7%
Large C&I	0.7%	1.8%
Weighted average	0.6%	1.6%

Source: ACIL Allen (2022)

Government should consider options to reduce the cost disadvantage that Australian companies face relative to international competition and encourage local manufacturing (for existing organisations and to attract international organisations). To help address cost disadvantages, the NSW Government has introduced the Renewable Manufacturing Fund. The fund allocates $250 million from 2023 to 2027 to support the manufacturing of plant,

[89] ACIL Allen (2022)
[90] Stakeholder interviews
[91] IEA (2021)

equipment, and processes needed to produce renewable energy and low carbon products. Internationally, significant subsidies have been used to develop local renewable energy manufacturing industries. For instance, in the US, the Inflation Reduction Act (2022) has provided significant support to the clean energy sector with $3 billion p.a. in manufacturing subsidies for clean technologies (batteries, wind and solar) and $15 billion p.a. in tax credits to support the production of clean energy (wind, nuclear and solar). In response, the European Union have established a €250 billion green subsidy scheme to boost renewable energy investment in a Green Deal Investment Plan. Additionally, the UK government has established supply chain growth schemes - Fit 4 Offshore Renewables and the Offshore Wind Growth Partnership - to increase the competency capability and cost competitiveness of the UK offshore wind supply chain (see section 4.3).

5.1.2 CAPACITY

While localisation will drive benefits for NSW, business capacity needs to be grown significantly before localisation is possible. Currently, many businesses who potentially could service the renewable energy sector do not have the capacity to do so. Limitations include steel production and fabrication for wind towers and pipe and tubing manufacturing for solar. For localisation to be viable, local suppliers need to invest significantly to build capacity to meet the volumes required in the roll out, be able to deliver quality goods and services, deliver on time, and be able to meet demand requirements. Suppliers also need to build their reputation in the renewable energy market to ensure developers have confidence in their supply. Some industry participants have suggested that strengthened local content requirements would give them more certainty regarding future revenue, so they would feel confident to make the investment required to grow capacity.

While the Renewable Manufacturing Fund may support a capacity uplift, government should consider also providing clear signals to the market regarding local content requirements and related policies to enable investment decisions. For instance, the UK's Offshore Wind Sector Deal (2019) has demonstrated the country's long-term commitment to industry development, setting a clear path forward for the industry with investment of up to £250 million and commitment of 60% local content by 2030 (see section 4.3).[92]

It is important that government gives certainty to the sector as soon as possible. In manufacturing, it is estimated to take 12 to 18 months to establish facilities after an investment decision is made.[93] Therefore there is a significant lag between the time that government clarifies its intentions regarding local content requirements and the time that suppliers are ready to support renewable energy projects.

Capacity tipping point within China's wind turbine manufacturing

Local content requirements can be used to support an infant industry develop but may not be required once the industry reaches a tipping point in which it reaches maturity. In China, local content requirements enabled the growth of local wind turbine manufacturing from 2003 to 2011. During this period, foreign manufacturers largely left the market, creating space for local industry to grow. With the removal of local content requirements in 2011, foreign manufacturers returned and facilitated knowledge transfer to improve the quality of local production, demonstrating a key tipping point for local content.[94]

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[92] UK Government (2020)
[93] ACIL Allen (2022)
[94] OECD (2015)

Additionally, to ensure the long-term viability of the industry, government should support domestic R&D to build on local technology and innovation. R&D can be used as a measure to facilitate knowledge transfer between global and local industry. One lever to build domestic R&D base is to set minimum R&D targets within local content requirements. R&D minimum requirements have been integral to successful localisation of supply chains internationally. For example, Norway's R&D specific local content requirements established the country's technological competitive advantage in parts of the oil and gas sector (see section 4.4). Furthermore, establishing domestic R&D skills and capabilities can have spill over impacts to technologies in other industries such as space, medical products, resources technology and critical minerals processing as evidenced in Australia's defence industry (see section 4.6).

5.1.3 CAPABILITY

Significant skills shortages exist across Australia, particularly in the regions. In the NSW REZ zones, there is a shortage of critical skills for trades and professions including, electricians, trades, technicians, labourers, and management professionals.[95] More broadly, Australia is facing a national shortage in occupations key to the renewable energy transition, with 43,200 (51%) of the 85,000 workers required by 2030 in occupations facing a national shortage (see Figure 23).

Furthermore, stakeholder interviews have highlighted the shortfalls in the suitability of current apprenticeship programs for the delivery of renewable energy specific training and on-the-job experience. Typical apprenticeships take 3 to4 years to complete, however, renewable energy projects run to shorter timeframes, between 1to 2 years, making them less suitable for the traditional apprentice training model.[96]

Government support is required to increase the supply of skilled workers, so that localisation does not have the unintended consequence of drawing skilled workers from existing industries, exacerbating shortages. For example, Australia's defence industry has streamlined governance of industry skills issues with a National Defence Industry Skills Office that work to define industry skills needs and provide a pathway forward (see section 4.6)

Government should also investigate alternative apprenticeship models such as group training organisations which can enable apprentices to rotate through various projects to enable more apprentices to work on renewable energy projects.[97]

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[95] SGS and UTS ISF (2022)
[96] Ibid.
[97] Stakeholder interviews

Figure 23: National workforce shortage across occupations key to the renewable energy transition, projected to 2030

	Occupation	Jobs required by 2030 *000s of jobs*	Current national shortage[1]
Higher skilled	Electricians	10.4	Shortage
	Engineering professionals	7.9	Shortage
	Other technicians and trades workers	4.9	Shortage
	Construction, distribution and production managers	4.7	Shortage
	Building and engineering technicians	3.6	No shortage
	Mechanical engineering trades workers	1.6	Shortage
	Other[2]	16.0	N/A
Lower skilled	Mobile plant operators	5.6	Shortage
	Other Labourers	5.2	No shortage
	Construction and Mining Labourers	4.9	Shortage
	Truck Drivers	2.1	Shortage
	Machine operators	1.1	No shortage
	Stationary plant operators	1.1	Shortage
	Other[2]	13.1	N/A
	Total	85.0	

Note: 1: The 3-digit occupation is classified as a shortage if most occupations at the 4-digit level are in shortage; 2. Other category includes 89 other 4-digit occupations that comprise of 38% of the renewable energy workforce
Source: 2022 Skills Priority List, *National Skills Commission* (2022), ABS, Burning Glass Data, VOCSTATS, DESE Higher Education statistics, Accenture Analysis of Climateworks data

6. CONCLUSION

Localising renewable energy supply chains in NSW has the potential to deliver strategic benefits to NSW and Australia. These benefits include a reduction in the probability of delays, due to both reducing the likelihood of supply chain disruptions and reducing community opposition and reducing embodied emissions of key inputs into the roll out.

Furthermore, localisation will have economic benefits These are significant, with up to 23,200 additional employee years in NSW between 2020-21 and 2040-41 and an increase to gross state product of up to $1.3 billion.[98]

However, benefits need to be considered alongside the potential risks and costs associated with localisation. Policies to encourage localisation need to consider any unintended consequences – particularly if they may pose a risk to the broader electricity infrastructure roll out.

Policies to support localisation should focus on three key outcomes:

- overcoming the cost disadvantage that Australian suppliers face compared to their international peers,
- building domestic capacity to ensure it can effectively serve the bespoke needs of the rapidly growing renewable energy sector, and
- building domestic capability by growing the number of skilled workers who can supply the labour required for the roll out.

Beyond the modelled economic and strategic benefits, overcoming the cost, capacity and capability challenges to enable increased localisation could have longer-term benefits to Australia due to diversifying the industrial base and increasing economic activity.

[98] ACIL Allen (2022)

7.APPENDIX

Stakeholder consultation summary

15 stakeholder interviews were conducted over the course of the project with representatives from renewable energy developers, suppliers, unions, relevant government departments. Key insights from these interviews have been considered in the analysis of the strategic benefits of local content in the report. Interviewees provided insight into current use of local content, supply chain vulnerabilities, barriers to establishing local content, perspectives on the strategic benefits of local content, opportunities for increased local content and perspectives on policies to increase the use of local content. Stakeholder consultations were used as inputs into modelling and validate outcomes.

#	Stakeholder	Key insights
1	Developer	**Current use of local content** • ~80% of capital is currently sourced internationally (panels, trackers, inverters), whilst ~20% sourced locally (copper cables, bespoke structures) • Most Chinese manufacturers now have secondary facilities in South East Asia that you can choose over Chinese locations • Australian suppliers are ~30-35% more expensive than international, for example, Australian steel pylons are rarely cost competitive • Australian steel is ~2.5x more expensive than China and ~3.2x more expensive than US (largely due to IRA subsidies) • Steel is an opportunity where local content could be increased with the support of pointed subsidies as well as cables with more of a push from the green metals sector (however, this would be ~10 years further down the track) **Supply chain vulnerabilities** • Supply chain disruption during COVID caused a 25% delay to project timelines (approximately 6 months of a 2 year project) • Projects generally run 10% over time, largely due to driving tighter timelines from contractors • Critical components that drive delays are currently invertors and transformers. Solar panels are ubiquitous and fast to deliver due to capacity and diversity in the market **Perspective on strategic benefits of using local content** • Some key benefits of using Australia suppliers is that you are negotiating with common law and have shared values and therefore dispute resolution is easier to handle
2	Supplier	**Current use of local content** • Offshore wind foundations production capacity is being overridden by demand in Europe, resulting in a need to look at other locations such as Australia for production • Setting local content requirements early is necessary as it will provide more confidence to foreign investors regarding Australia's pipeline

		• Offshore wind foundations are 30-40% more expensive to be produced in Australia **Barriers to establishing local content** • Key barriers to establishing offshore wind in Australia include; infrastructure and site access, competition for port-side land posed by hydrogen and materials (e.g. steel) **Perspective on strategic benefits of using local content** • Key benefits of localising offshore wind is the substantial regional job creation and economic activity at ports • Industry working groups are needed to build connections and learning between local and global companies
3	Supplier	**Current use of local content** • Supplied [components] for 15,000 turbines to date, ~50% of wind turbines in Australia • Official supplier to [EPC], however, their global procurement strategy does not focus on local and therefore do not use Australian [components]. [EPC] have said this will only change if the government mandates local • Australian steel is used over steel from other Tier 2 mills overseas in China and India that are more price competitive because customers require Australian certified steel **Barriers to establishing local content** • Key benefit of local production and assembly of [component] is faster delivery times due to pre-assembly • Local content requirements for steel should be increased gradually to targets that can be met. • Lessons to be learnt from Victoria's local content requirements whereby requirements were set too high and has created the view amongst OEM and developers who worked on VRET 1 and VRET 2 that Australian manufacturing can't keep up **Perspective on strategic benefits of using local content (environmental impact)** • According to a study commissioned by the company, [components] produced in Australia have 48% lower embedded carbon emissions than overseas equivalents
4	Industry expert	**Perspectives on policies to encourage use of local content** • Importance of group training organizations. • Need for improved safety practices and higher wages. • Collaborative efforts between EPCs, developers, unions, and smart energy councils to reach agreements. • Movement of apprentices between employers. • Targeting 4th year apprentices and aligning training modules with RE requirements. • Barriers faced by employers who wish to employ apprentices. • Existence of training packages but lack of enrolment in relevant electives.

5	Industry expert	**Supply chain vulnerabilities** • Categorisation of delays into minor, medium, and major, discussing the critical points or tipping points that escalate a delay to a significant impact. • Potential impacts on providers and the need to capture longer delays • Risks associated with securing equipment supply, including businesses operating in multiple jurisdictions and locking in equipment before finalising project sites. • Relationship between demand and supply in terms of cost. • Lower costs due to local production and subsidies but raises concerns about higher expenses when relying on international suppliers. • Increasing vulnerabilities in interdependent systems, such as supply chains and energy infrastructure, due to factors like war, climate change, and policy shifts. Emphasising the need to account for these risks and plan for unpredictability. **Perspective on strategic benefits of using local content (social licence)** • Social licence is significant in driving up prices and causing delays • There is potential for local job creation and community benefits to improve social licence and mitigate delays • Value at risk could be used to analyse and communicate risks associated with timing and the potential impact on government ambitions. The focus is on the nervousness surrounding coal plant closures and the need to consider both value at risk and timing.
6	Industry expert	**Barriers to establishing local content** • Potential use of buying power to support local content and mentions companies looking to establish solar panel manufacturing facilities and targeting residential solar. • Limited market demand for renewable energy technologies in Australia and the need to look outside the country for growth opportunities and export. Companies are exporting because the local market is considered too small. • Lack of existing supply chains and the need for certainty in supply chains are discussed as challenges in the renewable energy space. • Scaling up operations is a challenge faced by ambitious companies until they secure offtake agreements. **Perspectives on policies to encourage use of local content** • The need for collaboration across Australia and potential roles for government in facilitating workforce and business transition, supporting regional teams, and managing social license issues is touched upon. • Need to help workers transition from industries like coal mining to new industries in the renewable energy sector • Importance of making people aware of renewable energy opportunities and how they can be part of the transition needs to be balanced with managing expectations and address different perspectives **Perspective on strategic benefits of using local content (social licence)**

		• The importance of social licence for the rollout of renewable energy projects was acknowledged, with economic impact, jobs, and managing public perception discussed as factors influencing social licence • Regional teams, local councils, and organisations working to support businesses and tackle challenges in the renewable energy sector
7	Industry expert	**Perspective on local content** • The need for local manufacturing of components for renewable energy infrastructure like solar racking and wind towers. • Barriers to local fabrication due to the requirement for specialised facilities and capacity. • Need to set clear local content requirements to provide market signals for suppliers to invest in local manufacturing. • The potential for co-locating supply chains near REZs to stimulate regional economies and create local jobs. • Reluctance from industry to develop wind farm facilities due to lack of trust in procurement processes. • Lower-risk investments in pipe and tub manufacturing compared to dedicated wind tower facilities. • Resistance and lack of cooperation in dialogue between industry and demand side regarding increasing local content targets • Supply Chain Logistics and Economics: 1. Proximity and logistics as an issue in importing wind towers versus local manufacturing. 2. Increased demand for fabricated steel due to renewable energy infrastructure projects. 3. Short-sightedness in considering strategic benefits of local manufacturing, including reduced vulnerability and increased responsiveness. **Perspective on strategic benefits of using local content** Quality and Standards: • Quality issues with imported steel and the need for confidence in the source of supply. • Variations in steel grade requirements and cost implications for matching specifications. • Deficiencies in plate size and grade for certain renewable energy projects. Social Licence and Community Impact: • Consideration of social license and community acceptance for establishing wind tower manufacturing facilities. • Potential impacts on local communities, real estate, and the need for long-term investments and maintenance. • Balance between community considerations and return on investment for manufacturers. **Barriers to establishing local content** • Challenges related to transportation of wind towers, limited road capacity, and issues with bridge height. • Upskilling and importation of skilled labor in areas where manufacturing facilities are established.

		• Discussion on job creation and potential redeployment of workers from mining and coal-fired generation to renewable energy projects.
8	Developer	**Barriers to using local content** Challenges with Local Suppliers: • Faced challenges when working with local suppliers in NSW. The sentiment is that local suppliers prioritise their own work rather than treating [developer] as their customers. The lack of support for REZs and unfamiliarity with solar projects are mentioned as hurdles. Experience and Scale: • The challenges with local suppliers are attributed to an experience and scale issue. • Developments outside NSW have been smoother and better due to a greater level of experience and scale. Cost and Quality: • Price disparity between local suppliers in Australia and overseas suppliers, particularly from China. • While the quality and commitment of Australian suppliers are praised, the higher prices make Australia less competitive. • The importance of cost, commitment, and quality is very important for key components like posts, panels, trackers, racking systems, cables, transformers, and combiner boxes. **Current use of local content** • Source various components from different countries, with panels primarily coming from China, while inverters, racking systems, and cables are sourced from India and China • There have been developments in tracker systems and fixed structures from the US, India, and China **Opportunities for increased local content** • Potential for local manufacturing of certain components such as combiner boxes, power conditioning systems, transformers, and SCADA (Supervisory Control and Data Acquisition) systems. • However, the dynamic nature of PV panels, inverters, and racking systems makes local manufacturing less likely **Barriers** • Risks and Challenges: The rollout of solar farms faces several risks and challenges, including construction complexities, labor shortages, skill requirements, and logistical difficulties, especially in remote areas. The example of government support for infrastructure in Abu Dhabi was mentioned as a positive practice. • The regulatory environment in Australia is described as strict, which is seen as necessary but potentially slowing down the process. Improvements have been observed since 2019, but there is a call for collaboration between AEMO, ASPs, and construction companies to expedite the process. **Supply chain vulnerabilities**

<table>
<tr><td></td><td></td><td>Issues such as price increases leading to delayed shipments, reduced shipping availability, and air freight problems are mentioned. These delays have a significant impact on project timelines, as one day of delay equates to one week of delay in construction.
Challenges of quarantine inspections, where containers go through checks, and delays can occur due to the detection of snails, affecting the flow of shipments.</td></tr>
<tr><td>9</td><td>Developer</td><td>Supply chain vulnerabilities /risk
Different components have different levels of risk depending on where they are going
The impact of the Industrial Relations Act (IRA) in the US on manufacturing capacity, with investments being made in cell manufacturing, blade manufacturing, and tower manufacturing.
Blades and towers currently come from China – could be a geopolitical risk if Australia puts restrictions on Chinese imports
Opportunities for local content
Components that are site specific or service parts for maintenance and replacement
However, the organisation has had negative experiences dealing with local suppliers of wind towers
Importance of standardisation in order to be successful in Australia
Opportunity for skilled service jobs and localising the maintenance of wind components
Barriers
Challenges faced by Australia in being competitive in tower and blade manufacturing and emphasises the need for standardisation in order to succeed in the market.
The inexperience and lack of maturity in managing the supply chain of local suppliers
Need to bring in experienced suppliers rather than smaller local businesses
Concerns about the division of the wind market within local regulatory requirements, creating multiple markets with different goals and potentially slowing down the energy transition in Australia.
Creating a market division within local regulatory requirements is concerning – creates 5-6 different markets for developers to comply with
Building a local plan in what is a global business will only create different goals and will slow down ability for Australia to deliver on the energy transition</td></tr>
<tr><td>10</td><td>Developer</td><td>Barriers

Capacity constraints:
The Australian market faces capacity constraints in various areas, such as wind turbine manufacturing, solar module production, and battery cell and enclosure manufacturing. The limited availability of reputable wind turbine manufacturers and utility-scale solar modules in Australia poses challenges for developers.
Desire to increase the percentage of local content in their projects. However, developers cannot legislate this themselves and believe</td></tr>
</table>

		that government regulation is needed to support local companies and provide a steady pipeline of projects. **Supply chain vulnerabilities / risks** Risks associated with key components: • Turbines, blades, towers, and gearboxes are highlighted as key components with potential risks. • While OEMs manage a portfolio of suppliers and have diversification, suppliers are overwhelmed with demand, leading to concerns about supply chain disruptions. • Challenges with Australian towers: Australian towers are perceived as more expensive and slower compared to international quality standards. Small pipeline capacity and limited scalability are cited as reasons for these challenges. • Supply chain disruptions: Supply chain disruptions, such as conflicts or events like the COVID-19 pandemic, can have significant impacts on project delivery. The availability of all components is crucial for smooth project execution. **Perspective on strategic benefits of using local content (social licence)** Community opposition to projects: • While historically the company hasn't faced significant community opposition, there are occasional instances of opposition. • Projects perceived as part of a government rollout tend to encounter greater opposition. • localising projects may not necessarily mitigate community opposition, as it can create additional issues in small towns, such as rent increases. **Perspectives on policies to encourage use of local content** Need for realistic local content targets: • Increasing local content requirements without considering the feasibility and capacity of local suppliers may be pointless and discourage developers. • Realistic targets that align with supplier capabilities are more likely to be met. Considerations for local supplier relationships: • OEMs prefer to work with established suppliers with whom they have existing relationships and economies of scale. • Developing new local supplier relationships would require additional resources and may not necessarily be easier for developers. Incentives for local manufacturing: • While there is a desire to make components locally to ensure a more secure supply, the Australian market poses challenges, and it may not be easier for developers to use local suppliers.
11	Industry expert	**Barriers**

		• Three key barriers to localising renewable energy projects: cost of the rollout and its impact on energy consumers, capability and capacity in terms of workforce and skills, and availability of housing and infrastructure in the project areas. • Challenges related to workforce development, skills deficit, and housing shortage in areas where renewable energy projects are being implemented. Mention of the "boom town effect" and the need for long-term community investment. **Perspective on strategic benefits of using local content** Maintenance and Job Creation • Potential for sustainable jobs in the long term, particularly in offshore wind projects, but also notes the need for skilled personnel to support the growing renewable energy sector. Social Licence and Community Engagement: • Importance of social licence and community engagement for developers in the renewable energy sector. • Need for developers to improve their understanding of community engagement, including interactions with First Nations people, and the importance of effective communication. • Supply Chain and Local Sourcing: factors that drive decisions in sourcing the supply chain for renewable energy projects, including availability, compatibility with project technologies, cost, quality, and supply certainty.
12	Supplier	**Current use of local content** • Civil works and design take place in Australia • Batteries manufactured in the US • Transformers manufactured in China, Vietnam, Turkey or India • Some local suppliers of transformers used to supply projects • Switch gear manufactured in Germany and China • Cables come from overseas • Building suppliers and switch room and control room can be local • Control equipment and network equipment most comes from overseas **Perspective on strategic benefits of using local content** • Local suppliers can mitigate risks associated with freight and supply chain issues. **Supply Chain Vulnerabilities** • Long lead items and critical components, such as switch gear, protection relays, and main power transformers, are identified as potential vulnerabilities in the supply chain. • Booking Chinese suppliers in advance is necessary due to the limited capacity of local suppliers. **Barriers to localisation** • Challenges of competing with global companies for suppliers and the potential risks of relying on smaller suppliers • Highlighted the potential impact on quality and the need to meet targets on time

		• The market's response to the increasing demand and the expansion of bigger companies are considered. It is mentioned that constraints may be felt in a couple of years, similar to the situation in the US where tier 1 companies have been exhausted
13	Supplier	**Perspectives on policies to encourage use of local content** • The organisation is seeking government funding through the Modern Manufacturing Initiative • Reasonable local content requirements for wind energy projects would encourage investment • The organisation is working on business plans and evaluating the financial viability, ongoing demand, and potential for exports. • The effectiveness of minimum requirements varies. Solar projects have seen higher compliance rates, while the wind energy sector falls short. The lack of capacity and uncertainty in meeting local content requirements can lead to disruptions, congestion, and social licence issues. • The urgency to address the need for local capabilities is emphasised, with calls for greater recognition by REZ boards and tender processes. **Customer demands and co-location** • The organisation is exploring co-location opportunities with REZs.
14	Industry expert	**Opportunities to localise supply chains** • Refining of minerals for batteries. • Exploring potential areas for local manufacturing, such as refining minerals for batteries, manufacturing components of PV panels, wind turbines, and green hydrogen production and manufacturing parts of electrolysers • Industry pivoting: Highlighting examples of manufacturing companies successfully pivoting their operations during the COVID-19 pandemic to meet emerging renewable energy demands. • Defense sector as a model: Drawing lessons from the defense sector's approach to industry development, including working with primes and SMEs and setting local requirements. **Barriers to localisation** • Challenges in delivering certain components of the supply chain locally, particularly in offshore wind turbines. • Emphasised the importance of onshoring capabilities to reduce reliance on global supply chains and mitigate risks associated with the rollout of renewable energy zones. • Addressing the need for sustained local demand to attract manufacturers and create a viable business case for onshore production. • Emphasised the importance of strategic coordination and consistent industry policies between different levels of government to support the growth of the renewable energy manufacturing sector. • Identifying vital skill gaps in regional areas and the need for consideration of new visa policies to address labor shortages in the sector **Perspectives on policies to encourage use of local content**

		• Market signals and social license: recognising the significance of market signals, local content requirements, and community support in attracting international companies and building social acceptance for renewable energy projects. • International investment and trade opportunities: Exploring the potential for foreign investment and export opportunities in the Asia-Pacific region, considering the advantages of Australia's government and business infrastructure. • Promoting opportunities: the need to maximise opportunities through targeted marketing, participation in industry events, and promoting specific business prospects aligned with renewable energy targets.
15	**RESB board member**	**Barriers to localisation** • The shortage of skilled workers in the renewable energy sector is identified as a challenge. The need for workforce training and transitioning workers from other industries, such as the coal industry, is a potential solution. • Barriers and levers to local manufacturing: Various barriers to local manufacturing are discussed, including cost, competition with other states, and the impact of globalisation on supply chains. The need for appropriate policies and industry collaboration is highlighted as key levers to promote local manufacturing. • Time requirements and scalability: time requirements for building a local manufacturing industry and the potential for defense companies with capabilities in Australia to shift into the renewable energy sector. Scalability and the need for a skilled workforce are considered essential factors. **Strategic benefits and opportunities** • The strategic benefits of local manufacturing in terms of quality, job creation, and export opportunities are emphasised. The discussion also touches on the potential for companies to diversify into other sectors, such as defense, and the importance of government support and grants. • Social licence and community support: The importance of gaining social licence and community support for renewable energy projects is highlighted. Industry groups and networks are mentioned as valuable in engaging with local communities and addressing concerns related to mining and other industries. **Policies to increase localisation** • Enablers and challenges: The enablers discussed include financing, workforce development, policy support, and tracking progress. The challenges mentioned include the delta of disruptions to the supply chain, awareness of programs, and overcoming community opposition in certain regions. • Alignment and collaboration: The need for alignment between various stakeholders, such as industry, universities, and government, is highlighted. Collaboration and coordination are seen as crucial for the successful development of the renewable energy supply chain. • Focus on higher education and research: The potential role of universities in developing technology and conducting research is discussed as an opportunity for the renewable energy sector.

		• Role of universities and R&D: The text mentions the potential role of universities in research and development (R&D) for the renewable energy sector. Collaborating with universities and investing in R&D is seen as crucial for technology development and innovation.

Detailed methodology

CARBON EMISSIONS REDUCTION

Tables A1-A4 include the key variables used in the emissions modelling. In modelling, values from China (incumbent) and Australia were compared to identify potential reductions in emissions.

Table A1: Emissions modelling variables for steel

Variable	Country	Value	Unit	Source
Blast furnace emissions factor	Australia	2.01	tCO_2e/t	Weighted average based on Bluescope Climate Action Report and Safeguard Mechanism reporting
Electric arc furnace emissions factor	Australia	0.73	tCO_2e/t	InfraBuild Sustainability Report 2022
Blast furnace emissions factor	China	2.4	tCO_2e/t	A. Hasanbeigi, *Steel Climate Impact: An International Benchmarking of Energy and CO2 Intensities* (2022)
Electric arc furnace emissions factor	China	1.41	tCO_2e/t	A. Hasanbeigi, *Steel Climate Impact: An International Benchmarking of Energy and CO2 Intensities* (2022)
Scope 1 : Scope 2 factor blast furnace	Australia and China	80%	%	Bluescope Climate Action Report 2022, validated by expert interviews
Scope 1 : Scope 2 factor electric arc furnace	Australia and China	25%	%	InfraBuild Sustainability Report 2022, validated by expert interviews
Share of steelmaking by blast furnace	Australia	73%	%	World Steel Association 2022

Share of steelmaking by blast furnace	China	89%	%	World Steel Association 2022

Table A2: Emissions modelling variables for aluminium

Variable	**Country**	**Value**	**Unit**	**Source**
Smelting emissions factor	Australia	12.66	tCO_2e/t	Australian Aluminium Council
Smelting emissions factor	China	15.95	tCO_2e/t	Peng et al, *Life Cycle Energy Consumption and Greenhouse Gas Emissions Analysis of Primary and Recycled Aluminium in China* (2022)
Scope 1 : Scope 2 emissions factor	Australia	15%	%	Australian Aluminium Council
Scope 1 : Scope 2 emissions factor	China	12%	%	Peng et al, *Life Cycle Energy Consumption and Greenhouse Gas Emissions Analysis of Primary and Recycled Aluminium in China* (2022)

Table A3: Emissions modelling variables for copper

Variable	**Country**	**Value**	**Unit**	**Source**
Smelting emissions factor	Australia	1.4	tCO_2e/t	IEA, *Average GHG emissions intensity for production of selected commodities* (2022)
Smelting emissions factor	China	1.4	tCO_2e/t	IEA, *Average GHG emissions intensity for production of selected commodities* (2022)
Scope 1 : Scope 2 emissions factor	Australia	15%	%	IEA, *Average GHG emissions intensity for production of selected commodities* (2022)
Scope 1 : Scope 2 emissions factor	China	15%	%	IEA, *Average GHG emissions intensity for production of selected commodities* (2022)

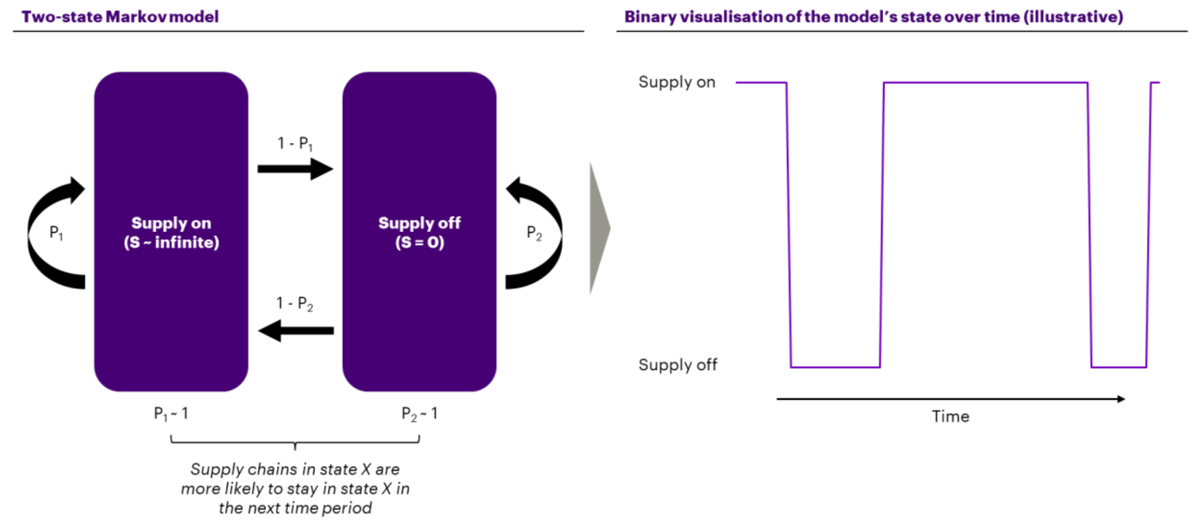
Table A4: Emissions modelling variables for transport

Variable	Value	Unit	Source
Transport emissions factor	12.7	gCO_2e/t-km	CN, Carbon Calculator Emission Factors (2021)

SUPPLY CHAIN DISRUPTIONS MODEL

The method taken to model the likelihood and duration of logistical delays in renewable energy supply chains utilised the UTS ISF and SGS supply chain maps for solar, hydro and batteries (see Figure A1). These maps were used to create a system of nested Markov models which combine to identify value and time-risk of disruptions. The Markov model used is two-state to measure supply disruptions with supply being in an 'on' state or an 'off' state.

Figure A1: Two-state Markov model



Source: Accenture analysis

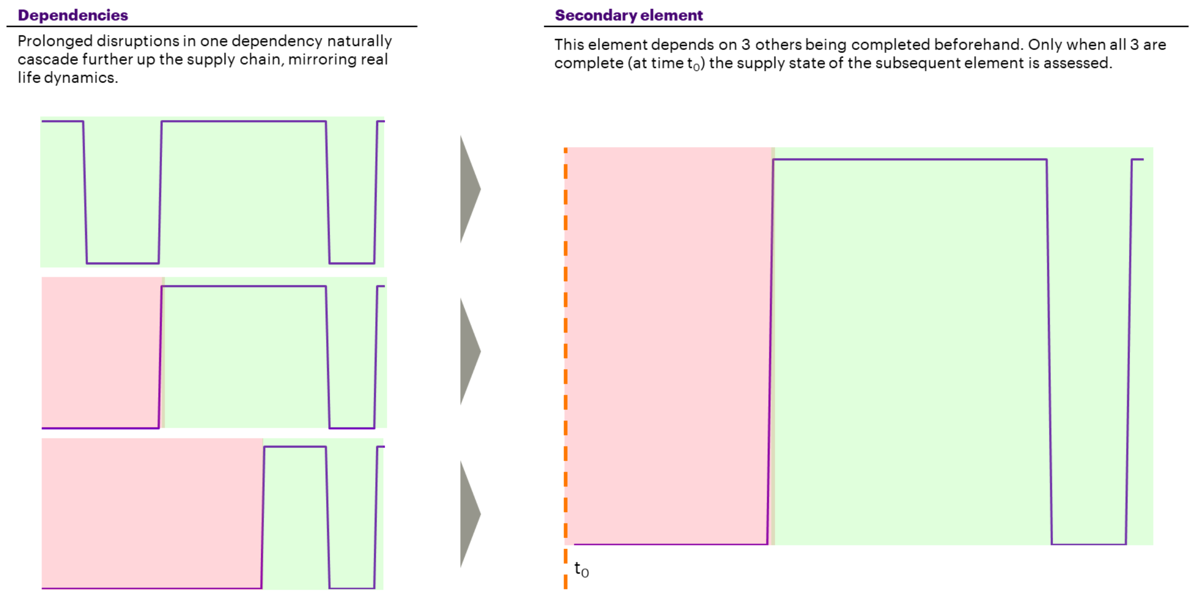
Each base level input within the supply chain map for respective renewable technologies has been treated as a separate supply variable in the model. These inputs create a condition on the next level of the supply chain, for example, in Figure A1, only when lithium, separators, cell casting electrolytes are ready can the battery cell be produced. The system of Markov models then simulates a dynamic supply chain which can be affected at any stage – once all branches reach the construction phase, the supply chain element of the model is considered complete.

The supply chain inputs labelled as 'NSW capacity' or 'NSW opportunity' will feature a difference in 'on' and 'off' probabilities. These two categories of inputs form path A and path B scenarios in the model respectively.

Components of the supply chain that are localised will initially be assumed to have a strong, distributed local presence – this implies that the likelihood of a disruption is lower, and the duration of the interruption (i.e. likelihood of the situation remaining disrupted) is also lower.

The model mimics just-in-time manufacturing, and therefore a supply chain input can only be assessed once all dependencies are considered (see Figure A2). Prolonged disruptions in one dependency naturally cascade further up the supply chain, mirroring real life dynamics. The secondary element depends on 3 others being completed beforehand. Only when all 3 are complete (at time t_0) the supply state of the subsequent element is assessed. For example, if three different elements of a battery cell are delayed, the consequent elements are not measured. Subsequently when all of the elements of the battery cell arrive, and the battery manufacturer is shut down for a period of months. Both the time taken for the elements to arrive and the shut down time period are measured.

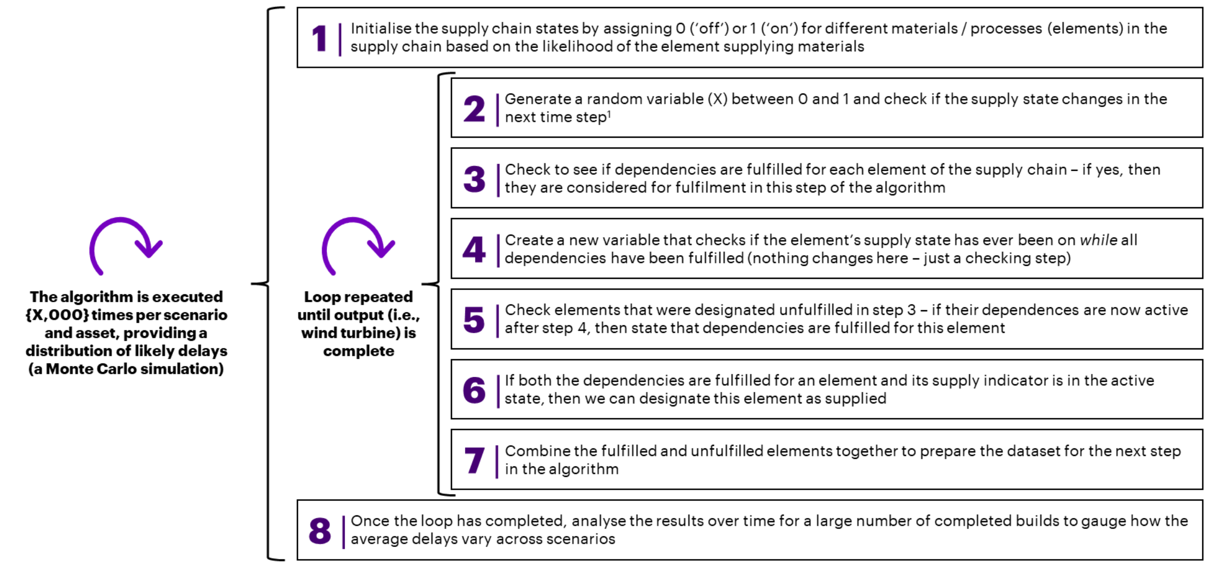
Figure A2: Two-state Markov model



Source: Accenture analysis

To model these dependencies. A custom Monte Carlo algorithm with specific inputs based on the respective RE technology supply chain. See the steps to implement the Monte Carlo algorithm in Figure A3.

Figure A3: Monte Carlo algorithm



Source: Accenture analysis

Notes: 1. If $X > p_i$ then the two-state system describing the element will change states, if $X < p_i$ then the element will stay in the same state. Typically, p_i is close to 1, implying that an element in a certain state is most likely to remain in that state in the next time step.