Hunter Renewable Energy Industrial Precinct

BRIEFING PAPER — APRIL 2022

Recognition of traditional custodians

We recognise that the sovereignty of Aboriginal and Torres Strait Islander peoples over their land was never ceded and the impact of this ongoing dispossession continues to this day.

Beyond Zero Emissions stands in solidarity with First Nations people in calling for the establishment of a First Nations Voice in the Constitution, as described in the Uluru Statement from the Heart. We further support calls for the establishment of a Makarrata Commission on agreement-making and truth-telling between Aboriginal and Torres Strait Islander peoples and governments.

Beyond Zero Emissions maintains an office in Melbourne on the traditional lands of the Wurundjeri-willam people of the Kulin Nation, and in Newcastle on the lands of the Awabakal and Worimi peoples. We pay our respects to all First Nations Elders past, present and future.

Beyond Zero Emissions Inc. is a registered charity, based in Victoria with a national outlook.

Beyond Zero Emissions is listed on the Commonwealth's Register of Environmental Organisations ('Beyond Zero Emissions Fund'), which allows organisations to be endorsed as Deductible Gift Recipients by the Australian Taxation Office.

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The **Hunter Renewable Energy Industrial Precinct Briefing Paper** is the result of extensive consultation with stakeholders in the Hunter region in 2021 and 2022, and a Beyond Zero Emissions' analysis of a precinct's energy requirements and industrial ecosystem.

An investor roundtable hosted by Beyond Zero Emissions and Climateworks Centre, with attendees representing $2.7 trillion in capital, found strong investor appetite for Renewable Energy Industrial Precincts. These investors are now seeking the long term certainty of bipartisan federal support and funding.

This briefing paper shows the enormous scale of renewable powered industries that could be developed as part of a Hunter Renewable Energy Industrial Precinct, including the build-out of new renewable energy and electrical infrastructure over the next ten years.

Beyond Zero Emissions and WWF-Australia prepared a pre-budget submission for FY22-23 that detailed how government investment in Renewable Energy Industrial Precincts leverages many more times the value from the private market. The current support for regional diversification of only $200m in the Hunter must be greatly expanded to fully capitalise on the opportunity ahead.

Essentially, a Hunter Renewable Energy Industrial Precinct is the region's best jobs and investment opportunity, capitalising on existing skills and infrastructure. It is central to realising Australia's $333bn/year potential in renewable energy exports and ensures the Hunter will remain prosperous in the global move to zero emissions.

Executive summary

For 200 years, the Hunter region of New South Wales has been a powerhouse of Australian mining and energy exports. In fact, Australia's first export commodity left from the Port of Newcastle as a shipment of coal bound for India in 1799. The region is also well known for manufacturing, and energy-intensive industries such as aluminium and steel.

Today the region is writing a new chapter in this proud history as an industrial and energy superpower. Establishing a Renewable Energy Industrial Precinct (REIP) in the region will support the Hunter's ambition to diversify its economy and realise its full potential in the zero-emissions economy.

Economic modelling by ACIL Allen commissioned by Beyond Zero Emissions and WWF-Australia demonstrated that a dedicated Renewable Energy Industrial Precinct in the Hunter has the potential to:

- unlock new capital investment of $28 billion
- create 34,000 new ongoing local jobs in new manufacturing and service industries
- generate $11 billion in revenue per annum by 2032[1]
- protect existing manufacturing activities and the jobs they provide by repowering them with renewable energy

Significant benefits will also flow to sectors beyond industry, providing low-cost, firmed renewables for households, transportation and support for the broader grid.

The complete decarbonisation of all existing industries in the Hunter (including Tomago Aluminium and Orica, and new green steel plants) requires approximately 22 GW of renewable generation – comfortably covered by the 29 GW in generation capacity potential of adjacent Renewable Energy Zones, of which 17.8 GW is already announced.

Many businesses are moving ahead. Industry-leading green manufacturing in the Hunter today includes MGA Thermal bricks, 3ME Technologies lithium-ion batteries for heavy vehicles, Kardinia Energy's printed solar film, Allegro Energy's redox flow batteries and supercapacitors, and Diffuse Energy's high powered wind turbines. There is also a burgeoning cleantech sector, with companies such as Saphi Engineering that integrates hardware to software solutions and SwitchDin that aggregates rooftop solar and storage to build virtual power plants.

Precincts and manufacturing hubs focused on decarbonisation are developing across the region, at the Port of Newcastle, the AGL Liddell site, in Muswellbrook, and there is a locally led Net Zero Hunter initiative. The NSW Government's Clean Manufacturing Precinct (CMP) initiative has encouraged collaboration and focused attention on low carbon industrial ecosystems.

Regional coordination of this diverse range of activity and job creation through a Renewable Energy Industrial Precinct will mean shared infrastructure and access to a growing knowledge base. Importantly, it represents an opportunity to build the manufacturing workforce of the future.

Newcastle Harbour

This briefing paper details the building of a renewable energy backbone for industry in the Hunter and the transmission and storage requirements of a Hunter REIP, with industries such as green aluminium, green steel, niche batteries and storage, cleantech, hydrogen, offshore wind and electrolysers at its foundation.

Building new transmission capacity for the full 22 GW to power industry needs would require an investment of $8.5 billion.[1] If the Hunter REIP adopts flexible operations, a storage investment of $3.7 billion is required. Our analysis shows there is investment interest in this scale of projects already announced in the Hunter (1.5 GW, 7 GWh), but they need the right government support to lock in these commitments.

Federal investment will scale and amplify the existing manufacturing base and signal to the private sector that the Hunter is a secure investment. Beyond Zero Emissions and WWF-Australia prepared a pre-budget submission for FY22-23 that shows a federal government investment of $6.3 billion in seven REIPs across Australia including the Hunter over the next decade would likely attract a $37.8 billion in private investment with the additional support of state governments and public sector financing.

A Hunter REIP will bring together existing capabilities, infrastructure and assets to enable the region to reap extraordinary benefits from the structural change caused by a global shift to a low carbon economy. By becoming a zero-emissions manufacturing hub, we can secure the continuation of Hunter's reputation as a global force in energy.

This briefing paper has been produced by Beyond Zero Emissions, based on our internal research and publicly available research, consultation with industry, unions, local, state and federal government departments and research institutions.

Figure 1: Some of the Hunter-based manufacturers, energy generators and industry associations that have provided a statement of support for a Hunter REIP to date

Hunter Renewable Energy Industrial Precinct

A Renewable Energy Industrial Precinct (REIP) is a cluster of industries powered by affordable 100% renewable energy (including for heating requirements), minimising the cost of shared infrastructure and benefiting from economies of scale and efficiencies.

A Hunter REIP will support energy-intensive businesses such as green aluminium and steel, hydrogen, ammonia and chemicals production, recycling and battery manufacturing. It will also provide a home for Hunter manufacturers of clean technologies such as wind turbines, electric vehicle chargers, batteries and mining equipment.

The Hunter offers many advantages for establishing a REIP, including:

- Established, export-focussed industrial sector
- Large, skilled workforce
- Strong trade relationships with Asia, especially Japan, Korea and Taiwan
- Excellent legacy air, rail and transmission infrastructure and a deepwater port
- Access to Renewable Energy Zones and within a Renewable Energy Zone
- Hydrogen Technology Cluster and Hydrogen Hub and private sector hydrogen development
- State Government commitment to decarbonisation
- High quality research institutions with strong ties to industry
- Culture of innovation

Sophisticated capital markets are looking for investments with exactly these elements, and the high Environmental Social and Governance (ESG) standards of the REIP.

Access to quality renewable energy resources is key to establishing a Hunter REIP. The NSW Government's Net Zero Plan[2] is implementing its Renewable Energy Zones (REZs) across the state, including in the Hunter, which has attracted the most projects and private sector interest. Power can also be sourced from the Central West Orana and New England REZs, as well as from offshore wind projects. Local procurement can maximise local supply chain opportunities.

Economic modelling by ACIL Allen commissioned by Beyond Zero Emissions and WWF-Australia showed the impact a REIP could have on the Hunter. The modelling retained the existing industries of steel, aluminium and chemical production and included new industries such as battery manufacturing, green hydrogen, renewable steel, resource recovery and low carbon building materials.

The modelling found that a Hunter REIP would:

- create 34,000 new, ongoing jobs in manufacturing and service industries by 2032
- attract new capital investment of $28 billion
- generate $11 billion in revenue per annum by 2032[1]

A new economic reality

Australia's export markets are being driven at a rapid pace towards net zero products with our top five export markets (China, Japan, South Korea, US and the EU) all setting net zero targets. These ambitious policy settings drive up demand for products made with renewable energy, and drive down demand for products made with fossil fuels.[3]

Australia's fossil fuel exports are exposed to collapsing demand as the world rapidly pivots to a zero-emissions future. Nearly 40% of Australia's total commodity exports are fossil fuels in the form of coal, oil and gas. Over the next two decades Australia will lose a third of total commodity export revenue and the jobs that go with them unless significant policy shifts are made to unlock investments in new export industries.[3] There is an urgent need to support regional economies to prepare and enable their resilience.

Green credentials are now an important part of doing business across sectors and whole industries. Major global brands such as BMW, Volvo and Ikea are introducing strong targets to reduce emissions in supply chains, and are acting on them. Sweden has led the way on fossil-free steel[4,5] and now Volvo has manufactured the world's first fossil-free vehicle.[6] The Glasgow Breakthrough on Steel[7] signed at COP26 aims for near zero emissions steel to be widespread across the world by 2030.

As the Hunter experiences such dramatic economic structural change,[8,9] communities and businesses in the region are looking to government to recognise the scale of the challenge and back the Hunter to adapt and thrive as a global energy hub into the future. [9,10]

Consultation conducted by Beyond Zero Emissions led to more than 40 local organisations expressing support for a Hunter REIP. These include Ampcontrol, Molycop, 3ME, BME, Concrush and TW Woods. A full list of public supporters is provided in Appendix 1.

Local institutions have also provided written support, including the Newcastle Institute of Energy and Resources, the Hunter Joint Organisation of Councils, the Committee for the Hunter, the Hunter Jobs Alliance, and HunterNet, a cooperative representing 120 members. The University of Newcastle-led Hydrogen Taskforce has included a Hunter REIP in its Hunter Hydrogen Strategy.

There are strong signs that the private sector already recognises the Hunter's potential in a zero emissions economy. A number of factories, hubs and precincts are in development, including:

- Macquarie Bank partnering with the Port of Newcastle and Idemitsu to develop a hydrogen hub at the port with a 40 MW electrolyser and $1.5 million funding from the Australian Renewable Agency (ARENA)[11,12]
- AGL planning to repurpose its Liddell power station site to become the Hunter Energy Hub with a number of partners including RayGen, Epuron and Fortescue Future Industries[13]
- Idemitsu/Muswellbrook Coal partnering with Energy Estate to develop green hydrogen assets in its old coal mine at Muswellbrook[14] where Idemitsu is developing a renewable energy hub integrated with complimentary industrial energy users.
- Energy Renaissance building a battery factory in Tomago[15]

Anchor industry Tomago Aluminium has indicated a shift towards 100% renewables by 2029,[16] and Orica has announced a 40% cut to emissions by 2030 and net zero by 2050.[17]

The Hunter is also fast becoming a centre of groundbreaking cleantech innovation. Game changing technologies are being developed, commercialised and manufactured, such as:

- MGA Thermal bricks
- Ampcontrol's Solar Cube, Gilghi and batteries for electric mining vehicles
- 3ME Technologies lithium-ion batteries for heavy vehicles
- Kardinia Energy's printed solar film
- Allegro Energy's redox flow batteries and supercapacitors
- Diffuse Energy's high-powered wind turbines
- Saphi Engineering integrating hardware to software solutions
- SwitchDin software aggregating rooftop solar and storage to build virtual power plants

It is a testament to the Hunter's culture of innovation and entrepreneurship that this diversification is already happening. Federal government support would provide the resourcing and coordination to leverage economies of scale and unlock the enormous potential of the greater Hunter region.

So far, the federal government has provided modest support for decarbonisation initiatives in the Hunter including:

- $1.5 million funding for the Port of Newcastle hydrogen study from ARENA[11]
- $100 million for early works in the Port's green hydrogen and ammonia project announced from the Regional Ministerial Budget[18]
- $9.8 million for Toshiba hydrogen manufacturing from the Modern Manufacturing Initiative (MMI)[19]

- $4.5 million for Batt Mobile Equipment (BME) from MMI[20]
- $15 million 3ME Technologies equity investment from the Australian Business Growth Fund[21]
- $200,000 seed funding for the NewH2 hydrogen cluster

The government's Activating Regional Hydrogen Industry[22] offers grants in two stages, up to $3 million then up to $70 million respectively, which will be announced this year.

Assuming the Hunter is successful in both rounds of the clean hydrogen funding, the total federal support of approximately $200 million toward diversifying the whole Hunter is both modest and partial, especially when compared with government investments in industrial decarbonisation in other countries. For example in Ontario, Canadian steelmakers ArcelorMittal and Algoma Steel have received federal funds of Can$400 million and Can$420 million respectively to support the decarbonisation of their operations. In the UK, £26 billion of government funds has been allocated to decarbonise UK industry with the goal of attracting £90 billion in private capital investment. The federal funding for the Hunter misses both the scale of the opportunity available to the Hunter, and the urgent need to adapt to the structural change the region is facing.

Beyond Zero Emissions and WWF-Australia prepared a pre-budget submission for FY22-23 that shows if the Federal Government invests $6.3 billion in REIP projects over the next decade, it would likely attract a further $37.8 billion in private investment to build a strong backbone for REIP projects across Australia with the additional support of state governments ($3.15b) and public sector financing ($15.75b) from institutions such as the Clean Energy Finance Corporation. The current federal investment of only $200 million towards diversification falls well short on capitalising on this opportunity in the Hunter.

As this briefing paper demonstrates, there is substantial interest and momentum towards a REIP for the Hunter. However the scale of this nation-building project, including over 22 GW of renewable energy, requires careful coordination and a well-articulated vision.

Solar Tower 1 at the CSIRO Energy Centre. Image supplied by CSIRO.

State government and local government support

The NSW Government's Net Zero Plan[2] is implementing Renewable Energy Zones (REZs) across the state, including in the Hunter. The NSW Net Zero Industry and Innovation Fund has $750 million to distribute but this has to cover three streams across all NSW: High Emitting Industry, Clean Technology Innovation and New Low Carbon Industry Foundations (which includes Clean Manufacturing Precincts and the Hydrogen Hubs).

Last year the NSW Government announced up to $3 billion in incentives (grants and waived fees and charges) for green hydrogen producers, and expects to attract $80 billion to $270 billion of investment for the Hunter and Illawarra.[23]

In February 2022 the government responded quickly to the announcement of the early closure of the Eraring power stations with a future energy package that offered a total of 3700 new jobs, including 2700 jobs in construction to deliver transmission infrastructure.[24]

- 500 jobs from a $300 million investment over 10 years to build up the NSW clean manufacturing industry, particularly green hydrogen.
- 500 jobs from a $250 million investment over five years for initiatives to boost locally manufactured content for the renewable energy sector such as wind towers, electrolysers and batteries.

The NSW Renewable Energy Sector Board's Plan aims to ensure the competitiveness of the sector, and local content to ensure that the benefits of the renewable energy industry are shared with workers and local communities.

At the local level, Hunter 2050 Foundation is a joint venture between AGL and the Hunter Joint Organisation. This specialised investment and redevelopment agency will provide seed funding for diversifying the region. It is still in the development phase.[25] Hunter-based NSW Department of Planning and Environment is leading a local consortium of key[25] Hunter Regional stakeholders to set a vision for Net Zero Hunter[26] and develop a roadmap for the Hunter region to create a net-zero economy.

Together these are steps in the right policy direction but do not meet the scale needed to maximise benefits to the Hunter economy.

Figure 2: Current and proposed energy generation and industrial use in a Hunter REIP

Industries	Required Renewable Energy (GW)
Tomago Aluminium	3
Hydrogen	16
Green Steel	2
Other Local Industries	1
Total	**22 GW**

Renewable Energy Generation and Storage (GW)	Announced Renewables	Renewables Required for REIP	Renewable Generation Potential^
New England REZ	8	6	10
Central West Orana REZ	3	6	10
Hunter REZ	2	2	TBC*
Offshore Wind	4.8	8	9
Total	**17.8 GW**	**22 GW**	**29 GW**

^Generation potential based upon *Australian Energy Market Operator, 2021. Final 2021 Inputs, Assumptions and Scenarios Report*

* Subject to change pending NSW government announcements

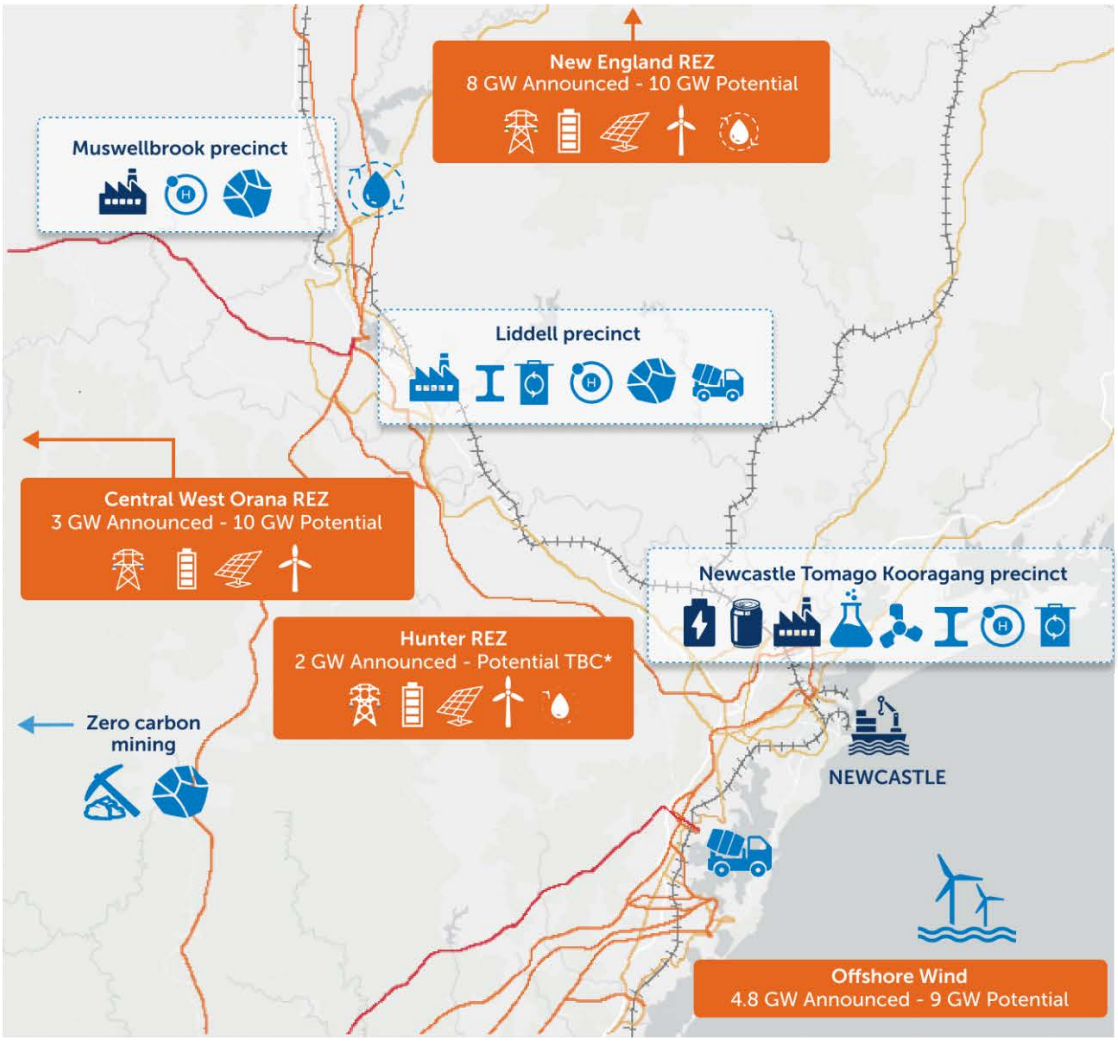


Figure 2 is an early stage proof of concept for a Hunter REIP. The scaling of new technologies and new developments in policy, investment and workforce will impact this model. Power flows (GW) used here are approximate, illustrate the potential of the region, and will be impacted by new developments and announcements. Actual systems deployed – for both consumers and suppliers – will influence flows, capacity factors, transmission losses, storage requirements, and excess renewable generation capacity required for supply security. The potential generation relies on AEMO data.[27] For modelling assumptions see Appendix 2.

Energy in, energy out

A Hunter REIP will require a significant and carefully coordinated build-out of renewable generation. Our analysis of building a renewable backbone for industry in the Hunter shows that there is more than enough renewable energy potential in adjacent Renewable Energy Zones to power a Hunter REIP. Modelling assumptions for a Hunter REIP are provided in Appendix 2.

According to our analysis, the complete decarbonisation of all existing industries in the Hunter (including Tomago Aluminium and Orica, as well as new green steel plants) will require approximately 22 GW of renewable generation. This is less than the 29 GW in generation potential from the Hunter and adjacent Renewable Energy Zones and offshore wind estimated by the Australian Energy Market Operator (AEMO), of which 17.8 GW has already been announced.

Transmission and storage

In our consultations with Hunter-based industry, we found that while many key stakeholders had confidence in renewable generation capacity, questions remained over how power can be delivered to load centres, how renewables can be firmed up with storage technologies, and how this can be done at levels that meet the needs of their facilities.

Coordination and planning, underpinned by a clear and ambitious vision, are key to the success of REIPs. Federal support for a REIP that builds on the state's Clean Manufacturing Precinct framework would be a powerful collaborative foundation for the Hunter. Network operators need to coordinate with large industry users of electricity, developers and governments. This collaboration will reduce risk and help unlock significant green investment capital for these key projects.

Table 1: Transmission and storage needs and costs in the Hunter REIP

Transmission	Transmission Capacity (GW)	Distance to REIP (km)	Investment Needed ($m)	MW Capacity added per $m
New England REZ	6.0	265	$2,914	2.1
Central West Orana REZ	6.0	300	$3,299	1.8
Hunter REZ	2.0	100	$367	5.5
Offshore wind	8.0	50	$2,000	4.0
Total	22.0		$8,580	

Storage Needed	Storage Capacity (GW)	Energy Storage (GWh)	Hydrogen Capacity Factor
Jun (24/7 operation)	2	22.7	100%
Jun (Flexible operation)	2	10.6	78%
Dec (24/7 operation)	2	12.2	100%
Dec (Flexible operation)	1.7	7.8	86%

Potential Storage	Storage Capacity (GW)	Energy Storage (GWh)	Cost ($m)
Pumped hydro Central NSW 8 hrs	1.8	14	$4,419
Pumped hydro Central NSW 24 hrs	0.2	4	$602
Announced projects	1.5	7	$2,814

Source: Beyond Zero Emissions calculations are based on AEMO data.

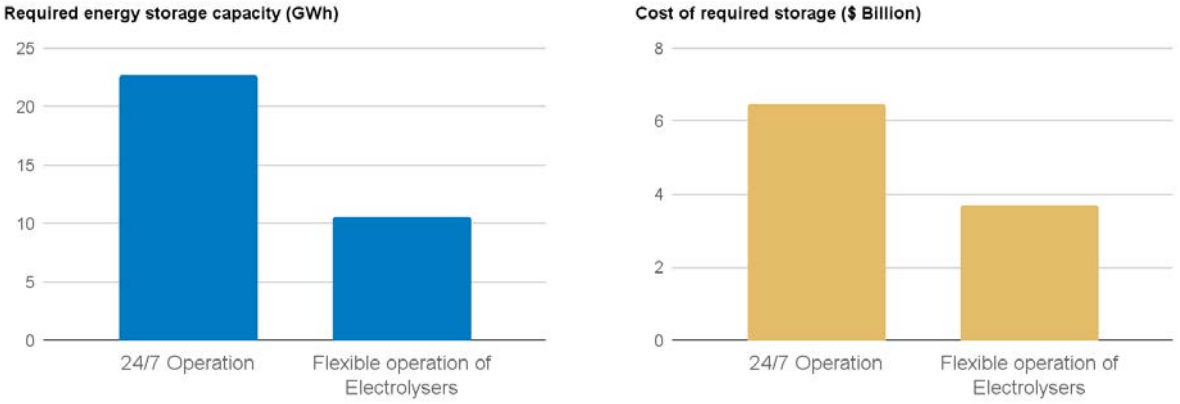
Table 1, above, shows that building new transmission capacity for the full 22 GW to power industry needs would require an investment of $8.5 billion.[27–29] Investing in nearby renewable generation will provide the greatest value in terms of transmission investment (5.5 MW capacity added per million dollars in the Hunter REZ), with offshore wind a close second at 4 MW capacity added per $m.

If all industries operate continuously 24/7, the storage requirements are estimated to be 2 GW for over 11 hours (22.7 GWh). However, the required storage can vary depending on the mode of operation, with flexible operation providing significant benefits.

For example, in the winter month of June when solar supply drops, if hydrogen electrolysers operate at maximum capacity only during periods of lowest electricity price, energy use could be cut by 22%. Importantly, this would slash storage requirements in half to 2 GW for just over 5 hours (10.6 GWh) and reduce required investment from $6.5 billion to $3.7 billion (see figure below).

The majority of storage requirements can be met by projects already announced in the Hunter (1.5 GW, 7 GWh) but they need government support to ensure their development. Additional storage is available from projects in the New England REZ such as the Oven Mountain Pumped Hydro (0.6 GW, 7.2 GWh), while demand can be further optimised by fine-tuning electrolyser operation.

Figure 3: Comparison of storage needs and costs between 24/7 and flexible operation of electrolysers



This simple comparison highlights the benefits of grid flexibility. The timing of reduced energy use is key: avoiding heavy use in periods of low generation optimises storage requirements thereby saving network costs and reducing the price of electricity for end users. Additional flexibility is also possible from other industries but the feasibility of this mode of operation highly depends on government policy and market mechanisms.

By coordinating the development of REIPs, balancing renewable generation with sufficient transmission capacity, and building 11 GWh of storage capacity matched to flexible industry demand, we have found the total infrastructure investment required would be about $12.2 billion (or $8.5 billion for transmission), which remains in line with previous estimates from ACIL Allen ($8.6 billion), plus an estimated $3.74 billion for storage.[1]

While significant, this is comparable to past investments made by key industries such as the LNG gas terminals in Gladstone ($20 billion for the Santos terminal alone).[30] A REIP investment has flow-on benefits to sectors beyond industry by providing low-cost, firmed renewables for households, transportation and supporting the broader grid.

It is also important to note that there are multiple technology solutions to address renewable droughts or multiple days with very low renewable generation:

- Strong interconnected transmission links to supply renewables from interstate or other regions with excess generation/storage capacity
- Demand-side response (businesses that can be flexible in their demand)
- Use of renewable gas peakers that run on green hydrogen, sustainably sourced biomethane or energy from municipal waste plants
- Novel storage technologies such as those developed by MGA Thermal, RayGen, Allegro Energy, HEOS - LAVO's grid-scale hydrogen solution

Strong and coordinated government policy and planning at local, state and federal levels will be needed to accelerate the deployment of these solutions. There is an urgent need to begin implementing these solutions, ensuring a well planned integration of renewables to the grid that will optimise investments, eliminate bottlenecks and reduce costs for end-users.

Joss Kesby, co-founder and CEO of Diffuse Energy in the Hunter.

Industrial ecosystem

Industries such as green aluminium, green steel, niche batteries and storage, cleantech, hydrogen, offshore wind and electrolysers form the foundation of a Hunter REIP.

In fact, many businesses are already focused on green manufacturing in the Hunter with cutting-edge products for the new energy economy, including MGA Thermal bricks, 3ME Technologies lithium-ion batteries for heavy vehicles, Kardinia Energy's printed solar film, Allegro Energy's redox flow batteries and supercapacitors, and Diffuse Energy's high powered wind turbines.

There is also a burgeoning cleantech sector – a local "silicon valley" – which includes companies such as Saphi Engineering that integrates hardware to software solutions and SwitchDin whose software can aggregate rooftop solar and storage to build virtual power plants.

Precincts and manufacturing hubs are developing across the region including at the Port of Newcastle, the AGL Liddell site and Muswellbrook. There is also a locally led Net Zero Hunter Roadmap initiative.[11,12,12,26] Coordination on a regional level can arrange shared infrastructure and capture supply chains' upstream and downstream processes, driving further decarbonisation, including throughout supply chains, and supporting Hunter manufacturing of low-emission or emissions-free products.

Altogether, this activity is a powerful combination of building on traditional strengths and embracing new opportunities. Federal investment will scale and amplify this existing manufacturing base and signal to the private sector that the Hunter is a secure investment.

Stakeholder engagement

More than a year of engagement in the Lower Hunter has laid a powerful foundation of local support for a Hunter REIP. More than 40 businesses and institutions have provided statements of support for a Hunter REIP, and many other businesses have privately expressed support. This included:

- disseminating REIP communication material, including economic modelling by ACIL Allen commissioned by Beyond Zero Emissions and WWF-Australia
- one-to-one engagement with Hunter businesses and institutions, weekly online briefings, and three online webinars featuring experts from Hunter industries
- a sold-out showcase and panel discussion at the Hunter Innovation Festival
- presentations at industry and government forums on diversification (with the Hunter Hydrogen Taskforce including a Hunter REIP in its Hunter Hydrogen Roadmap.)[31]

A full list of public supporters is provided in Appendix 1.

Green aluminium

Lightweight, versatile and recyclable, aluminium is in huge demand; in particular by the automotive, construction and electronics industries. It's also an energy-intensive industry, emitting over 1 billion tonnes of carbon dioxide (CO_2) each year across its value chain, or 2% of global emissions.

To produce emissions-free aluminium requires decarbonisation of the whole aluminium supply chain, from bauxite to alumina to aluminium.

Australia's four aluminium smelters use about 10% of Australia's electricity and are responsible for 6.5% of Australia's total greenhouse gas emissions (predominantly Scope 2 emissions from the electricity used).

The Hunter's Tomago Aluminium Company (TAC) produces around 595,000 tonnes of aluminium each year, directly employs about 1150 workers (including contractors) and uses 8300 GWh of electricity a year, which is about 12% of NSW's total electricity consumption.[32] If the right conditions are created, Tomago has potential to expand.

Tomago and part-owner Rio Tinto have recently announced TAC will "reduce … Scope 1 & 2 carbon emissions by 50% by 2030"[33] and "switch to a predominantly renewable power supply in 2029".[34]

By using renewable electricity, the greenhouse gas emissions could be reduced from about 13 tonnes CO_2-e per tonne of aluminium produced[35] to about 2 tonnes CO_2-e per tonne of aluminium. This low-carbon aluminium is likely to attract a premium market price.

The advantages of aluminium produced with renewable electricity include:

- A premium market prices for low carbon aluminium
- Limited exposure to international carbon import tariffs
- Decreased greenhouse gas emissions
- Falling renewable energy prices, while gas prices remain volatile

Green steel

Steel is the most used and recycled material in the world, with a wide variety of uses especially in the automotive and construction industries. Demand is expected to grow by more than a third by 2050.[36]

However, steel and iron are major sources of emissions, contributing to 2.6 billion tonnes of CO_2 per year or about 7% of global emissions.[37] Zero-emissions green steel can be produced using hydrogen and renewable electricity. Demand for green steel is growing, for example, Swedish

automaker Volvo will receive the first concept vehicles made with fossil-free steel in 2022 with mass production to follow.

Australia is the largest iron ore producer in the world. Combined with our abundance of renewable energy resources, Australia has a major opportunity this century to emerge as a leader in green steel. At COP26, Australia signed the Glasgow Breakthrough on Steel[7] indicating strong government support for green steel. However swift action is needed to catch up with other countries.

Based in the Hunter, Molycop is among the world's largest suppliers of mining consumables and services.

Several Hunter-based companies played a key role in the region's steelmaking heritage and are now innovating by taking emissions out of their steel products:

- Molycop is among the world's largest suppliers of mining consumables and services. In 2019 Molycop signed a power purchase agreement with Flow Power for 100,000 MWh of renewable energy annually from the Sapphire Wind Farm in Glen Innes and the Bomen Solar Farm near Wagga Wagga. A key driver for its decarbonisation efforts is the expectation of its customers, who have shown strong interest in supply chain emissions reduction.[38]

- InfraBuild has committed to carbon neutrality by 2030 and implemented a strategy to use electric arc furnaces powered by renewable energy to process scrap steel and create low emissions carbon-neutral steel.[39]
- Milltech Martin Bright produces steel bars and has been committed to driving up energy efficiency since 2011, including making heavy investments in high thermal efficiency. The company uses demand response to avoid high electricity costs and has installed 200 kW of solar over two sites.[40]

New opportunities with green steel

Emerging technology "molten oxide electrolysis" (MOE) uses electricity to extract crude steel from iron ore. It is a simpler, cleaner and cheaper process than smelting, and can produce high quality steel from most grades of iron ore. Major investors include BHP and Vale. A Hunter REIP is the ideal location to host the first commercial scale MOE factory in the world run on affordable 100% renewable energy.

Green hydrogen

Green hydrogen is a versatile ingredient for the zero-emissions future as a renewable fuel needed in many industrial processes, including the production of green steel and alumina, green ammonia and many other chemicals.[41]

The Hunter is rapidly developing capacity to produce hydrogen, backed by state and federal government policy and the Hunter Hydrogen Taskforce. The Taskforce's Hunter Hydrogen briefing paper identifies green hydrogen as a critical pathway for the region's ongoing prosperity and incorporates a REIP as an offtaker of hydrogen.[31]

"The Hunter will be Australia's leading hydrogen hub and technology cluster, demonstrated by excellence in research, innovation, technology and education, production, use, export and employment participation across the hydrogen supply chain." – Hunter Hydrogen briefing paper, 2021

Green hydrogen has many uses in a Hunter REIP:

- Chemical feedstock: green hydrogen can be used as a chemical feedstock. It will be critical to help decarbonise Orica's Kooragang Island ammonia plant. It can be used to create methanol and other valuable green chemicals as proposed by Energy Estate's H2N and UNSW's P2X initiative.
- Green steel: green hydrogen is a key feedstock for DRI-based green steel production. With a substantial steel industry ecosystem, the Hunter can participate in new steel

making. Global demand for green steel is growing as key players in the auto industry (such as General Motors and Volvo) and construction sector (such as Multiplex Construction and Severfield) begin to tackle supply chain emissions. Companies such as Fortescue Future Industries have signalled intent to capture this market and the Hunter is well positioned for this opportunity.

- Grid response: a direct benefit of green hydrogen and its production from electrolysis means that it can participate in demand-side response, ramping up production when low-cost renewable generation is high and ramping down during periods of low generation. This will also help reduce the overall cost of electricity by minimising the need for additional storage capacity.

- Grid storage: as the cost of production decreases, green hydrogen will become competitive for grid storage, providing long duration, firmed power for multi-day periods of low renewable generation.

Last year the NSW Government announced it would provide up to $3 billion in incentives (in grants and waived fees and charges) for green hydrogen producers, and expects to attract $80 to $270 billion of investment for the Hunter and Illawarra. Its strategy aims to drive hydrogen production through local demand, particularly with the state's heavy vehicle fleet.

Local hydrogen developments include:

- The Port of Newcastle has partnered with Macquarie Group to build a 40 MW electrolyser powered by the Hunter REZ. This project is the first phase of a larger project that aims for gigawatt scale production.[42]

- AGL and Fortescue Future Industries have signed an MOU to undertake a feasibility study for a green hydrogen facility on the sites of the Liddell and Bayswater power stations when decommissioned. The Hunter Energy Hub would embed green hydrogen production in an energy generation and industrial precinct, making it the ideal location for industries that use hydrogen as a feedstock.[13]

- Idemitsu Australia is working with Energy Estate to transform Idemitsu's Muswellbrook coal mine into the Muswellbrook Energy Training and Industry Precinct, which will integrate green hydrogen production at scale.[14]

The Newcastle research and business cluster, NewH2, is working towards coordinating the development of a hydrogen supply chain in the Hunter, connecting businesses to support the emerging local, state and national strategies. The Hunter has long excelled in the METS (Mining Equipment, Technology and Services) sector and the Hunter's Hydrogen Taskforce is seeking to claim leadership in the HETS (Hydrogen Equipment and Technology) sector.[31]

The success of green hydrogen in the Hunter is dependent on sufficient renewable generation, transmission infrastructure and careful management of water use. Hunter Water is examining the use of wastewater to support the hydrogen industry.[43]

What is green hydrogen?

Green hydrogen is produced by the electrolysis of water powered by renewable energy, meaning it is produced without fossil fuels.

Its production can be ramped up when there's abundant renewable energy and energy prices are low and wound back when renewables run low to help stabilise the electricity grid.[44] It's also useful for industrial processes that can't be easily electrified, such as bauxite/alumina refining, and can supplement energy storage needs alongside batteries and pumped hydro.[45]

Green hydrogen and ammonia exports represent some of the few zero-emissions methods to globally trade energy. This is particularly important for countries such as Japan and South Korea that have low renewable generation potential and will buy from countries such as Australia to support their zero-emission energy needs.[46]

CSIRO's Dr John Ward, Research Director for Energy Systems Program, at the Newcastle Energy Centre.

Offshore wind

Offshore wind is a huge opportunity for the Hunter. Europe has led in offshore wind to date, however the Asia Pacific region is the focus of new development. The International Renewable Energy Agency (IRENA) has estimated that to meet Paris commitments, 380 GW and 2000 MW of offshore wind need to be installed by 2030 and 2050 respectively.[47] It is estimated 840 GW of this will be in the Asia and Pacific region.[48] This includes the Hunter's key trading partners: Japan, South Korea, China and Taiwan.

Offshore wind is an nascent industry in Australia, supported by new technologies such as floating platforms. With its excellent wind resources, the Hunter is an outstanding location for this industry.[49] It has a deepwater port, dockside land to enable assembly of floating platforms, a maritime industry, strong grid connections and large load centre, and the Hunter REZ.

At the time of writing, there are at least seven proponents seeking gigawatt scale offshore wind farms off the Hunter coast, all requiring floating platforms.[49,50] Oceanex's project alone could attract $8 billion in investment, and feed millions of dollars into the local economy in development costs.[49]

The offshore wind supply chain includes steel production, tower manufacture, metal fabrication, fitters, welding, engineering and design, electronics – all existing skills in the Hunter.[51] The Maritime Union of Australia estimated that if 25% of components were required to be made locally and manufactured in the Hunter, building floating turbines to the scale of 4.8 GW would employ 900-1250 people, based on the jobs per MW power generation identified in the Blue Economy report.[52] This is in addition to more than 500 jobs per year over 10 years of project construction, and over 800 jobs per year in operations and maintenance. Similarly, the Blue Economy Cooperative Research Centre has recommended that the Australian Government "should develop local supply chain capacity, including leveraging the permitting process for local content."[53]

The Hunter's strong grounding in maritime expertise and skills in the energy, electronics and METS (mining equipment, technology and services) sectors can be applied to an offshore wind industry.

Mining Equipment, Technology and Services (METS)

Australia's METS sector is a major player in the global mining supply chain that contributes $92 billion to the Australian economy, grows around 7% per annum, and contributes more than half a million direct and indirect jobs.[54]

Both the METS and the oil and gas industries have been supported by the federal government's Industry Growth Centres (IGC) model through respective industry bodies METS Ignited and

NERA (National Energy Resources Australia). The federally funded IGCs are led by industry experts and build the whole industry.

The METs sector is strong in the Hunter, with companies such as BME, 3ME Technologies, Ampcontrol leading the decarbonisation of the mining industry through their innovations.

Given that the IGC growth model has been highly successful in growing METS and supporting Australian oil and gas sectors to become globally competitive, this same whole-of-industry approach to offshore wind would support the diversification of the Hunter economy and build the region's existing strengths to create a whole new industry. However, this will require government planning, industry support, firm policy settings and funding.

Niche batteries and storage

Australia earns only 0.5% of the ultimate value of its exported lithium ore. That means 99.5% of an estimated $213 billion of the value of Australian lithium ore occurs offshore through offshore electro-chemical processing, battery cell production and battery production.[55]

It is difficult to compete with the scale of mass battery production overseas but the Hunter's METS sector has driven niche battery manufacture, especially in the mining vehicle space.

The following Hunter battery manufacturers are strong supporters of a REIP, both to support decarbonisation of their supply chains and for the opportunity to be connected with other cleantech businesses and collaborate on new solutions.

- 3ME Technologies creates batteries for heavy vehicles in mining and defence. The lithium-ion "blade volt" battery is scalable so it can be customised to fit any size vehicle. 3ME's collaboration with BME to retrofit batteries into diesel heavy vehicles is already decarbonising the mining industry.
- Ampcontrol is a mature Hunter company that traditionally provided electronic solutions for mining. Ampcontrol is now diversifying to include renewable energy solutions in addition to developing battery electric vehicles (BEVs) for the underground mining industry. Ampcontrol has just received $5 million of NSW Government funding to collaborate with LAVO for the Hunter Manufacture of the hydrogen battery.[56]

CEO Rod Henderson and Electrical Apprentice Michael Cotton at the Ampcontrol facility in the Hunter.

- Energy Renaissance manufactures niche lithium-ion batteries suitable for hot climates including for domestic use and export to South East Asia. These batteries are suitable for many uses including buses.
- Allegro Energy is a startup that has locked in its first major buyer for its water-based energy storage solutions, including redox flow batteries and supercapacitors. This technology could also be a game changer for storage in the region given its low price. Supercapacitors are energy storage systems that are very fast at charging and discharging, but until now have been expensive and toxic. Allegro Energy's supercapacitor technology is water based, reducing cost and safety issues. Redox flow batteries are suitable for scale as the energy is contained in a liquid electrolyte.
- MGA Thermal develops high-density recycled graphite and aluminium brick with extraordinary heat storage capacity. It is a next generation storage material that can be charged by renewable energy or waste heat, and can discharge either heat or electricity with added benefits of grid security and frequency control. The start-up is already working with blue-chip companies and exporting its bricks.[57]
- RayGen has a high efficiency solar-plus-storage system that provides renewable electricity on demand at utility scale. Its water-based storage allows energy to be stored for hours or days at a time.[58] It is partnering with AGL to deploy its energy storage technology at the Liddell Energy Hub.[59]

Circular economy and recycling

There is significant momentum to build circular economy principles into the Hunter. The Hunter Joint Organisation has launched the Hunter Circular Economy Ecosystem report and website and undertaken background work to establish a region-wide circular economy, and the City of Lake Macquarie has developed a circular economy framework.[60]

In Muswellbrook, there has also been a proposal for the Hunter to become a world-scale centre for the conversion of waste and recycling.[61] Local company REVYRE will recover polymers from truck tyres used in mining through a low-emission process.

Another opportunity for the Hunter is repurposing and recycling lithium ion batteries. Electric vehicle batteries can be repurposed for use as residential or community scale batteries where performance requirements are not as high as for EVs. This extends the useful life of EV batteries and such re-purposing can be integrated within established battery manufacturing facilities to capitalise on existing infrastructure and technical capabilities.

Conclusion

There is an urgent need to support regional economies like the Hunter to prepare and build resilience as Australia's fossil fuel exports are exposed to collapsing demand as the world pivots to a zero-emissions future.

Given the right support, the Hunter has all the elements needed to thrive in a zero-emissions economy. The NSW Government has introduced a range of initiatives across the state to support industry to decarbonise. Given the scale of the challenge, and the scale of the opportunity, the Federal Government has the opportunity to back state and local efforts with both policy and funding to futureproof the Hunter.

A Renewable Energy Industrial Precinct (REIP) across the whole Hunter region is the Hunter's greatest jobs and investment opportunity, capitalising on existing skills and infrastructure. A Hunter Renewable Energy Industrial Precinct is central to realising the Hunter's potential, futureproofing jobs and ensuring the region will remain relevant and prosperous in the global move to zero emissions.

More information

bze.org.au/manufacturing

REIPs have the potential to protect Australia's regional economies and increase their status as export powerhouses, create tens of thousands of good quality regional jobs, and attract billions in new capital investment to regional communities. Learn more about REIPs, including the advantages they offer to Australian businesses and renewable energy and sustainable development principles.

bze.org.au/acil-allen

An economic analysis by ACIL Allen with Beyond Zero Emissions and WWF-Australia modelled the economic and job benefits of establishing REIPs in Gladstone and the Hunter Valley, two of the 14 priority regions identified.

It found that if expected projects eventuate, there is the potential for these two precincts to:

- Create 45,000 new ongoing jobs
- Create an extra $13 billion in annual revenue in the Hunter and Gladstone regions alone
- Attract new industries and tens of billions of investment dollars into regional areas
- Bring high-quality jobs back onshore

bze.org.au/budget22

A federal pre-budget submission by Beyond Zero Emissions and WWF-Australia detailed that a REIP program should provide $3.3 billion in total funding between 2022-23 and 2025-26, and $6.3 billion over the next decade for two grant streams designed to leverage private sector investment:

- $800 million for infrastructure and coordination funding
- $2.5 billion for renewable manufacturing precinct implementation funding

bze.org.au/exportpowerhouse

A report by Beyond Zero Emissions, Export Powerhouse: Australia's $333 billion opportunity, shows that with the right policy settings and financial investment, a network of REIPs in Australia can support the establishment of a new clean export market worth $333 billion a year by 2050 – almost triple the value of our current fossil fuel exports.

Appendix 1

Statements of support for a Hunter REIP

More than 40 local organisations have contributed statements of support for a Hunter Renewable Energy Industrial Precinct. Together these organisations employ thousands of people in the region.

Company or organisation	Submitted statements of support for a Hunter REIP
HunterNet Cooperative (membership of over 120 local companies)	The Hunter is an industrial and energy superpower, the engine room for NSW and largely the nation, and the REIP will support the Hunter on its climb to be the most attractive energy-intensive destination for manufacturing. Adding value to materials and manufacturing locally will maximise the value in our exported energy, embodied within manufactured products and better ensuring long-term employment opportunities and new industry.
Newcastle Institute of Energy and Resources	BZE's REIP proposal aligns with NIER's values of supporting strong links between industry, research organisations and government to drive innovation and growth for Australia's energy and resources. Meaningful collaboration and strong partnerships are the basis of a thriving resilient and innovative economy.
Committee for the Hunter	It's time to move the conversation forward from the opportunity of clean energy jobs to the plan and how we can secure the partnerships and the resources to get there. BZE's Hunter REIP offers a strategic place-based vehicle to do just this, tackling the fundamental challenge of how to decarbonise heavy industries, manufacturing to protect jobs and keep them competitive in the new energy economy
Hunter Jobs Alliance	There are huge benefits on offer but we need to make proactive steps to ensure we can take opportunities. REIPs and the policy, coordination and investment to enable them are a critical part of that picture. Supporting our manufacturing industries to thrive and grow as we shift to clean energy is critical for the future of manufacturing and the good jobs it provides in the Hunter.
3ME Technologies	The REIP will foster an excellent environment for collaboration among Australian companies whose mission is to make a positive impact whilst providing sustainable business solutions to Australian industry.
Ampcontrol	Ampcontrol is at the forefront of a lot of innovative engineering. We are already working extensively in the renewable energy sector and support a REIP here in the Hunter.

Molycop	Molycop is committed to further reducing the carbon emissions associated with our products and operations and REIPs here in the Hunter will help us achieve that.
MGA Thermal	We believe that REIPs offer opportunities for sustainability, innovation, collaboration and integration between research and industry that can drive growth in advanced manufacturing, clean energy technologies and high-value, highly skilled jobs.
BME	BME sees Australia's future as very bright, and an integral part of this is embracing new technologies and future-proofing both the economy and the natural environment. Australia becoming self-reliant and investing in our people and their skills is critical to this goal.
RayGen	Renewable energy, paired with long duration storage, can repower Australian manufacturing with the lowest cost energy day and night. RayGen can manufacture our technology in a REIP, and use that same technology to supply the precinct with affordable, baseload power, creating and supporting local jobs.
100% Renewables	We believe that REIPs offer opportunities for sustainability, innovation, collaboration and integration between research and industry that can drive growth in advanced manufacturing, clean energy technologies and high-value, highly skilled jobs.
Smart Energy Council	The Smart Energy Council supports the development of REIPs because they provide excellent opportunities for heavy industry and renewable energy resources to benefit each other.
REVYRE	REVYRE strongly supports the REIP initiatives to bring together renewables-powered manufacturing businesses, and aligns with our zero-waste, zero-emissions, zero-byproducts business model. Re-manufacturing businesses like REVYRE are a truly circular addition to an already exciting renewable precinct initiative.
SwitchDin	A REIP would be great for SwitchDin. Renewables are about community and this is building a community around innovation to create opportunity. We want to be part of that.
Hunter Cargo and Customs	Hunter Cargo & Customs supports the renewable energy sector from an international logistics scope of work. We are experienced with EPCs providing solutions for the Summerhill solar farm and the New England solar farm.
Hunter Angels (local Investors)	The Hunter has the skill base, infrastructure and innovative culture to develop a world-class hub in renewable energy. The REIP in the Hunter will be invaluable in providing more coordinated and focused resources to facilitate that growth.
Energy Estate	Energy Estate strongly supports the development of REIPs to future-proof and grow Australian industries, their export potential, creating enduring workforce opportunities, training and reskilling regional areas.

TW Woods	TW Woods has been involved with manufacturing in the Hunter for 55 years and supports the transition to renewable energy. This precinct will allow the Hunter to become competitive in the world economy and a leader in renewable Energy technologies
Allegro Energy	Being able to keep our manufacturing in Australia would be huge for us as it would allow us to leverage local expertise and help us to connect with the wider ecosystem here in Australia. We know that Allegro Energy's solutions will be useful to other businesses in the REIP and so having a place where we can connect and share ideas would be really helpful to help our businesses grow together.
Concrush	At Concrush we are ready to do more to reduce our carbon emissions. We burn a lot of diesel. BZE has given us a vision and pathway to electrification.
Energy Renaissance	As businesses increasingly demand products that are produced with a lower carbon footprint, the REIPs will deliver a more prosperous economy for all Australians that is built for the future generations.
Port Stephens Council	It's exciting for Port Stephens and the broader Hunter region to have renewable energy businesses interested in the Tomago Industrial area. This will complement our existing corporates and create new opportunities to collaborate. A REIP will act as a catalyst for ongoing investment in renewable energy production and utilisation, as well as future skills development for our people..
City of Newcastle	City of Newcastle recognises that industry and manufacturing powered by renewable energy projects are set to unlock billions in private sector investment, while creating thousands of great local jobs.
Hunter Joint Organisation	The REIP is consistent with the following action areas identified in the strategic plan 2018-2021 (Aspire, Act, Achieve) Action Area 2: Our enviable environment is protected for future generations and our resources are used efficiently. Action Area 3: Our economy is multi-faceted and is Australia's leading regional smart economy. It strongly aligns with the following programs and priorities currently being delivered by Hunter Joint Organisation: Circular Economy Program, Cities Power partnership, Hunter 2050 Foundation.
Lohmann	We are strongly in support of REIPs. We believe these are ideal vehicles to help engage and educate communities, demonstrate early success and to respond to and address the significant challenges ahead of us especially in the waste circular economy and to achieve net zero emissions targets for Australia.
Plithos Renewables	Plithos Renewables encourages the development of REIPs to enhance Australia's local knowledge and skill sets, reduce vulnerabilities in global supply chains and enhance the security of intellectual property rights.

Solpod	Solpod is the only Australian Made manufacturer of solar panel rooftop mounting solutions. Solpod supports BZE's REIPs, particularly in the Hunter where Solpod is attracted by the aluminium manufacturing capability.
Amtronics	Amtronics/Australian Hydrogen Generation are delighted to be partnered up with BZE in their REIPs initiative. As an Australian provider and installer of Hydrogen generation equipment, our services are key to paving the way for a clean future.
Rinnai Australia	We applaud the efforts by BZE to work with the various government, private sector and industry stakeholders. Rinnai stands ready to offer our array of leading edge renewable products to these initiatives, providing sustainable and rewarding skilled employment to Australians.
YZ Consulting	YZ Consulting as a Newcastle-based renewable energy business strongly supports the concept of a REIP.
Epuron	Epuron supports the development of REIPs for the support they offer to developing innovative technologies and competitive advantage to manufacturing in the global zero-emissions markets.
Newcastle Offshore Wind	The NOW project supports the concept of the REIP in the Hunter. As a local Newcastle company, we value local jobs for the local community in the new cleantech sector.
Diffuse	Diffuse Energy supports the development of a renewable energy precinct in the Hunter Valley region. We believe that the Hunter Valley can benefit from its strong manufacturing heritage and workforce to become a renewable energy powerhouse for export to the world.

Other statements of support have come from BOC-Linde, Newcastle Offshore Wind and Nu-Rock, as well as some entities that provided a statement of support confidentially.

Appendix 2

Modelling assumptions for a Hunter REIP

Energy in, energy out

All numbers are in GW and represent renewable generation based on a 30% capacity factor (ie. for Tomago, 3 GW of renewable generation is needed to supply approx 1 GW of constant load). Hydrogen for ammonia is based on stoichiometric conversions (0.1775 kg H_2 per kg NH_3); 72 kg hydrogen per tonne DRI green steel.[62] Electricity needed for hydrogen is assumed to be 60 kWh/kg H_2.[27] Theoretical renewable potential for each REZ is based on build limits as modelled from AEMO.[28] Offshore wind generation potential from Blue Economy CRC.[53]

Transmission and storage

Potential transmission and storage investment required to enable a Hunter REIP. Calculations assume a 80% round trip efficiency from generation to end user. Flexible operation is based on the switching of hydrogen electrolysers between 100% and 50% capacity; all other industries are assumed to operate 24/7. Transmission capacity is matched to full renewable generation capacity as a worst case estimate; the actual transmission capacity required will likely be lower than this. Transmission cost estimates from AEMO $1,833/MW/km.[28,29] Marinus link $5000m/MW/km used to estimate offshore wind. Potential storage estimates from AEMO's 2021 Inputs and Assumptions Workbook.[27] Renewable generation traces are from AEMO's ISP Solar and Wind traces 2019.[63]

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Hard at work at the Ampcontrol factory.

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