Northern Rivers Joint Organisation (NRJO)

RENEWABLE ENERGY BLUEPRINT for the NORTHERN RIVERS

Background paper

Date: 12 January 2022

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1 About Northern Rivers Joint Organisation and the region

1.1 Northern Rivers Joint Organisation

Joint Organisations were established under NSW Government legislation passed in 2017, aimed at strengthening collaboration between local councils and government to drive better planning, services and economic development across regional NSW.

The Northern Rivers Joint Organisation (NRJO) was established in June 2018 as a result of this legislation, and it represents six local government areas, including Ballina Shire, Byron Shire, Kyogle, Lismore City, Richmond Valley and Tweed Shire.

NRJO's role is to facilitate and lead advocacy, political representation and cooperative action on matters of regional significance. NRJO has identified five key strategic regional priorities that it focuses on, and these are documented in its Strategic Plan 2019-2022[1]. These include:

- Biodiverse natural environments
- Improved community wellbeing
- A connected region
- **Sustainable energy, water and waste**
- A diverse regional economy

Figure 1: Map of the Northern Rivers Joint Organisation Councils

[1] Northern Rivers Joint Organisation Strategic Regional Priorities 2019-2022

1.2 Strategic Regional Priorities – Action 8.3

As well as NRJO, the strategic regional plan was developed in consultation with other key stakeholders, including NSW Office of Local Government, NSW Department of Premier and Cabinet, Regional Development Australia – Northern Rivers and Rous County Council.

The strategic plan sets out NRJO's vision for the region as follows:

Our vision: For the Northern Rivers to be a unified region of well connected, integrated communities that affords its people a unique balance of place, lifestyle and opportunity.

And for our region to be known to the nation and the world for its:

- *outstanding environmental and scenic values*
- *commitment to sustainability*
- *respect for Aboriginal culture*
- *openness to visitors*
- *entrepreneurial drive*
- *creative and collective spirit and culture*
- *support of primary producers*

The fourth identified key regional priority is described as:

Innovative, sustainable energy, water and waste management.
For our region to establish itself as a leader in renewable energy production; effective, sustainable water management; and innovative approaches to waste management to improve environmental and service delivery outcomes.

Within this strategic priority, Goal 8 sets out the key strategic actions that will position the region as a leader in renewable energy generation, storage and use. This blueprint responds to Strategic Action 8.3.

GOALS	STRATEGIC ACTIONS
8. To strengthen our region's emerging position as a NSW leader in renewable energy generation, storage and use, in accordance with widespread community support for reduced emissions and action on climate change	8.1 Champion and promote the increased use of renewable energy for residential, public and commercial purposes.
	8.2 Advocate for changes to energy generation, purchasing, pricing and retailing regulations with a focus on: • Increased use of renewable energy • Reduced energy costs • Reliable supply
	8.3 Develop a Northern Rivers Renewable Energy Investment Prospectus that identifies opportunities for public, private and community investment in renewable energy projects

Figure 2: NRJO Strategic Regional Priorities – Action 8.3

1.3 About the six local governments of NRJO

We can draw on data developed by North Coast Regional Plan & profile.id to get an insight to the six LGAs that make up the Northern Rivers region of NSW.

Table 1: Summary of some key statistics for the six NRJO Councils

Local area	Ballina	Byron	Kyogle	Lismore	Richmond Valley	Tweed
Population 2020	44,398	35,773	9,209	43,667	23,490	97,277
Population 2040	46,213	38,494	9,635	53,771	26,190	119,868
Land area sq.km	484.9	566.6	3,589	1,290	3,051	1,309
Pop. per sq.km	91.54	63.13	2.57	33.85	7.70	74.31
SEIFA index of disadvantage	1003	1003	910	954	902	973
Private renting	21.9%	24.5%	17.4%	22.6%	22.6%	21.7%
Social housing	4.0%	1.7%	1.6%	3.8%	3.7%	2.8%
Total dwellings	19,104	15,542	4,488	19,019	10,296	42,707
Separate house	66.8%	77.3%	94.1%	81.5%	80.6%	80.2%
Medium density	26.8%	13.6%	2.5%	14.3%	14.2%	14.3%
High density	1.5%	1.1%	0.0%	0.5%	0.0%	2.5%
Registered businesses	4,649	5,097	1,134	4,136	1,700	7,808
# 1 employing industry	Construction	Accommodation and Food Services	Agriculture, Forestry and Fishing	Health Care and Social Assistance	Manufacturing	Health Care and Social Assistance
# 2 employing industry	Health Care and Social Assistance	Retail Trade	Health Care and Social Assistance	Education and Training	Agriculture, Forestry and Fishing	Retail Trade
# 3 employing industry	Retail Trade	Health Care and Social Assistance	Construction	Retail Trade	Health Care and Social Assistance	Construction

At a high level this can provide useful information to help guide the development of this blueprint.

- Local areas such as Kyogle and Richmond Valley are sparsely populated relative to other LGAs, and might therefore have greater scope for large utility-scale renewables,
- Around 25% of the region's residents are renters, with a fraction of these in social housing. This is a large cohort that may be 'left out' from participating in the energy changes by having few options to access solar and battery storage,
- SEIFA, an index measure of relative socio-economic advantage and disadvantage, shows that Byron and Ballina rank in the upper third in NSW, Tweed and Lismore rank in the middle third, and Richmond Valley and Kyogle are in the lower third among NSW local areas,
- Tweed Shire has 32% of all employing businesses and 38% of the resident population of the region, and their share of total population will grow to 41% of the region by 2040,
- The vast majority of the region's housing stock is single dwelling, with medium rise typically around 14% of dwellings, excepting Ballina (26%) and Kyogle (2.5%). There is very little high rise development in the region. Medium-rise residents may similarly be 'left out' in terms of participation in solar and battery storage opportunities.

2 Towards net zero emissions in NSW by 2050

Governments of New South Wales and the Commonwealth, key bodies and agencies such as AEMO and ARENA, and many other organisations across the public and private sectors are setting ambitious goals and policies for emissions reduction, investing in new and enabling technologies, collaborating and working to deliver a clean energy and low emissions future for the State.

Renewable electricity is at the heart of this change, together with bioenergy and hydrogen. Below a summary is provided of key State, Commonwealth, AEMO and ARENA-led policies, focus areas and programs that are driving the change, in addition to the Commonwealth's Renewable Energy Target (RET).

2.1 New South Wales net zero 2050 ambition

New South Wales is undergoing a paradigm shift in the way power is generated, dispatched, stored and used, underpinning the State's drive to reduce greenhouse gas emissions and achieve **net zero emissions by 2050**, aligned with most other States and Territories.

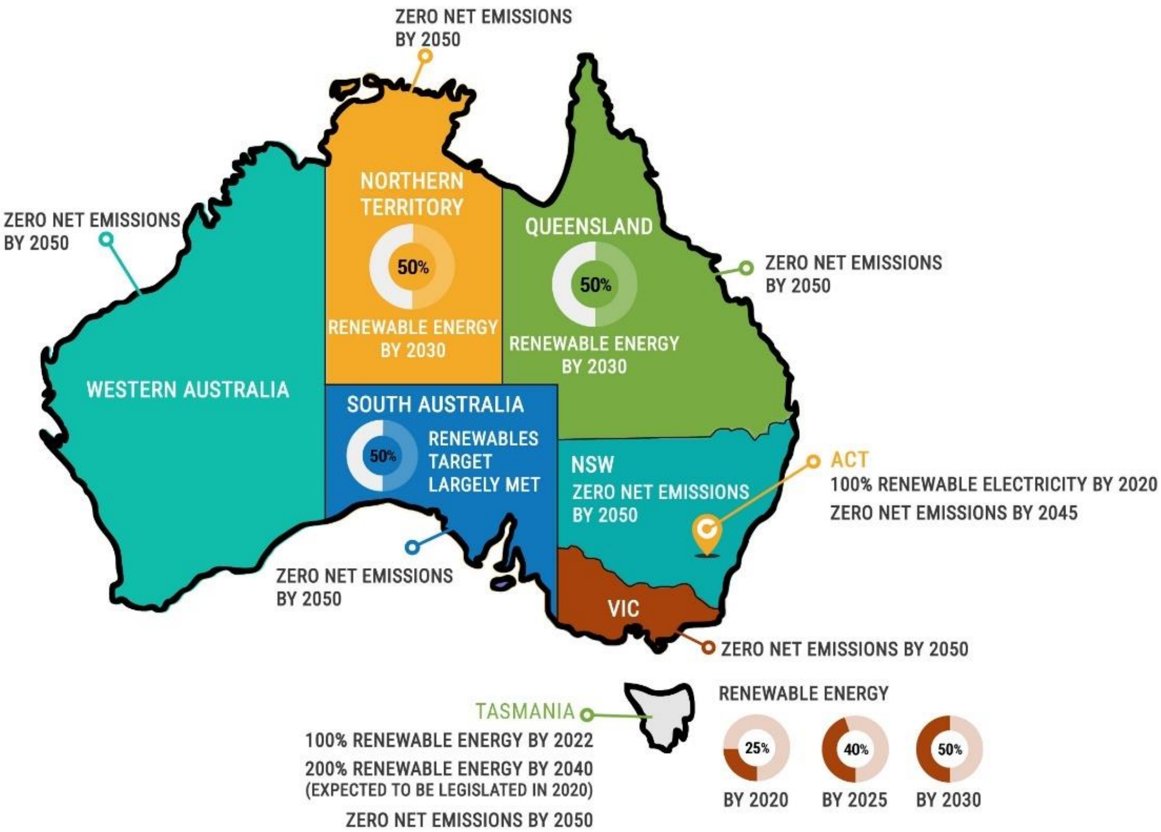

FIGURE 3: AUSTRALIA'S RENEWABLE ENERGY AND CARBON GOALS – STATE & TERRITORY LEVEL, 2021

2.1.1 Net Zero Plan Stage 1: 2020-2030

Supporting the commitment to reach net zero emissions by 2050, the NSW Government in 2020 released its **Net Zero Plan Stage 1: 2020–2030**[2]. This sees the first of three 10-year plans released that will set a pathway to net zero emissions in NSW by 2050.

Within the net zero target NSW has an interim goal to reduce emissions by 50% by 2030, upgraded from 35% in September 2021. The figure below, from the recent net zero plan implementation update[3], shows the forecast pathway for achievement of this emissions reduction.

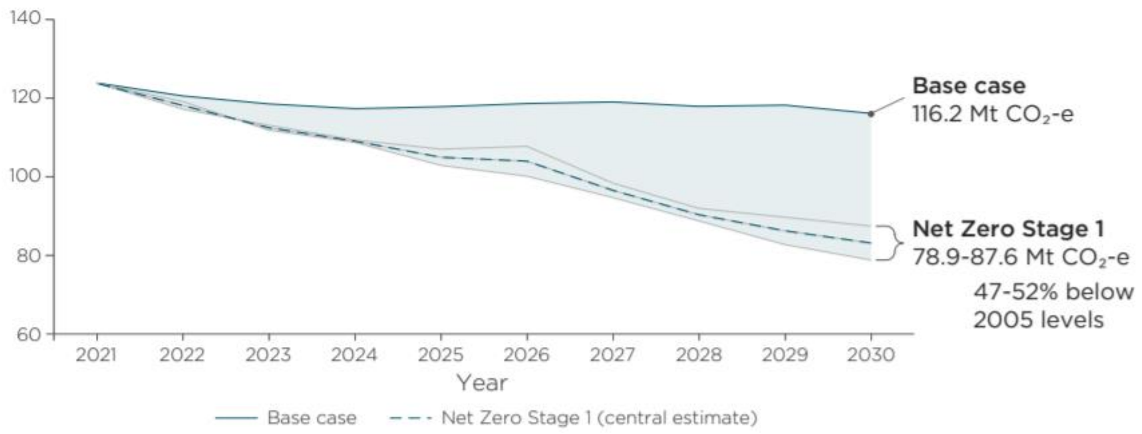

FIGURE 4: PROJECTED REDUCTION IN NSW EMISSIONS BETWEEN 2021 AND 2030

2.1.2 NSW Electricity Strategy

The **NSW Electricity Strategy**[4] is the NSW Government's plan that will see our electricity generation system transform from traditional coal and gas-fired centralised power stations, to a system that is largely served by new power plants established as "Renewable Energy Zones" across the state. Developed in a coordinated way it is intended that this transformation will maintain both reliability and affordability of electricity in future while contributing to meeting emissions reduction targets.

In November 2020, the NSW Government released the Electricity Infrastructure Roadmap, following the passing of the Electricity Infrastructure Investment Bill 2020 (NSW) on 27th November 2020[5]. The roadmap will help to drive the transition to renewables in the state in coming years by coordinating investment in new generation, storage and network infrastructure in New South Wales.

The Electricity Strategy and Electricity Infrastructure Roadmap are expected to attract billions in new private investment in NSW in the coming decade, with much of this directed to regional NSW and creating thousands of new jobs.

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[2] Department of Planning, Industry and Environment, Net Zero Plan Stage 1: 2020–2030, © State of New South Wales 2020. Published March 2020

[3] Department of Planning, Industry and Environment, Net Zero Plan Stage 1: 2020–2030 Implementation Update

[4] https://www.energy.nsw.gov.au/government-and-regulation/electricity-strategy

[5] https://www.parliament.nsw.gov.au/bill/files/3818/XN%20Electricity%20Infrastructure%20Investment%20Bill.pdf

2.1.3 Renewable Energy Zones

Renewable Energy Zones (REZs) are modern-day power stations, encompassing renewable energy generation, storage such as batteries and pumped hydro, and high-voltage poles and wires to deliver electricity. Economies of scale will be achieved by locating multiple generators in defined regions with access to transmission infrastructure to deliver power to cities, industry and regional areas.

The Energy Corporation of NSW (EnergyCo) is the NSW-Government-controlled statutory authority that will lead the delivery of NSW's REZs.

In the first instance a REZ in Central West Orana will be developed, attracting significant private sector investment to developing new generation assets in this region. The REZ is expected to unlock up to 3,000 MW of new network capacity by the mid-2020s, with expressions of interest received for 27,000 MW of new generation in the region in June 2020.

Beyond Central-West Orana, four additional REZs are also planned in the following areas:

- New England,
- South-West,
- Hunter-Central Coast and
- Illawarra

The figures below show the approximate locations of the Central West Orana and New England REZs'.

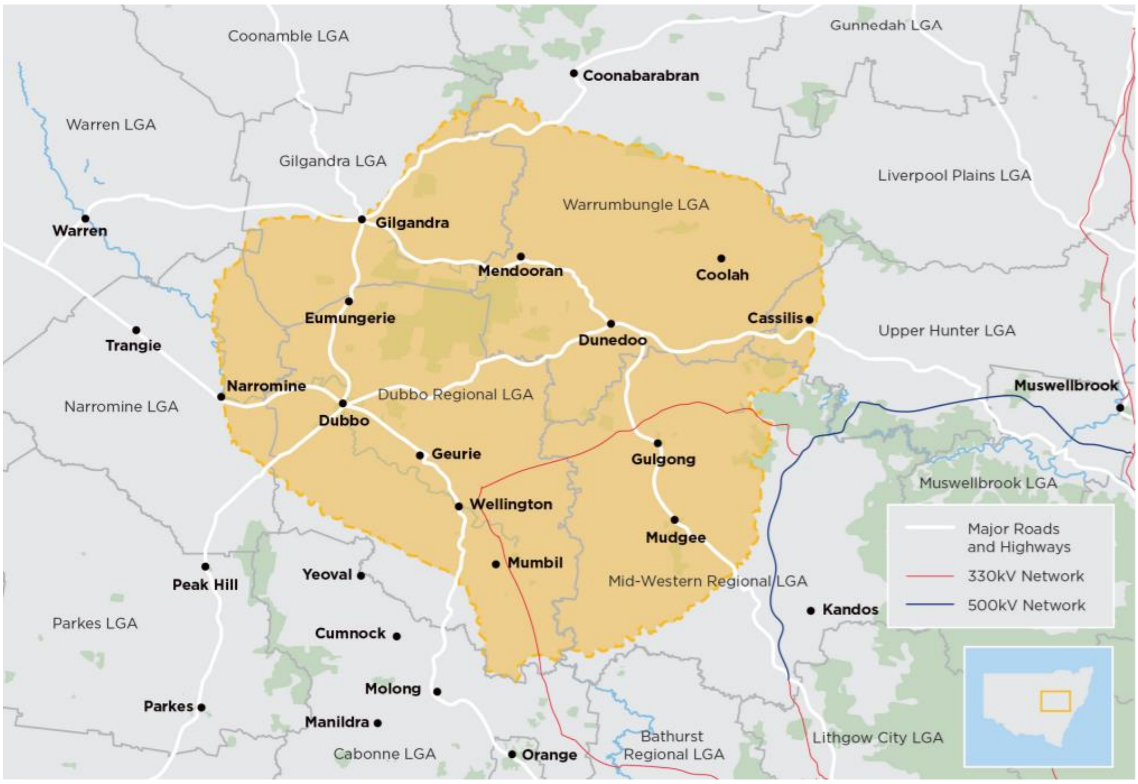

FIGURE 5: INDICATIVE CENTRAL-WEST ORANA NSW RENEWABLE ENERGY ZONE

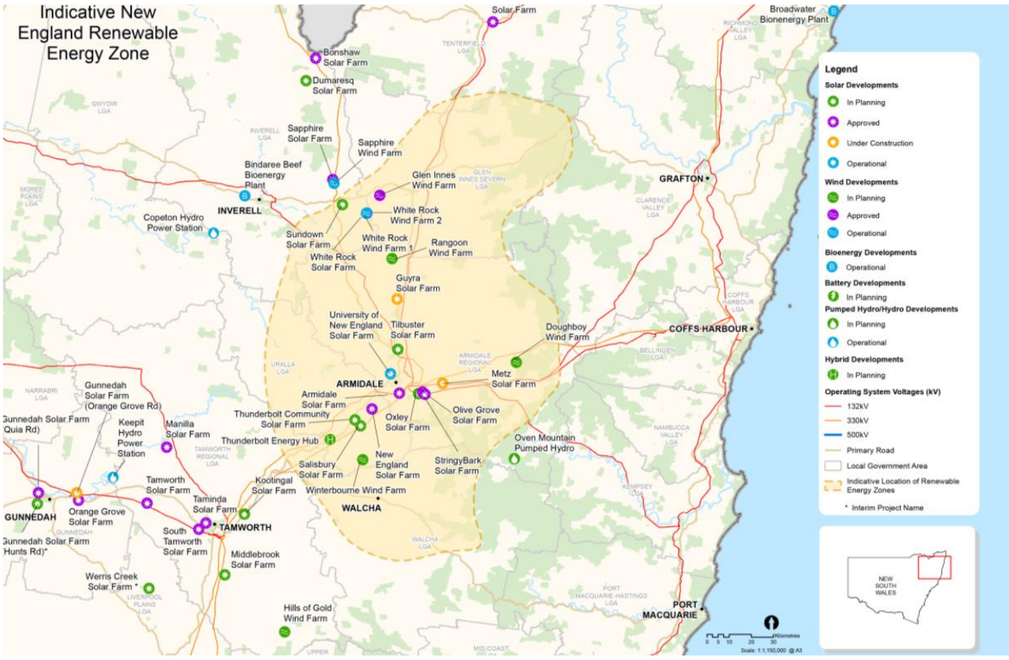

FIGURE 6: INDICATIVE NEW ENGLAND NSW RENEWABLE ENERGY ZONE

Seen in the context of the National Electricity Market (NEM) as a whole, the Australian Energy Market Operator (AEMO) provides a map setting out where a number of REZs may be built in coming decades.

FIGURE 7: INDICATIVE LOCATION OF RENEWABLE ENERGY ZONES IN THE NEM[6]

[6] Google Earth, imagery date 12/14/2015. Data SIO, NOAA, US Navy, NGA, GEBCO. Image Landsat / Copernicus, sourced via https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp/current-inputs-assumptions-and-scenarios

2.1.4 Hydrogen hubs

NSW is investing in the development of two potential major green hydrogen hubs, to be located in the two major industrial regions of the Hunter[7] and the Illawarra[8]. The NSW Government has committed at least $70 million to the development of these hubs. Further hydrogen capacity could be built as part of the Wagga Wagga Special Activation Precinct (SAP) development[9].

The development of these hubs is aligned with the planned development of two REZs in the Hunter Valley and the Illawarra, including offshore wind power generation. Locally produced hydrogen could be distributed locally to industrial users via common infrastructure, be used to fuel heavy vehicles and rail, and create export opportunities for these regions.

Both regions are attractive due to access to existing infrastructure, sustainable water sources, and ports and logistics capacity.

The development of these two regions' hydrogen potential is aligned with the Commonwealth Government's National Hydrogen Strategy[10], and its plans to create clean hydrogen industrial hubs in regional Australia, supported by the Clean Hydrogen Industrial Hubs program[11]. This program's funding was lifted in September 2021 to $464 million, and will provide up to $3 million towards feasibility and design, and up to $70 million for implementation. Key identified locations for this program include the Hunter Valley.

2.1.5 Community renewable energy

Community energy projects help people to collaborate to achieve clean energy goals whilst bringing economic benefits to their region. The NSW Government has supported a number of community-level renewable energy initiatives in recent years; key initiatives are outlined briefly below.

2.1.5.1 Clean Energy Knowledge Sharing Initiative

This initiative supported ten projects across residential and business settings that aimed to overcome barriers to the adoption of clean energy solutions in the community. Selected supported projects are outlined below. It is noted that not all of the projects are resulting in delivered projects, and further investigation would be necessary to determine the challenges, barriers, successes and key learnings from these initiatives:

1. Narara Ecovillage: 60-home smart grid including own residential and centralised renewable energy generation, battery storage and smart controls. It is intended that once complete the ecovillage will have over 650 kW of solar, 450 kWh of storage and its own wastewater treatment plant.
2. Solar for Rentals: one third of Australian households are renters, and miss out on opportunities to participate in the solar market. Solar Analytics developed a benefit-sharing model to make

[7] https://www.investregional.nsw.gov.au/news/hunter-hydrogen-hub/
[8] https://www.investregional.nsw.gov.au/news/first-steps-towards-port-kemblas-hydrogen-hub/
[9] https://www.nsw.gov.au/media-releases/6000-new-jobs-for-wagga-wagga-special-activation-precinct
[10] https://www.industry.gov.au/sites/default/files/2019-11/australias-national-hydrogen-strategy.pdf
[11] https://www.industry.gov.au/policies-and-initiatives/growing-australias-hydrogen-industry

the installation of solar onto rental properties simpler and transparent. Their solar calculator helps owners and renters to negotiate a fair increase in rent when solar is installed, with analysis and reporting to help demonstrate savings to all parties.

3. Enova has been developing a microgrid project in the Byron Bay Arts & Industry Estate, aimed at lowering energy prices and emissions in the community. The KSI project helped to recruit participants to the project and to develop a preliminary pricing model for the microgrid.
4. CLEAN Cowra is looking to develop a solar & battery microgrid in the North Cowra industrial precinct, to be augmented later with a larger bioenergy project that can meet much of the energy needs of the precinct and potentially the wider Cowra community.
5. COREM developed a pre-feasibility study to look at the potential to recommission a mothballed hydro-electric power station in Mullumbimby. The proposed hybrid mini-hydro system would add a reservoir for pumped hydro storage, providing on demand generation while helping to balance the local electricity network.

2.1.5.2 Community-owned renewable energy

Numerous communities are participating in projects and efforts to increase renewables, increase local participation and literacy, and increase regional economic benefits.

Community energy can involve energy supply projects such as renewable energy installations and storage, and energy reduction projects such as energy efficiency and demand management.

Models of community energy that have been delivered and are being developed across Australia have varying financial, contractual, technical, technology, scale and ownership arrangements. Interest in community energy projects is high, and there is a significant body of information and 'how to' available through:

- the National Community Energy Strategy,
- the Community Owned Renewable Energy (CORE) guide developed by Community Power Agency with support from NSW Government, and
- the updated Small Scale Community Solar Guide, which was developed by the Coalition for Community Energy (C4CE[12]).

ARENA has also sponsored a Community Renewable Energy Financing Toolkit, which was developed by Frontier Impact Group.

[12] The National Community Energy Strategy was a collaboration of the Institute for Sustainable Futures (UTS), Embark, Repower Shoalhaven, Moreland Energy Foundation, ClearSky Solar Investments and Starfish Initiatives, funded by ARENA. The solar guide from this publication was updated in 2017, written by Community Power Agency as a collaborative effort with Pingala, Starfish Initiatives, Macedon Ranges Sustainability Group, The Hub Foundation in Castlemaine, CORENA, Repower Shoalhaven, Bendigo Sustainability Group and Environmental Justice Australia.

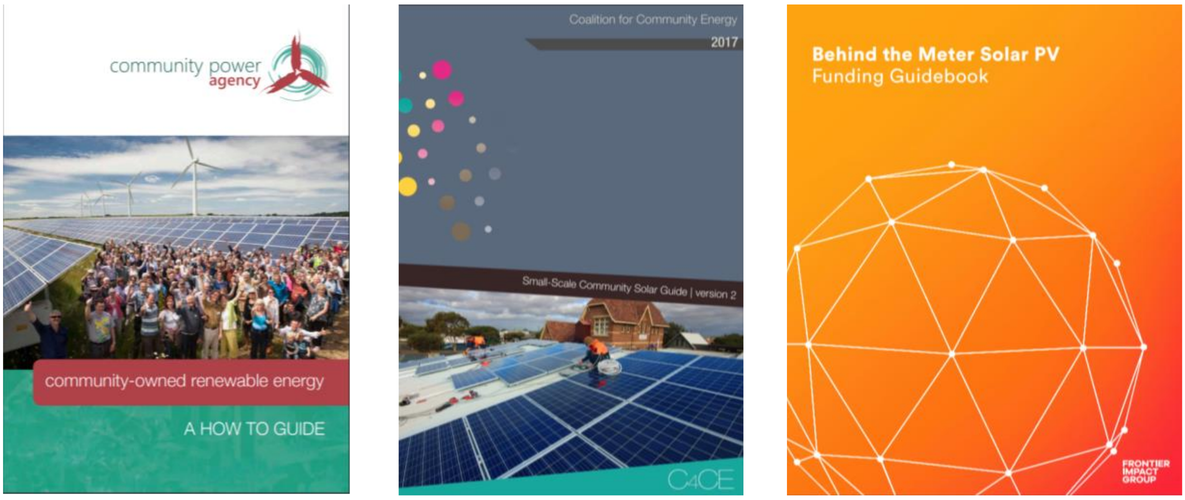

FIGURE 8: COMMUNITY ENERGY GUIDANCE MATERIALS

There are numerous examples of community energy projects across Australia, including prominent projects such as Lismore City Council and Farming the Sun's floating solar array at the East Lismore treatment plant, and Enova Energy's North Coast Community Housing (NCCH) Solar Garden.

Community Power Agency (CPA) has mapped out known community renewable energy projects across Australia, which includes at least eight projects in the Northern Rivers region. This is illustrated below.

FIGURE 9: MAP OF COMMUNITY-OWNED RENEWABLE ENERGY PROJECTS IN AUSTRALIA AND NORTHERN RIVERS[13]

[13] Sourced from Community Power Agency: https://cpagency.org.au/resources/map/

2.1.5.3 NSW Household renewable programs

Solar for Low-Income Households[14]

NSW Government provides 3 kW solar PV systems for free to eligible low income home owners in exchange for the removal of the Low Income Household Rebate of $285/year for ten years. Expected cost benefits to residents are around $600 per year. Up to 3,000 systems will be installed, with the trial being run in five regions, including Central Coast, North Coast, Sydney – South, Illawarra – Shoalhaven and South Coast. On the north coast of NSW the program implementation partner is SAE Group.

Empowering Homes solar battery loan offer

Through this initiative the NSW Government is providing homeowners in eligible postcodes access to interest-free loans of up to $14,000 for a solar + battery system or $9,000 to retrofit a battery to existing solar systems, with loans repayable over 8 or 10 years respectively.

The program is being run as a trial in selected postcodes, across the Central West, Central Coast, Hunter, Mid North Coast and New England regions of NSW, before being expanded across the State.

2.1.5.4 Regional Clean Energy Fund

The NSW Government's Regional Clean Energy Fund has provided part funding to seven projects, with over $15 million in grants aiming to leverage a further $36 million in private investment. If all projects are completed this will see an additional 17.2MW in electricity generation and up to 17.9MW/39.3MWh of energy storage. These projects are tabulated below.

Table 2: Regional Community Energy Fund grant recipients[15]

Recipient	Project Title	Primary technology and capability	Location
Byron Bay Solar Farm Holdings	Byron Bay Solar Farm + Battery Storage Facility	5 MW Solar PV 5 MW / 10MWh battery	Ewingsdale
Energise Gloucester	Gloucester Community Solar Farm	0.5 MW Solar PV	Gloucester
Community Energy for Goulburn	Goulburn Community Dispatchable Solar Farm	1.2 MW Solar PV 0.4 MW / 0.8MWh battery	Goulburn
Pingala – Community Renewables	Haystacks Solar Garden	1 MW Solar PV	Grong Grong
Manilla Community Renewable Energy	Manilla Community Solar	4.5MW Solar PV 4.5 MW / 4.5MWh battery 2 MW /17MWh hydrogen energy storage system	Manilla
ITP-NHT DevCo	Orange Community Renewable Energy Park	5 MW Solar PV Up to 5 MW / 5 MWh battery	Orange
Enova Community Energy Ltd	Shared Community Battery Scheme	1 MW / 2MWh battery	Kurri Kurri

[14] Sourced from: https://www.energysaver.nsw.gov.au/browse-energy-offers/household-offers/apply-solar-low-income-households

[15] Sourced from: https://www.energy.nsw.gov.au/renewables/clean-energy-initiatives/regional-community-energy

2.2 Australian Energy Market Operator

2.2.1 100% renewables-ready grid

The Australian Energy Market Operator (AEMO) CEO gave a keynote speech at a Committee for Economic Development of Australia (CEDA) event in July 2021. This speech highlighted a number of things about how our electricity grid is and will continue to evolve in coming years. Key points are summarised here.

- More than 90¢ in every dollar invested in energy generation since 2012 has been in wind and solar,
- The pace of change is well ahead of AEMO's forecasts, with 55 GW of proposed projects across the National Electricity Market (NEM), close to today's total generating capacity,
- Solar panels are fitted to more than 2.5 million homes, representing the fastest growing part of the generation mix,
- **With the continued rapid pace of change AEMO has set itself a goal for the grid to be capable of running on 100% instantaneous renewable energy by 2025,**
- AEMO has seen instantaneous penetration of wind and solar increase year on year in the NEM, to 52% in 2020, and to 65% in the Western Australia Electricity Market (WEM). 100% instantaneous penetration of wind and solar has been achieved in South Australia,
- Building on experiences learned in South Australia, AEMO is now beginning to partner with distribution companies in other states to help them to develop similar capabilities, to innovate to ensure that grid stability is maintained at times of high solar and wind penetration, and to make sure that consumer-level solar is the last resource that would be curtailed in the electricity system,
- AEMO has called for six to 19 gigawatt-hours of dispatchable capacity, such as from pumped hydro and batteries, to be built across Australia,
- AEMO recognises that integration of home energy and storage into the grid will help with the transition to renewable energy generation, through storage locally, virtual power plants, sharing at community level, and providing the right regulatory framework and incentives to make this feasible,
- AEMO also notes the change that will occur when millions of vehicles are electrified, and the importance of managing charging cycles to ensure a stable grid.

At an overarching level, the talk signals that:

- The switch to 100% renewables is occurring and faster than all previous predictions.
- Work with transmission and distribution businesses to ensure that grid stability can be maintained is progressing.
- The role of large-scale storage through batteries and pumped hydro, of consumers and communities through the use and aggregation of stored solar capacity, and of managing how and when electric vehicles are charged will all be integral to reaching AEMO's goal of a 100% renewables-ready grid by 2025.

2.2.2 Integrated System Plan 2020 and 2022

The Integrated System Plan (ISP) is a whole-of-system plan that provides an integrated roadmap for the efficient development of the National Electricity Market (NEM) over the next 20 years and beyond.

AEMO uses scenario modelling and cost-benefit analysis to determine the most efficient ways to meet power system needs through the energy transition and in the long-term interests of consumers. The 2020 ISP[16] modelled five key scenarios that consider different transition speeds:

1. a Central scenario is determined by market forces and current federal and state gov policies,
2. a Slow Change scenario assumes slower economic growth and emission reductions,
3. a High DER scenario assumes more rapid consumer adoption of Distributed Energy Resources,
4. a Fast Change scenario sees greater investment in grid-scale technology, and
5. a Step Change scenario sees both consumer-led and technology-led transitions occur in the midst of aggressive global decarbonisation

Work towards the development of the 2022 ISP is well underway. As with previous ISPs there are five scenarios that will be modelled. These include[17]:

TABLE 3: SUMMARY OF 2022 ISP INPUTS TO THE FIVE SCENARIOS

ISP Scenario	Input assumptions: by 2040….
Steady progress	• The power system has continued to develop based mainly on market-led investments. • The number of houses with rooftop solar has doubled and the amount of energy generated on the rooves of our homes has tripled since 2020. • In winter, homes are still heated to a large extent by ducted gas heating systems. • Industry has followed current technological trends, with no major changes. • One third of our cars are electric vehicles.
Net Zero 2050	• The NEM is on the way to a national abatement goal of net zero emissions by 2050. • Rooftop solar on homes and businesses generates four x as much energy as today. • In winter, we are increasingly heating our homes with electric heat pumps and reverse cycle air conditioning, with gas heating appliances reduced by 55% since 2020. • Industrial processes are over 30% powered by electricity, up from 20% in 2020. • Almost half our cars are now electric vehicles.
Step Change	• Electricity is generated with near zero carbon emissions, businesses and households are preferring electricity ahead of more carbon-intensive options. • Our rooftop solar capacity has more than quadrupled since 2020, with about triple the number of rooftops covered. • Energy efficiency and switching to electric heating and appliances has cut our use of gas in our homes by 85% since 2020, on the path to using no gas in homes by 2050. • Industry is using nearly 20% less gas, 30% less coal and 90% less oil than in 2020. • Almost 60% of cars are electric, and a third of heavy vehicles are fuelled by hydrogen
Slow change	• Not made co-ordinated efforts to reduce emissions across the NEM or to electrify. • Rooftop solar capacity has tripled since 2020. • Consumers are slowly pursuing efficiency and switching to electric heating. • There has been limited change in industry's use of gas. • One in five vehicles is electric.

[16] https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2020-integrated-system-plan-isp#Final%202020%20ISP

[17] Sourced from: https://aemo.com.au/-/media/files/major-publications/isp/2021/2021-inputs-assumptions-and-scenarios-report-overview.pdf?la=en

Hydrogen Superpower	• Electricity is generated with zero or near zero emissions. • Rooftop solar is about five times the capacity we had in 2020. • Houses are using 90% less gas than in 2020, switching to hydrogen (54%) or electricity. • 75% of all cars are electric, and almost half articulated trucks are fuelled by hydrogen. • Industry has reduced gas by >65% since 2020, with >50% of demand shifting to H2. • There is an important export market for hydrogen produced in the NEM, production will more than triple by 2050, and there is a fledgling green steel industry.

2.2.3 CSIRO Solar, Battery and EV forecasts

As input to the 2022 ISP, CSIRO has updated its forecasts for the uptake of solar panels, battery storage[18] and electric vehicles[19] in the NEM. A snapshot of some of CSIRO's key findings as they relate to the scope for new renewables in the Northern Rivers region is provided below.

Small-scale solar in the NEM is forecast to grow from approximately 10,000 MW (degraded) capacity in 2020 to between 20,000 MW and more than 55,000 MW by 2040; that is two to 5.5 times growth.

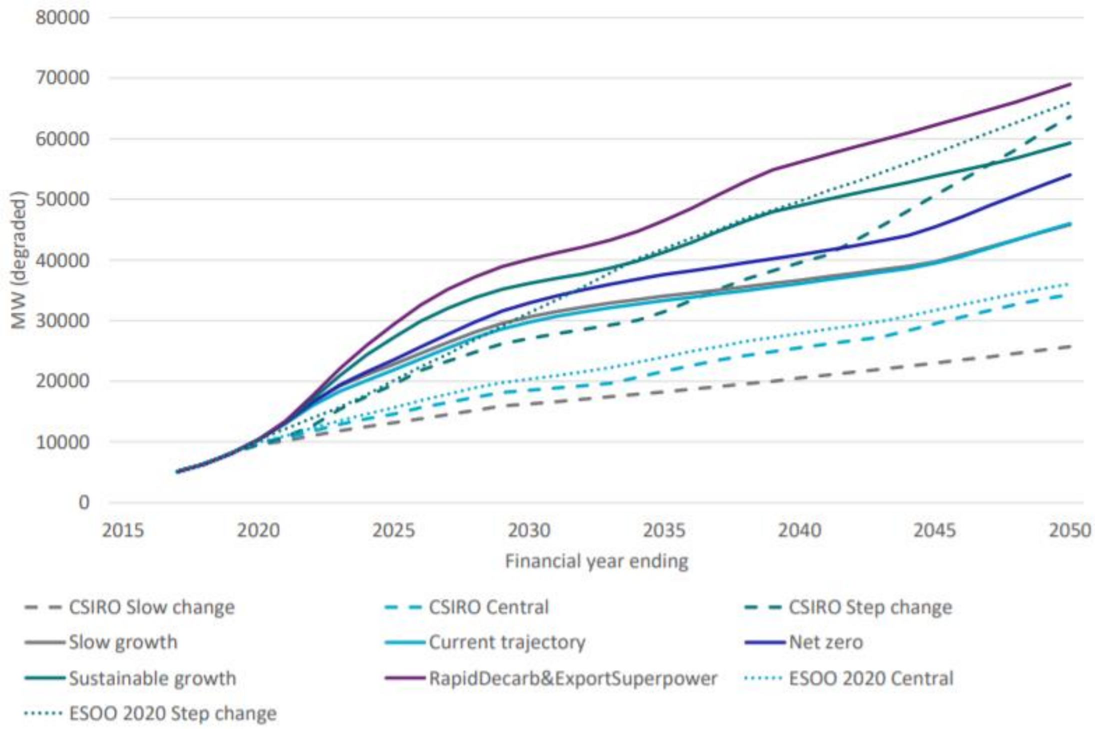

FIGURE 10: CSIRO'S PROJECTED CAPACITY OF SMALL-SCALE (<100 KW) SOLAR PV IN THE NEM

Non-scheduled solar – from commercial systems **>100 kW up to mid-scale grid systems up to 30 MW**, make up a much smaller current and forecast contribution to the mix of renewables, with under 1,000 MW today forecast to grow to between 2,200 MW to 3,800 MW by 2040 (approximate figures).

[18] Graham, P.W. 2021, Small-scale solar and battery projections 2021, CSIRO, Australia
[19] Graham, P.W. and Havas, L. 2021, Electric vehicle projections 2021, CSIRO, Australia

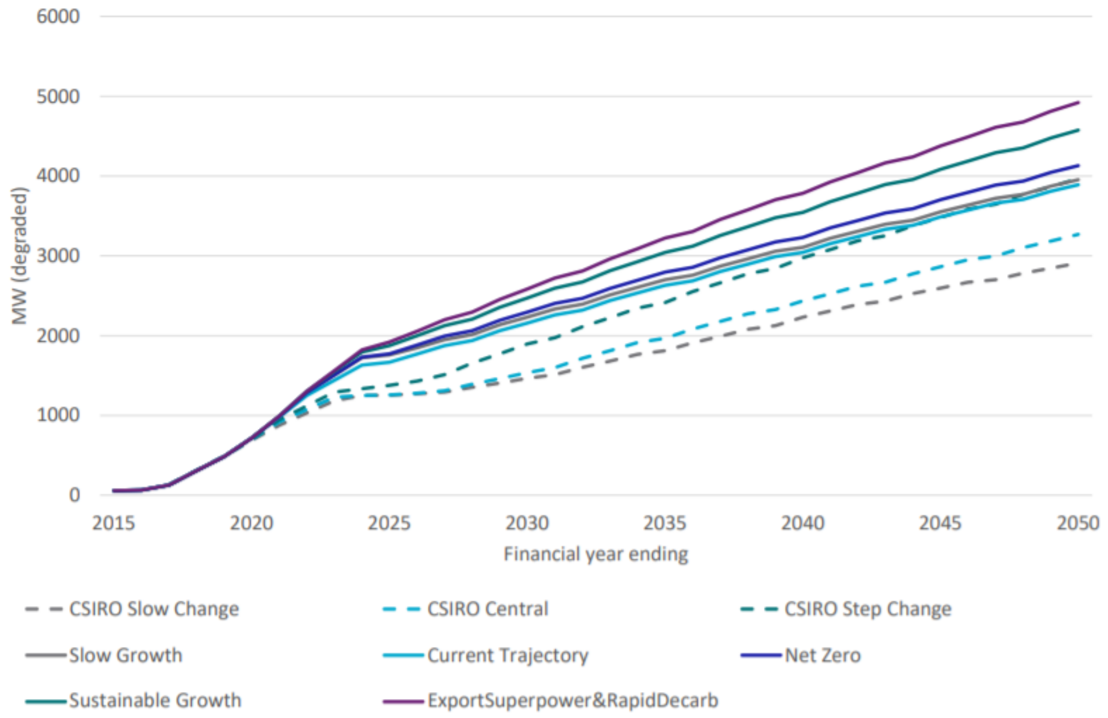

FIGURE 11: CSIRO'S PROJECTED CAPACITY OF NON-SCHEDULED SOLAR PV (100KW TO 30MW) IN THE NEM

When forecasting **small-scale battery storage**, linked to the scenarios for increased solar PV, CSIRO forecasts an increase from negligible (~1,000 MWh in 2020) to a range from a little under 5,000 MWh to as high as 40,000 MWh capacity in 2040.

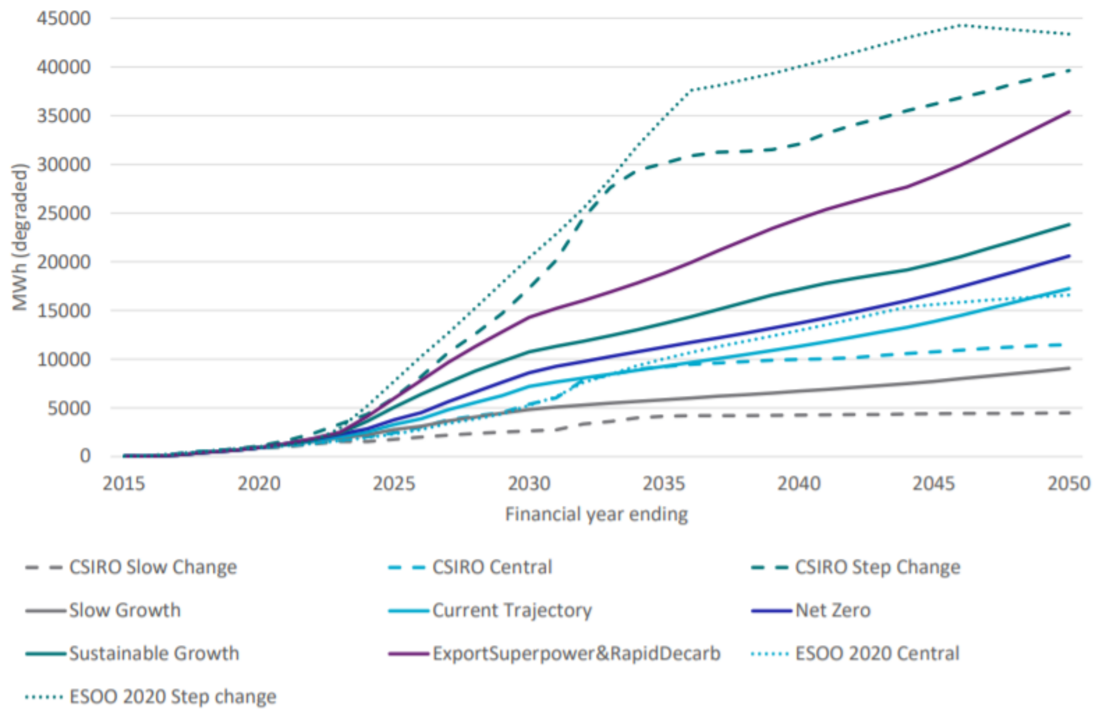

FIGURE 12: CSIRO'S PROJECTED CAPACITY OF SMALL-SCALE BATTERY CAPACITY IN THE NEM

Looking at their **projections for electric vehicles**, CSIRO forecasts that as a proportion of all vehicles in Australia EVs may make up between ~15% and ~70% by 2040.

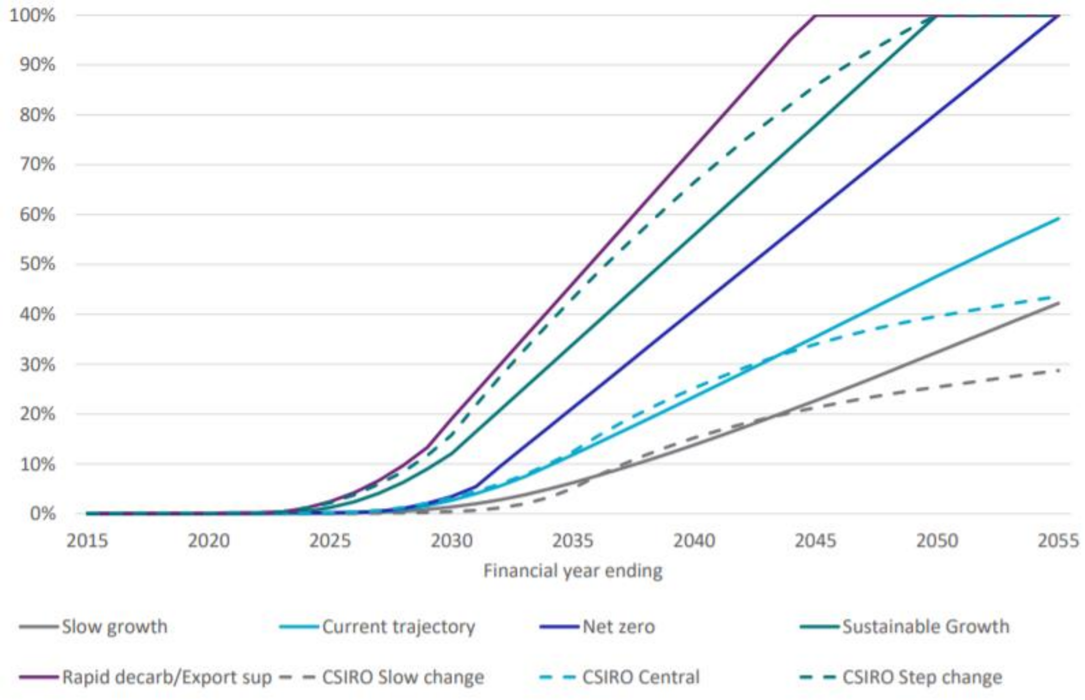

FIGURE 13: CSIRO'S PROJECTED EV SHARE OF ALL VEHICLES IN AUSTRALIA

CSIRO projects that electric vehicles will consume ~10,000 GWh to ~65,000 GWh annually by 2040.

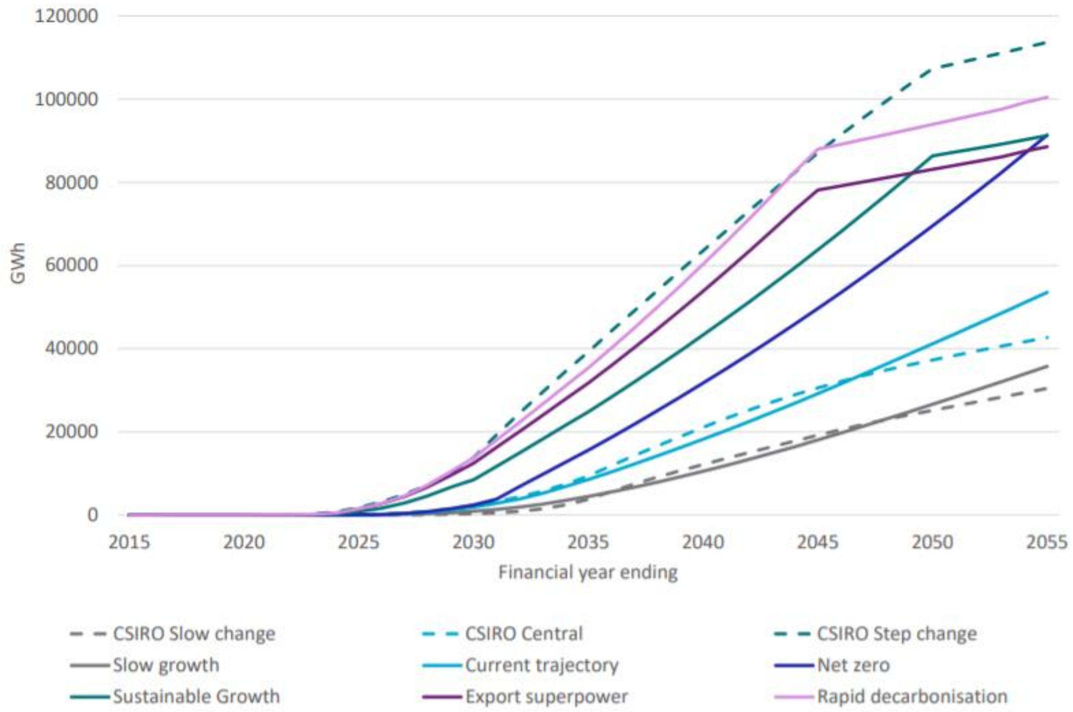

FIGURE 14: CSIRO'S PROJECTED ELECTRICITY DEMAND FOR EVS

2.2.4 AEMO's NEM Distributed Energy Resources Program[20]

AEMO's DER Program is dedicated to understanding and integrating high levels of Distributed Energy Resources (DER - consumer-owned devices that, as individual units, can generate or store electricity or have the 'smarts' to actively manage energy demand) into Australia's energy system and markets.

Examples of DER devices include:

- Rooftop solar photovoltaic (PV) units
- Wind generating units (at residential or commercial premises)
- Battery storage system
- Hot water systems, pool pumps and air conditioner
- Smart appliances
- Electric vehicles

Some of the key initiatives that are being trialled or that have been completed include:

2.2.4.1 Virtual Power Plant (VPP) Demonstrations

A virtual power plant (VPP) broadly refers to an aggregation of resources (such as decentralised generation, storage and controllable loads) coordinated to deliver services for power system operations and electricity markets. The VPP Demonstrations included the following;

- Eight VPP portfolios across all mainland National Electricity Market (NEM) states.
- A total registered capacity of 31 MW (equivalent to a small scheduled hybrid solar farm plus battery).
- Approximately 7,150 consumers who signed up in the VPP Demonstrations

The VPP demonstrations were a first step in a program of work designed to inform changes to regulatory frameworks and operational processes so Distributed Energy Resources (DER) can be effectively integrated into the National Electricity Market (NEM). To prepare for the safe and efficient integration of these resources, AEMO trialled VPPs' capability to:

- Participate in markets and value stacking, including through provision of contingency frequency control ancillary services (FCAS), responses to energy price signals, and interact with distribution networks.
- Provide operational visibility.
- Improve the consumer experience.
- Cater for cyber security threats.

The key findings and recommendations arising from the Demonstrations are detailed in a September 2021[21] report by AEMO.

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[20] Content here is copied from: https://aemo.com.au/initiatives/major-programs/nem-distributed-energy-resources-der-program/der-demonstrations/virtual-power-plant-vpp-demonstrations

[21] AEMO NEM Virtual Power Plant Demonstrations September 2021 Knowledge Sharing Report #4

2.2.4.2 Project EDGE[22]

Project EDGE (Energy Demand & Generation Exchange) aims to demonstrate how a proof of-concept DER Marketplace would work. This includes enabling aggregated DER to provide efficient, secure, and coordinated wholesale and local network support services at the grid edge. Project EDGE aims to:

1. Demonstrate how DER fleets could participate in existing and future wholesale energy markets at scale.
2. Demonstrate different ways to consider distribution network limits in the wholesale dispatch process.
3. Demonstrate how to facilitate standardised, scalable and competitive trade of local network services.
4. Demonstrate how data should be exchanged efficiently and securely between interested parties to support delivery of distributed energy services.
5. Develop a proof of concept, integrated software platform to facilitate delivery of objectives 1-4 in an efficient and scalable way.
6. Develop a detailed understanding of roles and specific responsibilities that each industry actor should play.
7. Conduct comprehensive cost benefit analysis to provide an evidence base for future regulatory decision making.
8. Conduct a customer focused social science study to understand customer opinions on the complexities of DER integration.
9. Deliver best practice stakeholder engagement throughout the project with a commitment to knowledge sharing.
10. Deliver recommendations, supported with evidence, on how and when the concepts demonstrated should be implemented operationally.

Project EDGE builds on and interacts with a number of other DER initiatives, including:

- Project Evolve DER, focused on operating envelope design
- SA Power Networks (SAPN) Flexible PV Exports project
- Engagements with the WA DER roadmap and related projects
- Dynamic EV Charging, led by Jemena
- AEMO VPP Demonstrations, outlined above

[22] Content sourced from https://aemo.com.au/initiatives/major-programs/nem-distributed-energy-resources-der-program/der-demonstrations/project-edge

2.3 Australian Renewable Energy Agency

2.3.1 ARENA's investment priorities

In September 2021 the Australian Renewable Energy Agency (ARENA) released its future investment priorities, reflecting those initiatives it will focus on over the next few years. Amongst the five priorities of the agency, three are potentially relevant in the context of the development of renewables in the Northern Rivers, including:

- Priority 1. Optimise the transition to renewable electricity, on and off-grid. Funding will be committed for innovation in areas such as:
  - Enable ultra low-cost renewable generation
  - Support flexible demand
  - Improve the economics of energy storage, and
  - Optimise integration of large-scale renewable energy into the electricity system
- Priority 2. Commercialise clean hydrogen, including innovation across cheap firmed renewables, electrolyser technology and scaling hydrogen usage. Key initiatives supported:
  - Reduce the cost of hydrogen produced from renewable energy
  - Research and development to demonstrate technologies that address technical challenges along the hydrogen value chain
- Priority 5: Deliver the targeted programs in the 2020-21 Federal Budget, including:
  - Regional Australia Microgrids Pilot Program (see below)
    - a $50 million six-year program that aims to improve the resilience and reliability of power supply for regional and remote communities.

2.3.2 Distributed Energy Integration Program (DEIP)[23]

The Distributed Energy Integration Program (DEIP) is a collaboration of government agencies, market authorities, industry and consumer associations aimed at maximising the value of customers' distributed energy resources (DER) for all energy users. The DEIP has four main work streams:

- DEIP Dynamic Operating Envelopes: where customer import and export limits can vary over time and location, allowing higher levels of energy exports from customers' solar and battery systems when there is more hosting capacity on the local network.
- DEIP Access and Pricing: examines how network regulations could evolve so that consumers get the best value from innovations in distributed energy.
- DEIP EV Working Group: considering how a growing number of electric vehicles can be integrated into Australia's electricity system.
- DEIP Interoperability Steering Committee (ISC): development and implementation of industry technical standards with a focus on interoperability capabilities to better enable the integration of DER into the Australian energy system.

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[23] Content copied from: https://arena.gov.au/knowledge-innovation/distributed-energy-integration-program/

2.3.3 Regional Australia Microgrid Pilots Program

ARENA have recently launched this program, which was announced in October 2021. The program provides $50m funding over six years to improve the reliability and resilience of regional and remote communities. It builds on previous work that assessed the feasibility of local microgrid technologies in these areas and aims to provide funding to projects that have previously completed a feasibility study.

Key focus areas for the RAMPP are the demonstration of solutions to technical, regulatory or commercial barriers to the deployment of microgrid technologies. Funding is non-competitive and will be delivered across two stages over six years or until funds are fully allocated:

- Stage 1: $30 million available from launch through CY2022
- Stage 2: $20 million available from CY2023

2.3.4 Bioenergy

ARENA has provided support to a number of key bioenergy projects in recent years. Bioenergy resources could play an important role in Australia's energy future, though at this time they make a small contribution to total energy supply.

2.3.4.1 Biogas opportunities for Australia

ENEA developed a report in 2019[24], led by Bioenergy Australia and with funding support from ARENA, Clean Energy Finance Corporation (CEFC), Energy Networks Australia (ENA) and the International Energy Agency's Bioenergy Task 37: Energy from Biogas.

As a baseline the report notes that electricity generation from biogas was 1,200 GWh, or 0.5% of Australia's total generation in 2016-17. There were 242 plants at that time, half of these being landfill gas sites, and that much of the biogas collected is flared rather than beneficially used to create energy.

The potential for bioenergy in Australia is reported to be 103 TWh (371 PJ) per annum, or 9% of final energy consumption. Based on the average size of biogas units in Australia this could require up to 90,000 bioenergy units, and could avoid up to 9 Mt CO_2-e annually.

The report made eight key recommendations, including:

1. Setting renewable gas target(s) at Commonwealth and State levels, possibly similar to the Renewable Energy Target (RET) for electricity
2. Government to consult with stakeholders with a view to harmonise policies, in particular relating to injecting biomethane into the gas grid, developing 'green gas' retail product, and supporting pilot biogas projects
3. State Governments to work together to develop waste management strategies to support feedstock quality and quantity, such as uniform levies, organic municipal waste separation, and work with industry to address issues around long term feedstock supply contracts
4. Encouraging plant operators, especially landfill operators, to maximise biogas use
5. Commonwealth Government to explore opportunities for the transport sector, particularly biomethane as a low carbon fuel for heavy vehicles, and excise duty concessions for biofuels
6. Providing regulatory clarity for the digestate, particularly around its commercial use

[24] Biogas Opportunities for Australia, ENEA Consulting – March 2019

7. Simplifying approval processes across governments and energy network businesses
8. Informing the community about biogas and its benefits

2.3.4.2 Australian Biomass for Bioenergy Assessment[25]

The ABBA project collected and collated new data regarding biomass feedstock location and availability, and amalgamated the data in one place, on the Australian Renewable Energy Mapping Infrastructure (AREMI) platform.

The data is available to renewable energy project developers, policy makers, and others, and provides a multi-faceted dataset that complements existing related information, such as energy infrastructure, power utilities, population data and land use data.

2.3.4.3 Australian Bioenergy Roadmap[26]

ARENA has developed a roadmap to identify the role that the bioenergy sector can play in Australia's energy transition and in helping Australia further reduce our emissions. The Bioenergy Roadmap will help to inform the next series of investment and policy decisions in the bioenergy sector in Australia. Key opportunities identified, particularly for regional areas, include:

- Potential for bioenergy to contribute ~$10 billion in extra GDP per annum by 2030,
- Potential for 26,200 new jobs,
- Emissions reduction potential of 9% plus 6% waste diversion from landfill

The roadmap's four main themes include:

1. Enabling market opportunities in hard-to-abate sectors: in renewable industrial heat, sustainable aviation fuel and renewable gas grid injection.
2. Enabling market opportunities where bioenergy can complement other low emissions alternatives: in the road transport and electricity markets.
3. Developing our resources: Australia has a significant bioenergy resource potential. However, there is insufficient clarity and detail over the viability and sustainability of these resources.
4. Building supportive ecosystems: An enduring and successful bioenergy industry will require concerted efforts beyond those relating to markets and feedstocks. It will be necessary to harness an ecosystem that links the diverse parts of the bioenergy industry to facilitate its growth

[25] Australian Biomass for Bioenergy Assessment 2015-2021, Final report, Prepared by AgriFutures Australia, April 2021, and https://arena.gov.au/knowledge-bank/australian-biomass-for-bioenergy-assessment-final-report/
[26] https://arena.gov.au/knowledge-innovation/bioenergy-roadmap/

2.3.5 Hydrogen[27]

ARENA's investment of resources into hydrogen is underpinned by Commonwealth Government-led work to quantify the opportunities for hydrogen in Australia. Key goals for hydrogen include:

- Target production cost for H2 of under $2 per kilogram as set out in The Low Emissions Technology Statement (H2 under $2), and
- The Government's National Hydrogen Strategy sets a vision for commercial renewable hydrogen exports by 2030, with research performed for ARENA suggesting the potential for a $10 billion annual export potential by 2040.

In addition to export potential, hydrogen made from renewable energy could be used to displace gas and other fuels in heavy industry, fuel heavy vehicles, and potentially be used to power homes.

In May 2021 ARENA announced $103 million of funding to support three 10 MW hydrogen electrolyser projects in Western Australia and Victoria, which would be among the largest renewable hydrogen demonstrations in the world. One of the projects will see H2 used to make ammonia for export, while the other two will blend clean H2 into gas networks.

2.4 Industrial precincts

In parallel with the rapid development of renewables in Australia, and the more recent rise in interest in hydrogen as a fuel, there is also a focus on the development and/or re-invigoration of regional industrial and business hubs and industrial processes. These offer the potential for integration of renewable energy to part or fully power and fuel businesses with low cost, low or zero emissions energy, helping to meet Australia's and NSW' emissions reduction goals.

Two examples of development in this area are highlighted.

2.4.1 Special Activation Precincts[28]

A Special Activation Precinct is a dedicated area in a regional location identified by the NSW Government to become a thriving business hub. Coordinated planning and delivery by multiple departments (Regional NSW, DPIE and the Regional Growth NSW Development Corp) focuses on fast-track planning, infrastructure investment, Government-led studies, Government-led development and a business concierge to attract investment and support businesses to set up and grow.

NSW Special Activation Precincts are under development in Parkes, Wagga Wagga, Snowy Mountains, Moree, Williamtown and Narrabri

Parkes is the first Special Activation Precinct announced for regional NSW. **Highlighting the renewable energy opportunities these projects potentially offer, Parkes SAP will be Australia's first UNIDO Eco-Industrial Park, incorporating onsite clean energy-generation**.

[27] https://arena.gov.au/renewable-energy/hydrogen/
[28] https://www.planning.nsw.gov.au/Plans-for-your-area/Special-Activation-Precincts/SAPs-explained

2.4.2 Regional Job Precincts[29]

Regional Job Precincts are an extension of the SAP program, and will provide planning support to help fast-track approvals to drive growth, investment and development opportunities in regional NSW.

The NSW Government will work with local councils to streamline planning processes and make it easier for businesses to set-up or expand. It is intended that RJPs will deliver faster planning approvals to increase confidence for councils, communities, industry and businesses to invest.

Six Regional Job Precincts are planned, including **Casino in the Richmond Valley**.

The intent of the program is to implement in the six regional towns, and review to determine how it can be rolled out in other regional areas.

[29] https://www.nsw.gov.au/snowy-hydro-legacy-fund/special-activation-precincts/regional-job-precincts

3 Renewable energy technologies, storage and NSW resources

A high-level overview of key renewable energy technologies that are deployed and have potential for deployment in Australia and globally is provided. The primary goal of this review is not to provide an insight into leading edge research that may inform future technology development, but to highlight those technologies for renewable energy generation and storage that will likely be deployed in the coming couple of decades. Key questions that are addressed include:

- What is the relative commercialisation/maturity of a range of renewable technologies e.g. solar, batteries, concentrated solar with molten storage, anaerobic digestion, green hydrogen?
- What are the benefits gained from scale of projects?

3.1 What is renewable energy and what technologies are used?

Any form of energy generated using a resource which doesn't emit any direct emissions and doesn't get depleted with utilisation is termed renewable energy. From an Australian perspective the main renewable energy and storage technologies that are used to supply homes and businesses include[30]:

3.1.1 Bioenergy

- Bioenergy (as biogas, biomethane, electricity, etc) is produced from municipal landfills, sewerage treatment, agriculture residues, forestry residues, and industrial waste such as abattoirs
- CEC estimates bioenergy electricity generation of 3,164 GWh in 2020, some three times estimates in the ENEA report
- Landfill gas is one of the major sources of biogas for electricity generation
- A project to inject biomethane from the Malabar STP in Sydney to the gas grid was completed in 2020
- Byron Shire Council is proposing a bioenergy plant for its STP at Myocum
- Biogass built and operates a 2 MW bioenergy plant in Perth
- Cape Byron Power's two cogeneration plants in the Northern Rivers use biomass from bagasse, energy crops, woodwaste and approved clearance

[31]

[32]

[30] Sourced from https://www.cleanenergycouncil.org.au/resources/technologies
[31] Image from: https://arena.gov.au/projects/australian-biomass-for-bioenergy-assessment-project/
[32] Image from: https://www.alburycity.nsw.gov.au/services/waste-and-recycling/alternative-energy (Albury Waste Management Centre Landfill Gas Plant)


[33]


[34]

3.1.2 Small scale solar

- Solar panels on homes and businesses supply energy directly to appliances, to batteries or export power to the grid
- Solar power is well aligned with usage patterns, particularly for business, and also well aligned with high demand devices such as air conditioners
- “Behind-the-meter” solar users save on generation, enviro and network costs
- In 2020 small scale solar accounted for 23.5% of renewable energy generation and 6.5% of total power generation
- Almost 3 million small scale solar systems are installed, with over 27% of houses now having solar
- 3 GW of capacity was installed in 2020, previous record of 2.2 GW in 2019

3.1.3 Large-scale solar

- Large-scale solar uses the same technology as rooftop, but feeds directly into the grid and not direct to loads
- Prices for large scale solar have fallen steeply, to an average of a little over $50/MWh in 2020
- Contribution to Australia’s renewable energy mix was 10.9% in 2020 from 893 MW of new capacity
- In NSW 2.4 GWh was generated from large solar in 2020, second behind Qld
- 52 new solar farms were under construction in 2020
- Most larger scale renewable energy projects also now install batteries to allow dispatch to the market at any time
- Australia is planning to export solar via the planned Sun Cable project in the Northern Territory (17-20 GW)


[35]


[36]

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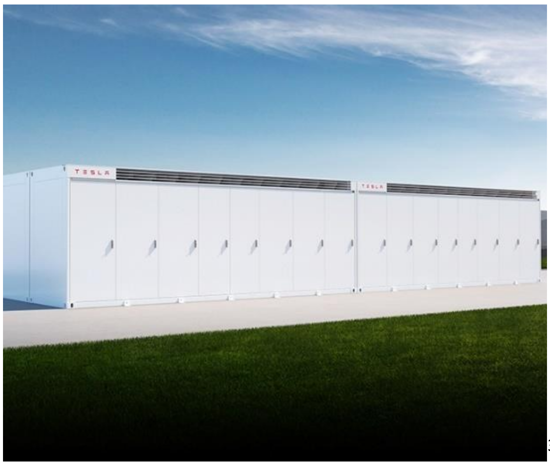
[33] Image from: https://www.tweed.nsw.gov.au/environment/climate-sustainability/sustainable-operations
[34] Image from: https://www.energysaver.nsw.gov.au/get-energy-smart/find-technology-guide-your-equipment/nsw-home-solar-battery-guide
[35] Image from: https://www.energy.nsw.gov.au/renewables/renewable-generation/solar-energy
[36] Image from: https://www.energy.vic.gov.au/batteries-and-energy-storage

3.1.4 Energy storage

[37]

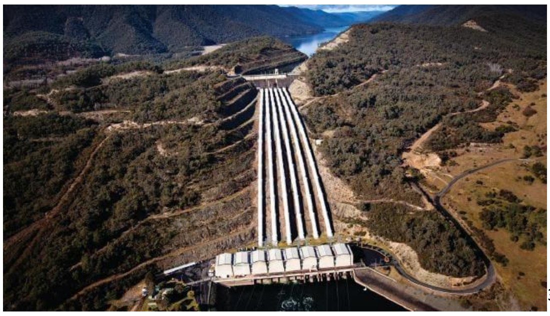


[38]

- Storage is critical to facilitate the development of dispatchable renewable energy
- Chemical batteries and pumped hydro are the major forms of storage for the electricity market
- Storage, like solar is scalable and will meet consumer and market needs at small to large scale
- Numerous grid-scale batteries are built and planned, such as AGL's plans to build storage at the site of Liddell coal-fired power station, the 2,000 MW Snowy 2.0 project, and 500 MW at Dungowan Dam
- The market for small-scale storage is still small, and most states and territories have some form of incentive scheme to boost uptake, such as NSW Empowering Homes battery loan program
- At the consumer level batteries will be important for increased self-consumption, EV charging and potentially in VPPs

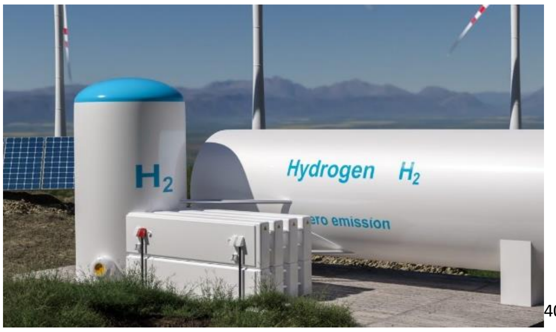
3.1.5 Hydro

- Snowy Hydro and Tasmanian hydro power are the largest hydro schemes in Australia
- Expansion of these with pumped storage will be important for future grid stability (Snowy 2.0 and Battery of the Nation)
- The contribution of micro- and mini-hydro is small with just 20 small-scale units installed since 2001, and just two in NSW



[39]

[37] Image from: https://www.energysaver.nsw.gov.au/get-energy-smart/find-technology-guide-your-equipment/battery-storage-guide
[38] Image from: https://www.environment.nsw.gov.au/news/energy-storage-project-to-strengthen-grid-reliability-in-nsw (Credit Public Affairs / DPIE)
[39] Image from: https://arena.gov.au/blog/back-to-the-future-with-pumped-hydro-energy-storage/



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3.1.6 Hydrogen

- Most efforts to develop a "hydrogen economy" are focused on splitting water using an electrolyser powered with renewables. This is zero emissions in operation but energy intensive.
- H2 can be made from other renewables like ethanol and biomethane
- Hydrogen is a flexible energy that can be used for vehicle fuel, dispatchable electricity, displacing gas, industrial processes and production of ammonia.

3.1.7 Solar thermal

- Australia has a small amount of installed solar thermal capacity, a 9.3 MW plant co-located at the Liddell power station, and the Sundrop farm in South Australia
- Concentrated solar thermal (CST) technology is more expensive than solar PV and wind and has seen lower uptake
- CST offers the advantage of being a dispatchable supply
- As the cost of CST falls there may be a greater role in Australia's energy future


41

42

3.1.8 Solar water heating

- Water heating with solar hot water is commonplace across Australia
- Heat pumps are also a renewable energy technology, taking energy from ambient air to heat water
- There are 334,000 heat pumps and over 1 million solar hot water heaters installed across Australia
- Both types of system are eligible to receive small-scale technology certificates (STCs) under the RET

[40] Image from: https://reglobal.co/arena-invests-103-million-in-three-green-hydrogen-projects-in-australia/
[41] Image from: https://www.sundropfarms.com/our-technology/
[42] Image from: https://www.solahart.com.au/products/solar-water-heating/rheem-52d-series/52d300/

3.1.9 Geothermal

- Geothermal energy generation makes a very small contribution to Australia's energy mix at the moment
- Most favourable regions for geothermal electricity generation are remote from current grid systems and heavy industry
- At residential and commercial level, ground-source heat pumps and geothermal heating and cooling systems may become competitive against other technologies for water heating and air conditioning

[43]

3.1.10 Wind Energy

- Cheapest renewable energy at scale
- Turbines have increasingly larger diameters and heights to produce more energy, more efficiently and with smart technology
- Wind supplied 35.9% of the country's clean energy in 2020 and 9.9% of Australia's overall electricity
- The Commonwealth's Offshore Electricity Infrastructure Bill 2021 (introduced Sept 2021) will pave the way for the development of offshore wind energy development
- The potential for offshore wind energy in NSW is underscored by the proposed development of offshore wind at Hunter and Illawarra regions
- Small wind generating unit installations are just 424 nationally since 2001, in contrast to almost 3 million small-scale solar PV systems

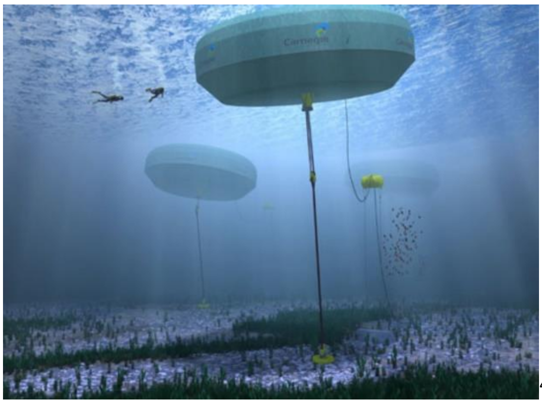

[44]


[45]

[43] Image from: https://reneweconomy.com.au/alinta-turns-to-geothermal-for-sustainable-heating-and-cooling-55901/
[44] Image from: https://inverell.nsw.gov.au/building-and-development/wind-farms/white-rock-wind-farm/ (credit White Rock Wind Farm)
[45] Image from: https://reneweconomy.com.au/two-massive-offshore-wind-farms-proposed-for-bass-strait/

3.1.11 Ocean

- Australia has a very large source of potential electricity generation from ocean energy technologies
- Wave (esp. south coast), tidal (esp. northwest Australia), ocean thermal + current energy resources are available
- Marine energy technologies in Australia are still at the demonstration and pre-commercial stage, and no large-scale projects are planned


[46]

3.2 How cost-effective are renewable energy technologies?

Eleven technologies are highlighted above. Of these rooftop or behind-the-meter solar PV, solar water heating (with solar hot water or heat pumps) are widely used in Australia, with the highest uptake of solar PV compared with anywhere else in the world. Particularly when supported with incentives such as the Renewable Energy Target these solutions are cost-effective for many Australian homes and businesses. Some bioenergy generation plants are also built behind-the-meter, typically using industrial waste (e.g. from food processing) to make biogas for industrial process heating and/or electricity generation.

Other technologies noted above are at various stages of cost, maturity and deployment. Two recent updates to the cost of different renewable energy grid-scale technologies are presented below. The cost of energy generation technologies is typically reported on a lifetime basis taking development, operation and decommissioning costs and output into account. Outputs are expressed in $/kWh of electricity on a Lifetime Cost of Electricity (LCOE) basis.

3.2.1 International Renewable Energy Agency – Global renewable energy costs

The International Renewable Energy Agency (IRENA) published a review of renewable energy technology costs over the period 2010 to 2020[47]. Three outputs from this review are presented below.

- A table showing the LCOE of different renewable energy technologies in 2010 and in 2020, with the % change in costs, highlighting the significant drop in the cost of solar and wind energy technologies, no change in the costs for bioenergy generation, and increased costs for hydro and geothermal energy,
- Graph associated with this table, and
- Change in the 2019-20 period in the global weighted average LCOE of solar and wind energy technologies

[46] Image from: https://arena.gov.au/blog/how-does-wave-energy-work/
[47] : IRENA (2021), Renewable Power Generation Costs in 2020, International Renewable Energy Agency, Abu Dhabi

TABLE 4: SUMMARY OF LCOE FOR RENEWABLE ENERGY TECHNOLOGIES FROM IRENA 2020, TABLE H1

Technology	Levelised cost of electricity (2020 US$/kWh)		
	2010	2020	% change
Bioenergy	$0.076	$0.076	0%
Geothermal	$0.049	$0.071	+45%
Hydropower	$0.038	$0.044	+18%
Solar PV	$0.381	$0.057	-85%
CSP	$0.34	$0.108	-68%
Onshore wind	$0.089	$0.039	-56%
Offshore wind	$0.162	$0.084	-48%

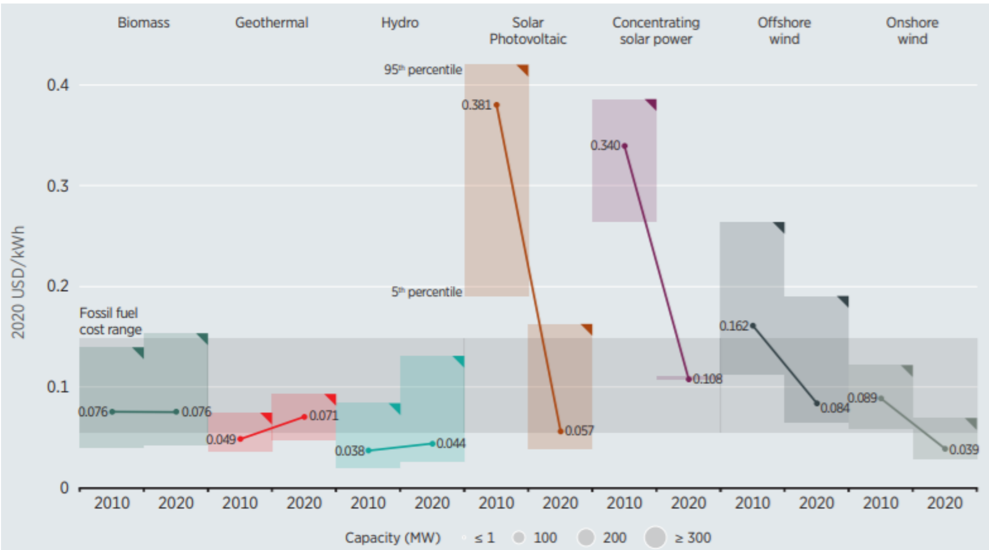


FIGURE 15: SUMMARY OF LCOE FOR RENEWABLE ENERGY TECHNOLOGIES FROM IRENA 2020, FIGURE ES.2[48]

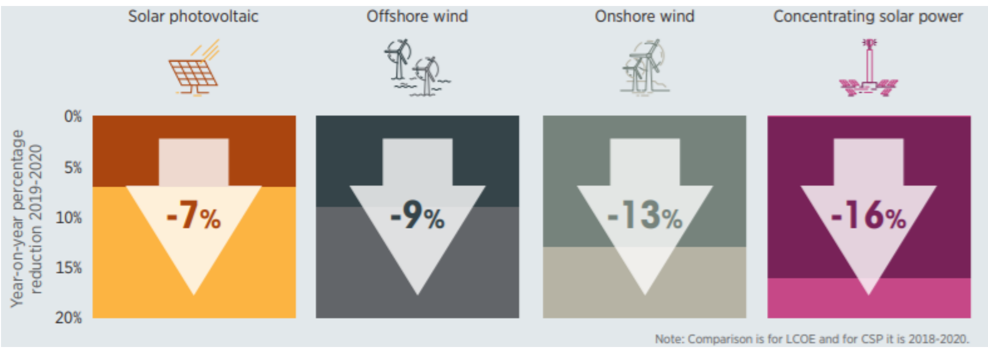


FIGURE 16: IRENA'S GLOBAL WEIGHTED-AVERAGE LCOE FROM NEW SOLAR AND WIND POWER, 2019-2020

[48] Per IRENA: "The thick lines are the global weighted-average LCOE value derived from the individual plants commissioned in each year. The project-level LCOE is calculated with a real weighted average cost of capital (WACC) of 7.5% for OECD countries and China in 2010, declining to 5% in 2020; and 10% in 2010 for the rest of the world, declining to 7.5% in 2020. The single band represents the fossil fuel-fired power generation cost range, while the bands for each technology and year represent the 5th and 95th percentile bands for renewable projects

3.2.2 CSIRO – Australian renewable energy costs

In conjunction with AEMO, CSIRO develops GenCost, a model of electricity generation and storage costs for Australia, on an annual basis. Their 2020-21 report[49] provides an insight into their assessment of the costs of a range of technologies in 2020 as well as in 2030. Levelised costs of electricity are provided to enable ready comparison of technologies. A summary of the 2020 and forecast 2030 LCOEs are provided below.

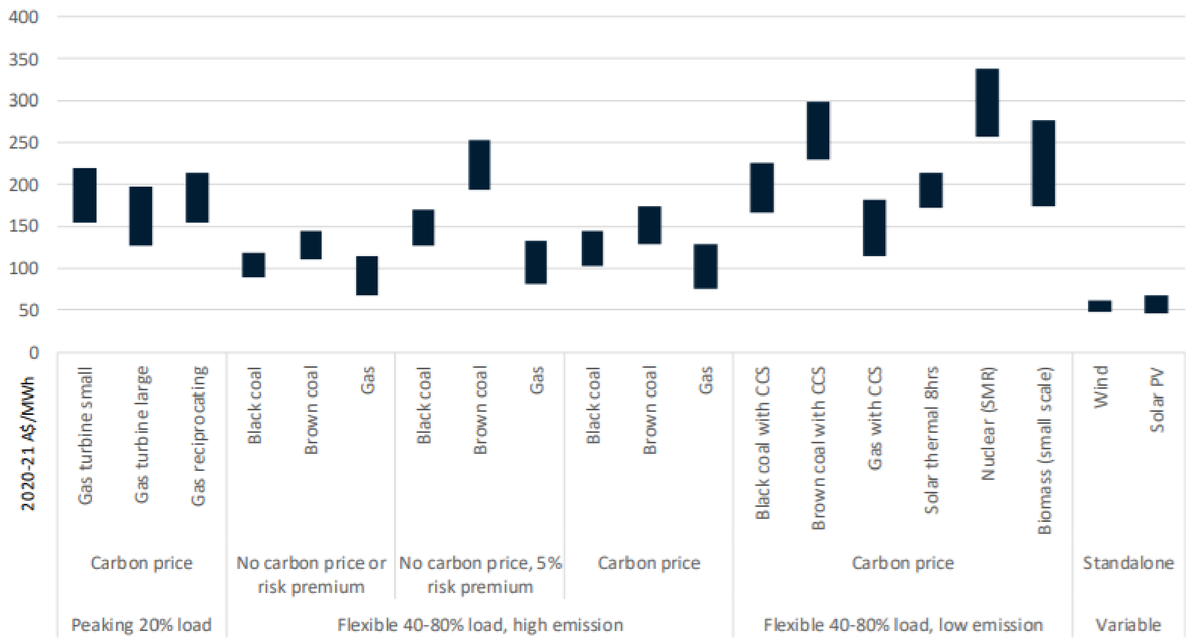


FIGURE 17: LCOE FOR GENERATION & STORAGE TECHNOLOGIES FROM CSIRO AT 2020, FIGURE 5-3

It is clear that at 2020 the cost of new wind and solar PV projects is already lower than any other options modelled, including all fossil-fuel based generation as well as bioenergy, solar thermal and nuclear generation.

LCOE for small-scale biomass projects are modelled to be $175-275/MWh, while solar thermal is modelled to have an LCOE in a narrower range from $175-210/MWh. By comparison the cost of solar PV and wind energy technologies is closer to $50/MWh on an LCOE basis.

Looking at forecasts out to 2030, GenCost's modelling includes energy storage and transmission costs for several Variable Renewable Energy (VRE) scenarios, essentially for variable renewables with higher levels of firming. The output from this modelling is shown below.

[49] Graham, P., Hayward, J., Foster J. and Havas, L.2020, GenCost 2020-21: Consultation draft, Australia

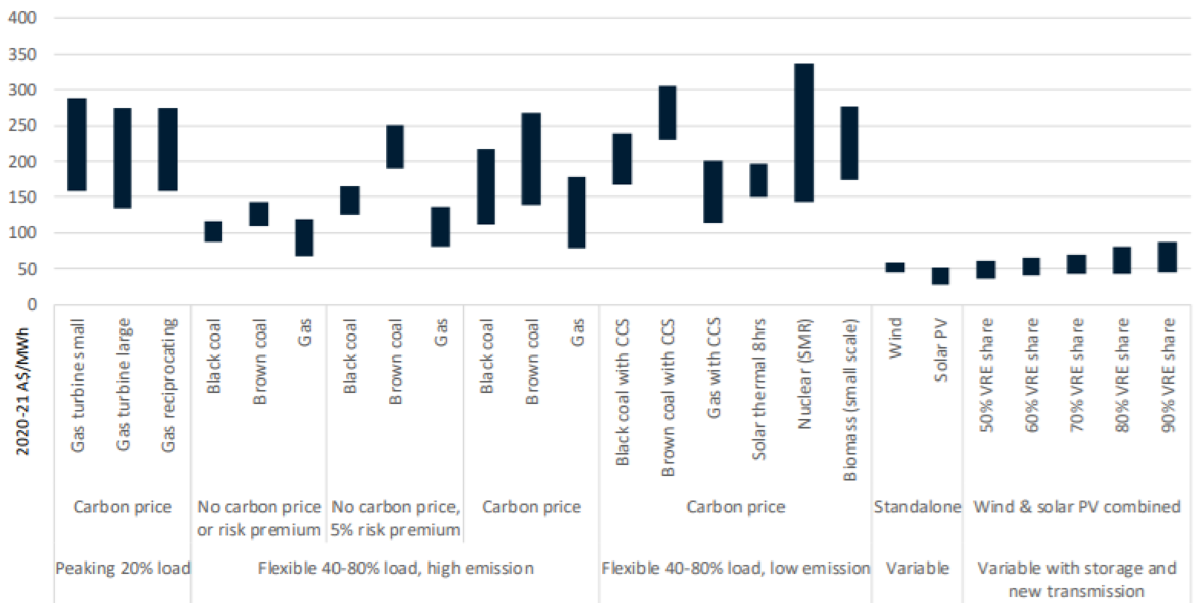


Figure 18: LCOE for generation & storage technologies from CSIRO at 2030, figure 5-4

So by 2030, even with the cost of high levels of battery energy storage and new transmission costs, wind and solar PV generation is lower than for all other generation at scale, excepting the LCOE of gas generation technologies at the low end of estimates for gas.

Among other factors, the scale of solar and wind projects modelled would far exceed – on a capacity basis – the size of bioenergy / biomass projects modelled, which are taken to be small-scale.

Not modelled here is the cost of mid-scale solar PV, which would also be grid-connected. There is little reported on the cost of this – on an LCOE basis for example – compared with larger scale wind and solar generation projects. Based on our experience the cost for mid-scale projects is higher than utility-scale.

3.3 Mapping of renewable energy resources in Australia

Taking a whole-of-NSW view, the scope for renewable energy can be visualised using publicly available mapped resources for the state, from one or more of the following sources:

- Geoscience: https://www.regional.nsw.gov.au/meg/geoscience/products-and-data/renewable-energy or
- Australian Renewable Energy Mapping Infrastructure Project (AREMI): https://www.nationalmap.gov.au/

A summary map of NSW renewable energy resources is shown below. In following sections of this report we use these maps to look more closely at renewable energy resources specifically in the Northern Rivers region.

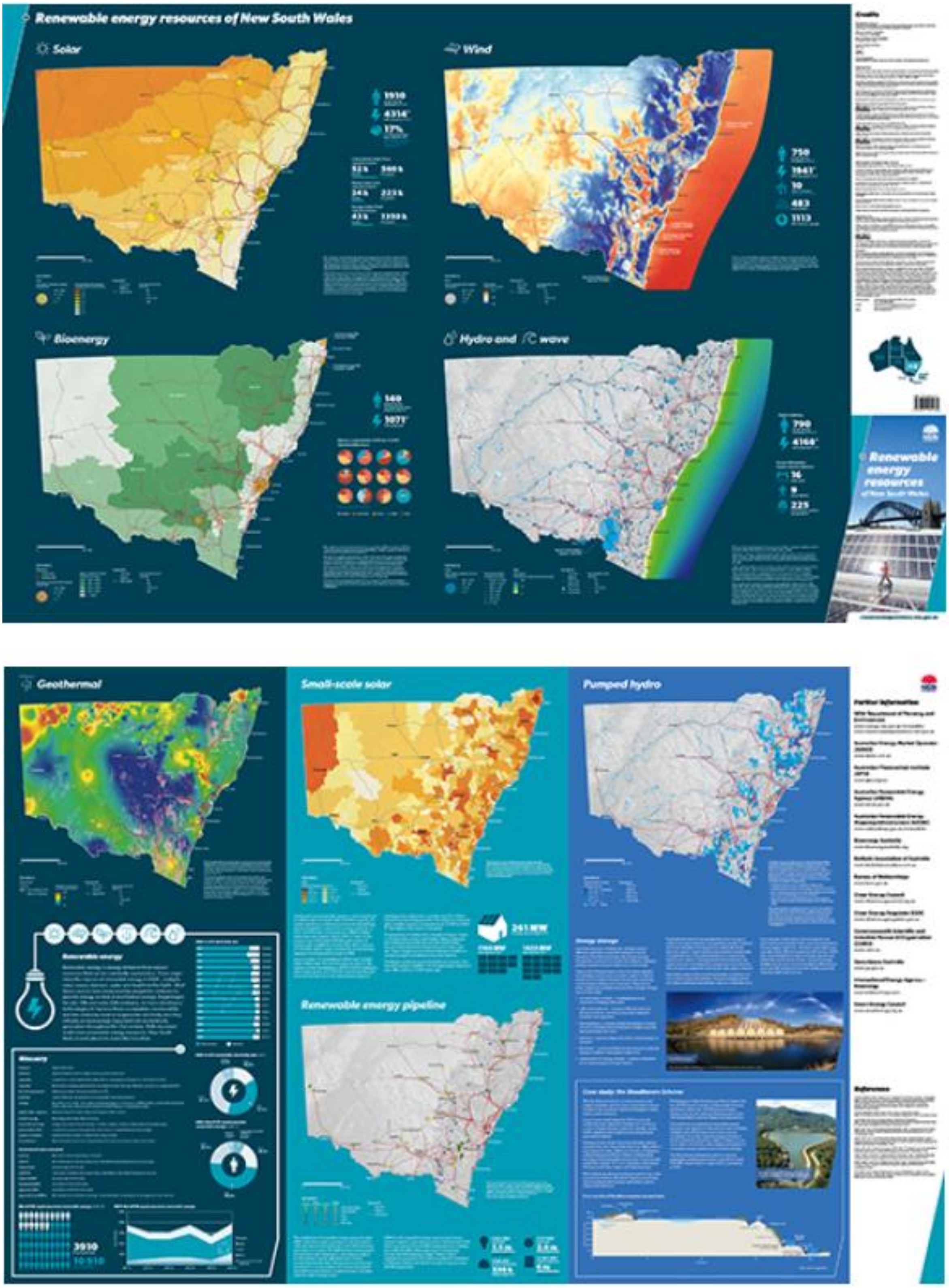


FIGURE 19: SUMMARY MAP OF RENEWABLE ENERGY RESOURCES IN NSW (GEOSCIENCE)

Looking at selected resources individually, such as solar and bioenergy, we can see the spread of good and inferior resources across the State.

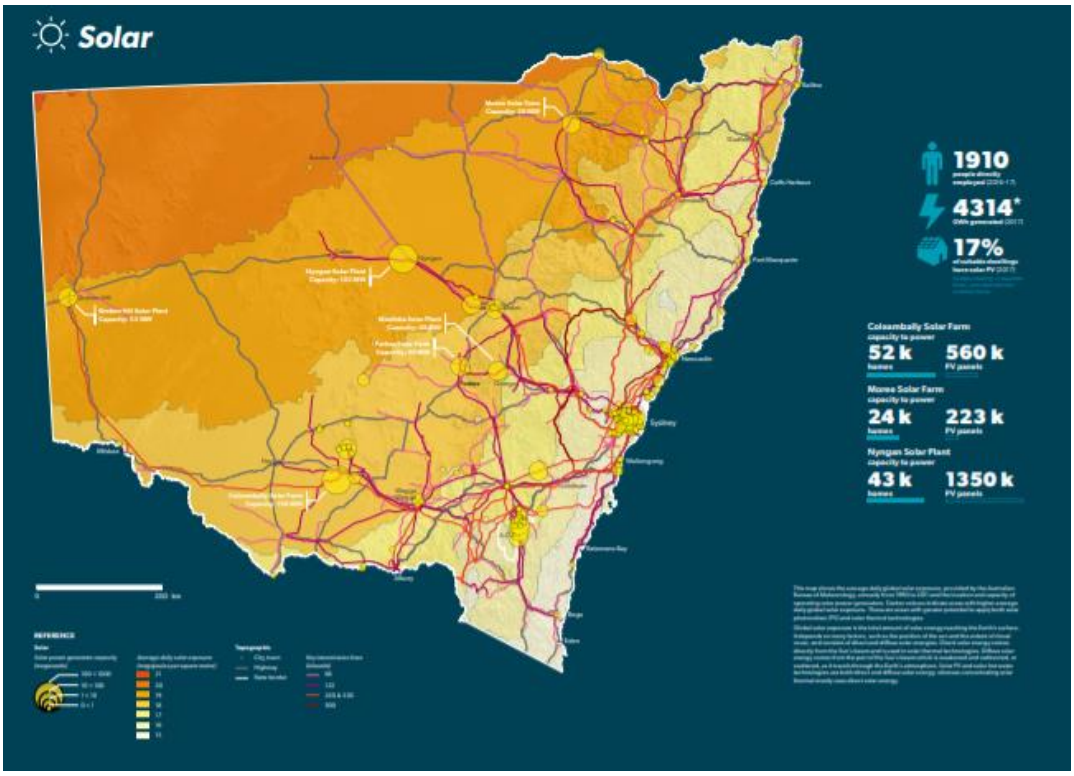


FIGURE 20: SUMMARY MAP OF SOLAR ENERGY RESOURCES IN NSW (GEOSCIENCE)

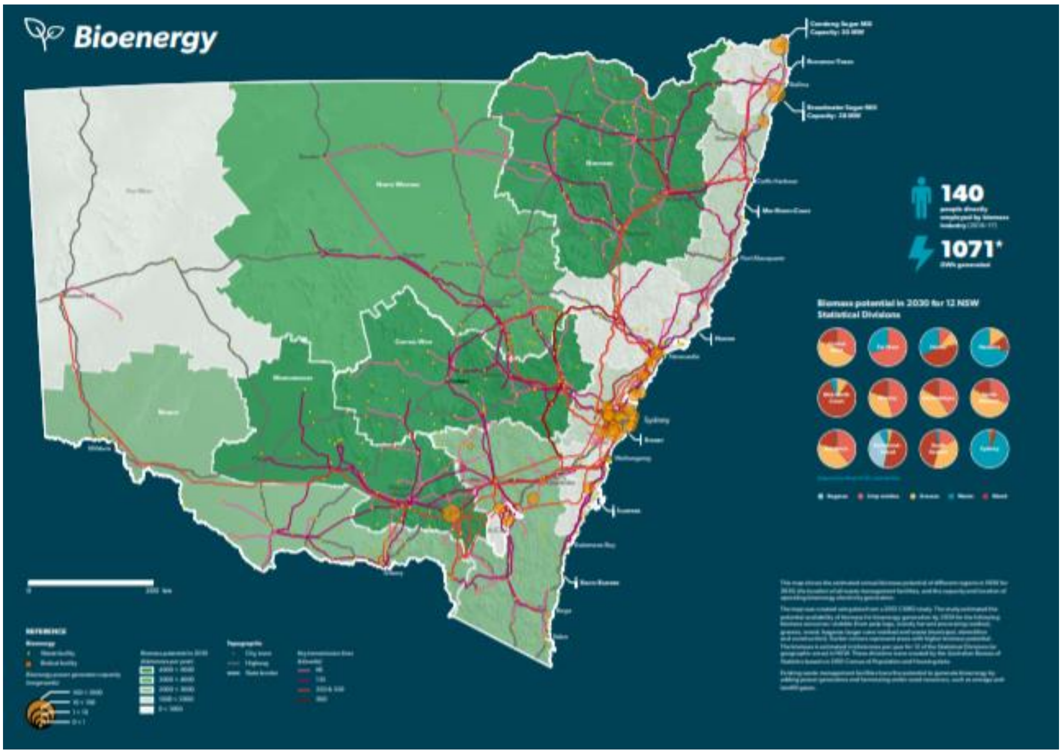


FIGURE 21: SUMMARY MAP OF BIOENERGY RESOURCES IN NSW (GEOSCIENCE)

4 Current & future energy demand in the Northern Rivers

Before looking at the capacity and potential for renewable energy in the Northern Rivers it is helpful to frame this by looking at the demand for energy in the region, both now and in the future.

Energy demand – for homes, business and for transport – is not static, and the needs of the Northern Rivers region will change over time as population increases, as uptake of solar and batteries in the region continues, and as vehicle technology changes and more people switch to electric technologies.

4.1 Electricity consumption today

Essential Energy publishes electricity usage data for all local government areas on an annual basis, with their latest report available to the end of the 2020/21 financial year[50].

Looking at the region's consumption since 2013/14 (all six LGAs) it can be seen that there has been no increase in grid electricity usage since that time.

One of the key reasons for the lack of growth in electricity demand from the grid is the growth of solar in the region, with installed capacity rising from ~70 MW in 2013/14 to around 180 MW by the end of 2019/20, and rising further to ~250 MW by the end of 2020/21.

The estimated demand that is met in the Northern Rivers from both grid and solar PV systems (based on an assumed 50% self-consumption fraction) is shown below. This shows that electricity demand in the Northern Rivers region has increased by 1.02% per annum since 2013/14.

TABLE 5: HISTORICAL TO CURRENT ELECTRICITY DEMAND IN THE NORTHERN RIVERS

Year ending June	Electricity grid demand	Electricity grid + solar demand
2014	1,145,738 MWh	1,194,983 MWh
2015	1,170,285 MWh	1,228,349 MWh
2016	1,161,380 MWh	1,222,917 MWh
2017	1,171,505 MWh	1,233,585 MWh
2018	1,155,690 MWh	1,226,057 MWh
2019	1,166,068 MWh	1,257,591 MWh
2020	1,143,770 MWh	1,268,017 MWh

4.2 Fuel consumption today

Without a gas network in the Northern Rivers, fuel use for transport makes up nearly all the regional energy demand after electricity. Beyond Zero Emissions (BZE) snapshots[51] provide an indication of greenhouse gas emissions from transport at the level of each local government area (LGA), and this provides a useful starting point to look at vehicles and their role in the changing energy landscape in the Northern Rivers region. Looking at snapshot reports for the six LGAs in the region for 2019 we see the following estimate of transport emissions.

[50] Sources include Essential Energy LGA-level electricity use and solar export data, and Essential Energy DAPR Report-2020 report https://www.essentialenergy.com.au/our-network/network-pricing-and-regulatory-reporting/regulatory-reports-and-network-information

[51] https://snapshotclimate.com.au/

TABLE 6: TRANSPORT EMISSIONS IN THE NORTHERN RIVERS

Local Government Area	Transport GHG emissions 2019 (BZE snapshot)
Ballina	123,000 t CO2-e
Byron	121,000 t CO2-e
Kyogle	56,000 t CO2-e
Lismore	109,000 t CO2-e
Richmond Valley	125,000 t CO2-e
Tweed	366,000 t CO2-e
Northern Rivers	**900,000 t CO2-e**

Drawing on Australian Bureau of Statistics data for 2020[52] and Australia's National Greenhouse Accounts Factors 2021[53], we can develop reasoned estimates of petrol and diesel fuel consumption for passenger vehicles and other large vehicle categories (LCV and heavy trucks)[54]. ABS data indicates the following:

- Diesel and petrol fuel usage is approximately equal nationally, so the ratio of diesel to petrol GHG emissions will be 54%:46%;
- Petrol accounts for 80% of passenger vehicle fuel use, diesel accounts for the remaining 20%
- Diesel accounts for 75% of LCV fuel use, petrol s]accounts for the remaining 25%;
- Heavy vehicles exclusively use diesel fuel;
- Passenger vehicle fuel economy in Australia is 11.1 L/100km;
- Light commercial vehicle (LCV) fuel economy in Australia is 12.8 L/100km;
- Heavy vehicle fuel economy is taken to be 40 L/100km, a balance between rigid and articulated truck figures

Building on these assumptions and applying them to the estimated transport emissions for the region, we can estimate the total distance travelled by different types of vehicle (passenger, LCV and heavy), and apply estimated power needs for equivalent electric vehicles. For completeness we also estimated the equivalent hydrogen needs for heavy vehicles, and the associated electricity generation requirements.

- Electric Vehicle (EV) passenger cars efficiency is taken to be 175 Wh/km, an average of many EVs on the market[55];
- Electric LCVs are taken to consume 400 Wh/km[56];
- Heavy electric trucks are taken to consume 1,800 Wh/km[57]

[52] https://www.abs.gov.au/statistics/industry/tourism-and-transport/survey-motor-vehicle-use-australia/latest-release
[53] https://www.industry.gov.au/data-and-publications/national-greenhouse-accounts-factors-2021
[54] We ignore LPG fuel and fuel use by smaller vehicle categories in this analysis
[55] https://ev-database.org/cheatsheet/energy-consumption-electric-car
[56] https://enveurope.springeropen.com/articles/10.1186/s12302-020-00307-8
[57] https://www.volvotrucks.com/en-en/trucks/trucks/volvo-fh/volvo-fh-electric.html

- Heavy trucks fuelled with hydrogen would also require electricity, for example in the form of renewables to power electrolysers. One kg of hydrogen displaces approximately 3.36 L of diesel fuel, and assuming 75% electrolyser efficiency it takes over 53 kWh of electricity to make 1 kg of hydrogen.

This heuristic analysis allows us to develop an indicative estimate of the demand for transport energy in the Northern Rivers region if this was fully met with electricity today, expressed as MWh per annum.

Table 7: Indicative transport energy demand if met with electricity – Northern Rivers

Vehicle type	Petrol consumption	Diesel consumption pa	Kilometres travelled pa	Equivalent electricity demand pa
Passenger vehicles	160,080,759 L	40,295,234 L	1,805,189,130 km	315,908 MWh
Light commercial vehicles	18,462,945 L	55,769,504 L	579,941,012 km	231,976 MWh
Heavy vehicles (EV) (Option 1)	0 L	83,289,586 L	208,223,965 km	374,803 MWh
Heavy vehicles (H2) (Option 2)	*0 L*	*83,289,586 L*	*208,223,965 km*	*1,320,145 MWh*

4.3 Population changes in the Northern Rivers

Population trends and forecasts are taken from profile.id[58] and the North Coast Regional Plan 2036[59]. For this work populations were taken for each LGA in 2020 and as forecasted for 2036, and then extrapolated on a simple basis to 2040. This gives the following estimates of future regional population.

Table 8: Projected population to 2040 – Northern Rivers

Year (ending June 30)	Tweed	Ballina	Kyogle	Lismore	Byron	Richmond Valley	Total Northern Rivers Population
2020	97,277	44,398	9,209	43,667	35,773	23,490	**253,814**
2025	102,925	44,852	9,316	46,193	36,453	24,165	**263,903**
2030	108,573	45,305	9,422	48,719	37,134	24,840	**273,993**
2035	114,220	45,759	9,529	51,245	37,814	25,515	**284,082**
2040	119,868	46,213	9,635	53,771	38,494	26,190	**294,172**

This is equivalent to a population increase of 0.7% per annum, marginally lower than the estimated annual increase in electricity demand in the region in recent years.

[58] https://home.id.com.au/demographic-resources/
[59] https://www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/North-Coast-Regional-Plan

4.4 Future (2040) energy requirements for the region

We can draw on all of the previous analysis to develop high level forecasts of energy demand in the future (say 2040) for the Northern Rivers region. To develop this estimate we use the average annual growth in electricity demand for the last six years, applied to both electricity and transport energy demand, where all transport is taken to be met with battery electric technology. This results in the following potential 2040 demand for energy in the Northern Rivers.

TABLE 9: POSSIBLE FUTURE FULLY-ELECTRIC DEMAND FOR THE NORTHERN RIVERS

Year (ending June 30)	Stationary energy forecast	Passenger + LCV EV forecast	Heavy truck EV forecast	Sum of all demand if met 100% with electricity
FY2040	1,400,768 MWh	670,991 MWh	459,019 MWh	**2,530,778 MWh**

4.5 How can this demand be met with renewables?

The purpose of the above analysis is not to recommend a target for renewable energy for the Northern Rivers, but to provide an indication of what the future (electrified) energy demand of the region might be as context for any targets that NRJO and its member councils may want to set or to aspire to (noting that if hydrogen meets some heavy fleet energy demand the regional electricity footprint would be bigger).

For example if the region were to set a net zero emissions target by 2040 (aligned with science to have a two-thirds chance of limiting warming to 1.5C), the Northern Rivers region could require (among other measures to abate non-energy emissions) some 2,531 GWh of electricity from renewables to meet its stationary and transport needs by 2040.

So how could this be met? Well, renewable energy, primarily in the form of rooftop solar and biomass cogeneration already meets some of this demand, with an estimated 700 GWh of annual renewable energy generated by these systems[60]. This is around 55% of current stationary energy demand, and 28% of stationary plus transport demand if this was electrified today.

The development of Renewable Energy Zones and hydrogen hubs throughout New South Wales, and indeed across the National Electricity Market will see renewable energy and storage technologies developed at scale that will bring bulk power and renewable fuels to all parts of the country. Notwithstanding this the Northern Rivers could target or aspire to develop further renewable energy resources locally that meets more than, all or part of its energy demand.

The three scenarios below each present possible targets and pathways for locally-developed renewable energy, by generation type.

[60] Sources include Essential Energy LGA-level electricity use and solar export data https://www.essentialenergy.com.au/our-network/network-pricing-and-regulatory-reporting/regulatory-reports-and-network-information, APVI and Clean Energy Regulator data on installed small-scale solar PV systems, and National Greenhouse and Energy Reporting (NGER) published data on generation output for Broadwater and Condong cogeneration plants.

4.5.1 Scenario 1: generate 100% of 2040 electricity demand from renewables

An ambition to generate as much renewable energy locally as is consumed for all[61] stationary and transport needs across the Northern Rivers by say 2040 could see a mix of large scale renewables (most likely solar), rooftop / behind-the-meter solar, and a mix of bioenergy, mid-scale solar and micro-hydro generation. There may be hydrogen generation associated with some solar or bioenergy generation.

The two tables below summarise two possible generation mixes that could potentially meet the forecast regional demand. These can be summarised as:

- 1a: 50% large-scale solar, 30% rooftop solar, 20% bioenergy, mid-scale and other generation
- 1b: 25% large-scale solar, 45% rooftop solar, 30% bioenergy, mid-scale and other generation

Table 10: Scenario 1a – 45% large-scale solar, 30% rooftop solar, 25% other generation

Generation technology	Contribution to generation	Annual electricity generation	Capacity factor	Installed MW	Average size	Number of systems
Large scale solar	50.0%	1,265,389 MWh	20%	722 MW	200 MW	3.6
Rooftop solar (resi, C&I)	30.0%	759,233 MWh	15%	578 MW	0.010 MW	57,780
Community / mid-scale solar	1.8%	45,554 MWh	20%	26 MW	5.00 MW	5.2
Bioenergy	18.0%	455,540 MWh	75%	69 MW	NA	
Hydro resources	0.2%	5,062 MWh	40%	1 MW	0.25 MW	5.8
TOTAL GENERATION & CAPACITY		**2,530,778 MWh**		**1,397 MW**		

Table 11: Scenario 1b – 25% large-scale solar, 45% rooftop solar, 30% mid-scale & other generation

Generation technology	Contribution to generation	Annual electricity generation	Capacity factor	Installed MW	Average size	Number of systems
Large scale solar	25.0%	632,695 MWh	20%	361 MW	200 MW	1.8
Rooftop solar (resi, C&I)	45.0%	1,138,850 MWh	15%	867 MW	0.010 MW	86,670
Community / mid-scale solar	10.0%	253,078 MWh	20%	144 MW	5.00 MW	28.9
Bioenergy	19.5%	493,502 MWh	75%	75 MW	NA	
Hydro resources	0.5%	12,654 MWh	40%	4 MW	0.25 MW	14.4
TOTAL GENERATION & CAPACITY		**2,530,778 MWh**		**1,451 MW**		

[61] Noting that 'all' may omit some energy sources such as bottled LPG that may be used to meet some heating requirements in residential, commercial and industrial situations

4.5.2 Scenario 2: generate 2040 stationary energy & EV demand from renewables

If we exclude the electricity demand required from heavy vehicles, and a goal to generate renewable energy locally is limited to generating all stationary energy and electrified passenger and light commercial transport, then the scale of locally-generated renewables is lower than in scenario 1.

Similar to the above scenario we developed two possible generation mixes that could meet the demand, drawing on the same generation sources. The two tables below summarise the outputs from this analysis.

- 2a: 45% large-scale solar, 30% rooftop solar, 25% bioenergy, mid-scale and other generation
- 2b: 20% large-scale solar, 40% rooftop solar, 40% bioenergy, mid-scale and other generation

Table 12: Scenario 2a – 40% large-scale solar, 50% rooftop solar, 10% mid-scale & other generation

Generation technology	Contribution to generation	Annual electricity generation	Capacity factor	Installed MW	Average size	Number of systems
Large scale solar	45.0%	932,292 MWh	20%	532 MW	200 MW	2.7
Rooftop solar (resi, C&I)	30.0%	621,528 MWh	15%	473 MW	0.010 MW	47,300
Community / mid-scale solar	2.8%	58,009 MWh	20%	33 MW	5.00 MW	6.6
Bioenergy	22.0%	455,787 MWh	75%	69 MW	NA	
Hydro resources	0.2%	4,144 MWh	40%	1.2 MW	0.25 MW	4.7
TOTAL GENERATION & CAPACITY		**2,071,759 MWh**		**1,109 MW**		

Table 13: Scenario 2b – 20% large-scale solar, 40% rooftop solar, 40% mid-scale & other generation

Generation technology	Contribution to generation	Annual electricity generation	Capacity factor	Installed MW	Average size	Number of systems
Large scale solar	20.0%	414,352 MWh	20%	237 MW	200 MW	1.2
Rooftop solar (resi, C&I)	40.0%	828,704 MWh	15%	631 MW	0.010 MW	63,067
Community / mid-scale solar	9.7%	200,961 MWh	20%	115 MW	5.00 MW	22.9
Bioenergy	30.0%	621,528 MWh	75%	95 MW	NA	
Hydro resources	0.3%	6,215 MWh	40%	1.8 MW	0.25 MW	7.1
TOTAL GENERATION & CAPACITY		**2,071,759 MWh**		**1,078 MW**		

4.5.3 Scenario 3: generate 200% of 2040 energy demand from renewables

An alternate future scenario could potentially see more large-scale solar, rooftop solar at five times 2020 levels aligned with the AEMO "Hydrogen superpower" scenario, and potentially even offshore wind energy generation. We modelled a single scenario for this, including:

- 4a: 30% large-scale solar, 35% offshore wind, 25% rooftop solar, 10% bioenergy, mid-scale and other generation

Table 14: Scenario 3a – 30% large-scale solar, 35% offshore wind, 25% rooftop solar, 10% other

Generation technology	Contribution to generation	Annual electricity generation	Capacity factor	Installed MW	Average size	Number of systems
Large scale solar	30.0%	1,518,467 MWh	20%	867 MW	200 MW	4.3
Offshore wind energy generation	25.0%	1,265,389 MWh	40%	361 MW	350 MW	1.0
Rooftop solar (resi, C&I)	25.0%	1,265,389 MWh	15%	963 MW	0.010 MW	96,301
Community / mid-scale solar	5.0%	253,078 MWh	20%	144 MW	5.00 MW	28.9
Bioenergy	14.8%	749,110 MWh	75%	114 MW	NA	
Hydro resources	0.2%	10,123 MWh	40%	2.9 MW	0.25 MW	11.6
TOTAL GENERATION & CAPACITY		**5,061,556 MWh**		**2,452 MW**		

5 Regional renewable energy capacity and strengths

An assessment of the capacity in and the strengths of the Northern Rivers region in relation to renewable energy is developed taking a range of factors into account. These include:

- The leadership that is shown by the member councils of NRJO,
- The leadership that is shown by the communities and businesses in the northern rivers,
- Mapped capacity for renewable energy generation in the region,
- Engagement with numerous regional stakeholders,
- Multi-criteria (high-level) review of renewable energy technologies for the region, and
- An overview of potential renewable energy solutions / projects

5.1 Leadership on renewables by NRJO member Councils

Five of the six councils in the Northern Rivers region have set themselves ambitious goals for renewable energy. Led by Lismore City Council's 2014 goal to be self-reliant on renewables for their operational needs by 2023, Tweed, Byron, Kyogle and Ballina Shire Councils have each set goals to source power from renewable energy sources. A summary map of the councils' commitments is shown below.

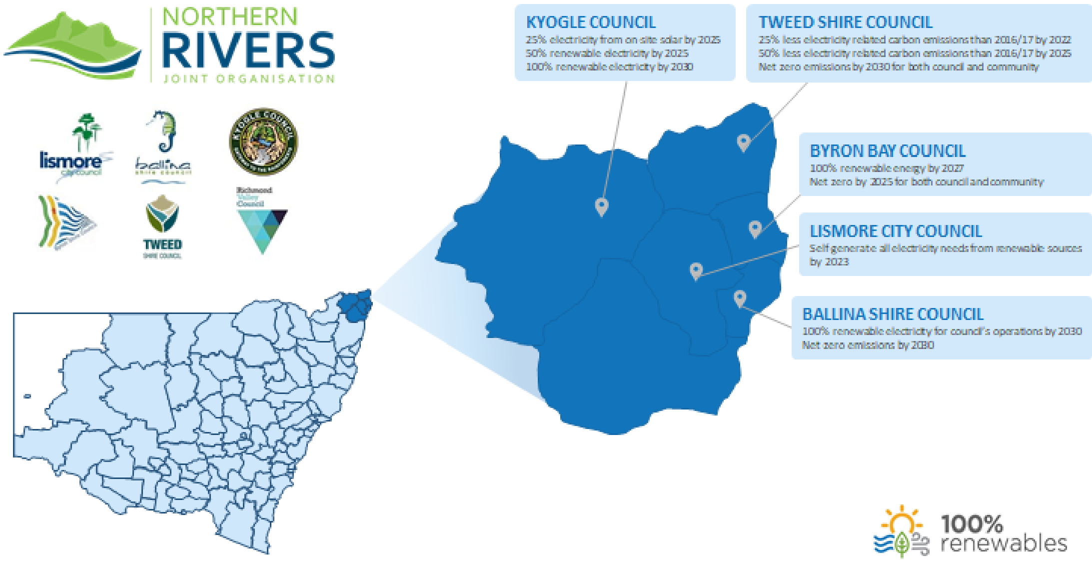


FIGURE 22: SUMMARY MAP OF NRJO MEMBER COUNCIL'S RENEWABLES COMMITMENTS

This ambition is supported with the implementation of numerous solar PV systems, including:

- 100 kW ground-mount solar array at the Casino water treatment plant,
- 650 kW of solar installed across 9 facilities by Ballina Shire Council up to 2020,
- Community-owned 99 kW solar installations by Lismore City Council at the East Lismore sewer treatment plant and at the Goonellabah Sports and Aquatic Centre, and a 330 kW ground-mount solar array at the South Lismore sewerage treatment plant,
- 600 kW of roof and ground-mount solar installed across Byron Shire Council's operating assets, with planning advanced for the installation of a bioenergy plant and/or mid-scale solar PV system at Council's Myocum sewerage treatment plant,

- More than 800kW of solar arrays are installed at 20 of Tweed Shire Council's facilities with plans for a further rollout that will add another 1,515 kW of solar, including several hundred kW at the Banora Point sewerage treatment plant, and
- Implementation of several of the solar PV projects included in Kyogle Council's Renewable Energy Action Plan, building on previous installations by Council

Several Councils in the region are also interested in sourcing some or all of their grid electricity requirements from renewable energy through their electricity contracts, and have been assessing contract models, pricing and other factors to inform these decisions.

5.2 Leadership by the Northern Rivers community and business

Action by each of the councils in NRJO mirrors the commitments and actions by the Northern Rivers community and businesses. In addition to some individual towns and communities setting themselves ambitious goals to increase renewables and reduce emissions, two of the six councils have set net zero emissions goals with their communities. Further to this, uptake of solar PV across the region is among the highest in Australia, with ~45% of all dwellings now having solar installed. As well as homes and businesses installing solar, Australia's first solar garden, a 35 kW solar array installed at the North Coast Community Housing (NCCH) building in Lismore, helps 19 NCCH tenants and four community groups to participate in the benefits of solar.

The region is also host to two of Australia's largest biomass energy generators, 30 MW generators at the Condong (Tweed) and Broadwater (Richmond Valley) sugar mills, running on bagasse and other biomass sources.

The key regional commitments and achievements in solar uptake are illustrated below.

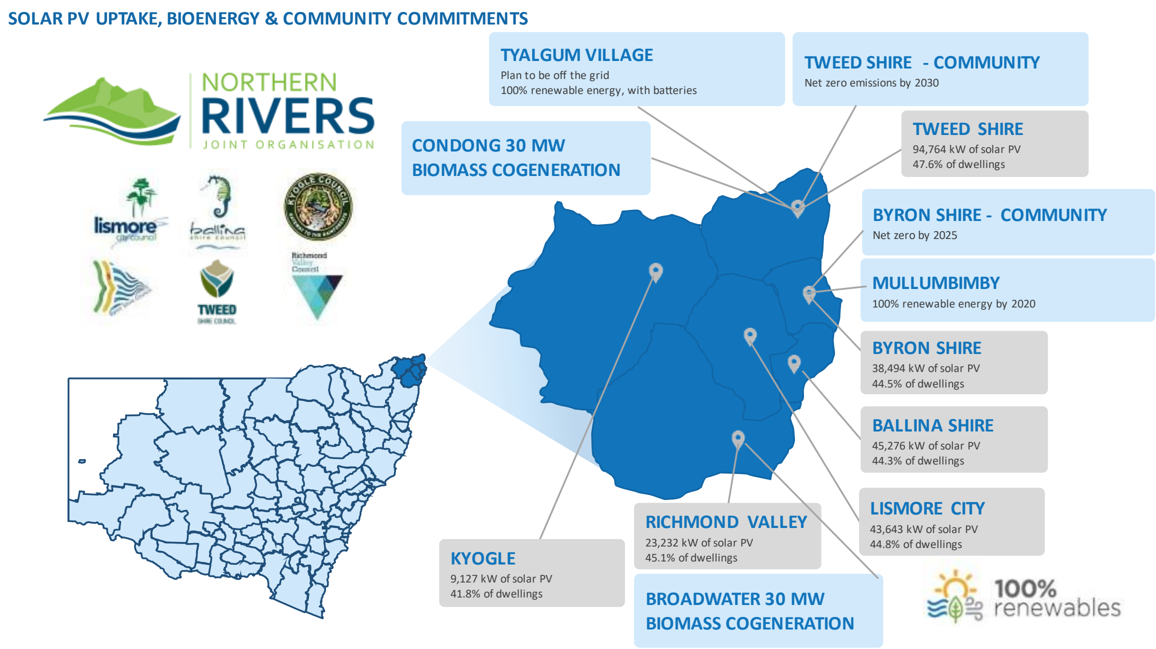


FIGURE 23: SUMMARY OF NRJO COMMUNITY EMISSIONS AND RENEWABLES COMMITMENTS + UPTAKE

5.3 Northern Rivers renewable energy capacity

For this project we have accessed mapping and data from a number of sources to inform an assessment of the capacity for renewable energy in the Northern Rivers.

- This includes the "*Renewable energy resources of New South Wales - advanced viewer*" maps, via Geoscience:
  - https://www.regional.nsw.gov.au/meg/geoscience/products-and-data/renewable-energy,
  - https://oeh.maps.arcgis.com/apps/webappviewer/index.html?id=4aa2febf15964dc5951729d8d1dade84
- National map data, at https://nationalmap.gov.au/,
- Australian Photovoltaic Institute, at https://pv-map.apvi.org.au/.
- Stakeholder interviews and project proponent website information.

5.3.1 Wind energy

In general the Northern Rivers region has low wind energy resources. Mapping indicates that the majority of the region's on-land wind energy at 100m height is at the very low end of the range, with better wind resources in the Mount Barney, Lamington and Border Ranges National Parks.

Offshore wind energy resources are uniformly higher than inland across NSW, with 100m height speeds of ~7.5 m/sec along the coastline of the Northern Rivers. Terranora and Mullumbimby are the main near-shore high voltage transmission substations in the region, with others in the Byron and Ballina areas at 66 kV or less.

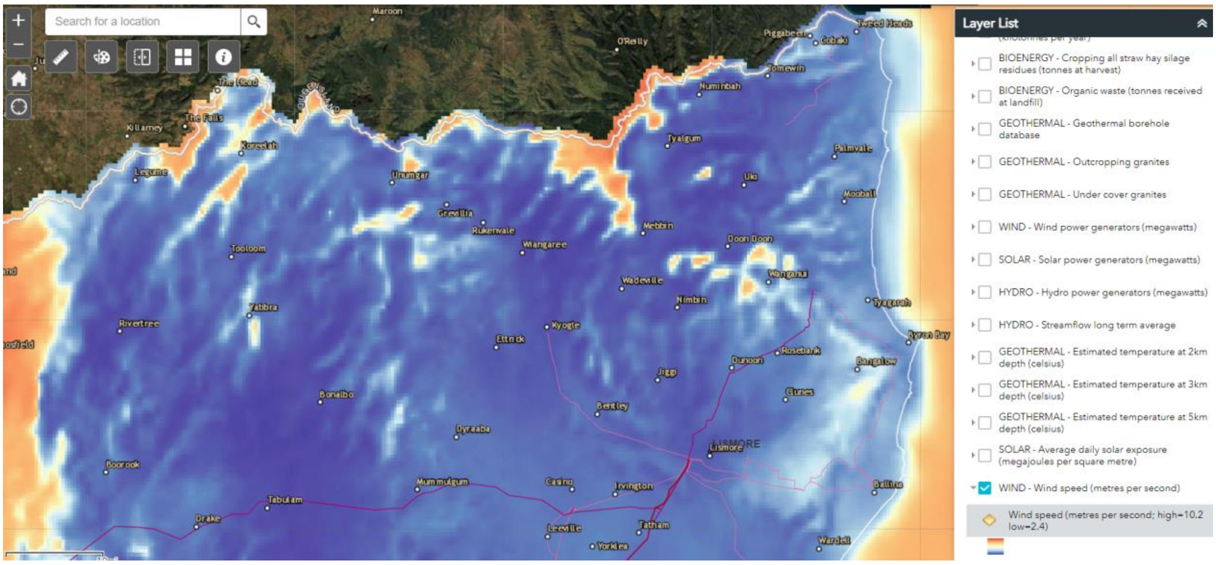


FIGURE 24: OVERVIEW OF WIND ENERGY RESOURCES IN THE NORTHERN RIVERS

5.3.2 Solar energy

The Northern Rivers' solar resources are not high by comparison with most of NSW, with average daily solar exposure in the range 16-18 MJ/m^2. By contrast solar resources in Broken Hill, Nyngan and Moree are around 19 MJ/m^2, and maximum resources in the state are around 21 MJ/m^2.

While some solar farms are being developed in regions with better solar resources, many of the solar farms to be built in the Central West-Orana and South-West NSW REZs will have comparable resources to the Northern Rivers. The 22 MW solar farm built as part of the White Rock renewable energy project (solar and wind) is in a region with similar solar resources to much of Richmond Valley, Ballina, Byron and Tweed Shires.

The region is well served by high voltage transmission infrastructure south from Tweed Heads through Lismore to Grafton, and west from Lismore through Casino to Tenterfield. The Lismore-Ballina-Byron-Mullumbimby area is further served off a 66 kV system.

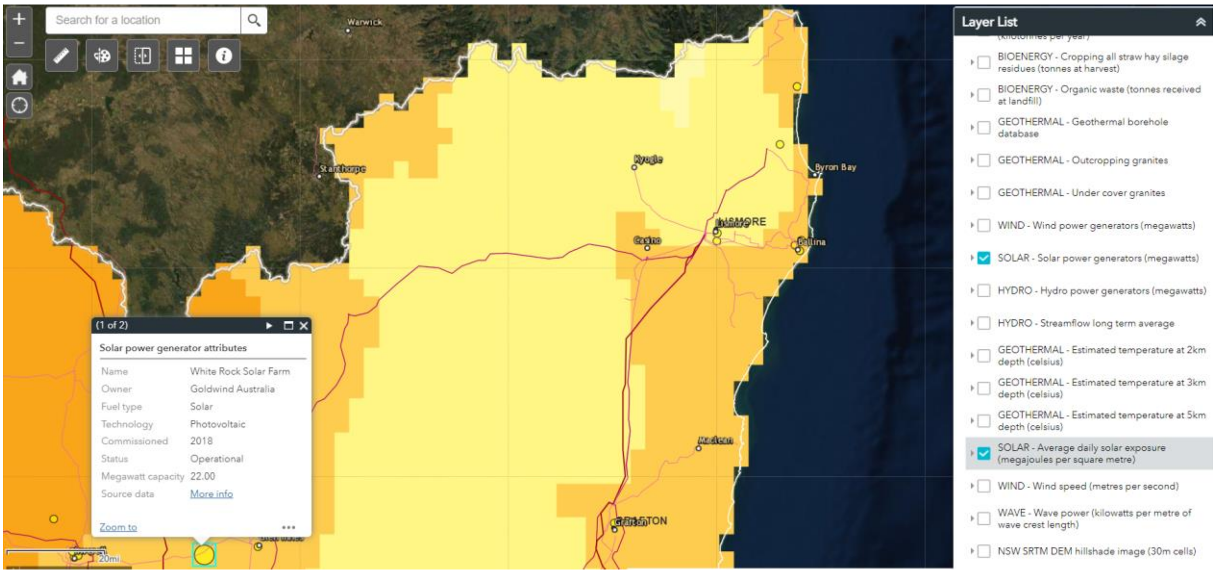


FIGURE 25: OVERVIEW OF SOLAR ENERGY RESOURCES IN THE NORTHERN RIVERS

5.3.2.1 Utility-scale solar potential

At the time of the development of this blueprint there are proposals to build three utility-scale solar farms in the region, all located in the Richmond Valley LGA. Two of these include:

- Myrtle Creek Solar Farm: Terrain Solar is proposing to develop an approximately 100 Megawatt AC (MWac) solar farm, including a Battery Energy Storage System (BESS) with a potential capacity of up to 100 megawatt hours (MWhours)[62],
- Epuron is seeking to develop a 400 MW solar farm, also in the Myrtle Creek area of Richmond Valley[63]

[62] https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-12360774%2120201223T061921.317%20GMT

[63] https://epuron.com.au/solar/richmond-valley/

FIGURE 26: LOCATION OF PROPOSED RICHMOND VALLEY SOLAR FARM (EPURON[64])

5.3.2.2 Mid-scale solar potential

Mid-scale solar may refer to any solar farm development that is up to 30 MW in capacity, below which the applicant or owner can apply for an exemption to be registered as a Generator provided they do not also have a battery system of 5 MW or more. Solar farms of 5 MW or less will generally be exempt from registering as a Generator.

Some of the key criteria that may be applied when determining whether a mid-scale solar farm is feasible as part of an initial screening may be:

1. Site topography: select fairly flat terrain, say no more than 5 degree slope from the horizontal and ideally towards the north.
2. Land type/utilisation: no heritage listed or biodiversity conservation areas, national parks, etc.
3. Electrical infrastructure: physically close to electrical infrastructure at 11kV and up to 66kV – i.e. within 1.5 km.
4. Zoning: exclude other land use zoning that would preclude solar farm development.
5. Flooding: outside 1-in-100 year flood prone land (or could select 1-in-50 years if it was considered that an array on tilts were feasible)
6. Soil: exclude class 1, 2, and 3 acid-sulphate soil locations (or include but note so that this constraint is understood), class 4 and 5 are ok.
7. Land size: lot sizes of greater than 5 hectares (this could potentially host a 2-3 MW solar farm)
8. Vegetation: the selected site should ideally have minimal vegetation, such that the clearing requirements are low.
9. Road access: sites with road access at a radius of <5km.
10. Electrical infrastructure: physically close to electrical infrastructure at 11kV and up to 66kV – i.e., within 3 km.
11. Aboriginal Cultural Heritage: exclude land that is classified as Aboriginal Cultural Heritage
12. Bushfire: exclude land that is classified as Bushfire Prone land

[64] https://epuron.com.au/solar/richmond-valley/

13. Optional, proximity to residential and commercial centres: Based on the SEPP Infrastructure provisions but dependent on each council's preference, exclude land that is less than 5km from residential and 10km from commercial centres.
14. Other constraints: exclude roads, rivers, etc.

These criteria could typically be applied (formally or informally) to determine whether a site could be feasible to host a solar farm. Beyond this the more rigorous and formal planning, consultation and connection processes would be progressed to determine if a solar farm is feasible.

Based on discussions with a range of stakeholders it is understood that there are a handful of current proposed solar farms of around 5 MW in scale in the Northern Rivers. These include:

- Byron Shire Council: 5 MW solar farm on Council-owned land at Dingo Lane, Myocum,
- Byron Eco-Park 5 MW solar farm near Tyagarah,
- Ballina Solar Farm, a 5 MW planned farm near the Ballina sewerage treatment plant

5.3.2.3 Small-scale solar potential

As described earlier there is now ~250 MW of installed rooftop solar across the Northern Rivers region, with some 45% of all dwellings having some solar installed. However this remains a fraction of the total potential for solar based on mapping of all eligible roof space, accessible for analysis via APVI.

An analysis has been conducted to aggregate the potential for rooftop solar across all Northern Rivers postcodes, and to extrapolate this out based on forecast dwellings to 2040. This analysis indicates that the total regional capacity is almost 2,000 MW, capable of generating nearly 2,800 GWh of electricity annually, far more power than is used today, and more even than the forecast power requirements under an "EV future" where all vehicles are electric.

What this analysis of APVI's data shows is that, while ~45% of dwellings have some PV, there is potential space for more on existing roofs as well as potential for solar on roofs where there is currently none.

The realization of the region's potential for rooftop solar can happen in several ways:

- New homes installing solar as part of their construction,
- Older systems replaced with new systems with greater efficiency and generation potential,
- Existing systems expanded, potentially with batteries to increase solar self-consumption, particularly as feed-in tariffs decline and/or export limits are placed on solar,
- Systems expanded to charge electric vehicles

Even at an annual increase in installations similar to today and with no increase in average system size, the region's installed rooftop solar capacity could reach 1,250 MW by 2040, generating over 1,750 MWh annually, 70% of the region's 'electrified' energy demand.

Under a scenario where system sizes gradually increase in both residential and business sectors, installed solar in 2040 could reach more than 1,900 MW and generate more than 2,600 GWh of electricity annually, close to forecast 'electrified' energy demand.

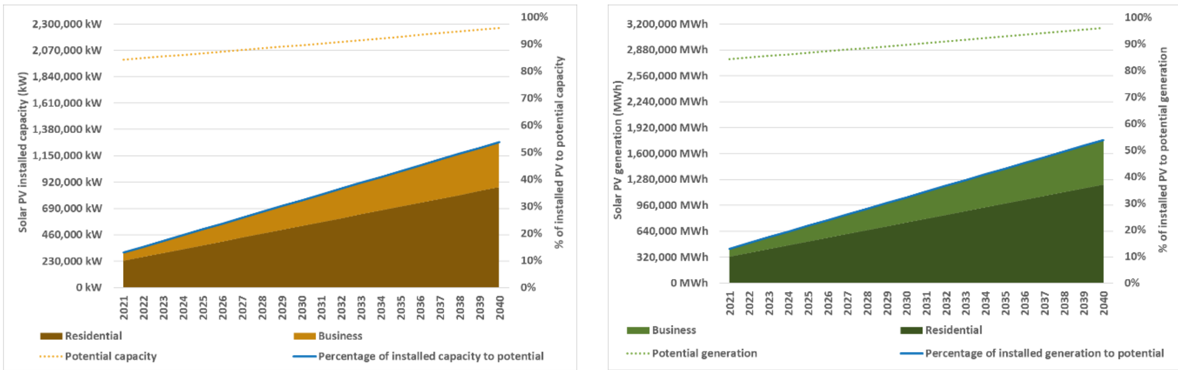


FIGURE 27: POTENTIAL ROOFTOP SOLAR PV CAPACITY AND GENERATION BY 2040 – STEADY UPTAKE

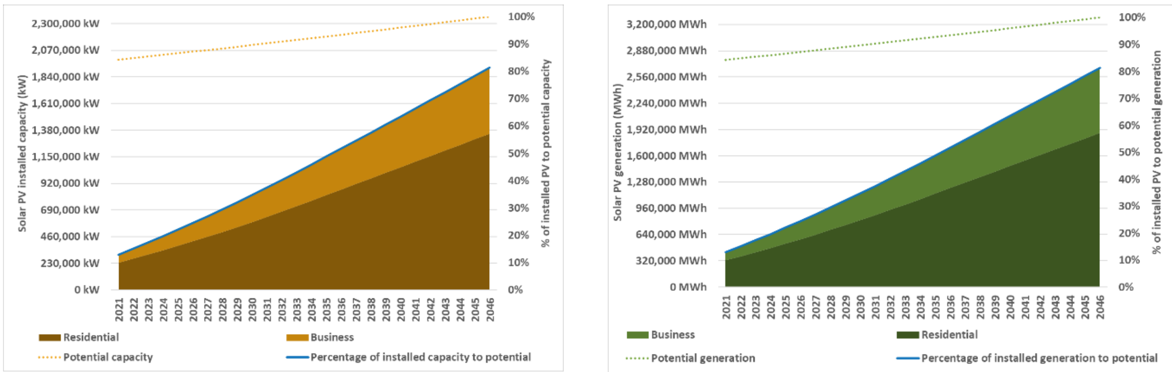


FIGURE 28: POTENTIAL ROOFTOP SOLAR PV CAPACITY AND GENERATION BY 2040 – MODERATE INCREASE P.A.

5.3.3 Ocean energy

Of the four main types of ocean renewable energy (wave, tidal, ocean thermal and ocean current), wave and tidal are more advanced but remain at pre-commercial stage. Prior research by CSIRO highlights that the best wave energy potential in Australia exists in the Northwest of the country and off Tasmania[65]. The potential for these as well as ocean thermal energy in NSW is low.

The best potential in NSW lies in ocean currents as the East Australian Current flows down the northern NSW coast[66]. Research by UNSW[67], published in 2020, studied the EAC ocean currents and found that the second best site along the east coast is at 29.1°S, with a mean power density of 333W/m^2 at 50m depth above the 400m isobath, with consistent flow above the cut-in speed for a turbine for 70% of the time. This latitude corresponds to Evans Head in the Richmond Valley LGA. The best location, off Port Macquarie, is noted to likely be a promising site for renewable energy generation given the proximity to the coast.

Notwithstanding the renewable energy generation potential indicated for these locations, the study notes that numerous other factors including environmental considerations would have to be evaluated.

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65 2012, CSIRO: Ocean renewable energy: 2015-2050. An analysis of ocean energy in Australia, July 2012
66 https://www.energy.nsw.gov.au/renewables/renewable-generation/ocean-energy-nsw
67 http://www.oceanography.unsw.edu.au/private/publications/2020/1-s2.0-S0924796319304221-main.pdf

5.3.4 Hydro power & pumped hydro

5.3.4.1 Pumped hydro

The NSW Government's Pumped Hydro Roadmap[68], developed in 2018 presents the key findings of research by ANU to identify potential sites across NSW with good potential for pumped hydro to provide on-demand energy storage to firm variable renewables entering the grid from solar and wind farms. The Snowy 2.0 project, and major potential pumped hydro projects such as Ovens Mountain (600 MW), Central West at Yetholme (325 MW) and Dungowan near Walcha (500 MW) will provide some of the key storage capacity in NSW.

In the north-east of the state, the pumped hydro potential is significant, however the vast majority of sites with significant capacity in this region are at the southern end between Coffs Harbour and Armidale. Few sites with significant capacity are indicated for the Northern Rivers.

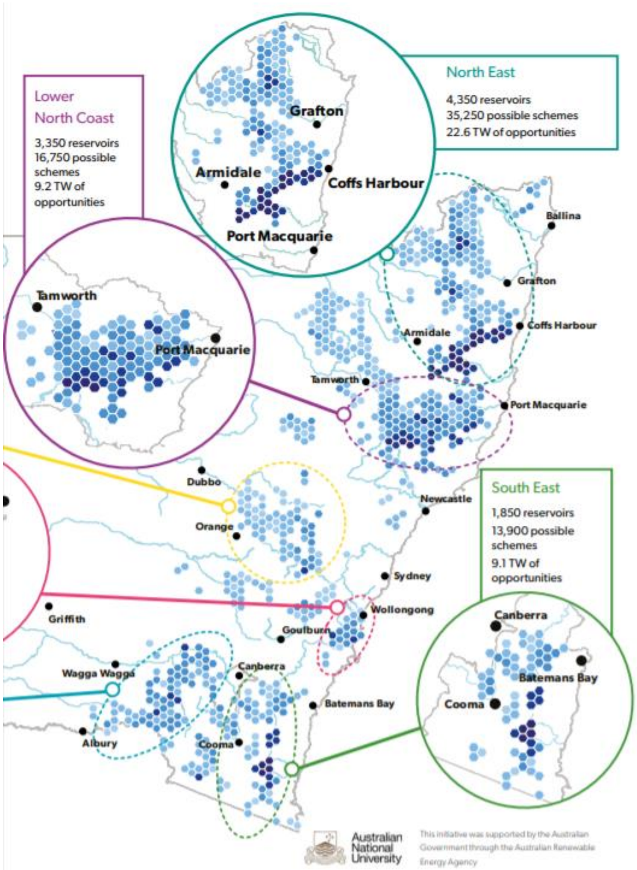

FIGURE 29: MAPPING OF PUMPED HYDRO POTENTIAL IN NSW

Looking at the National Map data we can take a closer look at the region's assessed pumped hydro capacity[69]:

[68] NSW Pumped Hydro Roadmap December 2018

[69] https://nationalmap.prod.saas.terria.io/

- Two sites with very large capacity (150 GWh in 18 hours) lie just west and south-west of the region, in Tenterfield and Clarence Valley, outside the NRJO region.
- Two locations with large capacity (50 GWh in 18 hours) are mapped, one each in Kyogle and Lismore Councils.

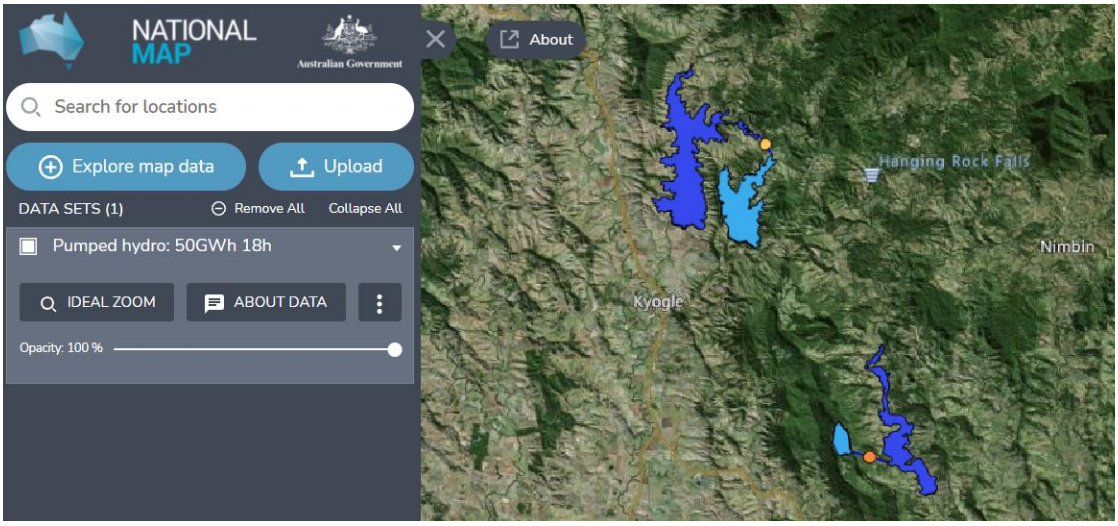

FIGURE 30: MAPPING OF 50 GWH / 18 HR PUMPED HYDRO POTENTIAL IN NORTHERN RIVERS

- Several locations in the Northern Rivers are mapped to have around 15 GWh of potential pumped hydro capacity, over 18 hours and over 6 hours. Most of the mapped locations are in Kyogle and Lismore Councils (including the above two sites), with single sites identified in each of Tweed Shire and Byron Shire, near Murwillumbah and Mullumbimby respectively.

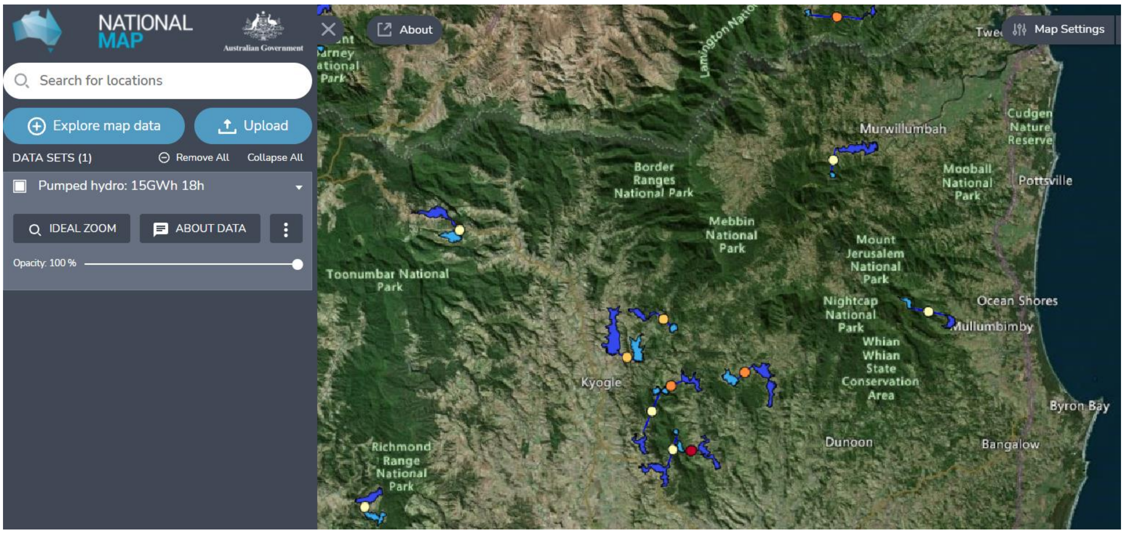

FIGURE 31: MAPPING OF 15 GWH / 18 HR PUMPED HYDRO POTENTIAL IN NORTHERN RIVERS

The potential feasibility for any of these sites to be developed into a pumped hydro project in future is not evaluated in this report, and a preliminary scoping study could be developed to look at these sites if this were determined to be a regional or local council priority.

5.3.4.2 Mini & micro-hydro

We understand that there are currently no operating mini or micro-hydro projects in the Northern Rivers. Just 20 small-scale (<100 kW) hydro projects have been installed under the RET since 2001, with just two of these located in NSW.

There was one former mini-hydro project installed in Mullumbimby until it was decommissioned in 1989. It is known as Laverty's Gap Power Station and Mullumbimby Power Station and Substation. Community Owned Renewable Energy – Mullum (COREM) commissioned a study (funded via the NSW Government's Clean Energy Knowledge Sharing Initiative) to investigate the potential for this 288 kW project to be reinstated. The study looked at both generation and pumped hydro potential. It found that there is potential subject to more detailed feasibility assessment for the project to be developed, with the following identified potential.

Method of generation	Energy generation and consumption	% of year in use	Key benefits
Run of the river hydro Using natural river flows	1,230 MWh generation	45%	Fastest and cheapest option
Pumped storage hydro (PSH) Day: pumping into storage tank Night: generating power	2,980 MWh pumping demand 1,260 MWh generation	100%	Store energy from solar for use at night
Hybrid run-of-river + PSH Wet season (45% of year): generating power day & night Dry season: day—pumping into storage; night—generating power	1,010 MWh pumping demand 1,660 MWh generation	100%	Year-round generation and solar storage benefits

FIGURE 32: IDENTIFIED GENERATION AND PUMPED HYDRO POTENTIAL LAVERTY'S GAP MINI-HYDRO[70]

Local councils in the region, as well as Water NSW and Rous Water have carried out feasibility studies into the potential for micro or mini hydro generation projects at a number of locations, such as dams and Pressure Reducing Valves (PRVs) in their water networks (Toonumbar, Clarrie Hall, Howards Grass and others). It is understood that these projects are not economically viable at present, however this situation could potentially change in future.

5.3.5 Bioenergy

The potential for regional bioenergy in the Northern Rivers is underpinned by work commissioned by Sustain Northern Rivers Energy Working Group and developed by the Institute for Sustainable Futures with RDA-Northern Rivers in 2013[71].

[70] Sourced from Table 2 of Case Study: COREM: https://www.energy.nsw.gov.au/media/2086/download

[71] Ison, N., Wynne, L., Rutovitz, J., Jenkins, C., Cruickshank, P. and Luckie, K. (2013) *NSW North Coast Bioenergy Scoping Study,* Report by the Institute for Sustainable Futures to RDA-Northern Rivers on behalf of Sustain Northern Rivers.

The study identified potential for 1,100 GWh of annual electricity generation, where data was available. Much of this is associated with the operation of the two 30 MW cogeneration plants at Condong and Broadwater year-round. Existing projects in the region were highlighted, and a total of 14 potential feedstock sources were evaluated including:

- Plantation forestry residues
- Saw mill waste
- Sugar cane
- Camphor laurel
- Woody energy crops/coppicing
- Macadamia
- Coffee
- Poultry
- Piggeries
- Dairy cattle
- Meat processing/abattoir
- Food processing
- Landfill gas
- Municipal solid waste

FIGURE 33: BIOENERGY SCOPING STUDY MAP OF EXISTING ACTIVITIES AND POTENTIAL FEEDSTOCKS[72]

Further feasibility assessment has looked in further detail at the biomass resources available in the region, and at the scope for bio-hubs to be developed at key locations in the Northern Rivers, including at Casino, Murwillumbah, Nimbin and at Bora Ridge. Casino is identified as the location with the most viable opportunity, with the Northern Cooperative Meatworks Meat Company (NCMC) a key anchor generator of waste and energy user.

In addition to the two cogeneration plants operating at capacity, and the potential for these regional biohubs to develop (or individual site bioenergy projects within these areas), Byron Shire has a proposal to develop a bioenergy facility to convert organic green waste into renewable energy and a compost product at its sewerage treatment plant.

[72] Bioenergy Scoping Study, Figure 1, p3

5.3.6 Geothermal energy

Prior work by Regional Development Australia Northern Region[73] has identified that there is no high-temperature geothermal resource in the region, but that there is potential for shallow low temperature generation. The main geothermal resources in the region are centered around Bonalbo in the Richmond Range National Park (Kyogle LGA), where temperatures at 2km depth exceed 180C.

Given the location, distance from transmission infrastructure, that geothermal energy generation makes up a very small fraction of Australian energy, and that there are better and larger geothermal resource areas it is unlikely that this represents a significant opportunity for clean energy generation in the Northern Rivers.

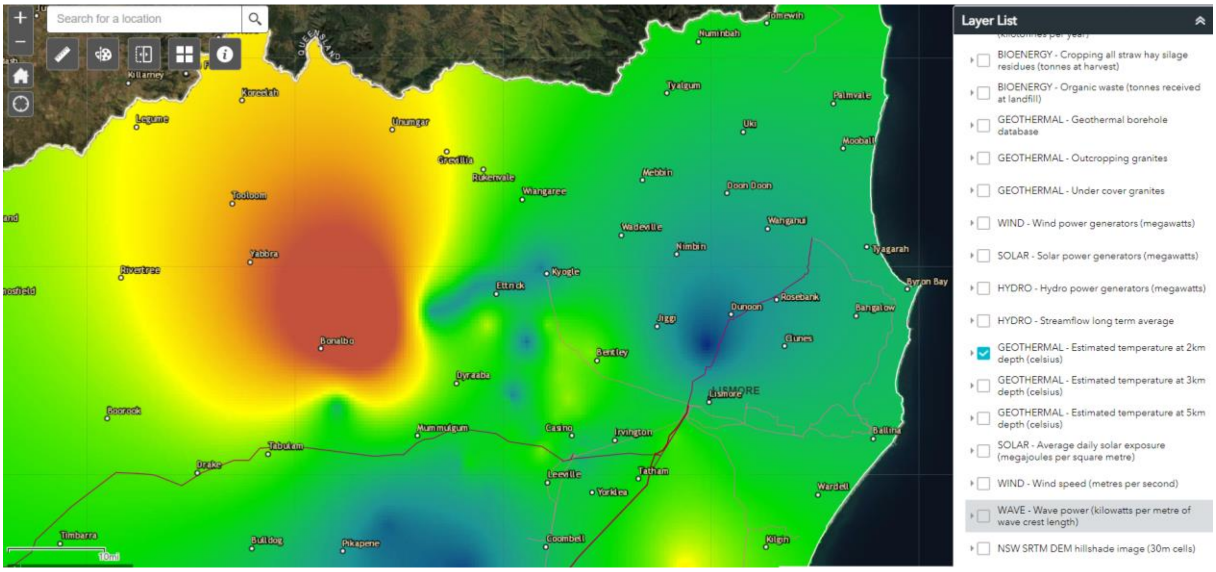

FIGURE 34: OVERVIEW OF GEOTHERMAL ENERGY RESOURCES AT 2KM DEPTH IN THE NORTHERN RIVERS

[73] Regional Development Australia – Northern Rivers, Northern Rivers Regional Profile 2013, RDA–Northern Rivers, 2013.

6 Planning, land and approvals processes

6.1 Infrastructure SEPP[74]

The Environmental Planning and Assessment Act, the State Environmental Planning Policy (State and Regional Development), and the Infrastructure SEPP provide a multi-level planning approval process for electricity infrastructure in New South Wales.

The Infrastructure SEPP outlines different planning pathways for electricity infrastructure and help to provide an efficient approach to developing very small and large-scale electricity generation in NSW.

6.1.1 Planning approval pathways

The pathways for developing electrical infrastructure vary depending on a range of factors such as the selected site for development, the proponent, the project’s scale (MW / $$), the project's environmental significance, and the proposed development's purpose.

Different pathways inform the level of assessments required based on the significance and size of a proposed development. Different types of approval pathways in NSW have been summarised below[75].

1. **Prohibited development**: These sites prohibit the development of any projects due to the likelihood of environmental impacts or inconsistency with the strategic vision for land uses in the broader area.
2. **Exempt development:** These are generally small-scale developments that have minimal environmental impacts. Developments can be carried out without notifying or attaining approvals from neighbours.
3. **Complying developments:** These are typically small to medium-scale developments with low impacts on the environment and neighbouring properties that can be approved via certification. This pathway must adhere to clear and unambiguous rules and should be assessed by a Council or an accredited certifier. An accredited certifier needs to approve this development if the development complies with all the rules and regulations.
4. **Development with consent**: These developments do not fall under the three aforementioned pathways and are subject to a merit-based assessment. An applicant can submit a development proposal with consent authorities to weigh the assessment against multiple deciding factors. The consent authorities may approve based on certain conditions or refuse the development application. Furthermore, development with consent is allocated to different consent authorities (local, regional or State) based on its environmental significance.
5. **Development without consent**: Activities undertaken by government departments or agencies as part of their responsibilities are subject to self-assessment. However, if the development has significant environmental and community impacts, the Minister for Planning and Public spaces become the consent authorities.

[74] NSW Government. (2020, April). Amendment of State Environmental Planning Policy (Infrastructure) 2007. https://shared-drupal-s3fs.s3-ap-southeast-2.amazonaws.com/master-test/fapub_pdf/00+-+Infrastructure+EIE/Explanation+of+Intended+Effect+-+Infrastructure+SEPP+Amendment+-+Sydney+Metro+West+Interim+Corridor.pdf

6.2 State significant development process[76]

Under the Environment Planning and Assessment (EP&A) Act, and the State Environmental Planning Policy (State and Regional Development) 2011, any development for the purpose of generating electricity and heat or co-generation (using energy sources including biofuel, hydro, wind or solar power) is State-significant if it:

- has a capital investment value of more than $30 million, or
- has a capital investment of more than $10 million and is located in an environmentally sensitive area.

Alternatively, under the EP&A Act, the Minister of Planning may declare a specific project at a certain location to be of State significance.

6.2.1 Regulations to set up a large-scale renewable energy project

The regulations to implement a large-scale renewable energy project is governed by the EP&A Act and other policies and plans, including the local environmental plans (LEPs – Council specific) and State Environmental Planning Policies (SEPPs).

Furthermore, the developer can lodge a development application (DA) with relevant parties where the renewable energy development is permitted with consent. However, if the developer is not the landowner that a DA has been lodged against, then consent from landowner/s needs to be supplied along with the application.

6.2.2 Importance of stakeholder engagement for State Significant Development process

As part of the development application for a State significant renewable energy project, an applicant must prepare an environmental impact statement (EIS). The EIS is an integral part of the development application. This publicly available document outlines the potential impact of the proposed project's environmental, social, and economic impact. Therefore, to determine these impacts and risks, an applicant is encouraged to liaise and maintain relationships with key stakeholders throughout the development process.

We have summarised a list of key stakeholders that may need to be consulted while applying for an application of State significance.

1. **Department of Planning, Industry and Environment:** It is key to conduct kick-off and scoping meetings with the Department to understand the project constraints, timelines, impacts, and site selections. Preliminary feedback based on the applicant's information would be made available to commence the development assessment process. Furthermore, the Department may also provide the applicant with information about other relevant stakeholders that need to be consulted during the development assessment process.
2. **Other government entities:** Based on the project size, impact, and site selection, relevant agencies at local, State and Commonwealth would need to be consulted; these may include:

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[76] NSW Government. (2018, December). Large-scale solar energy guideline for State significant development. https://www.planning.nsw.gov.au/-/media/Files/DPE/Guidelines/large-scale-solar-energy-guideline-2018-12-11.pdf?la=en

   a. *Commonwealth Government*: An applicant is required to engage with government agencies if the project has any impact on protected matters under the Environment Protection and Biodiversity Conservation Act, 1999 or matters of national environmental significance.
   b. *State Government (NSW):* The State government is usually involved in a project that is of State significance scale to investigate the site constraints, approval requirements, potential project impacts and risks, and to develop project designs based on mitigation plans and consultation results. Some of the agencies that are usually involved include:
      i. Road and Maritime Services,
      ii. Rural Fire Services,
      iii. Fire and Rescue Services,
      iv. Division of Resources and Geosciences,
      v. Environment Protection Authority,
      vi. Transport for NSW,
      vii. State and Emergency Services.
   c. *Local Government*: Council bodies within the Northern Rivers Joint Organisation can provide strategic advice to applicants relating to land zoning, potential land use barriers, waste and water management, local flora and fauna or vegetation impacts to inform project designs and plans. The LGAs can help applicants identify community groups that would be interested in the development of the renewable energy project.
3. **Network service providers**: Engaging with the network service provider during the initial stages of project development can assist the applicant in understanding all the contestable and non-contestable work that needs to be carried out before the formal development assessment process. The grid connection application can inform project design and suitability of the site in terms of grid connection infrastructure.
4. **Community:** As part of the environmental impact assessment for a renewable energy project of State significance, it is vital to consult all stakeholders within the community that could be affected presently and in the future. The construction of a renewable energy project can be long and may cause certain disruptions to the local community, such as road blockages, visual and noise impacts, and development on culturally significant sites. The communities may include the following entities:
   a. *Landlords/owners*: From a development perspective, if the applicant does not own the site selected for the project, the respective landowner/owners need to consent to implement the renewable energy project. Furthermore, the applicant needs to provide evidence on all engagement sessions with the landowners regarding risk assessments and mitigation solutions considered part of the project design.
   b. *Community groups*: The applicant can engage with the local council to understand relevant community groups such as environmental bodies or nearby residential groups that would be keen to be part of the impact assessment of the project. Furthermore, it would be prudent to engage with local aboriginal members to understand any cultural significance on the proposed site.

6.2.3 Importance of site selection for large-scale renewable energy projects

Site selection usually forms the foundation of any renewable energy project. Selecting the right site is usually a combination of technical, commercial, and economic factors. For an applicant these may include proximity to existing electrical infrastructure, good resource availability, access to roads, sites with mostly flat terrains, and in reasonably close proximity to towns or cities.

From a planning and approval point of view, an applicant must consider the environmental, social and other factors underpinning the development of the project at the selected site. Usually, a site that is correctly selected with limited social, environmental, and other impacts to the community and government have a faster turnaround in achieving development approvals.

As part of the environmental impact assessment and progress the development assessment, the applicant needs to develop a 'constraints map' for the proposed renewable energy project. The constraints map will provide the relevant authorities with an overview of environmental and other constraints pertaining to the site selection. The constraints map usually forms part of the initial planning phases of the project and would be viable for the applicant to discuss any environmental and planning constraints with DPIE and other relevant stakeholders. To develop a constraints map, an applicant may carry out a filtering process on geographical information systems (GIS) platform. Some of the constraints that should be included, but not limited to are:

- Land zones,
- Terrain and land profiles,
- Road access,
- Proximity to existing electrical infrastructure,
- Heritage items,
- Flora and Fauna communities,
- Bush fire and flood prone lands,
- Water resources,
- Proximity to nearby residences or businesses.

6.2.4 What are the different stages of a State significant development assessment?

The development and approval of environmental impact assessment process for State significant development can be summarised into six key steps, which have been outlined in the section below.

Phase 1
- **Scoping**
  - *Outcomes: Scoping report and Secretary's Environment Assesment Requirements (SEARs)*

Phase 2
- **Environment Impact Assessment**
  - *Outcomes: Environmental Impact Statement from the applicant*

Phase 3
- **EIS public exhibition**
  - *Outcomes: EIS on public exhibition, and all submissions are recorded and sent to applicant*

Phase 4
- **Submission responses**
  - *Outcomes: A report to be developed by the applicant addressing all submission comments recieved during the exhibition.*

Phase 5
- **Assessment**
  - *Outcomes: Assessment report by the Department and recommended conditions of consent is published and provided to consent authorities*

Phase 6
- **Determination**
  - *Outcomes: Authorities to determines the approval/refusal of the development based on different merits and internal considerations.*

Phase 7
- **Post approvals**
  - *Outcomes: Authorities to provide development approvals based multiple conditions for managing and mitigating the impacts of the development.*

FIGURE 35: STATE SIGNIFICANCE DEVELOPMENT ASSESSMENT PROCESS FLOW

- **Phase 1 – Scoping:** The first phase of a State significant development assessment process is scoping. This phase can be subdivided into two stages, which involves;
  - *Development of scoping report*: During the project initiation phase, the applicant maps out relevant matters that could be impacted by implementing a renewable energy project. During this phase, the applicant is encouraged to liaise with key stakeholders to get their views and thoughts on the mapped out impacts and risks of developing the project. These are complied as a report and submitted to the Department as a 'scoping report'.
  - *Issuance of SEARs*: DPIE receives the scoping report from the applicant, which is the basis for developing the Secretary's Environmental Assessment Requirements (SEARs) in consultation with relevant government bodies. The SEARs is a guide of requirements

that the applicants can use to develop their EIS and constraints that need to be addressed to achieve development approvals.

- **Phase 2 – Environmental Impact Statement**: The applicant prepares the EIS document to accompany their development application for the State significant renewable energy project. EIS will outline details of the proposed renewable energy project and its potential impacts on the economic, social and environmental impact in accordance with the SEARs. Please note, Schedule 2 of the Environmental Planning and Assessment Regulation (NSW) sets out requirements for the content of an EIS.
- **Phase 3 – EIS public exhibition:** The applicant will submit the EIS to relevant authorities to provide additional information on their State significant development application and to provide information regarding the proposed renewable energy project and its impact on key stakeholders. DPIE will evaluate the EIS and put it on public exhibition if no additional clarifications or information are required from the applicant. The State significant applications are publicly available documents that are published for comments and feedback.
- **Phase 4– Submission responses:** The Department will compile the comments and feedbacks made to the applicant and invite the applicant to respond to any issues and concerns raised from the public exhibition. If the concerns require changes to the project plans and designs, the Department expects the applicant to submit an updated development application to reflect any changes.
- **Phase 5– Assessments:** The finalised EIS document is reviewed by the Department and is assessed based on the different levels of government policies, regulations and standards. On behalf of the Secretary, the Department reports on the assessments carried out and provides their findings to relevant authorities for approval.
- **Phase 6– Determination:** The consent authority needs to evaluate the development application for consent based on different merits and provide the applicant with an acceptance or refusal of the application. The consent can be granted based on different conditions and modifications to the development based on the evaluation completed by the consent authority. Some of the matters that need to be considered before granting the development conditions include:
    - Site suitability for development,
    - Environmental planning and processes,
    - Addressing impacts of economic, social and environmental impacts from the project,
    - Responses to comments and feedback from public,
    - Public interest.
- **Phase 7– Post approval:** Once the applicant receives the consent to develop the project, the applicant can progress to the next stage, which is usually construction. However, a couple of key elements need to be considered post-approval of the development application.
    - *Management plans*: These are plans that need to be provided by the applicant to address all the conditions that have been set out as part of achieving the consent for development.
    - *Compliance*: The entity that carries out the development is responsible for ensuring all activities are compliant with conditions of consent. The Department may ensure the compliance of the project development through unannounced site visits, undertaking surveillance, conducting compliance auditions and other measures as set out by the Department's policies.

- *Modifying an approved project*: An applicant, at any time may modify their application through another development approval process. The modification of the development consent is governed by the EP&A Act.

6.2.5 Connection proposals of State significance in the Northern Rivers

Within the Northern Rivers Region, there are three major projects that are of State significance development.

- Myrtle Creek Solar Farm (100 MW): Terrain solar is developing a 100 MW solar farm at Myrtle Creek, Richmond Valley Council. The developer submitted a scoping report for the project in late 2020 and was issued SEARs by the Department in 2021. The next stage of the development is the preparation of the environmental impact statement by the applicant.
- Myrtle Creek Solar Farm (500MW): Epuron has introduced the development of a 500 MW solar farm at Myrtle Creek in Richmond Valley Council. At this stage, the developer is consulting with key stakeholders to prepare a scoping report that will provide the Department with sufficient information to issue SEARs which will inform the development assessment requirements. Epuron has mentioned they have good levels of engagement with key stakeholders to progress the approval process and expects the approval process to take around 1.5 to 2 years. The development is proposed at a location that is expected to have minimal environmental impacts.
- Lismore BESS (100MW/200MWh): Maoneng is currently developing a utility-scale battery storage project at Lismore Council. The project will have a 100 MW battery storage capacity connected to the Lismore 330kV transmission substation. This is a standalone battery storage project that will charge and discharge from the grid and will not be coupled to a renewable energy generator. Maoneng has lodged the scoping report in September 2021, and based on the SEARs if issued by the Department, the applicant will develop the EIS report as part of the State significance approval process.

6.3 Approval and planning processes for midscale renewable energy projects

Development of renewable energy projects, usually below $30 million in capital expenditure, falls below the State significance assessment process. The development of such projects is governed by the State Environmental Planning Policy (Infrastructure) & (State and Regional Development), local environmental plans, and development control plans. Furthermore, the approval authorities for projects of this scale are generally the local council or the joint regional planning panels.

6.3.1 Local Environmental Plans for Northern Rivers Councils

Local Environmental Plans (LEPs) inform the planning decisions across local government areas through land zoning and development controls. LEPs are a key resource in developing renewable energy projects as they inform the site selection and ensure the local developments are carried out appropriately.

The LEPs for each council in Northern Rivers have different requirements in terms of developing a renewable project based on 30 different types of land use zoning, where renewable energy generation development is categorised as permitted, permitted with consent, or prohibited.

Given that most mid-scale renewable energy projects (such as mid-scale solar farms) would likely engage with this process, this project engaged with the six councils to create high-level (conservative) filtering criteria to map out potentially viable sites across the Northern Rivers regions to develop mid-scale renewable solar farm projects. The list of criteria we used for this assessment is summarised below.

- **Site topography:** Flat terrain, say no more than 5-degree slope from the horizontal and ideally towards the north.
- **Land type/utilisation**: No heritage listed or biodiversity conservation areas, national parks.
- **Electrical infrastructure:** Physically close to electrical infrastructure at 11kV and up to 66kV – i.e. within 1.5 – 3 km.
- **Zoning**: Exclude other land use zoning that would preclude solar farm development.
- **Flooding:** Outside 1-in-100-year flood prone land (or could select 1-in-50 years if it was considered that an array on tilts were feasible)
- **Soil**: Exclude class 1, 2, and 3 acid-sulphate soil locations (or include but note so that this constraint is understood), class 4 and 5 are ok.
- **Land size**: Lot sizes of greater than 5 hectares (this could potentially host a 2-3 MW solar farm)
- **Vegetation:** The selected site needs to have minimal vegetation, such that the clearing requirements are low.
- **Road access:** Sites with road access at a radius of <5km.
- **Electrical infrastructure:** Physically close to electrical infrastructure at 11kV and up to 66kV – i.e., within 5 km.
- **Aboriginal Cultural Heritage:** Exclude land that is classified as Aboriginal Cultural Heritage
- **Bushfire:** Exclude land that is classified as Bushfire Prone land
- **Proximity to residential and commercial centres:** Based on the SEPP Infrastructure provisions but dependent on each council's preference, we could exclude land that is less than 5km from residential and 10km from commercial centre
- **Other constraints:** Exclude roads, and rivers.

Based on the criteria mentioned above, three of the six councils performed a GIS exercise and the results have been summarised in the table below.

TABLE 15: SUMMARY OF OUTCOMES OF CONSTRAINT MAPPING AND GIS EXERCISE

Council	Available sites	Details
Tweed Shire Council	None	The exercise indicated three viable sites; however, these were RU1 and RU2 zones which are prohibited for renewable energy projects under Tweed's LEP
Ballina Shire Council	There were 10 viable sites which were zoned as deferred matter (DM), and the remaining 56 sites were RU1 and RU2.	While the exercise mapped out 66 viable sites, most of them were RU1 and RU2 sites which are prohibited zones for renewable energy developments according to Ballina's LEP

Lismore City Council	We identified 1 site which was zoned as R5, having a total area of 8.5 ha.	The identified site is zoned as large lot residential (R5); and there are nearby residences which could have an impact from a mid-scale solar farm project.

6.3.2 Developing guidelines for mid-scale solar PV projects

As noted above, a high-level GIS exercise performed by three councils mapped out multiple sites that are viable to install a mid-scale solar farm in the Northern Rivers region. The primary purpose of this exercise was to get an indication of the scope for this type of project using fairly conservative constraints. This indicates relatively low scope which may improve with the widening of some constraints – e.g. smaller lot sizes, 1-in-50-year flood zoning, etc. In terms of contribution to an overall emissions reduction goal for the region, this type of project is likely to have low impact relative to other options. Co-benefits such as community ownership and climate literacy will nonetheless make this type of project attractive for many local landowners, entrepreneurs, community groups and local councils.

Building on our engagement with member councils, having a regional approach in project assessment policies and processes could assist in streamlining the development process of mid-scale renewable energy projects, with the level of guidance or streamlining commensurate with the scale of the opportunity.

The Northern Rivers Joint Organisation can work with the member councils to develop guidance that can provide relevant information to proponents regarding key constraints, assessment issues, resource availability, opportunities, and assessment process flows. The guide could include the following information, for example:

- **Constraint mapping:** When developing a mid-scale solar PV project, it is important to understand the environmental and planning constraints at the proposed development site. This can be done similar to the exercise carried out in section 6.4.1. Council members can work with NRJO to align and/or map out their constraints and provide proponents with a list of key constraints that proponents need to consider while developing the project.
  Based on the above preliminary (and conservative) analysis, we were able to map out 11 potentially viable sites that could host a mid-scale solar farm, and with further community and local council engagement, these could increase and showcase the potential of the Northern Rivers region to interested proponents. A constraint mapping can inform the consent authorities with adequate information to progress the development assessment of the project. Furthermore, a constraints list may vary for different types of renewable energy projects such as wind, biodigesters and standalone battery storage systems. For example, standalone battery storage could have different environmental and social impacts than a mid-scale solar farm.
- **Assessment issues:** It is important for the proponents to understand issues that need to be addressed as part of the development assessment within the Northern Rivers region. Some of relevant issues that councils would require consideration of are;
    - Biodiversity,
    - Heritage,
    - Visual and noise impacts to communities,
    - Socio-economic impacts,

    - Waste and water management,
    - Health and safety.

- **Resource availability**: Compile or develop the resource availability within the Northern Rivers region. This could include scoping for natural resource availability, grid stabilities for new projects, the potential for biodigesters, EV uptake and feasibilities of commercial and utility-scale battery storage projects. This will attract interested proponents in developing innovative and long-term projects that are of regional significance.
- **Opportunities**: The region can conduct multiple community and stakeholder engagements to scope opportunities and impacts of these developments. These can include trialing of innovative solutions such as virtual distribution power plants, peer to peer trading, microgrids or vehicle to grid discharging, as these become financially viable in the market. Furthermore, if the region has a plan and process in place for such projects, they could be more easily implemented as and when there is network support, government or external funding made available for such projects.
- **Process flows:** Similar to the State significant project assessment process; it may be beneficial for the Northern Rivers region to develop environmental and development assessment process guidance and process flow. While there are differences within the local environmental plans, an idealised process flow for mid-scale projects could potentially remain the same to increase development efficiencies in the region and reduce any ambiguity among interested proponents.

7 Renewable energy connection processes

One of the initial tasks to implement and develop a renewable energy generator of any scale is contacting the distribution network service provider's (DNSP) or transmission network service provider's (TNSP) network, depending on the generator's connection point. A transmission network service provider transports electricity over larger distances and at higher voltage and connects larger-scale generators to local substations. A distribution network service provider manages the grid network that transports electricity from a substation to consumers.

The voltage of a TNSP's grid infrastructure is classified as high-voltage or greater than 1000 V, which is required to transport electricity over long distances. The voltage of a DNSP's grid infrastructure can be either low voltage (less than 1000 V) or high voltage, depending on the voltage and transmission distance requirements. Generally, low voltage mains are used across domestic, light industrial, and commercial end-users.

The purpose of involving the network service provider (DNSP) at an early stage of project planning is to identify any network requirements or limitations in achieving the grid connection for implementing a renewable energy generator. The network service provider would be responsible for advising the proponent with project-specific connection requirements such as protection devices, SCADA requirements, cost of achieving grid connection and export limitations. Essential Energy is the DNSP that manages all the network infrastructure within the NRJO region. Essential Energy would undertake a process to connect any system from a residential-scale solar PV system to a utility-scale wind farm.

7.1 Renewable energy generators

There are different types of renewable energy generators that can be installed at different scales, such as residential, commercial, and utility scale. Based on Clean Energy Council reporting, in 2020 27.7% of Australia's energy generation was from renewable sources.

The section below summarizes the range of renewable energy projects.

- **Residential scale projects** – These refer to generators that are primarily used within the domestic sector. These are mainly roof-top or ground-mounted solar PV systems connected to the low voltage distribution network. The residential scale projects may also include micro-wind and hydro projects on domestic dwellings. Most of the grid connection application offers received by Essential Energy would fall under low voltage basic/standard connection contracts.
    - **Battery storage (residential scale)** – There was a 20% increase in battery storage systems installed across households in 2020[77]. The Victorian battery program for households, ACT's NexGen program and South Australia's Home Battery Scheme, have incentivised battery storage uptake among the residential sector. From a connection perspective, battery storage systems can be connected to the network with a connection application process similar to those for other renewable systems. Additionally, there is the potential to install larger solar PV systems per phase with battery storage systems as the exports back to the grid are expected to be lower than a system without a storage unit. There are potential

[77] https://www.smh.com.au/business/the-economy/battery-uptake-booms-during-coronavirus-as-clean-energy-gathers-pace-20210318-p57bx6.html

opportunities for additional revenue streams for homeowners through new solutions such as virtual power plants and demand management programs.

- **Commercial scale projects** – These are projects carried out by private or public entities and communities. There are multiple types of projects such as solar PV, concentrated solar thermal technology, wind, biogas and small-scale hydro projects. The scale of projects varies from kW to MW scale. If these are connected to the network via the low voltage network, then the application offer would either be a low voltage basic/standard connection, or a negotiated connection usually governed by Chapter 5A of the National Electricity Rules.
  - **Battery storage (commercial scale)** – These are battery sizes from kWh to MWh range of capacity and have multiple benefits such as demand management and grid support. Battery storage could also be implemented as community storage, where proponents could install local batteries across communities and harvest excess solar from different homes into a battery storage unit which the wider community could utilise at a later stage. Such batteries could also provide network and FCAS services to the market.

- **Utility scale projects** – These are large projects which range from MW to GW scale, which are generally connected to the HV section of the distribution or transmission network. The grid connection application processes are governed by Chapter 5 or Chapter 5A of the National Electricity Rules depending on the size and whether proponents wish to become a registered participant/generator with AEMO. The connection application process for these projects is complex and requires a longer time period to finalise the connection agreement.
  - **Battery storage (utility scale)** – These are batteries of MWh or GWh scale and can provide a multitude of services to the grid and the generator itself. The application process to attain grid connection approval is similar to any other high-voltage connection application process mentioned in the sections below. Some of the key services that utility-scale batteries can provide are; Frequency management, black start services, energy shifting and assisting grid for decongesting demand during peak hours, reduced curtailment issues for generators, and capacity firming.

7.2 Connection application process for Essential Energy

Under the National Electricity Rules (NER) Chapter 5 and Chapter 5A, Essential Energy has an obligation to review and process applications submitted for a new connection, modification to a connection and provide a contractual connection agreement with the applicant. The connection application process for Essential Energy can be classified into low voltage (refer Connecting to the Network Package) and high voltage connection application process (refer CEOP8079 Connection Process Guidelines)[78].

To correctly determine the type of application process and guidelines an applicant needs to follow, Essential Energy has developed a decision tree which has been included below.

[78] These Essential Energy documents outline the detailed application process and cost schedules for connecting a new generator or modifying an existing generator within the low and high voltage network.

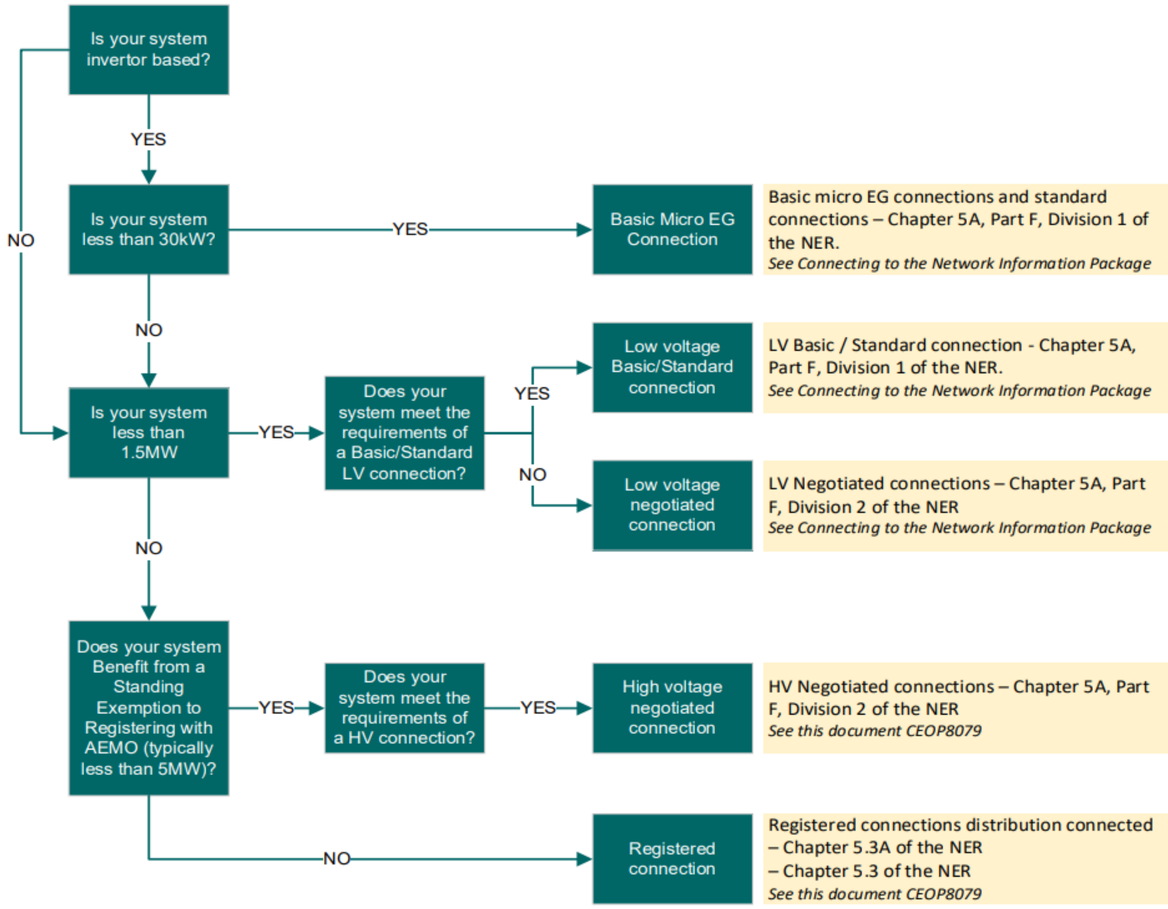


FIGURE 36- DECISION TREE FOR APPLICATION PROCESS[79]

7.2.1 Low voltage connection application

These are systems that are being connected to the low voltage network of the distribution network, where the voltages of the mains are less than 1000 V. These applications could be further classified as;

- Basic micro-embedded generator,
- Low voltage basic/standard connection,
- Low voltage negotiated connection.

However, the initial application process remains the same across these three classifications.

7.2.1.1 Process to lodge a connection application

The following section summarises the process to lodge a connection application to attain a successful grid connection approval from Essential Energy.

[79] http://documents.essentialenergy.com.au/CEOP8079.pdf

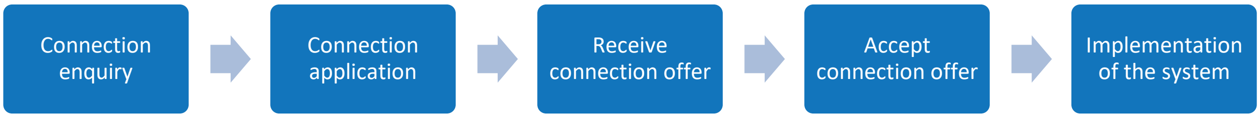


FIGURE 37- HIGH-LEVEL PROCESS FLOW FOR LV CONNECTION APPLICATION

- **Connection enquiry** – If the applicant/proponent has never installed an embedded generator with Essential Energy, it would be beneficial to enquire with Essential Energy's connections team about the required documentation, regulations, and limitation for a specific site. At this stage, the team at Essential Energy may advise on any required network augmentation to achieve grid connection and direct you to an appropriate type of Accredited Service Provider (ASP).
- **Connection application** – For an embedded generator, either the applicant or your ASP would need to lodge an application with Essential Energy for review and approval. The preferred means of applying for grid connection is via Essential Energy's online portal (preferred method) - https://essentialconnect.essentialenergy.com.au/necf/connection-application/home.jsf. Some of the key information that needs to be provided to lodge the application with Essential energy include National Metering Identifier (NMI) number, property/site location and details, single-line electrical diagram, voltage rise calculations and ASP credentials. It is also required to have all the installed embedded network generators to follow the AS/NZS rules and regulations, NSW electrical work compliance requirements and other local body standards to achieve a connection with Essential energy.
- **Receive offer** – If the lodged application is complete and follows all the requirements set out by Essential Energy, the proponent would receive a connection offer with 10 business days for basic and standard contracts, and 65 business days for negotiated contracts. The connection offer would include the standard terms and conditions, connections costs and charges and technical details provided by the applicant as part of the LV application process.
- **Accept offer** – For a non-expedited connection application, which requires you to receive the connection application from Essential Energy, review, sign, return and await confirmation of acceptance prior to any new connection; or, a negotiated contract, which will enable the applicant to negotiate on the application prior to achieving grid connection approval, the applicant would need to sign and return the connection offer to Essential Energy**.**
- **Implementation of the system** – Once the connection offer has been signed and returned, the applicant can work with their selected ASP to install the embedded generator. Please note that, depending on the location of the project and other grid factors, Essential Energy may request a variation in the design of the embedded generator prior to finalising the connection application. Therefore, it is important that the applicant only considers installing the system after achieving a successful grid connection.

7.2.1.2 What are the different types of connection contracts?

There are three main types of connections contract that proponents receive based on the connection type.

- **Basic micro-embedded generator** - For systems ≤3 kW in rural areas and ≤5kW in urban locations would receive an automatic connection approval after lodging the connection application via the connection portal mentioned above. For systems >3kW for rural customers and ≤30kW for urban customers will receive the connection application after technical and contestable works[80] review before a connection agreement.
- **Low voltage basic/standard connection** - For systems >30kW and <1.5MW with or without LV network augmentation. The connection application would be processed after technical and contestable works review by the connections team.
- **Low voltage negotiated connection** – These are applications that the proponent opts to negotiate with the DNSP. Please note that negotiations would be done in accordance with Essential Energy's Negotiation Framework. The proponent has 20 business days to respond after a connection offer is made by the DNSP**.**

7.2.2 High voltage connection application

The connection application process for connecting to high voltage electricity network is different from connecting to low voltage electricity network. The application process for high voltage is differentiated based on National Electricity Rules of Chapter 5 and 5A.

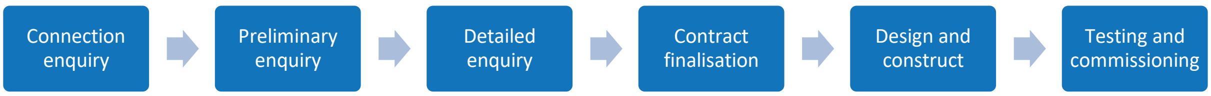
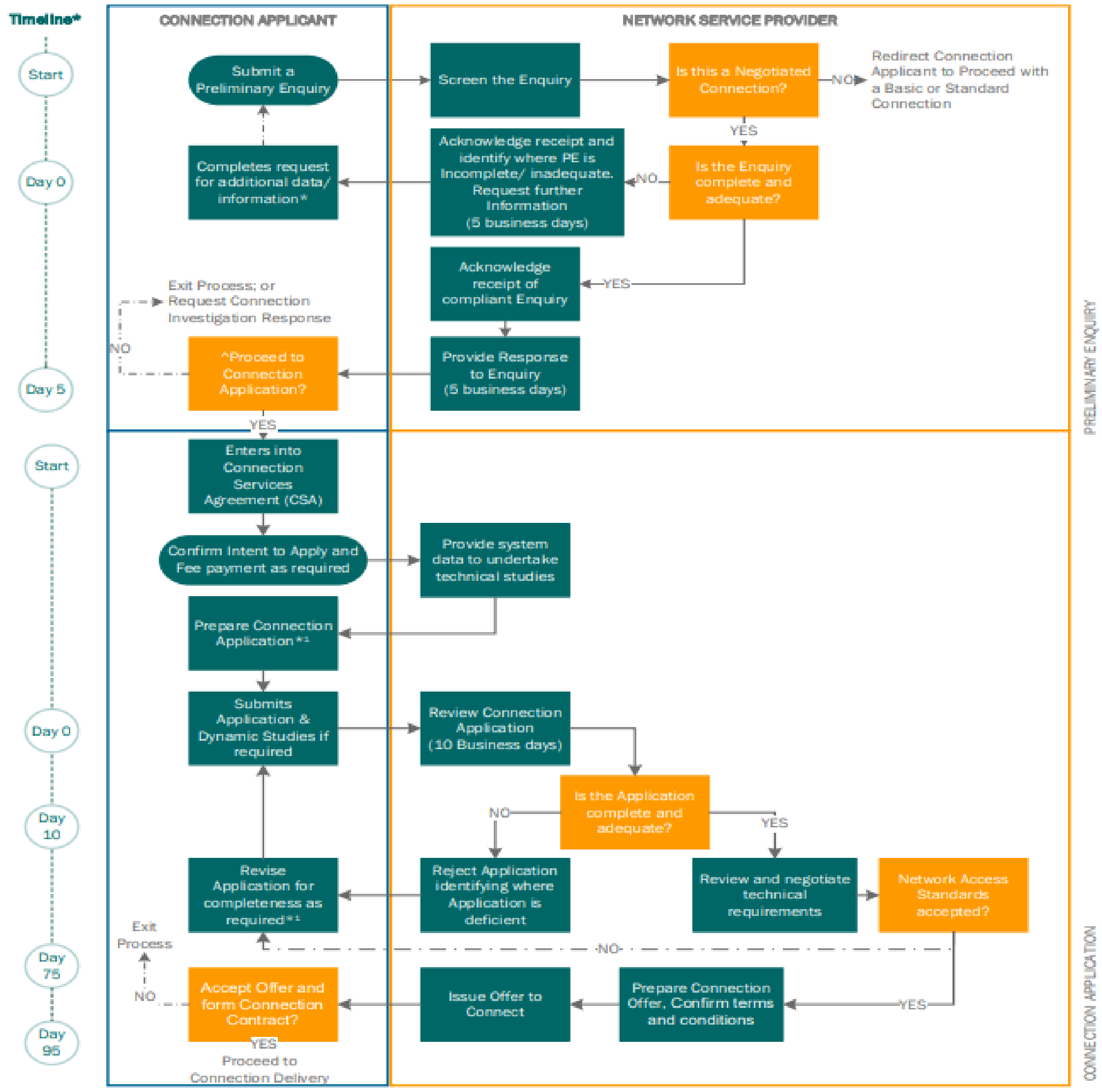


FIGURE 38- HIGH-LEVEL PROCESS FLOW FOR HV CONNECTION APPLICATION

[80] Contestable works – Works that may need to be carried out on the network to host your embedded generator system.

7.2.2.1 Chapter 5A

These refer to all high voltage connections of generating units to the high voltage distribution network for which the generators are not required to be a registered participant with AEMO (between 30kW – <5 MW). The typical processing time for applications under Chapter 5A is 100 days.



*Timeline subject to; no. of days Connection Applicant requires to provide additional data/info and Request for Extension under NER

^Note: Connection Applicants can engage Essential Energy to assess various connection options via Connection Investigation service recovered under CSA prior to progressing an application.

¹Essential Energy provide collaborative support via RFI/TQ process, Requests for Review, Application Issues tracker while Connection Applicants conduct Network Studies/Application Documentation Revisions etc. Costs recovered under CSA or drawn down on applicable fees.

FIGURE 39- CHAPTER 5A CONNECTION PROCESS[81]

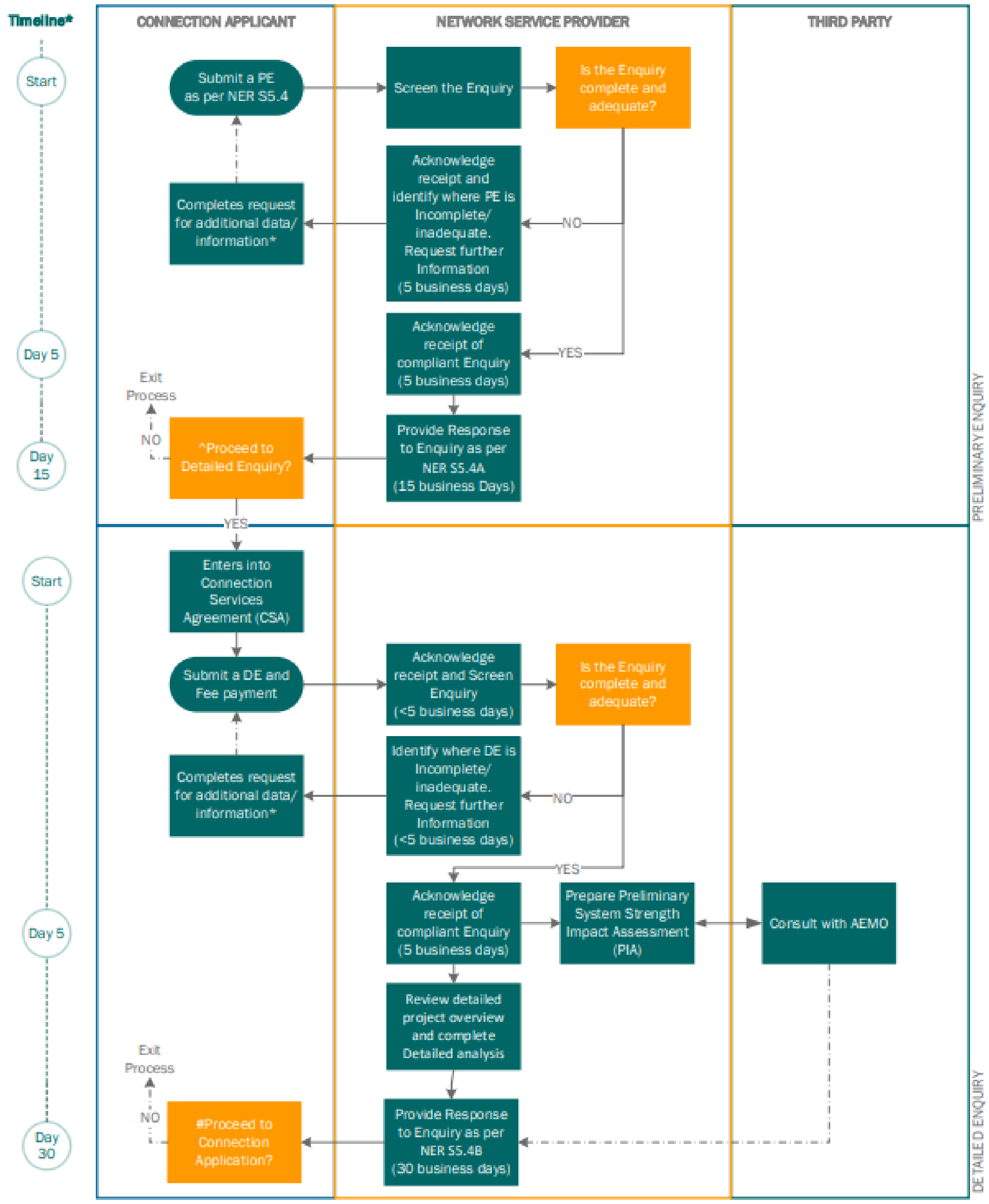
[81] http://documents.essentialenergy.com.au/CEOP8079.pdf

As seen in the figure above, the connection process under chapter 5A can be divided into the following steps.

- **Preliminary enquiry** – This is the initial stage of the connection application process, which requires the applicant to submit an electronic preliminary enquiry form via https://www.essentialenergy.com.au/our-network/connecting-to-the-network/hv-connection-preliminary-enquiry-form. The preliminary enquiry response will cover technical information about Essential Energy's network and high-level requirements for proceeding with the connection application to the next stage.
- **Connection investigation** – At this stage, the applicant can request a connection investigation to investigate the feasibility of the connection to Essential Energy's network. The minimum response time for a connection investigation report is 30 days, and a typical response may cover specific connection requirements, and high-level cost guidance for non-contestable works.
- **Application to connect** – At this stage, the applicant can proceed to submit the connection application with Essential Energy. Based on the system specifications, Essential Energy may carry out technical studies and request additional information such as a dynamic study review from the applicant to proceed further with the application. Essential Energy may also request the applicant to provide detailed project plans and timelines to ensure the overall desired project timeframe is achievable.
- **Application submission** – If the application meets all the requirements and standards set out by Essential Energy, the application will proceed to an offer to connect. However, if these are standards are not met based on the application, then further studies would be required.
- **Offer to connect and contract finalisation** – The applicant would receive an offer to connect, which outlines the terms and conditions for connection to the network in accordance with NER, extent and cost of network augmentation work, network service charges and other relevant standards. Based on an agreement from all parties, the connection offer can be accepted by the applicant

7.2.2.2 Chapter 5

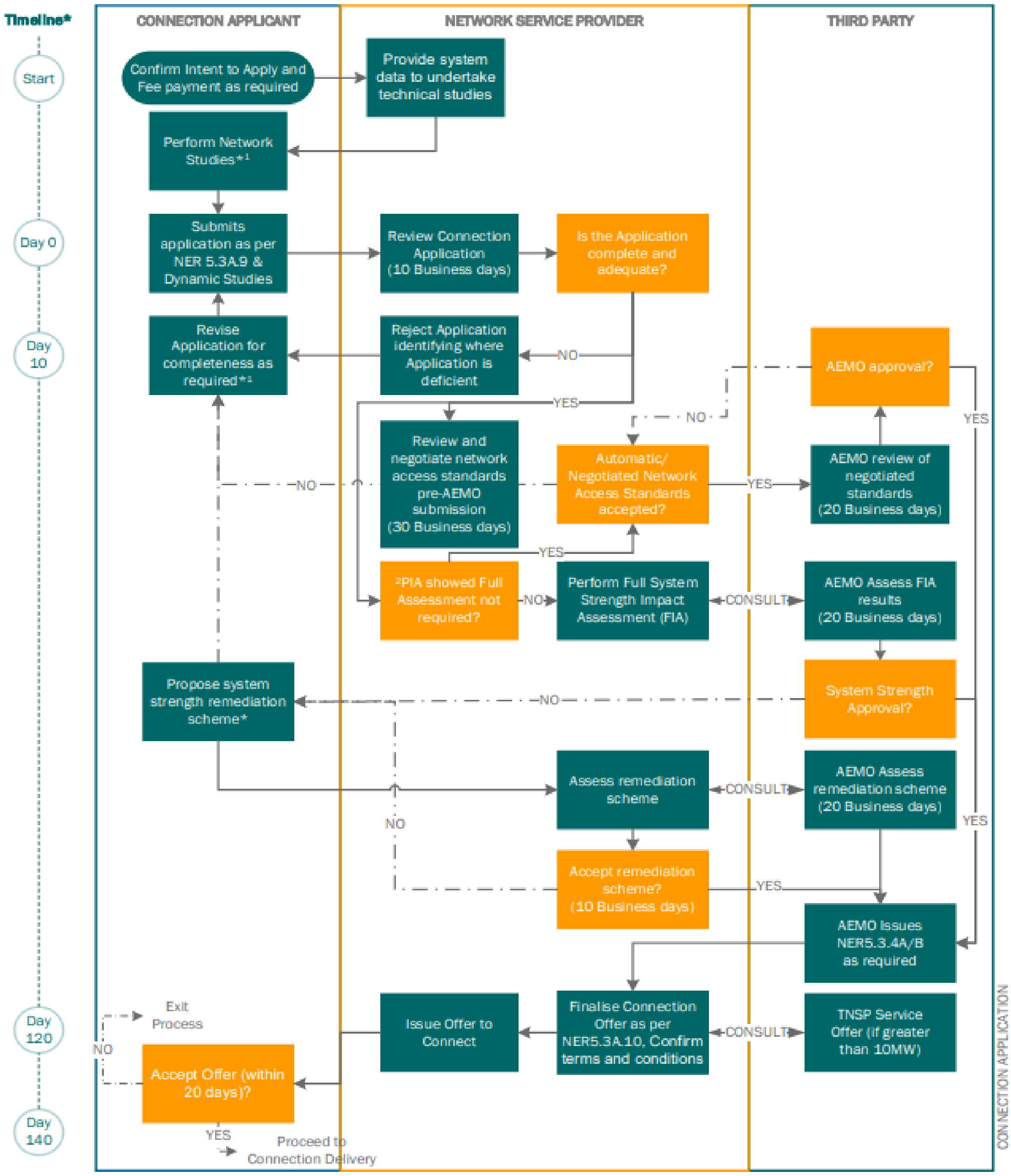
All generating units greater than 5 MW or seeking exemption from becoming a registered participant with AEMO are governed by Chapter 5 of NER. The typical processing time for applications under Chapter 5 is 155 days.



*Timeline subject to; no. of days Connection Applicant requires to provide additional data/info and Request for Extension under NER5.3A.7(c)/5.3A.8(e)

^Connection Applicant can elect Skip directly to Detailed Enquiry noting intention on Preliminary Enquiry submission.

#Note: Connection Applicants can engage Essential Energy to assess various connection options via Connection Investigation service recovered under CSA, or submit multiple Detailed Enquiry per connection option and can progress an application per option. Fees applied per Submission.



*Timeline subject to; no. of days Connection Applicant requires to undertake Network Studies, impacts of Network or Rule Change Requests/RFIs/TQs/Requests for reviews, required Application Documentation Revisions/ReSubmissions and works to complete FIA/ remediation scheme proposals.

[1]Essential Energy provide collaborative support via RFI/TQ process, Requests for Review, Application Issues tracker while Connection Applicants conduct Network Studies/Application Documentation Revisions etc. Costs recovered under CSA or drawn down on applicable fees.

[2]Preliminary System Strength Impact Assessment (PIA) results initially performed during Detailed Enquiry Stage or subsequent assessment as required due to Change Impact.

FIGURE 40- CHAPTER 5 CONNECTION PROCESS[82]

[82] http://documents.essentialenergy.com.au/CEOP8079.pdf

As seen in the figure above, the following steps are divided into the connection process under chapter 5.

- **Preliminary enquiry** – The initial step is similar to Chapter 5A, and requires the connection applicant to lodge an electronic application via https://www.essentialenergy.com.au/our-network/connecting-to-the-network/hv-connection-preliminary-enquiry-form.
- **Detailed enquiry** – Essential Energy will conduct a detailed analysis of the application. The detailed enquiry response will cover connection requirements, high-level information regarding contestable and non-contestable work with estimated price guides, and a draft connection agreement.
- **Application to connect** – At this stage, the applicant can submit the connection application with Essential Energy. Based on the system specifications, Essential Energy will carry out technical studies and request additional information such as a Dynamic study review from the applicant to proceed further with the application. Essential Energy may also request that the applicant provide detailed project plans and timelines to ensure the desired project timeframe is achievable.
- **Application submission** – If the application to connect requires correspondence with other TNSP or DNSP then Essential Energy work to identify requirement that would be included in the draft connection agreement. AEMO and other third-party charges would be passed on directly to the applicant.

The remaining process remains like that of Chapter 5A; however, with Chapter 5, there are additional technical study requirements and consultations with AEMO to ensure the viability of connecting to the network. The detailed process flow of connecting to a high voltage network governed by Chapter 5 of the NER can be found in Essential Energy's CEOP8079 – Connection Process Guidelines document.

7.2.3 Post connection application

After the application is executed and signed by all parties, there are several steps to ensure the grid connection delivery is successful.

- **Design and construct** - This may include both or either of the contestable and non-contestable works that need to be carried out to ensure grid connections. The non-contestable works are carried out by Essential Energy; however, the cost is borne by the connection applicant. Whereas all the contestable works are carried out by the proponent and their selected ASPs.
- **Testing and commissioning** – Please note that all the required tests specified by Essential Energy needs to be carried out by the connection applicant to complete and energise the HV equipment. The tests need to cover HV equipment, control and protection equipment, auxiliary supplies and earthing requirements that follow specific industry requirements and standards.

8 Assessment of priority renewable energy technologies

8.1 Stakeholder engagement

A key input to the assessment of the regional capacity for renewable energy was direct engagement with a range of stakeholders in the region, encompassing Council staff, community stakeholders, project proponents and developers, as well as electricity system regulators, retailers and network operators. In total around 35 online meetings were held with stakeholders. The summary below has sought to take key points out from each of these consultations to capture and reflect the vision for, barriers to, opportunities for and other key aspects relating to the development of renewables for the Northern Rivers region.

TABLE 16: SUMMARY OF STAKEHOLDER INPUT TO THE RENEWABLE ENERGY BLUEPRINT

Mid-scale solar farms
When proposing to develop mid-scale renewable energy projects such as a solar farm, find the right site and instigate engagement early.
There is an opportunity to develop numerous mid-scale solar farms in the region that can build resilience and retain money in the region, but there needs to be a regional project assessment policy and process that helps proponents to develop these, including addressing social license needs in the community.
Mid-scale solar can be difficult in the region where social license can be difficult to obtain, and land may be flood prone. Finding the right sites is key.
There are opportunities for ~5MW solar farms but to be of interest to developers ideally multiple would be identified and developed as a package; some landowners are interested enough to take on projects themselves.
A ~5 MW solar farm application may be a Regionally Significant Development. Where local planning processes apply there is a process for unsolicited proposals to be assessed. There is no specific framework or process for the assessment of solar farms at mid scale.
Basic permissions for mid scale electricity generation is defined in the LEP, highlighting rural landscape in particular. There is no specific process set out at the DCP level as there are too few projects of this type, so project applications work through the key processes or steps in consultation with Council and Essential Energy.
For mid-scale projects there can be many important aspects in addition to social license that a proponent needs to address, such as flood zoning, soil type, vegetation management and a range of biodiversity aspects. Two factors that favor such developments are working with rural landscape that has no vegetation, and use of the concept approval process as a way to initiate a project.
A regional forum of north coast councils could work towards a guide or highlighting the main constraints by council area for mid-scale solar projects. Planners aim to provide realistic advice to proponents.
There is interest regionally in mid-scale solar, with some projects proposed.
Place an emphasis on community-scale or focused solutions such as mid scale solar farms.
Mid-scale solar in the right locations is a feasible opportunity that the community wants, but there are barriers both at the regulatory level and at a local level that inhibit progress.
A clearer or more proactive process that highlights the potential to connect to the network (e.g. mid scale solar) would be beneficial.

Bioenergy
For bioenergy it is hard to create scale and it may be preferred to start small and at site level and look to expand.
For bioenergy to compete a proper waste market is needed, where waste resources are properly valued, such as green gas credits, flexibility of biogas to be a transport fuel, H2 feedstock, electricity, process heat.
Assessment of bioenergy proposals is different again with the requirement to assess hazardous materials as well.
Bioenergy is a key strength but social license issues are common. Solutions that help renters and low income houses par is important.
Bioenergy opportunities may be simpler to progress as single-stream single-site projects rather than regional due to complexities in feedstock management and competing priorities and approaches.
Feedstock sourcing is also important from a social license to operate perspective.
Reliability of feedstock is the most important element to get right in order to help create a bankable bioenergy project.
Without regulatory and planning reform bioenergy will largely remain a behind-the-meter opportunity.
Bioenergy challenges include transport in the region, and may favor smaller on-site / on-farm solutions.
Distributed Energy Resources & Electric Vehicles
Key goals for the region are to see greater deployment of solutions that improve local resilience, including microgrids, off grid solutions, commercial solar & battery storage, bankable solutions for tenants, rooftop solar, smart energy management, EV integration and vehicle to grid technologies.
Rooftop solar continues to be a key opportunity.
Distributed energy resources are feasible opportunities that the community wants, but there are barriers both at the regulatory level and at a local level that inhibit progress.
Employment opportunities may be stronger with distributed renewables - i.e. high volume installations across the region.
Regulatory and legislative frameworks do not support community renewables and the full range of Distributed Energy Resource opportunities that are available.
If more and more renewables are to be implemented in the region then there is a need for more batteries in the network (small and community scale), with 3rd parties managing these to provide FCAS services and avail of the multiple potential revenue streams. A focus on batteries, as well as EVs will help to achieve greater solar penetration.
There is a high interest in batteries and in EV (both tariff trials and bulk buy opportunities), and strategies for managing these will become more important. There is a willingness to innovate both by the community and the network.
EV impact on the grid is manageable and there is a good degree of influence that can be had on this; this is being modelled. There can be gaps between projects that are proposed and the needs of the network in terms of constraints management, for example in terms of location on the network.
One of the region's biggest opportunities is the use of large amounts of C&I roof space to host solar and enable this output to be shared.
A large amount of money leaves the region each year, and some of this could be retained locally. This can happen through building self-reliant sustainable communities, where no-one is left behind, including renters and low-income houses. However community energy initiatives and DER opportunities face barriers and many have not been completed. EVs are a game changer and will decentralize the grid even further; there is a need to partner and engage between networks and community to achieve a vision of building resilient communities.

People in the Northern Rivers are willing to innovate and want more distributed energy resources, but recognize that the region has other significant environmental attributes that need to be protected, so obtaining social license for some opportunities is really important.
The complex and slow-changing legislative and regulatory framework make the development of distributed energy resources very difficult. Opportunities such as microgrids, virtual power plants, peer-to-peer trading, community batteries and mid-scale solar are not progressing.
Going forward key goals - work proactively with the community to locate generation in areas with capacity, dynamically manage risk in constrained areas, get better insights from smart metering within the network to improve predictions, evaluate smart appliance standards, continue to trial and deploy measures such as storage (via 3rd parties) and EVs / vehicle-to-grid to curate the network that can help manage peaks and troughs in the network.
The key focus of ARENA is how to achieve a high % of renewables in the grid, including storage, load flexibility, and on innovations that will transform the market and move this goal forward. Initiatives for batteries, distributed energy and microgrids feed in to that goal.
Large-scale solar
The State Significant Development process for large-scale solar is fairly easy to follow. The large-scale sector is highly focused on early community engagement and consultation, and Councils are important partners in their projects.
Although State Significant Development planning processes are streamlined, the connection process is still complex and takes time. Key decision points for developer can be when there is clear social license to develop and biodiversity aspects have been assessed.
There is a new local interest in large-scale solar with changes to marginal loss factors for renewable energy projects.
Regional advantages, innovation and competitiveness
There are opportunities for the Northern Rivers to use its high skills and innovation to add value to the renewables sector in the areas of micro-payments, transport as a service models, recycling, safety and others.
The Northern Rivers community is engaged and highly literate, and willing to (and does) invest in renewables like solar, bioenergy and mini-hydro. There is a strong link between the region's renewable energy potential and interest, and regional electric vehicle deployment.
Leveraging the region's brand to help drive projects from ideas to planning and delivered projects is important.
Innovation and collaboration and adaptability to the changes that are happening in the energy sector are part of the regional make-up and competitive advantage, as are the growing influx of skilled people from metropolitan areas and the education & training services in the region. These can up-skill the next generation of school leavers who can benefit from the development of renewables in the region, which may be characterized by the strong interest in solar, bioenergy and the emerging hydrogen sector.
Leveraging the region's brand is important for the blueprint.
Social
There are many renters and low income households in the region who are being left behind.
Evolving solutions so that renters, low income and community housing can participate in renewable energy opportunities is an important goal.
Solutions that help renters and low income houses participate in the renewable energy transition is important.
A key goal is to build resilience in the community and to leave no-one behind.

Other
There is work to be done to determine what the real or best opportunities are - eg large-scale solar and bioenergy projects, or small distributed solar and site-specific AD opportunities?
Incentive programs for homes are available but are focused mainly on owners and not renters.
The REZ approach will transform how electricity is generated and distributed. The ISP process provides a framework for different approaches or models to be accommodated, such as hydrogen in the latest version. There are no plans to develop a REZ for the Northern Rivers at this time as the region offers lower wind and resources than other regions.
Hydrogen is also a key focus area, largely about trialing different things to understand the real cost of deployment and the real opportunities moving forward.
Provide direction on what kind of RE developments are feasible and not feasible.

8.2 Multi-criteria assessment of renewable energy technologies

Drawing on all of the available previous research and mapping of renewable energy technologies, on data relating to the region, and on the views of the numerous stakeholders that were consulted to develop the blueprint, a high-level multi-criteria assessment of a range of renewable energy solutions is developed and shown below. Note that this is not a multi-criteria decision assessment framework and analysis, which would be a more systematic, thorough analysis.

TABLE 17: HIGH LEVEL MULTI-CRITERIA ASSESSMENT OF RENEWABLE ENERGY TECHNOLOGIES FOR THE NORTHERN RIVERS

Renewable energy solution	Resource capacity for the region	Social license to operate	Favorable sites	Grid connection	Regulatory & Planning	Economically viable	Significant contribution to renewable energy generation	Job creation, literacy and education	Retains money in the region	Technology maturity in Australia	Overall qualitative assessment of suitability
Small-scale solar	Significant remaining rooftop PV potential based on APVI data	Very high acceptance of solar in the region with ~45% uptake	Significant areas of rooftop and commercial roof space for new solar	Standard connection process to connect	Streamlined approvals for systems under 100 kW in NSW	Most rooftop PV systems have a payback of 3-6 years	Yes, rooftop PV could generate as much energy as the region consumes	Local jobs are created for installation and maintenance	Yes, cost savings for homes and business may be $60-70 million pa, plus local wages	Very high	Very high
Battery storage	Very high, linked to excess solar exported to the grid and as a grid resilience solution	Likely to be very high; desired at individual level, community level and network level in the right situations	Behind-the-meter, utility projects and where network support is req'd there will be favorable sites. A gap is in the role of community batteries to support DER in a 100% RE-ready grid	Will follow established connection processes for new loads.	The framework at AEMO, NSW gov and Essential Energy levels to support community-level batteries is not defined and this has led to most projects being unviable at this time.	Batteries are the norm for utility projects, and privately cost-effective in some single-site applications. Viability in the sharing / community space remains low	Batteries will enable more generation to be installed, and storage increases the value of each kWh of renewable energy generated	Similar to solar PV, the growth in battery installations will increase local jobs, skills and energy literacy	Yes, each kWh of exported solar stored and used locally retains more savings / money in the region, in addition to local wages	High, price remains the main barrier for resi-scale batteries, and larger battery packs for commercial applications have very low market at this time	High
Utility-scale solar	Comparable on a MJ/m^2 basis to some REZs being developed in NSW and Victoria but a smaller suitable region for large-scale solar	May be better in remote/sparsely populated areas, lower in areas with smaller lots, high-value agricultural land and population centres	Developers have identified and proposed sites in Richmond Valley Shire, other favourable sites may be identified	Identified sites are close to the Rappville zone substation and to 330 kV and 132 kV transmission infrastructure	Any project would be large and be progressed on a State significant development planning pathway	Solar energy is a cheap form of renewable energy and will be the cheapest form by 2030	Yes, any large solar farm would generate a significant fraction of the region's electricity demand	Similar to other large-scale projects, most jobs would be in construction with smaller numbers in O&M	O&M jobs and potentially Community Benefit Fund income could be kept locally	High	High (region, location dependent)
Bioenergy	Very high as identified via– significant previous assessments by SNR and others	Variable – highly dependent on feedstock types, transport, engagement – has also been assessed in the region	Favorable bio hub sites have been identified, and there are numerous single-site opportunities in the region	Many sites would offer behind-the-meter opportunities; bio hubs may require own connection application	Regulatory framework and planning processes are anecdotally reported as complex and time-consuming	Feasibility of regional bio hubs has looked at financial viability. Feedstock security and real markets for gas, electricity and agriculture products is needed	Bioenergy is already a very large regional energy generator, and the potential has been assessed by others to be >1,100 GWh per year	Jobs creation potential is in construction, O&M, supply chain management of feedstocks, and potentially attracting industries to regional bio hubs	Savings on waste management, value of sold products to local industry and associated grid savings, local wages	Anaerobic digestion and engine technologies are mature; pyrolysis and similar technologies are less well applied in Australia	Likely to be medium to high

Renewable energy solution	Resource capacity for the region	Social license to operate	Favorable sites	Grid connection	Regulatory & Planning	Economically viable	Significant contribution to renewable energy generation	Job creation, literacy and education	Retains money in the region	Technology maturity in Australia	Overall qualitative assessment of suitability
Mid-scale solar	Regional assessment may be warranted to map this resource potential / sites	Variable – early community consultation for 'good' sites is good practice	Regional assessment may be warranted to map this resource potential / sites	Anecdotally this can take significant time; Essential Energy preliminary assessment and application processes are well documented	More complex than SSD and small-scale systems, with LEP and DCP processes often not standardized for this type of development	Typically more expensive than large scale solar, and lacks the full benefits of rooftop solar; may need co-benefits to be financially feasible	Moderate; it is likely that mid-scale solar provides some local resilience and community benefit, but overall RE contribution may be modest	Contribution to literacy, education, local knowledge is likely to be high, most jobs would be created in construction, limited ongoing O&M work	Subject to ownership, yes; particularly if community-owned or part-owned	High, several mid-scale solar farms have been implemented nationally	Medium
Mini & micro-hydro	Low expected overall resource capacity that can be tapped	Would require a case-by-case assessment of the local environmental impacts	Laverty's Gap MH recommissioning has been evaluated, and Councils have evaluated sites in their water networks	Proximity to the existing LV grid would likely be a pre-requisite for any proposal; ability to connect subject to Essential Energy's normal process	The regulatory and planning process for a project like this would require further review	All MH project opportunities that have been assessed in recent years show low return in investment	Overall contribution would be low	Contribution to literacy, education and local resilience would be high, job creation opportunities would be low	Yes, it is likely that projects would generate savings locally	High, there are numerous micro and mini hydro projects and technologies	Low to medium
Hydrogen	Technically unlimited as it can be produced anywhere, but not an identified hydrogen hub	Not assessed but comparable to other industrial facility	Not assessed, could be stand-alone with RE supply or linked with regional solar projects	Would follow normal connection processes for a new load	Not assessed at this time as this is evolving	Commonwealth target for 2030 is to reduce cost to $2/kg, significant learning rates will be needed to achieve this. At present uneconomic	Local market for hydrogen and local manufacturing would determine contribution beyond the creation of renewables to make other renewables (fuel, feedstock, etc)	Not assessed at this time as this is evolving	Not assessed at this time as this is evolving	Low, pilot projects for H2 gas substitution and NH3 manufacture are being developed	Low but emerging
Pumped hydro	National Map indicates some mid-sized PH resources in the Kyogle and Lismore LGAs, overall capacity is unknown	Would have to be evaluated at the level of discrete opportunities / sites	National Map indicates some mid-sized PH resources in the Kyogle and Lismore LGAs. PH was also reviewed as part of Laverty's Gap MH review	This would be determined as part of any future assessment of this resource, currently unknown	The regulatory and planning process for a project like this would require further review	Unknown at this time – larger projects such as Oven Mountain and Central West PH may provide an indication for future evaluation	Unknown what the size of the feasible resource at identified sites is at this stage and the energy source for pumping	Likely to be mostly in construction with limited ongoing O&M work	Would depend on ownership of any future PH scheme	High, there are large PH schemes in operation and under construction	Potentially low to medium (further assessment required to properly evaluate)
Onshore wind	Low compared with other	Likely to be low with high visual impact and	Only a few areas in border area national parks	Likely limited with just a 132 kV line west from	Any project would be large and be progressed on a	Wind energy is the cheapest form of new	Yes, any large wind farm would generate a	Similar to other large-scale projects, most	O&M jobs and potentially Community	High	Low

Renewable energy solution	Resource capacity for the region	Social license to operate	Favorable sites	Grid connection	Regulatory & Planning	Economically viable	Significant contribution to renewable energy generation	Job creation, literacy and education	Retains money in the region	Technology maturity in Australia	Overall qualitative assessment of suitability
	regions of NSW and the NEM	numerous environmental impacts in sensitive regions	and potentially to the south-west of Kyogle have mapped resources	Casino to Tenterfield	State significant development planning pathway	generation; less economic in the Northern Rivers with lower resource and connection	significant fraction of the region's electricity demand	jobs would be in construction with smaller numbers in O&M	Benefit Fund income could be kept locally		
Offshore wind	High compared with onshore but lower than other NSW coastal areas	Unknown – likely to be low near-shore for visual impact. Farther offshore marine impact assessments would have to be determined	Unknown what if any sites have been examined	Likely to require significant onshore transmission upgrade	Commonwealth bill to enable offshore wind is before Parliament and regulatory and planning frameworks would follow	Costs are declining rapidly through overseas experience, and the first few Australian projects will see learning rates fall here as well	Yes, capacity factors are high and the scale of offshore wind farms tends to be larger than onshore farms	Similar to other large-scale projects, most jobs would be in construction with smaller numbers in O&M	O&M jobs and potentially Community Benefit Fund income could be kept locally	Low, but the technology itself is well-established globally	Low
Ocean current	Evans Head identified to be second best site on the East Australia Current from 2020 UNSW research	Unknown, marine environment studies would be a key part of any future exploration of this potential	Evans Head provides the best near-shore, shallow-water potential for ocean current energy on the Northern Rivers	This would be determined as part of any future assessment of this resource, currently unknown	The regulatory and planning process for a project like this would require further review	Pre-commercial and unlikely to be financially feasible at this time	Unknown what the size of the resource at this site is, would depend on the number of turbines feasible and impacts of the project	Likely to be mostly in construction with limited ongoing O&M work	O&M jobs and potentially Community Benefit Fund income could be kept locally	Low maturity globally and no known projects in Australia	Very low
Geothermal	Very small and limited to the Bonalbo region of Kyogle LGA	Unknown as the resource has not been investigated for its extraction potential, but the main area is in a national park	Mapping suggests this is limited to Richmond Range National Park (Kyogle LGA)	Likely to be complex and expensive in the area identified	The regulatory and planning process for a project like this would require further review	Highly likely to not be economically viable	Unknown for the area	Unknown	Unknown	Low	Very low

8.3 What are the best renewable energy solutions for the region?

Drawing on the above assessment and on consultations, the Northern Rivers region's natural renewable energy advantages are in solar PV and bioenergy. While solar resources are not as significant as in other regions of Australia, they are still high and well able to support commercially feasible generation.

Large-scale solar and rooftop solar on homes and businesses, offer opportunities to scale up the region's renewable energy generation significantly, enhanced by growth in electric vehicles and by opportunities to accelerate the uptake of battery energy storage at grid, community and small-scale.

Bioenergy generation and mid-scale solar farms provide opportunities to complement these renewable energy solutions, meet a proportion of the region's energy demand and increase resilience and opportunities for energy sharing, and supporting access to segments of the community who are unable to access renewable energy. The emerging hydrogen market may also provide opportunities for the regional economy.

At this time these are the main renewable energy and related opportunities that should be pursued in the Northern Rivers. The region is open to the exploration of new renewable energy solutions, and as offshore wind energy develops and pumped hydro projects are built to support the creation of dispatchable electricity these will be followed and the potential in the Northern Rivers reviewed.

Technologies such as mini and micro hydro are unlikely to deliver a significant fraction of the region's energy needs, but there are nonetheless opportunities that can be developed in the right situations.

Onshore wind energy resources are lower than those available in other regions of NSW, while geothermal energy resources are low. Neither of these technologies appear to offer significant potential for regional development.

9 Unlocking the region's economic and other benefits from renewables

The six NRJO member councils are committed to the development and expansion of a local renewable energy production, which will deliver significant benefits to the Northern Rivers region.

9.1 Keeping money in the regional economy

The Australian Energy Market Commission reports average residential electricity prices for NSW in 2020 of 28.98¢/kWh[83]. Without local solar electricity would cost the Northern Rivers community some $370 million annually. With solar Northern Rivers residents and business are saving nearly $45 million each year on their bills through lower grid usage and export of surplus solar to the grid.

With growth in demand through increased population and more housing, energy spend could exceed $400 million each year, and with 100% electric vehicles the regional energy spend could rise to more than $700 million annually, with most of this money leaving the region.

Increasing local renewable energy generation keeps more of this money in the local economy. At 30% of future demand for example, rooftop solar could retain around $220 million in the local economy each year, and if solar were to meet 45% of future demand, then $330 million could be kept in the local economy each year. Increased community-scale solar and bioenergy generation would increase this.

9.2 Strengthening regional employment

A strong and growing local renewable energy market will generate more employment opportunities.

The construction and maintenance of renewable energy systems employs a qualified regional workforce which will grow as the number of installed systems accelerates. This will be boosted with the development of large-scale and mid-scale solar farms and bioenergy generation, and with the development of the planned Regional Job Precinct in Casino. This directly responds to the objectives of key regional agencies such as Regional Development Australia Northern Rivers and the NSW Office of Regional Economic Development.

In addition, jobs will be created across the broader renewable energy value chain, for example in the training sector, the recycling or re-use of older solar and battery storage systems and in the emerging circular economy.

9.3 Improving resilience

Renewable energy generation, especially at small and medium scale, can be distributed, that is produced locally, near the customers, as opposed to centralized, which will eventually reduce the stress on the grid and the network costs for all consumers.

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[83] Sourced from: https://www.aemc.gov.au/market-reviews-advice/residential-electricity-price-trends-2020

In combination with local energy storage, distributed generation has the potential to create microgrids that will provide power to critical infrastructure and homes when it is needed, as well as support edge-of-grid communities during power outages. And unlike conventional diesel generators, which are the most common source of emergency backup power, Distributed Energy Resources (DERs) do not need fuel deliveries, further increasing the system's resilience, especially in case of extended outages.

Totally Renewable Yackandandah

The town of Yackandandah in Victoria has a goal, led by Totally Renewable Yackandandah (TRY), to be 100% renewables and to increase local resilience, savings and reduce emissions. Previously, the town imported power of 3,100 megawatt-hours annually and has had three bushfire threats over a 15-year period. A seven-year project has achieved numerous goals, including:

- Nearly 60% uptake of solar PV across the town,
- Three operating microgrids,
- Multiple bulk buys of solar and heat pump hot water systems,
- Implementation of a community virtual power plant (VPP), and a 274 kWh community battery,
- Provision of an energy coaching service and the launch of community energy retailer, Indigo Energy

TRY has also been awarded a federal grant to assess the feasibility of further community-scale storage and generation to reach 100%, help the regional town develop more reliable, secure, and cost-effective energy solutions, and develop greater resilience for the town during weather extremes and natural disasters.

One of the study's goals is to investigate 'islandability' in the event of a grid outage for a period, for essential services or for the town as a whole. Local resilience is also achieved through the avoidance of future grid upgrades, and through local community engagement and cohesion.

9.4 Increasing business' competitiveness

The transition to renewable energy will provide a cheaper source of electricity to consumers, with wind and solar already the most cost-effective electricity generation technologies ahead of fossil-fuel based generation.

Combined with increased grid reliability from Distributed Energy Resources (DERs), especially the avoidance of black-outs, businesses in the Northern Rivers will have access to cheaper and more reliable electricity.

In addition to pure cost benefits, access to 100% local renewable energy will enable local businesses to meet the increasing demand for products and services that are sustainable. A 2017 study by ARENA found that 80% of Australian consumers believe big businesses should be using more renewable energy, and 64% would pay more for products and services made with renewable energy.

9.5 Unlocking innovation

Positioning the region at the forefront of the renewable energy transition will provide the ability to seize future development opportunities and create the jobs of tomorrow that come with innovation breakthroughs.

Besides technology improvement directly linked to energy generation, innovation will also cover services that can be deployed in support of renewables.

For example, financing and micropayment services will follow the development of microgrids and the monetization of local, discreet storage capacity, such as from electric vehicle batteries.

Furthermore, the vast amount of data that will be generated by smart meters will require new types of artificial intelligence and IT analytical tools to enable the development of smart grids.

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Level 32, 101 Miller Street
North Sydney 2060

www.100percentrenewables.com.au