Department of Planning and Environment

Narrabri Special Activation Precinct

Renewable Energy Report

April 2023

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Narrabri Special Activation Precinct
Renewable Energy Report

Department of Planning and Environment

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	Name	Date	Signature
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WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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Acknowledgement of Country

We acknowledge country and pay respects to the Gomeroi/Gamilaroi/Gamilaraay/Kamilaroi people as the Traditional Owners and Custodians of the land and waters on which the Narrabri Special Activation Precinct is located on.

We recognise their continued connection to Country and that this connection can be seen through stories of place and cultural practices such as art, songs, dances, storytelling and caring for the natural and cultural landscape of the area.

We also recognise the continuing living culture of Aboriginal people, and the significance of Narrabri in that living culture. We recognise the contemporary stories of displacement and the cultural significance of Narrabri in the continued journey of self-determination in Australia.

Executive summary

The Narrabri Special Activation Precinct (SAP) is one of the six distinctive areas throughout regional NSW to bring together planning and investment to stimulate economic growth across a range of industries including freight and logistics, manufacturing, waste management and recycling, energy generation and agricultural and food processing activities. Narrabri SAP was declared the sixth and final SAP investigation area as its location has a strong reputation and proximity to one of Australia's highest productive grain regions and strong transport linkages to road and rail including the future Inland Rail.

The renewable energy technical assessment is the focus for this report and provides a key technical input for the overall Narrabri SAP Structure Plan.

This report assesses the potential for renewable energy generation in and around the precinct. Having analysed all potential sources of renewable energy generation earlier in the project, this report focusses on the remaining options available for Narrabri:

1. Rooftop solar for new businesses across the industrial zones
2. Ground mounted solar farm within the SAP
3. Potential for additional ground mounted solar farms outside the SAP investigation area.

The report includes capturing engagement with the multiple stakeholders over the course of the delivery including Narrabri Shire Council, Regional Growth NSW Development Corporation and NSW Department of Planning and Environment, as well as parallel investigation work streams – primarily Utilities Infrastructure.

Key findings

With the identified limitations in the power transmission network, looking outside the SAP investigation area for opportunities to implement large scale solar farms has limited potential. These would support the town and the grid, but provide little demonstrable support to the new development within the SAP. Encouraging an uptake of rooftop solar and taking advantage of the space available within the SAP for additional solar power generation are the remaining options for renewable energy generation with this SAP.

Indicative timing

The indicative timing of renewable energy infrastructure upgrades is shown in Figure ES.1. The timing is based on the nexus between the upgrade and land use generating the need for the upgrade. This timing is influenced by the rate of development and the staged release of land within the SAP and the Mt Kaputar residential area.

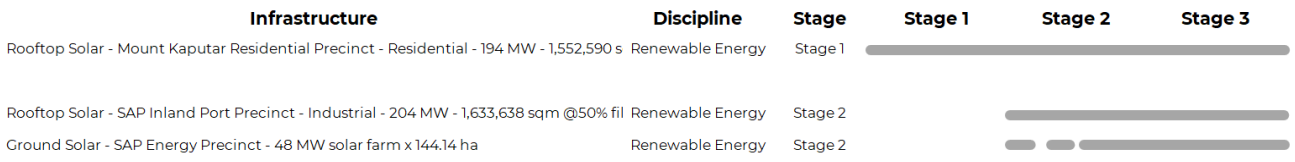


Figure ES.1 Overview staging of Renewable Energy infrastructure

1 Introduction

1.1 Narrabri strategic significance/context

The New South Wales (NSW) Government, through its introduction of the Special Activation Precincts (SAPs) has identified six distinctive areas throughout regional NSW to bring together planning and investment to stimulate economic growth across a range of industries including freight and logistics, manufacturing, waste management and recycling, energy generation and agricultural and food processing activities. The planning and creation of these areas is partially facilitated and funded through the $4.2 billion Snowy Hydro Legacy Fund.

The establishment of SAPs is a joint NSW Government Agency initiative by the Department of Regional NSW, Department of Planning and Environment (DPE) and the Regional Growth NSW Development Corporation (RGDC) as part of the 20-Year Economic Vision for Regional NSW. DPE is responsible for preparing the planning framework whereas the Department of Regional NSW manages each precinct.

1.2 Scene setting

Narrabri is located in the heart of the Namoi Valley on the North West slopes and plains of New South Wales. The word Narrabri means ‘forked waters’, which describes the splintering waterways of the Namoi River, the Narrabri Creek and Horse Arm Creek. The township of Narrabri is the administrative centre of the Shire. Much of the Narrabri Shire population is centralised in the township of Narrabri, Wee Waa and Boggabri, and around the villages of Bellata, Edgeroi, Maules Creek, Baan Baa, Gwabegar and Pilliga. The Narrabri region is known for its fertile soils, abundant natural resources, strong industry and world-leading research.

In November 2020, Narrabri was declared the sixth and final SAP, enabled by its strong reputation and location within one of Australia’s highest productive grain region as well as its strong transportation linkages including existing road and rail connections and the future Inland Rail. To facilitate the planning within this precinct DPE has engaged WSP to prepare a series of technical studies regarding Renewable Energy for Narrabri SAP. An overview of the Narrabri SAP area is shown in Figure 1.2.

Set against the backdrop of the Nandewar Ranges and on the banks of the Namoi River, the topography of the area varies from river plains through to mountain ranges. The Namoi River meanders through these plains and acts as the lifeblood of the area supporting agriculture, industry and people. The Namoi traverses the township of Narrabri from north west to south east. A number of smaller tributaries of the Namoi are also located within Narrabri including Mulgate Creek, Horsearm Creek and Long Gully. Narrabri has historically experienced flooding from each of these sources on a regular basis.

Narrabri township is located within the Narrabri Shire local government area (LGA), approximately 530 km northwest of Sydney. As of 2021 census, the population of Narrabri township was 6,898 persons with 16% identifying as Aboriginal and/or Torres Strait Island Peoples.

The township lies at the junction of the Newell and Kamilaroi highways and has direct rail connection to the Port of Newcastle via the Walgett branch of the Main North line. Once completed, Narrabri will also have a direct connection to the new Inland Rail route which will connect Melbourne to Brisbane via new and upgraded track.

1.3 Masterplan process

The Narrabri Masterplan is the initial stage in determining the area and land uses for the Precinct and is guided and informed by DPE in partnership with the Department of Regional NSW and Narrabri Shire Council. Throughout master planning process, community, stakeholder and industry consultation will take place, as well as a range of technical studies to help inform the preparation of a draft master plan.

Creation of the Masterplan is developed across a series of key inputs and includes a range of technical disciplines including urban design, architecture, landscape design, engineering, and environmental disciplines. The Masterplan process and its stages are summarised in Figure 1.1.

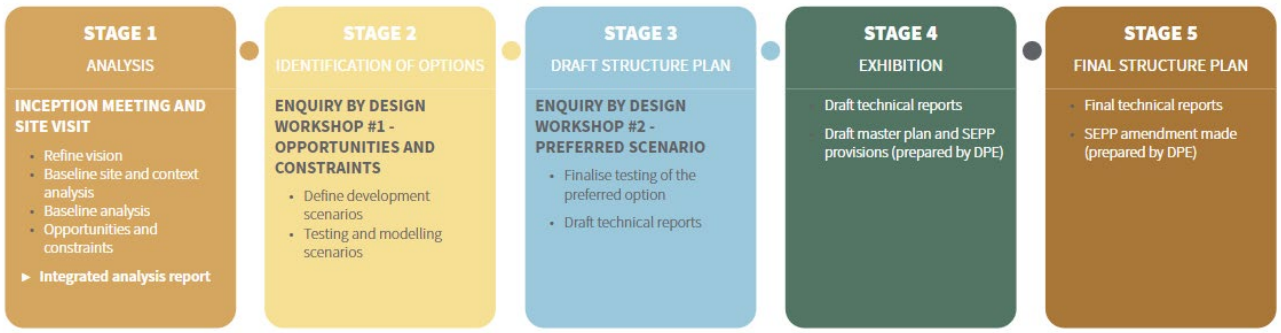


Figure 1.1 Narrabri SAP Masterplan process

The following is a summary of key inputs and activities completed to date that support the findings of this technical report:

- **Stage 1 Analysis:** This stage sets the scene for Narrabri SAP by refining the vision and providing a more detailed understanding the SAP. This stage is supported by overview findings from a site visit, baseline assessment across various technical topics, and identification of key opportunities and constraints.
- **Stage 2 Identification of Options:** Various scenarios of the Narrabri SAP were developed in conjunction with council and inputs from the technical findings from the baseline assessment. A preliminary Enquiry by Design (EbD) workshop was held on 29 and 30 March 2022 to develop a range of initial land use scenarios for further assessment.
- **Stage 3 Draft Structure Plan:** Develops more detailed structure requirements based on the preferred land use scenario based on the range of options assessed in Stage 2. The preferred land use scenario was assessed through a final EbD workshop held between 5 and 8 September 2022 to study the interdisciplinary constraints and key infrastructure requirements. This technical report assesses the land use Structure Plan from the final EbD workshop from a Renewable Energy perspective. Figure 1.2 is an overview of the Narrabri SAP preferred land use scenario.

Following Stage 3 Draft Structure Plan, further community and stakeholder consultation will occur in the form of an exhibition period which includes display of technical reports from the Draft Structure Plan, Draft Master Plan, and SEPP.

1.4 Report structure

This Renewable Energy report has been prepared to provide key inputs for the Narrabri Structure Plan.

The remainder of this report is structured as follows:

- **Narrabri SAP overview – Structure Plan**

  Chapter 2 is an overview of the Narrabri SAP including key elements of the SAP as well as relationship with the Inland Port, Town Centre, and proposed residential areas. In addition, an indicative summary of land uses, employment, and population are summarised.

- **Local context**

  Chapter 3 provides an overview of local context from a Renewable Energy perspective summarising key strategic plans, policy, and planning documentation as well as existing conditions of the area.

- **Methodology**

  Chapter 4 includes a description of the process used of undertaking the study, and list of stakeholders involved and information relied upon as part of the study.

- **Assessment and findings**

  Chapter 5 provides technical inputs and findings for the Structure Plan against the visions and aspirations of the Narrabri SAP from the context of Renewable Energy perspective.

- **Recommendations and conclusions**

  Chapter 6 summarises recommendations and conclusions based on findings and inputs for Renewable Energy within the Narrabri SAP.

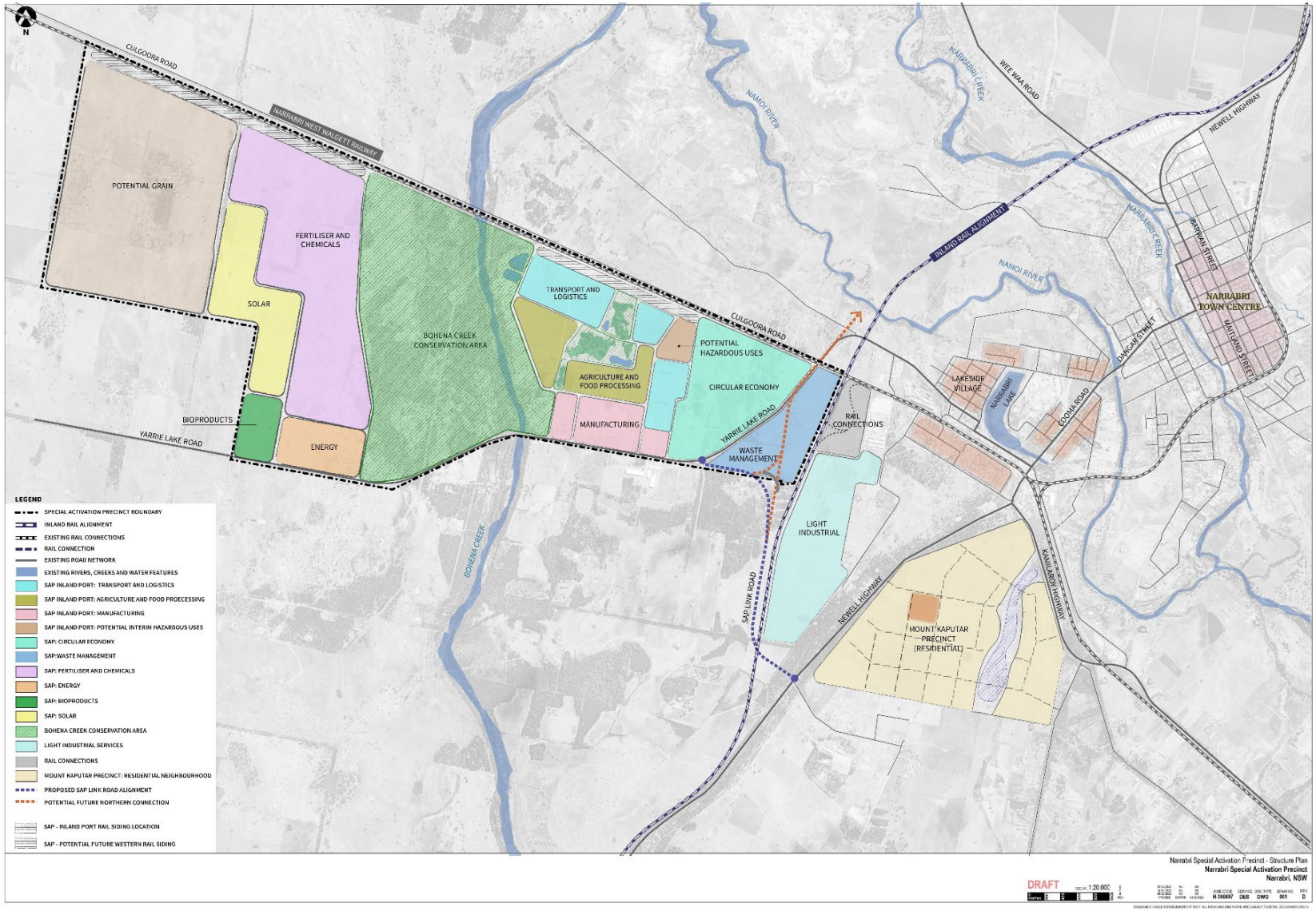


Figure 1.2 Overview of the Narrabri SAP (DPE, April 2023)

2 Narrabri SAP overview – structure plan

2.1 Overview

The Narrabri SAP boundary was developed at the Final EbD workshop and covers an area of 2,629.45 ha. It is located to the west of the existing township and incorporates two areas separated by an environmental buffer zone. This boundary was utilised as a basis for all technical studies and was refined during the master planning and technical assessment process as summarised in Section 1.3. Figure 2.1 provides an overview of key elements of the Narrabri SAP.

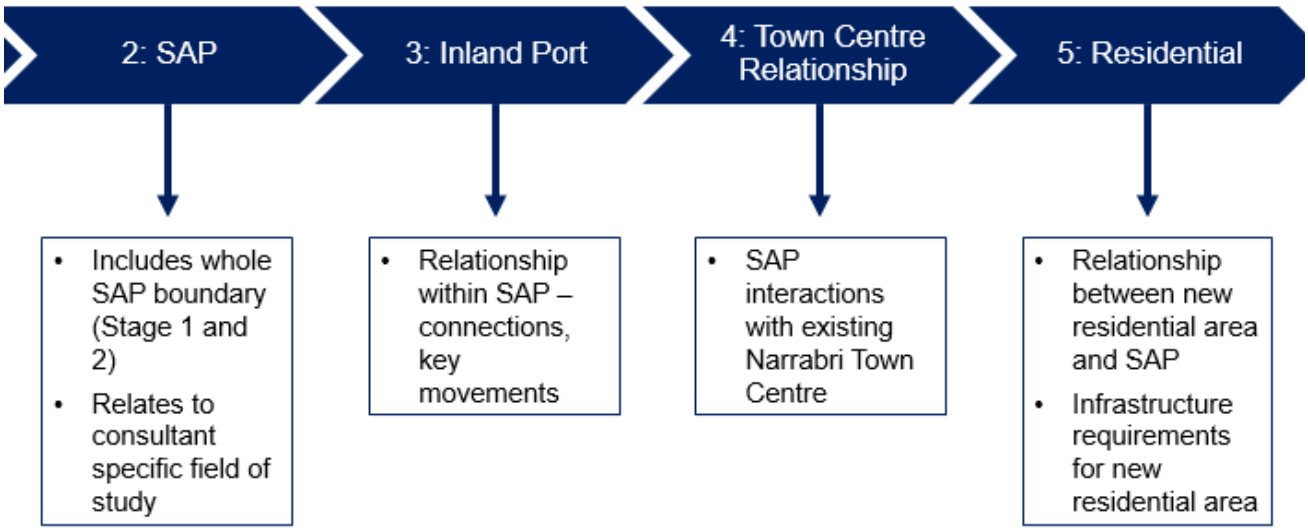


Figure 2.1 Overview of key elements of Narrabri SAP

2.1.1 Visions and aspirations

The vision and principles for the Narrabri SAP is grounded by the *7 Elements of Great Places* which is based on the United Nation's *The New Urban Agenda framework.* The Narrabri SAP Vision and Principles were developed with this framework and summarised in Table 2.1. They were refined during the preliminary EbD to respond to feedback from stakeholders and consultants. This vision will guide the design and development of the precinct and the assessment of the merits of each of the scenarios.

Strengthening our relationship with Country and Water; the Narrabri SAP will retain the Town Centre as the heart of Narrabri, unlock greater economic growth for the region, leveraging from the Inland Rail, the Northern NSW Inland Port and the Narrabri Gas Project.

Table 2.1 Narrabri SAP vision

Element	Vision
 **Equity**	Strengthen the existing community and businesses; giving them the tools and the reason to stay whilst attracting economic and residential growth for Narrabri that will 'give back' to Narrabri. Respect the cultural and lifestyle diversity by providing access to housing, health, education, social and community infrastructure to enhance the liveability and lifestyle of Narrabri.
 **Identity**	Establish a legacy at Narrabri for future generations to be proud of which reflects diversity, protects and respects the site's natural features, heritage and vegetation whilst integrating a cultural lens across the entire SAP in all actions.
 **Greenery**	Use science and local knowledge to define constraints and opportunities enabling the protection of community and environment with a strong focus on safety, flood and bush fire risk, water security and bio values.
 **Urbanity**	Reinforce the Town Centre as the heart of Narrabri breaking down boundaries, addressing basic social deficits and embracing diversity to achieve a liveable and lovable place that is safe, connected and active.
 **Mobility**	Plan for both regional and local equitable access for future residents, visitors and workers of all ages, abilities, and economic position aiming to improve health, convenience and social connectedness.
 **Wellness**	Prioritising the community's health, well-being and sense of belonging and setting a new environmental sustainability benchmark for energy intensive development.
 **Resilience**	Grow and retain the local small industry community whilst up-skilling and attracting new industries and enterprises; setting a standard for innovation and circular economy across the board and including energy-intensive industries.

2.1.2 Staging

For the delivery of the Narrabri SAP, an indicative staging delivery plan is assumed to commence in 2024 and ongoing toward 2030 and beyond. Staging at this time is assumed across three stages:

- **Stage 1:** east of Bohena Creek with a focus on the transport and logistics land use (e.g. the inland port development), associated light industrial industry and assumed development of 600 new residential lots.
- **Stage 2:** remaining development east of Bohena Creek and associated industrial industry, waste management and circular economy land uses.
- **Stage 3:** west of Bohena Creek focussing on more hazardous heavy industry land development (such as energy, fertiliser and chemical production), bulk grain handling, and assumed development of a further 1,800 new residential lots.

Figure 2.2 provides an overview of the infrastructure delivery for the Narrabri SAP.

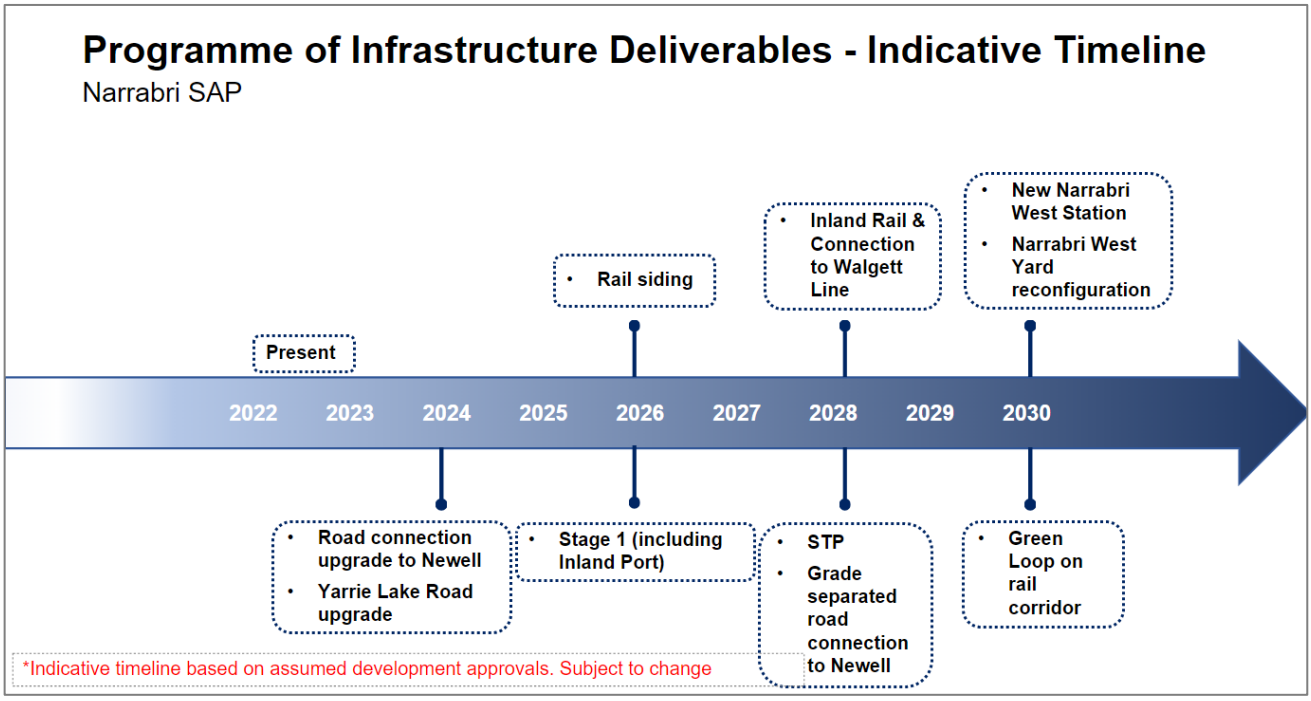


Figure 2.2 Indicative Program and staging of infrastructure deliverables (subject to change)[1]

(1) Note: Reference of the 'Green loop' is considered a long-term strategic concept and is not assessed in this report.

2.1.3 Land uses

Land uses and size within the Narrabri SAP and external to the SAP are summarised in Table 2.2 and Figure 2.3 provides an overview of the land uses.

Table 2.2 Overview of land use and sizing within and outside the Narrabri SAP boundary

Land use within the Narrabri SAP boundary	Area (ha)	Land use outside of the Narrabri SAP boundary	Area (ha)
Fertiliser and Chemicals	366.62	Rail connection	44.92
Solar	144.14	Light Industrial (North)	106.75
Grain (Potential)	527.48	Light Industrial (South)	187.30
Western Rail Siding	37.75	Residential (2060 Target)	597.15[3]
Energy	63.31		
Bioproducts	40.79		
Inland Port (Rail siding and additional rail siding reserve)	36.07		
Transport and Logistics	108.20		
Interim Potential Hazardous Uses	19.19		
Waste Management and Recycling	94.32		
Agricultural and Food Processing	90.88		
Manufacturing	72.59		
Circular Economy[1]	181.75		
High Value Vegetation (To be retained)[2]	45.85		
Bohena Creek Conservation Area[2]	626.27		
Others (Rail, Roads, Decoupling Infrastructure)[2]	174.24		
Total	**2629.45**	**Total**	**936.12**

Source: DPE, 17 February 2023

(1) Circular Economy land use is identified land that align with circular economy goals by valuing resources, by getting as much use out of products and materials as possible, and reducing the amount of waste generated.

(2) Non-employment land uses.

(3) The net residential area (excluding flooding area and main indicative connections) = 488.18 ha.

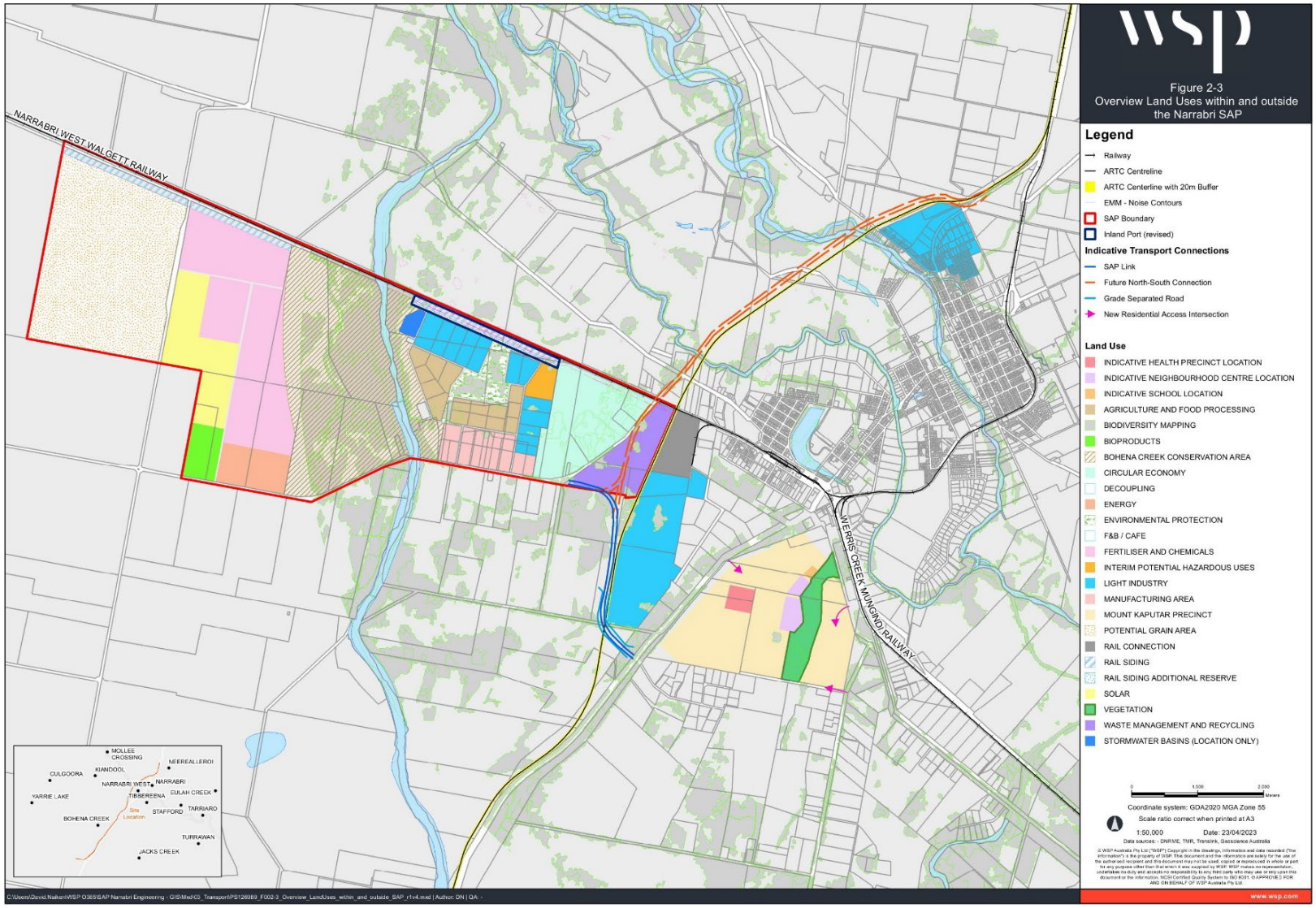


Figure 2.3 Overview of land uses within and outside the Narrabri SAP (April 2023)

2.1.4 Employment

An estimate of the number of forecasted jobs created within the SAP is summarised in Table 2.3.

Table 2.3 Estimated employment requirements (FTEs) within the SAP based on high uptake sensitivity[1]

Industry	2027	2032	2042	2062
Fertiliser & Chemicals	260	260	260	260
Energy	10	10	10	10
Bioproducts	0	0	0	50
Transport & Logistics	70	80	90	120
Agricultural & Food Processing	40	220	220	220
Waste Management & Recycling	50	60	110	110
Total	**430**	**630**	**690**	**770**

Source: Narrabri SAP Economic Analysis Updated employment figures following September 2022 Enquiry by Design (EbD) Workshop (Aurecon, 2022-10-10)

(1) Employment numbers correspond to high uptake sensitivity with gas project

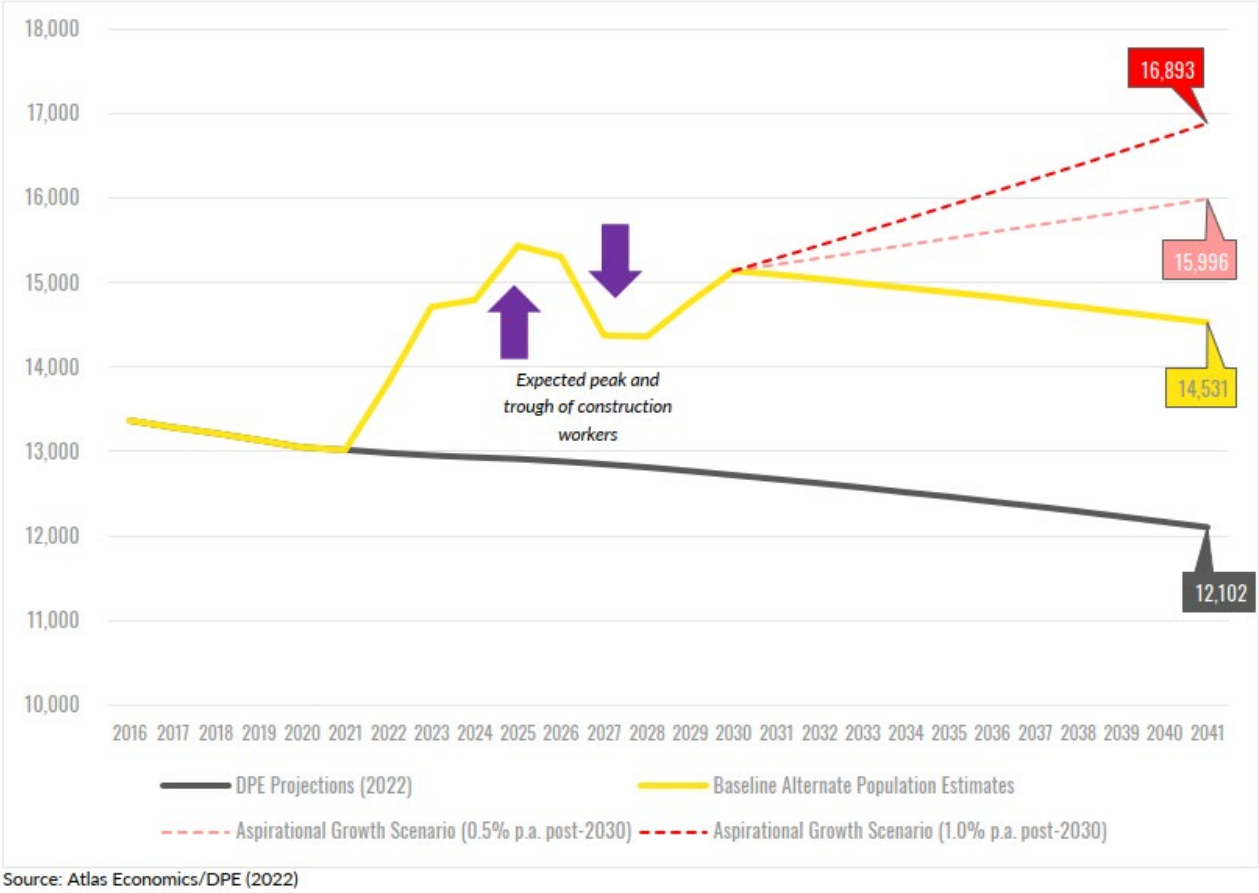
Assumptions related to these estimates include:

- It is assumed that the employment in the grain, rail siding, interim potential hazardous uses and circular economy areas would not increase substantially or is included in the estimates for other land uses.
- The employment numbers in Table 2.3 do not include a specific allowance for the land allocated for Manufacturing. DPE has advised that the total employment estimate should be considered the maximum number. For the purposes of this assessment, we have assumed that the manufacturing jobs are included within the Agricultural & Food Processing estimate (as they are adjacent to each other).
- It is assumed that the Transport & Logistics employment forecasts include those associated with the Inland Port and light industrial within the SAP.
- The numbers in Table 2.3 do not include an estimate of the number of jobs potentially created in the identified land external to the SAP (Light Industrial North and South). While the impact of this development is outside the scope of this assessment, we have included a nominal allowance for the purposes of estimating the road network performance for the SAP. Based on the relative proportions of their land areas (3.5 times), it is estimated that the number of jobs in the Light Industrial South area are 245 in 2027, 280 in 2032, 315 in 2042 and 420 in 2062.

2.1.5 Population

The Narrabri Shire region could reach a resident population between 14,500 and 16,900 residents by 2041 as shown in Figure 2.4. Based on these estimates the potential dwelling need for the Narrabri Shire region would be between 7,000 and 8,000 dwellings by 2041. Accordingly, the population estimate scenarios could require between 1,000 and 2,100 additional dwellings over the coming 20 years to 2041, equating to between about 50 to 110 additional dwellings per annum. These estimates identify a significant uptick in housing supply would be required to meet population growth.

Population estimates indicate that the SAP would increase the potential workforce as well as the population of Narrabri as a whole. The peak increase in workers is expected to occur in 2025/2026.



Source: Atlas Economics developed alternate population forecasts for DPE, November 2022

Figure 2.4 Narrabri Shire population projections

For the purposes of this assessment, we have assumed that the maximum increase of new residents would be contained within the new residential area, and that it would be maintained, even if there is a decline in the population in current residential areas within Narrabri Town.

3 Renewable energy context

3.1 Strategic plans, policy, and planning

Table 3.1 provides an overview of plans, policy, and planning for this report.

Table 3.1 Overview of plans and policy

Name	Description
A 20-Year Economic Vision for Regional NSW (2021)	Renewable energy has been identified as one of the three emerging sectors which will drive the diversification of regional economies.
Narrabri Shire Local Strategic Planning Statement 2040 Final (2020)	One of the planning priorities defined in the strategic planning is to "manage and support the transition to renewable energy".
New England North West Regional Plan 2036 (2017)	One of the priorities defined in this plan for Narrabri council is to "Identify and promote wind, solar and other renewable energy opportunities".
Narrabri Growth Management Strategy (2020)	Narrabri Local Government Area (LGA) is not in the identified energy zones, however the suitability of the LGA for renewable energy generation is proven by existing investment.

3.2 Existing conditions

Table 3.2 provides an overview of the existing (operational) key (>10MW capacity) renewable energy projects in the New England Northwest region for this report.

Table 3.2 Existing renewable energy projects in New England Northwest region

Technology	Description	Name Plate Capacity	Distance to Narrabri (approximate straight line)
Solar Energy Projects	Gunnedah Solar Farm	144 MW	86 km
	White Rock Solar Farm	20 MW	181 km
	Moree Solar Farm	56 MW	85 km
Wind Energy Projects	White Rock Wind Farm (Stage 1)	175 MW	181 km
	Sapphire Wind Farm	270 MW	172 km
Hydro Energy Projects	Copeton Hydro Power Station	23 MW	119 km

Due to the distance between the Narrabri SAP and these existing renewable energy projects, the contribution of these renewable energy projects to the SAP energy usage cannot be quantified. However, if any Narrabri SAP energy consumer buys electricity from the electricity retailer company which source their electricity from any of these renewable energy projects than we can consider this to be a virtual contribution to the Narrabri SAP's energy usage by these renewable energy projects.

There are currently several solar farms planned for the Narrabri Shire Council LGA totalling over 200 MW at various stages of development (from Development Approved to under consideration). Should all projects be executed then the total electricity generated will be more than the broader Narrabri area forecasted indicative estimated annual energy consumption in Essential Energy's Distribution Annual Planning Report (DAPR) 2020.

Further to the Narrabri Shire Council LGA, there are 14 solar, 3 wind, and 1 hydro energy projects planned key (>10 MW capacity) in the New England Northwest region. Like those existing (operational), the contribution of these renewable energy projects to the SAP energy usage cannot be quantified due to their distance to the Narrabri SAP.

3.3 Potential renewable energy source assessment

From WSP's baseline analysis of Renewable Energy options, the following solutions have been identified with the highest potential for utilisation in and around the SAP area:

- large scale solar and roof top solar photovoltaic (PV) for electrical energy generation
- medium scale biomass power generation
- battery energy storage systems (BESS).

A summary of resource availability and potential key constraints for the technology to participate in the Narrabri SAP is illustrated in Table 3.3 below:

Table 3.3 Summary of resources' availability and constraints

Renewable energy source	Resource availability	Potential constraints
Bio Energy	— Biomass electricity generation — Agricultural residue resources within a reasonable radius of the Narrabri SAP region may be sufficient for medium scale power generation, pending variability of the biomass.	— Security of supply can be a challenge for biomass systems — The higher cost of biomass combustion equipment — Transportation challenges for the agriculture residue (in terms of cost, road quality etc).
Energy from Waste (Biogas)	— Biogas based electricity generation — Biogas based heat generation.	— Livestock residue and wastewater sludge quantities are likely insufficient to support heat or power plants — Domestic municipal waste quantities likely insufficient for reliable supply — Landfill gas quantities likely to be insufficient for capture and use for heat and power applications.
Solar Energy	— Good solar irradiance — Land availability in wider SAP area — Large scale solar PV electricity generation — Small scale and domestic/commercial scale rooftop solar PV electricity generation — Annual mean monthly global exposure for Narrabri is 5.4 kWh/m^2.	— Land availability and other preferred land uses in Industrial/employment investigation area of the SAP — Proximity of Industrial/employment Investigation area to the existing TransGrid and Essential Energy substations — Grid/network system capacity for new solar farms considering three planned large scale solar projects.
Wind Energy	— Electricity generation through wind turbines — The wind speed reported at 100 m over the SAP area is approximately 6.1 m/s.	— Wind speeds is significantly lower than the wind speeds at the regional operational and prospective sites — Grid/network system capacity.

Renewable energy source	Resource availability	Potential constraints
Hydro Energy	— Electricity generation through conventional hydropower & pumped hydro power — Electricity generation through run-of-river hydro power.	— Water availability and topology of the area are unlikely to be viable for conventional or pumped hydro — The closed waterways are the Bohena Creek and Narrabri Creek which have intermittent flow and is unlikely to be viable for run-of-river systems.
Geothermal Energy	— Electricity generation through geothermal energy.	— Likely inadequate temperature for heat generation or electricity generation — Cost of technology for large scale applications.
Hydrogen	— Green hydrogen production — Potential consumer industries of hydrogen to be established in the SAP to create a circular economy — Renewable energy projects planned to be in Narrabri SAP.	— Hydrogen production is to only rely upon solar PV generation of the SAP as wind energy has limited potential for the development in the SAP — Current economic viability of using solar PV and BESS to produce green hydrogen — Limits to water availably and competing water uses, especially agriculture.
Battery Energy Storage	— The immediate business case is stronger for short storage duration batteries providing grid support and frequency control ancillary services — Planned solar farms in the Narrabri LGA and available grid infrastructure.	— The business case for spot market arbitrage is not as strong, and to some extent is not entirely compatible with provision of the grid support functions.

4 Methodology

4.1 Overview of the key components

Throughout this project, all potential sources of renewable energy have been explored, however, only some have been deemed viable. Table 3.3 covers all options explored and can be summarised as:

- solar PV has high potential for implementation within the SAP, ground based and rooftop
- biomass generation has viability, however, may not be of a scale attractive to investors
- hydrogen creation has limited viability due to the water and energy requirements to produce at scale
- the region is not suitable to other renewable energy technologies available at present.

The potential output based on estimated spaces available under the scenarios has been considered. These estimates were also considered with the wider potential near to the SAP for alternative additional renewable generation. It was found that there exists ample suitable land outside the SAP to implement additional solar PV generation but would come at the cost of valuable arable land that is currently being used for agriculture.

Based on this, the project team held a second Enquiry by Design workshop and have contemplated the final scenario that is discussed in this report. This scenario provides a green loop from the centre of the town to the SAP area as well as offering the opportunity for expanding a gas network from the proposed Santos Narrabri Gas project into the town, reducing the use of bottled gas.

To support the prospective load growth proposed by the new SAP, and to fit within the present network constraints, consideration has been given to the available technologies as follows:

- SAP Solar farm – Considers the available land within the SAP for use as a ground mounted solar farm.
- SAP Rooftop Solar – Considers the potential roof spaces that could develop based on the land use plan that could be used for roof top solar.
- Solar outside the SAP investigation area – Reviews the areas outside the SAP for consideration as additional ground mounted solar farms of a larger scale than could fit within the SAP boundary.

This report consolidates the previous investigations and outcomes of the SAP process. It aims to quantify the prospective generation potential of the available spaces within and without the SAP and relate this to the prospective load growth.

For each potential renewable generation avenue, the following was considered:

1. space usage
2. space alternate uses
3. generation capacity estimate
4. the generation solutions are considered against the increased demand estimates for the growing SAP
5. integration with the changing network.

5 Assessment and findings

The proposed structure plan focuses on the majority of the industrial developments occurring west of the Narrabri Town Centre and a new residential area to the south of the Narrabri between the Newell and Kamilaroi Highways. Stage 1 focusses on the Inland Port and growing the associated adjacent industrial area. Stage 2 focusses on the eventual growing of the heavy industry area, including the in-SAP solar farm.

The initial focus would be on rooftop solar to offset the expanding industrial area and growth in the residential spaces.

5.1 Rooftop solar

Table 2.2 outlines the land uses within and outside the SAP area. From these allocations, a building footprint can be estimated based on the type of industry identified – this ratio is different for each industry. Of the allocated land, there is an average of 32% estimated built space.

For a given building, the roof is not expected to match the area at ground level. For any given roof, not all of the roof space is suitable for installing solar panels. Depending on the building, other services might need the space or the structure may not be entirely suitable. However, it can be reasonably assumed that 25% to 50% of a given roof space is suitable considering the average roof space.

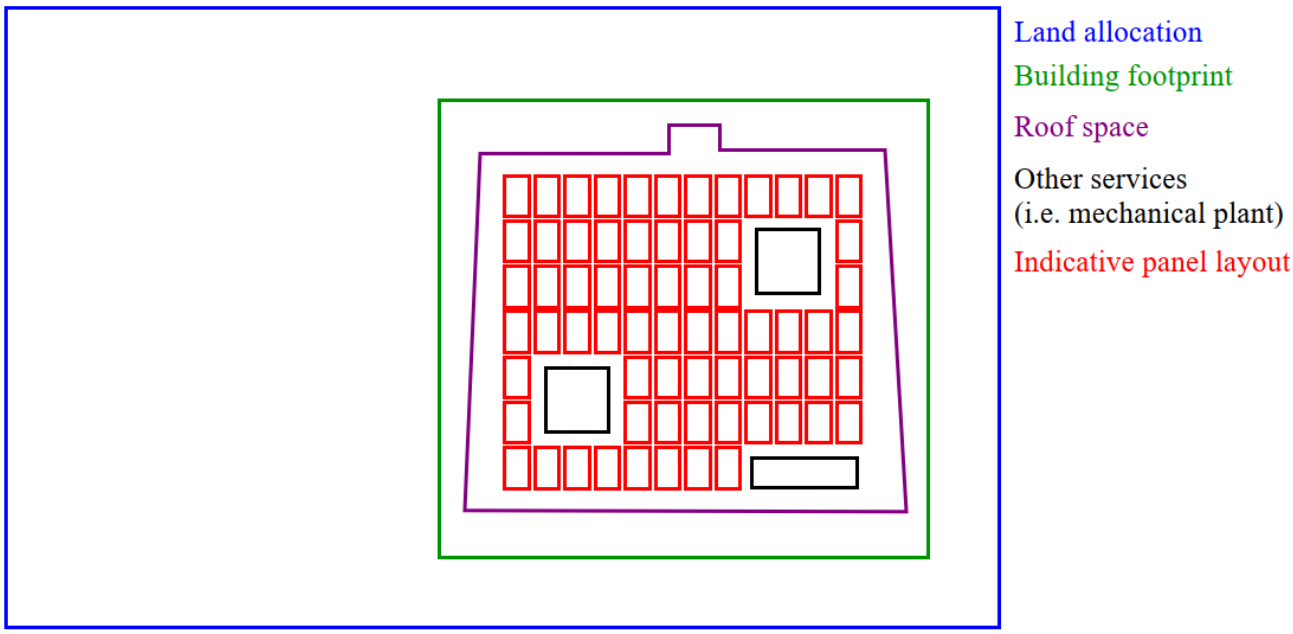


Figure 5.1 Demonstration of available rooftop space for solar PV

There are limited alternative uses for a roof which is why rooftop solar PV is a good use of the otherwise unused space. The roof of industrial buildings often is used for locating the mechanical plant and exhausts to ensure maximising internal space usage. The industries expected to develop within the SAP are not expected to differ in design and therefore will not have alternate uses for the roof space.

Because of the uncertainty of what specific industries will develop within the SAP, the generalised allocation is the extent to which this assessment is defined. This limits the accuracy of the prospective generation capacity but is the best available information for this assessment.

The remaining roof area for installation of solar PV is shown in Table 5.1 along with peak capacity and annual generation values for each of the 25% and 50% fill scenarios. Although there are potential scenarios where a limited number of roofs that are converted for solar generation is closer to 100%, these would be exceptions, not the majority.

Table 5.1 Rooftop solar generation capacity within the SAP

	25% fill			50% fill		
	Roof area (m^2)	**Capacity (MW)**	**Annual generation (MWh/year)**	**Roof area (m^2)**	**Capacity (MW)**	**Annual generation (MWh/year)**
Industrial	816,819	102	142,943	1,633,638	204	285,887
Residential	776,295	97	135,852	1,552,590	194	271,703

The Utilities Infrastructure report explores the load growth through the stages and has informed this report with respect to the values in Table 5.1. The final expected additional average load demand from the SAP is approximately 281 MW. The industrial rooftop solar can be expected to produce 70% of the demand at peak times. Depending on the industry, this may match with load usage and provide benefits to the business and the network.

Residential rooftop solar has a strong potential to offset daytime loads in the areas associated with the SAP. The expected total residential load is 70 MW – capable of being met by the lowest rill rate. However, this is only looking at the peak demand and peak output – the estimated energy consumption of the residential category is 388,147 MWh/year. Only 70% of this energy consumption can be met by the solar, the remainder of which will need to be met through the regular network supply.

A typical industrial rooftop solar installation would configure the installation to place the solar PV "behind the meter" meaning the power is used within the installation and is not placed into the network to be used by others. Some configurations could be set to "no export" which means the power meter only runs if the solar PV is not sufficient to meet the power needs of the building. This means no payment received for excess generation, but means the network needs less augmentation to cope with the excess generation.

A "behind the meter" installation would encourage businesses to install the maximum possible solar PV system to limit the amount of power purchased from the network. The "no export" arrangement works against this by providing limited benefit to oversizing the system to account for times within the day where generation is limited (early morning, late afternoon, cloudy conditions, etc.).

The introduction of batteries at bigger scale has changed this market. Having both a "behind the meter" and "no export" arrangement can be leveraged by putting excess generation into a battery and relying on the battery during generation limited times. Both the network and the user benefit from this arrangement, although it is an additional expense and requires ongoing condition monitoring.

As explored during this project, an alternative to individual businesses installing batteries, a Virtual Power Plant can be implemented within the SAP to allow trading of renewable power between heavy generators and heavy users. This does need external moderation and a third party to manage, but provides an opportunity to more widely utilise the locally generated renewable energy for the benefit of the SAP.

5.2 SAP solar farm

The space within the SAP allocated to a solar farm is 144.14 ha. This is expected to enable the construction of a 48 MW solar farm. Depending on the adjacent industries, this may be further constrained due to potential shadowing from the fertiliser and chemical space. Solar farms should be installed free of shading and away from structures that may cast shadows over the land. The layout of a solar farm on the allocated land can be optimised to make best use of the space with consideration for adjacent land use.

The allocated land has been set aside specifically for use as a solar farm within the context of the SAP. However, the land usage will always be argued as better used for alternate purposes including farming and agriculture. With the proximity to the land space assigned for Agriculture and Food processing, it would be reasonable to see suggestions that the space is incorporated into that usage instead.

With the minimal amount of generation available from the space, the inclusion of a solar farm within the SAP is not critical. Able to account for only 18% of the prospective future load and the location within the SAP, the solar farm would look to offset some of the heavy industrial applications nearby. There is limited scope to link the solar farm generation with the industries being grown in the east of the SAP and is therefore of low priority.

For a small solar farm of this nature, the impact on the electricity network is reduced compared to the larger installations planned for nearby. In this way, it would be simple to include some additional generation within the SAP. Conversely, the small solar farm may introduce complications for planned and unplanned adjacent solar farms of a larger scale. Due to the planned timeframes of the SAP solar farm relative to other projects, this is unlikely to introduce issues.

5.3 Solar farms outside the SAP

Looking outside the SAP boundary there are many opportunities for larger scale solar farms. Two are already in planning – Silverleaf, north of Narrabri and Narrabri South to the south-east of Narrabri. These two farms have been planned without consideration for the development of a SAP at Narrabri – development would have been based on generating power into the national electricity market for a profit. Due to the nature of electricity, no power generation from the two solar farm could be attributed to the SAP.

Figure 5.2 identifies some land spaces that are identified solely on their apparent suitability for the purpose – flat and already free of trees/large vegetation. As noted in Figure 5.2, there is considerable solar generation capacity in the area surrounding the SAP.

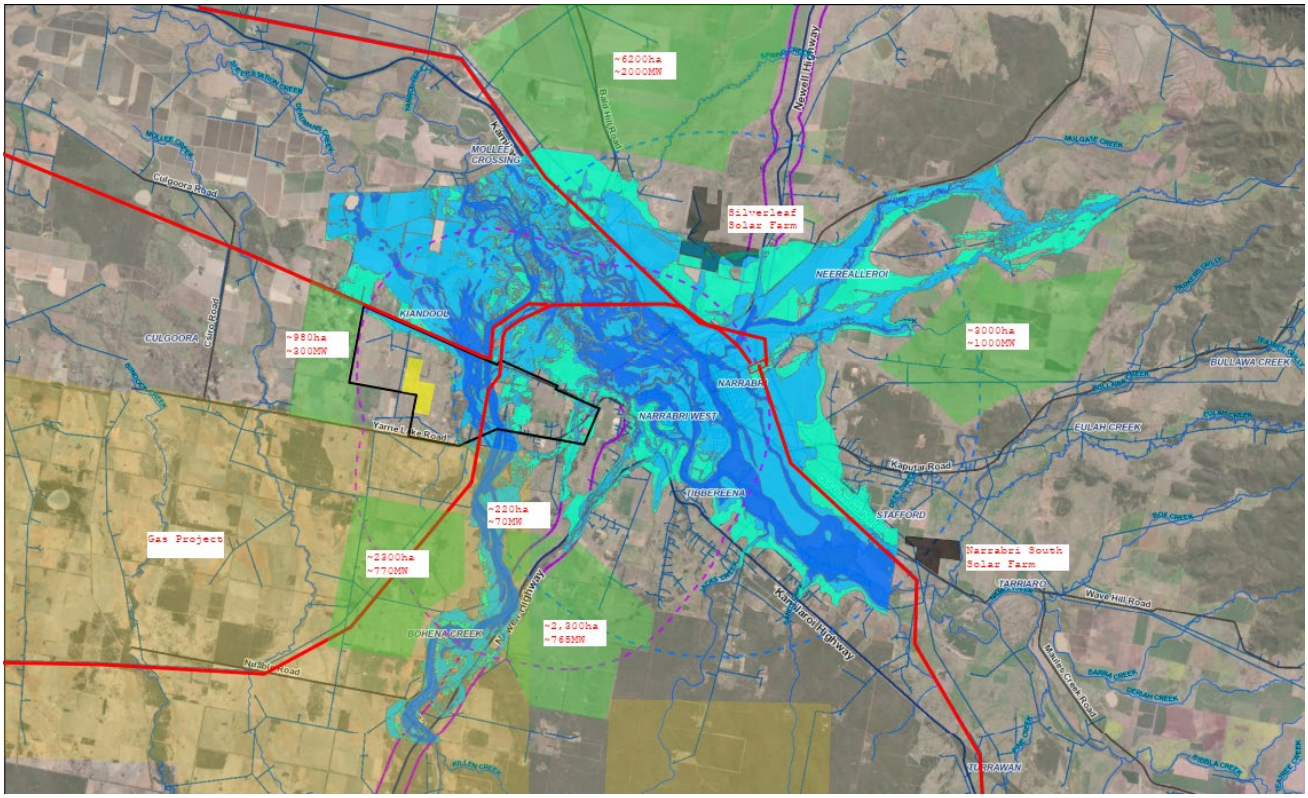


Figure 5.2 Solar farm spaces outside the SAP

As with all solar farms mounted on the ground, large areas of land must be cleared of all shade causing-structures, both organic and man-made. The clear land surrounding Narrabri is predominantly agricultural land that would be owned by independent groups. It could be argued that this land is already being used for its highest value and to change the land use would be to reduce that value.

Solar farm developers will select land that is of low cost – often due to landowners deciding to reduce the size of their holdings for the life of the prospective farm. It would be expected that if any of the spaces identified in Figure 5.2 were of low enough value to entice a solar farm developer, then the spaces would already be under development.

Some agriculture can be used in conjunction with an active solar farm. Sheep farming is suitable, however other traditional livestock is not compatible with solar farms due to the nature of the animals, either being too big or too destructive, to be viable. Crops would conceivably grow within a solar farm – grass grows prolifically around solar farms – but harvesting is complicated by the structure and, depending on the crop, there would be interference with the mechanisms from the growing plants.

No fixed estimate is presented for this component due to the large volume of land available, but not acquired, for use as a solar farm. Land acquisition should be done relative to the amount of generation required. Section 5.1 discusses the potential for rooftop solar and how much of the forecast load could be covered – 199 MW to 398 MW, depending on the average rate of conversion for rooftops.

To reduce the impact on the network, and defer augmentations at the zone substation, a solar farm outside the SAP can be sized to suit:

Table 5.2 Out of SAP solar farm sizing

	Rooftop capacity (MW)	Solar farm capacity (MW)	Solar farm land requirement (ha)
25% Roof coverage	199	82	246
50% Roof coverage	398	0	0
No rooftop solar	0	281	843

Figure 5.2 identifies multiple land options for consideration. Of these, most are big enough to provide a peak-of-day offset equivalent to the final land use plan demand estimate. The remainder could be scaled to suit the demand requirements.

The location of three of the sites are suitable for associating with the SAP to enable distribution of the renewable energy primarily into the SAP without negatively impacting the existing distribution network. This would not demonstrably provide benefit to the town. The remainder would need to feed power into the transmission network and would not directly benefit the SAP but would provide some benefit to the town. These would also require the transmission network to have completed augmentations prior to establishment.

5.4 Biomass generation

Biomass generation is not a priority within the Narrabri SAP. The land allocated for Bioproducts would be sufficient to build an estimated 40 MW generator and associated feedstock storage facilities. The location of the Bioproducts space within the SAP places it too far away from both the rail and road corridors to enable efficient transportation of feed stock to the facility.

Like all combustion-based power generation technologies, Biomass requires water. With an already heavily taxed water supply due to the planned increase in population, adding another drain on the water supply would not be a valuable use of the land.

Market sounding during the Scenario Reporting phase found that there was limited appetite from industry to establish a new Biomass generator at Narrabri. With the other limitations, there is little reason to believe this has changed.

6 Recommendations and conclusions

To reduce the burden of the new industrial areas on the distribution network, it is recommended that all new structures are encouraged to install rooftop solar for as much of the roof space as can be spared. As a benefit to the incoming business, power from the solar installation can be implemented “behind the meter” to reduce, or possibly negate, the power requirements from the network.

To improve the benefits of solar power, it is recommended that batteries should also be encouraged at the user level. Batteries can be used to capture excess power during low load times during the day, or if the generation capacity is higher than the demand. This stored power can then be used during high load times or even to provide power during times without sunshine.

Implementation of a Virtual Power Plant (VPP) is recommended if the local or state government is involved with establishing the arrangement. Establishment of a VPP has a high complexity that the incoming businesses might not be interested in developing.

Using the allocated space within the SAP as a solar farm is recommended but should be delayed closer to the establishment of the heavy industry in the same area to offset the power demands and defer the costs. If larger solar farms are planned outside the SAP, then this may not be required.

A larger solar farm adjacent to the SAP, sized to suit the SAP needs, is recommended. This has the potential to defer distribution network augmentation and provide a positive step towards a lower carbon footprint for the SAP. Other solar farms in development in the area are not to be relied on to deliver power to the SAP as they are planned for connection into the transmission network and will not be attributable to the needs of the SAP.

At the point in the future when a solar farm is to be designed, within or without the SAP, consideration should be given to advancements in solar cell technology and the continued research in this field. Research is finding now, with top-of-the-line solar panels and minimising spacing of rows, that a density of 1ha/MWp is theoretically possible. This has yet to be deployed in practical settings.

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