# YACKANDANDAH MICRO-GRID:

## - Feasibility Study

## FINAL REPORT (PUBLIC)

**RCRF 000079**


## Abstract:

This feasibility study addresses options for establishing a Yackandandah Micro-Grid to realise the community's vision to be '100% renewable'.

It describes options for establishing grid-facing (front-of-meter) solar generation combined with batteries and/or pumped hydro storage technology. The study is informed by technical studies that assess each of the solar and pumped hydro options.

The study scopes up each the options available, provides capital and operating cost/revenue estimates and addresses the financial feasibility of each.

It also provides an assessment of the broader benefits and impacts of the options in terms of greenhouse emissions and the environment. It also addresses the costs/disadvantages of each option and outlines a potential pathway forward for the community.



32 high street
yackandandah 3749

Ph: 02 6027 0777

e: mach2@yackandandah.com
www.mach2consulting.com.au



October 2021


Totally Renewable Yackandandah and Mach 2 Consulting acknowledge the Tradition Owners of the land on which we live and work. We pay our respects to their elders, past and present.

# Contents

# Executive Summary

## *Context:*

Totally Renewable Yackandandah (TRY) is a not-for-profit community-based organisation formed in 2014. TRY has set for itself the 'stretch goal' of powering Yackandandah with 100 per cent renewable energy by the year 2022.

It also aims to facilitate the introduction of new renewable energy generation and storage assets and facilities that will enable the phasing out and replacement of energy from non-renewable sources with renewable energy. Under the leadership of TRY, significant in-roads towards the 100% goal have been made by the Yackandandah community including:

- Achieved local rooftop solar penetration well above national average (57.6% [1]).
- 3 micro-grid projects (solar + battery, controller etc.) within the township.
- Installed solar panels and batteries in many public buildings.
- Implemented two highly successful hot water replacement cooperative buying programs.
- With Indigo Power, established Australia's first community-scale grid-facing solar-battery system.

## *Project Objectives:*

The objectives of this project were:

- To define and scope the optimal power solution for the Yackandandah community in the context of the stated 100% renewable energy goal.
- To accurately define and quantify what the '100%' target means in practice and to explore a target for the Yackandandah community that is both challenging and realistic.
- To identify potential sites and develop options for potential renewable energy solutions/installations.
- To define the capital/establishment costs and ongoing operating costs for each site-specific option and define the energy generation and storage capacity of each, including the extent to which it will realise the defined 100% renewable goal.
- To assess the financial viability of each option, together with the environmental impact in terms of each option's impact on Yackandandah's greenhouse emissions and carbon footprint.
- To address potential community ownership models for the options identified.
- To develop a pathway for the community that will enable Yackandandah to realise its stated 100% renewable energy goal.

## *Methodology:*

The project was conducted by the consultants and closely overseen by a TRY-appointed Project Control Group (PCG). The methodology for this project included the following steps:

1. Demand/consumption and local generation analysis and baseline definition.
2. Site identification, assessment and land-holder liaison.
3. Options definition for selected sites/options, including technical studies, project scoping and costing.
4. Feasibility assessment (including ROI, LCOE and NPV assessments).
5. Assessment of environmental and other costs/benefits of options ('islandability', emissions reductions etc.)
6. Report preparation.

[1] University of NSW, Solar Penetration Data, 2020

### *Community Engagement – Local Appetite for Renewables:*

- The engagement process undertaken with this feasibility study confirms that the Yackandandah community is highly engaged with renewable energy as an idea and aspiration.
- TRY enjoys broad-based trust within the Yackandandah community.
- There are legitimate concerns within the community about the possible impacts that renewable energy projects and installations may have on the landscape and on the visual amenity and aesthetics of the area. There are also concerns (and mixed views) about the need to protect the high quality rural land in and around Yackandandah.
- Most people in the Yackandandah community are likely to engage positively with renewable energy initiatives as long as they are <u>engaged</u> by trusted community-based parties (such as TRY and Indigo Power).

### *National Demand/Consumption*

- Electricity demand across the NEM is growing. AEMO estimates that about 31.3% of total electricity generated in the NEM in 2021 is from renewable sources.
- The renewable energy component/share of power generated in the NEM grid grew by an average of 15.1% over each of the past 2 years. It is expected to continue to grow in future years.

### *Yackandandah Demand/Consumption:*

- Yackandandah's average electrical load across the whole year (24/7) is about 1.726MW. It has a peak load of about 3.071MW and uses about 15,606 MWh of electricity per year.
- Of total use, about 35%, comes from solar PV generated on rooftops. That's relatively high compared to other places across Australia as Yackandandah has 57.6% of households with rooftop solar.
- But despite high rooftop solar take-up, the total power Yackandandah consumes/uses still grew by an average of 5.4% in each year over the past 3 years. This indicates that Yackandandah's rate of increase in electricity consumption compared to Australia generally is relatively high.
- The increase in consumption in Yackandandah is mostly driven by local building development and population growth. It may also be driven, in part, by an increased tendency to consume electricity (and /or to acquire electricity consuming consumer products).
- Rooftop PV generation in Yack has grown by over 14% each year for the past 3 years. This is due to cheaper solar PV costs, increased generation yields, increased average system size and increased community take-up. The average size of a rooftop solar PV system in Australia is now over 8kW.

### *100% Renewable Target:*

- The achievement of a <u>100% net renewable energy target</u> by Yackandandah is realistic and achievable by the mid-to-late 2020s. However, it does not appear possible or realistic to achieve this by 2022.
- Achieving a <u>100% gross renewable target</u> for Yackandandah is extremely challenging. It is unlikely to be realistic within the timeframe of this feasibility study (30 years) without the installation of significant new generation (wind, solar and back-up motorised generation) and storage assets well beyond those contemplated in the options in this study
- If Yackandandah continues on as it is currently going and relies just on 'organic' behind-the-meter solar PV growth, it will achieve 100% net renewable by 2027.

*Limited Site Options Around Yackandandah:*

- The relatively small scale landholdings/higher density land use in the Yackandandah Valley, combined with the high quality of productive agricultural land, conspire to make it more difficult to find local sites suitable for renewable energy installations.
- This is compounded by the need to recognise widely-held community concerns about the visual and aesthetic impacts.
- These factors mean the opportunity cost of using local land for renewable energy purposes is relatively high in Yackandandah and suitable sites with sufficient space are very hard to find.

*'Islandability':*

- 'Islandability means being able to 'turn off the switch' somewhere along the main feeder line coming into Yackandandah and continuing to operate a fully charged grid on this side of it.
- The goal of Yackandandah being capable of being 'islandable' in a grid shut-down situation is a complex. It is tied up in a range of governance, accountability, policy, regulatory and community safety / compliance issues.
- If Yackandandah aspires to be a fully islandable sub-grid, it would need to install grid-facing back-up diesel generation capacity to meet extended low solar generation periods.

*'Scale Economies' for Grid-Facing Renewable Projects:*

- The five core options (on four sites) considered for this feasibility study could generally be considered to be smaller/'community-scale' grid-facing (or front-of-meter) assets. Considering these options, it is clear that significant economies of scale apply in the establishment of grid-facing renewable energy installations.
- These scale economies mean that the larger the installation, the cheaper it is likely to be on a $/MW basis. These economies of scale are particularly evident with pumped hydro storage schemes (compared to batteries and PV solar systems).
- These scale economies are substantially associated with the 'flag-fall'-type establishment costs of getting access to and onto a suitable site for even a smaller grid-facing facility.
- Further, most options considered for this study require significant up-front investment in grid upgrades (estimates for these works were provided by the DNSP AusNet Services).

*Financial Merit/Considerations:*

- On a LCOE basis, the predicted life-cycle costs of energy produced by each of the five options is relatively expensive. In a climate emergency context, this does not mean these options should not be considered. However, it does suggest that thought should be given to other options available to achieve Yackandandah's goal of being 100% renewable (ie; behind-the-meter options with similar or comparable outcomes).
- Further, the NPV of each of the options is significantly negative. The NPVs for the five options considered range from (-$5.0 mil.) to (-$16.0 mil.). This is significant.
- A negative NPV means that, prima-facie, the investment proposition is not worthy of being pursued, based on financial outcomes alone.
- In the consultant's opinion, the key contributing factors for the lack of financial viability of the options assessed in the study (on an NPV basis) are:
    a) The relatively high capital costs (on a $/MW basis) for each of the options assessed;
    b) The currently low (and potentially declining) wholesale 'spot' electricity prices;
    c) The predicted reducing role/prices of LGCs as a long-term revenue stream; and
    d) The volatility and uncertainty that appears to apply to FCAS as a reliable long-term revenue stream.

- On this basis, (and in the absence of majority external/grant capital funding support), there would need to be a significant increase in the wholesale price of electricity in the future in order for any of the options addressed in this study to be considered financially feasible.
- All of the above financial analysis and conclusions is done through the specific 'lens' of financial /investment merit only. Whilst important metrics to consider, the options addressed in this study **ought not be assessed** solely through the narrow confines of this prism alone.
- In practice, this means that a local community-scale grid facing generation-storage asset in Yackandandah will need substantial grant funding support (in the order of $5-8 million minimum) in order to be viable (depending on project scope).

*Greenhouse Emissions/Environmental Impact:*

- The options considered for this study are estimated to result in significant emissions savings of 51,000 to 157,000 tonnes of $CO_2$ equivalent over the assessed 16 year timeframe (assuming a 100% renewable energy NEM by 2040).
- This equates to about 42 to 132 tonnes saved/reduced for each current household in Yackandandah.

*Value for Money - Behind-the-Meter Options:*

- Given the above financial assessment of the grid-facing options assessed in this study, there is significant merit in considering other ways of achieving the same (or similar) renewable energy and emergency resilience outcomes for Yackandandah.
- A comprehensive package of behind-the meter options that can deliver similar energy, greenhouse gas emission reductions and community energy resilience outcomes should be developed.
- In addition, exploration of potential sites for and the scope of a grid-facing installation (or installations) should also be continued.

*Community Ownership Pathways/Models:*

- Local community ownership can play an important role in bringing renewable energy projects to fruition and may be considered as part of a future community-scale/grid-facing project. However, of itself, it is not considered to be an essential component or goal of renewable energy projects where they are able to proceed with commercial investment.
- In this case, TRY is the local, trusted organisation to lead, facilitate and engage in relation to such a project.
- In terms of the project development, ownership and operations roles, Indigo Power Ltd., is considered the most appropriate local partner for this. However, this role is likely to be exercised in partnership/joint venture arrangement with another suitably experienced/capable renewable energy organisation.

*Ongoing Option Analysis and Assessment:*

- The process of option development and analysis continues for TRY and the community beyond this study. At the time of issue of this report, further options continue to be addressed and analysed.

### *Recommendations:*

Our recommendations are:

a) That Yackandandah pursue a strategic direction involving a package of bespoke, multi-dimensional behind-the-meter initiatives, including:
   - energy consumption/demand efficiency/reduction programs (including a resistive hot water service replacement program);
   - targeted/strategic community facility-based BTM generation/storage capacity building; and
   - a 'top-up' community subsidy scheme to encourage BTM generation and storage take-up.

b) That the exploration of potential installations and sites in and around Yackandandah (including smaller solar/battery sites at the North East Water site, Allan's Flat site and other identified potential sites) for the establishment of grid-facing solar/ battery assets be continued. As part of this, investigations should be undertaken into options and possible funding opportunities for the inclusion of grid-facing back-up motorised generators to improve emergency resilience.

c) That the scoping and investigative processes (including refinement/ 'right-sizing' of the project scope parameters) for the establishment of an appropriately scaled, generation and storage 'Community Renewable Energy Park' on the Leneva site be continued in association with Indigo Power Ltd., the landowners, the DNSP and other potential project partners.

d) That the exploration of the structure and governance/accountability/communication protocols and arrangements that would need to apply to enable Yackandandah to be islanded under a future grid shutdown scenario continue with AusNet Services.

# 1. Introduction and Context

## 1.1 About Totally Renewable Yackandandah ('TRY')

Totally Renewable Yackandandah (TRY) is a not-for-profit community-based organisation. It was formed in early 2014 by a group of residents after a community energy forum was held in Yackandandah. Since then, TRY has been a very active organisation in Yackandandah, with its initiatives and vision being widely embraced by the local community. It has been a vehicle for community members who are passionate about sustainability and renewable energy to come together and act in response to the current climate emergency.

When it was formed, TRY set for itself the challenging 'stretch goal' of powering Yackandandah with 100 per cent renewable energy by the year 2022.

To achieve this goal, TRY has worked tirelessly with organisations, governments, businesses, individuals and energy stakeholders in the community. It seeks to first reduce overall energy consumption and improve energy efficiency. Secondly, it aims to enable and facilitate the introduction of new renewable energy generation and storage assets and facilities (both behind-the-meter and front-of-meter) in the community that will enable the phasing out and ultimately replacement of energy from non-renewable sources with renewable energy.

TRY is committed to working alongside the local community to implement its strategies. It envisions its work will strengthen community cohesion and resilience and this aspect has become a core part of its place in Yackandandah.

## 1.2 Progress to Date

With the leadership and advocacy of TRY, significant in-roads towards the 100% goal have been made by the Yackandandah community to date. A key plank in the approach employed by TRY has been to partner with other existing community organisations. This partnering approach has been used from the very start/initiation stage of ideas, through to the funding and implementation of projects and programs. Key projects and achievements of TRY to date include:

- ✓ Achieved local rooftop solar penetration well above national average (57.6% [2]).
- ✓ Established 3 micro-grid projects (solar + battery, controller etc.) within the township.
- ✓ Installed solar panels and batteries in public buildings.
- ✓ Implemented two highly successful hot water replacement cooperative buying programs.
- ✓ With Indigo Power, established Australia's first community-scale grid-facing solar-battery system (274 kWh battery with behind-the-meter 65 kW rooftop solar) on the 'Agency of Sculpture' workshop within the township.
- ✓ Established a widely-embraced community culture in Yackandandah that renewable energy is the way of the future.
- ✓ Taken a lead role in and participated in the incorporation of a new social enterprise (Indigo Power Ltd) to become a local/regional vehicle for retail operations in this region (and potentially future generation/storage operations).

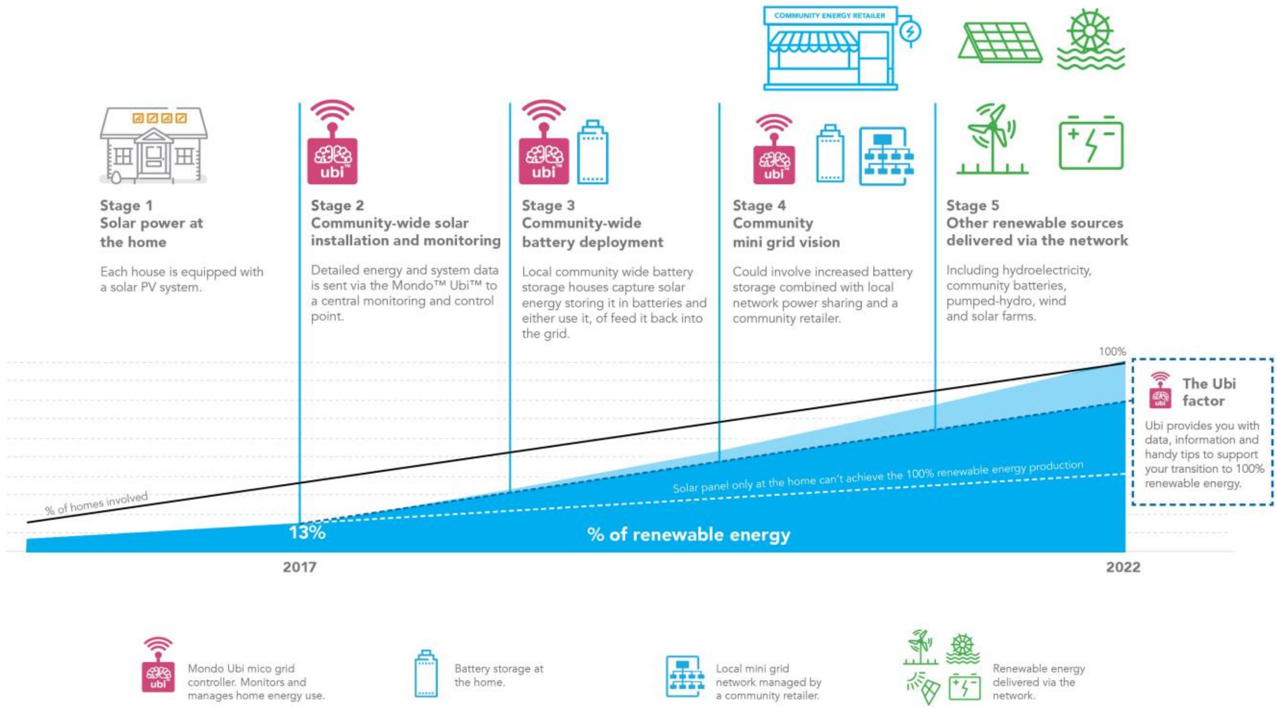
TRY has also partnered with Mondo (a commercial subsidiary/arm of AusNet Services) to develop and implement a five-stage roadmap to achieve a Community Mini Grid to help achieve the 100% goal. TRY is currently working with Indigo Power Ltd., Indigo Shire Council and Yackandandah Community Development Co Ltd. to install an electric vehicle charge station.

## 1.3 TRY's Five Stage Plan

TRY, with the input and assistance of Mondo, developed a five stage Plan for how it was going to approach the challenge of becoming 100% renewable.

[2] University of NSW, Solar Penetration Data, 2020

The TRY five stage Plan is illustrated below:




This five stage plan acknowledged that the early phase of change would be focused on domestic/behind-the-meter solar and efficiency measures. The latter stages were expected to move into the mini/micro-grid initiatives and with community scale grid-facing generation and storage solutions, together with continued behind-the-meter generation, storage and energy efficiency initiatives.

Having established Yackandandah as a national leader and benchmark in renewable energy, the realisation of the challenging 100% goal has become incrementally more difficult with the passing of each year.

# 2. Problem Definition and Objectives

## 2.1 Problem Definition – A 'Climate Emergency'

The core problem is that there is a **global climate emergency** and Yackandandah is part of it. The climate emergency is widely recognised globally by a vast majority of the scientific community, research bodies and by many, though not all, governments. Those recognising the climate emergency includes the local Indigo Shire Council. [3].

However, every day, Yackandandah still imports most of the electricity it uses via the National Electricity Grid (see demand analysis later in report). Whilst the amount of local behind-the-meter (rooftop) generation in Yackandandah is nationally significant (and continues to grow at a significant rate), the community's local generation capability remains concentrated on solar during the daylight hours.

The current amount of renewable electricity generated from rooftop solar in Yackandandah is still relatively small (about 35%) compared to the total electricity used. Further, there are presently limited means of storing this energy for after-hours (evening peak) use. The recently commissioned 'Yack 01' solar battery system has a 274 kWh capacity (65kW solar generation). That's enough for about 20 homes but still well short of what Yackandandah needs.

[3] Indigo Shire Council, Ordinary Meeting Minutes, 30 July 2019

Further, the community of Yackandandah has limited control over the source of the imported electricity currently used (about 65% of total use) other than to choose to buy 'green power' through retail purchase choices. It is also known, from information in the public domain (AEMO and the Clean Energy Council), that most of the electricity imported into Yackandandah is generated from non-renewable (coal and gas-fired) sources and therefore has a damaging effect on the environment.

Another part of the problem is the extent to which Yackandandah relies on the National electricity grid for its energy needs, especially in times of emergency. When the electricity grid fails, many aspects of the Yackandandah community health and safety, as well as day-to-day convenience, are disadvantaged. Further, the community's ability to respond in emergency situations, such as storms and fires, is constrained by its being so reliant of the electricity grid.

So, the goal is to take more tangible control of the environmental impact/'footprint' of the town's collective lifestyle and take meaningful measures to reduce local carbon emissions. Yackandandah also wants to improve its energy self-sufficiency and emergency response capability and resilience so the community can continue to function and deal with crises as and when they arise.

To do this, Yackandandah needs to:

1. Find ways to exercise more tangible and direct control over the energy the community uses and where it comes from.
2. Generate much more renewable energy locally.
3. Build more capacity to store energy locally and 'time-shift' its use from day to peak/evening time.
4. Develop mechanisms to respond quickly and effectively to grid shutdowns and provide sufficient energy for the community to respond and continue to function during emergency situations.

## 2.2 Study Objectives

In the above context, the objectives of this feasibility study are:

- ✓ To define and scope the optimal power solution for the Yackandandah community in the context of the stated 100% renewable energy goal.
- ✓ To accurately define and quantify what the '100%' target means in practice and to explore a target for the Yackandandah community that is both challenging and realistic.
- ✓ To identify potential sites and develop options for potential renewable energy solutions/installations, including possible site identification/assessment, and landholder liaison/negotiations.
- ✓ To define the capital/establishment costs and ongoing operating costs for each site-specific option and define the energy generation and storage capacity of each, including the extent to which it will realise the defined 100% renewable goal.
- ✓ To assess the financial viability of each option, together with the environmental impact in terms of each option's impact on Yackandandah's greenhouse emissions and carbon footprint.
- ✓ To address potential community ownership models for the options identified.
- ✓ To develop a pathway for the community that will enable Yackandandah to realise its stated 100% renewable energy goal.

The financial feasibility of the options has been addressed in commercial terms by calculating the Net Present Value (NPV) and the Levelised Cost of Energy (LCOE) for each option.

Using these measures, the study will address the extent to which the options studied are commercially viable and/or represent good value-for-money or not. In this regard, the 'financial viability gap' of options is also identified.

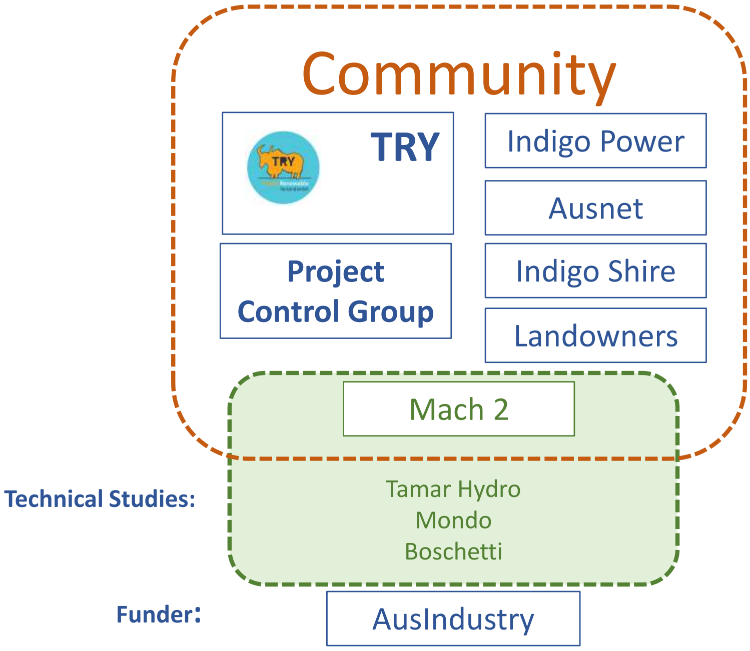
### 2.3 The 2022 Timeframe

This project represents the means through which the Yackandandah community can **meaningfully address** its goal to be powered by 100% renewable energy by 2022. This statement acknowledges that, in reality, it is unlikely that the various types of renewable energy (grid-facing generation and storage) assets of the scale contemplated in this study will be ready to be operational by the end of the 2022 calendar year.

# 3. Project Structure, Scope and Methodology

### 3.1 Project Structure

This project has been established with the community of Yackandandah as the focal point. Recognising this, the project has been managed with an engagement process with the community (led by TRY) continuing throughout. The following illustrates how the project has been set up and the various project stakeholders:




Under this model, TRY established a Project Control Group to oversee and manage all aspects of the project on its behalf. Membership of the Project Control Group included three TRY Committee members and the Mach 2 Consulting team. Meetings were held regularly (fortnightly to three weekly) throughout the project duration.

Mach 2 Consulting directly project-managed and provided overall direction for the feasibility study. This included the scoping and briefing of technical studies for specific aspects of the project by the relevant technical consultants. Mach 2's role was also to take the outcome of the various technical studies, together with the outcomes of the site assessment and landholder liaison, to develop and mould a group of the best options available. The choice of the options pursued/assessed was undertaken through the Project Control Group. Mach 2 also undertook the detailed energy consumption modelling for Yackandandah using base data provided by the distribution network operator (AusNet Services). Mach 2 also used the outcomes of the technical scoping work and project costings to undertake the financial feasibility assessment that forms the core of this report.

Widespread engagement has occurred with this study as the project options developed within it are site specific (as opposed to desk-top/ generic or benchmark based). Engaged regarding the reports, the options and future directions also continues on.

The community engagement process was led directly by TRY and TRY committee members (with the input, advice and participation of the Mach 2 Consulting team).

## 3.2 Methodology

The following is a high-level summary of the methodology that has been applied for this feasibility study:

**1. Inception/ Establishment**
- Project Control Group set up
- Finalise approach/timing
- Roles/communication etc.

**2. Analyse Demand/ Consumption**
- Modelling of current electricity demand/consumption
- Estimation of local solar generation
- Assumptions regarding future usage/consumption patterns/changes

**3. Site Identification/ Assessment**
- identify potential sites (solar/battery & pumped hydro)
- Public invitation for site EOIs from community
- Assess/shortlist sites (solar/battery & pumped hydro)
- Selection of preferred sites for feasibility study
- Community Engagement Round 1 ('Spring Conversation', listening posts, postcards, Facebook etc.)

**4. Technical Studies/ Option Costings**
- Commissioning of technical scoping studies
- Estimation of capital and operating costs for each option

**5. Production/ Financial modelling**
- Develop energy production / financial model
- Assess impact of each option on Yackandandah's 100% Renewable Goal
- Financial feasibility assessment of options (based on Net Present Value etc.)

**6. Identification of Preferred Direction /Pathway Forward**
- Consider costs/benefits and merits of each option
- Identify preferred direction/pathway forward
- Draft Report

**REPORT**
- Community engagement on options/pathway
  - Focus Groups
  - Community group discussions
  - interviews
  - social media/web media
- Prepare report and recommendations

**TIMING:** July 2020, Sept 2020, Feb 2021, Oct 2021

**ENGAGEMENT:**

## 3.3 Scope Boundaries/Limitations

This study has been established to address a tightly scoped range of options based on known and established technologies. The generation and energy storage technologies addressed include solar generation with battery storage and/or pumped hydro storage assets. Whilst numerous other potential and emergent technologies are known to exist (ie; hydrogen, compressed air, $CO_2$ storage etc.), these have not been addressed as they were not within the scope of the study.

The rationale for this was that it was decided, for this study, to focus on what was realistically possible/feasible for Yackandandah using well-established/mainstream technologies. The potential to include a component of wind generation in a future solution for Yackandandah is recognised as an established and mainstream option.

However, wind generation as an option has been addressed in this report in a summary manner only. This is because the feasibility study, when initially conceived (at funding application stage), did not contemplate that wind generation was likely to be a realistic option in the Yackandandah area, given its general perception as being a 'low wind area'. As a result, the final funded project scope did not include any budget allowance to address the technical feasibility of possible wind generation sites. It is also noted that the assessment of wind resource on any particular site (from a commercial perspective) takes longer (at least 12-18 months) and is more costly than, say, solar resource assessment.

It should also be noted that this study was clearly focused on addressing front-of-meter/grid-facing options. Consideration of demand/consumption-side and energy demand reduction/efficiency measures was not included as part of the scope of this study. Similarly, the exploration of behind-the-meter options to reach 100% renewable was not within the scope of the study. The reason it was excluded was that, locally, TRY was already deeply involved in various BTM micro-grid trials and significant learnings were already forthcoming from these activities. As a result, it was decided to focus the effort and budget of the current feasibility study on grid-facing generation and storage options.

Despite this, consumption/efficiency measures and behind-the-meter options are both discussed and addressed but only in a summary/contextual manner.

# 4. Demand /Consumption Analysis

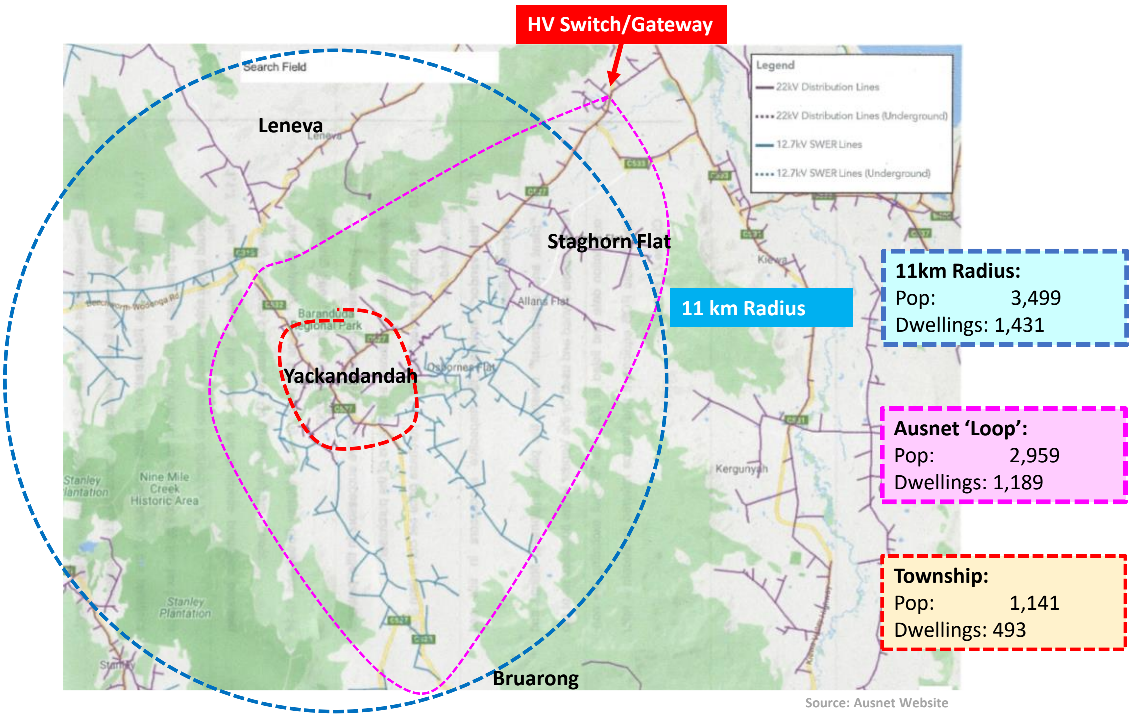
## 4.1 Methodology- Baseline Data

The baseline data accessed for this study from AusNet Services was interval data for electricity moved (at 15 minute intervals) through the High Voltage (HV) switch located on the Yackandandah Road at Patrice Vale (grid ref: 36°13'10.8"S/146°57'15.4"E). However, this data only represents a part of the local energy consumption picture. This is because a significant amount or electricity consumed in Yackandandah is self-generated (mostly from roof-top solar installations). So, the methodology applied for this project was to calculate total consumption as follows:

**IMPORTED ELECTRICITY** (Per AusNet interval data) **+** **LOCAL YACKANDANDAH SOLAR GENERATION** (Per PV generation estimate) **=** **TOTAL: LOCAL YACKANDANDAH CONSUMPTION**

## 4.2 Target Area/Analysis 'Footprint'

As stated, the first task in this project was to define the quantum of energy that Yackandandah **currently** consumes. This provides a baseline to estimate how much energy will be needed in the future. To establish the baseline, it was necessary to define the geographic 'footprint' for this analysis. The map below shows the Yackandandah valley/region and the existing AusNet Services electricity distribution grid.



Source: Ausnet Website

The map shows (in red) the location of the HV switch at Patrice Vale. This switch is where all AusNet data for imported electricity into the Yackandandah Valley was taken, feeding into the various 22kV and 12.7kV SWER distribution lines (also shown on the map).

Overlaid on this map are three areas that are relevant to this feasibility study (together with the estimated population and number of dwellings within each):

- The general target/focus area for TRY (for communication, advocacy and general initiatives) [BLUE line]
- The Yackandandah Valley AusNet 'loop' defined by the actual properties connected to the 22kV /12.7kV SWER distribution lines [PINK line]; and
- The Yackandandah Township area- the estimated number of properties within the general immediate township area [RED line].

The technical and demand/consumption analysis undertaken for the purposes of this feasibility study have focused mostly on electricity consumption in the AusNet 'loop' (PINK LINE) area. The reason for this is that it was considered the best-reflection of the wider Yackandandah community (in terms of its identity and engagement with Yackandandah) that also had a directly measurable electricity use/consumption data source (ie; it didn't require assumption-based extrapolation).

## 4.3 Current Demand/Consumption

The following table shows the total amount of electricity **imported** into the Yackandandah AusNet 'loop' and **locally-generated** energy for the past three years:

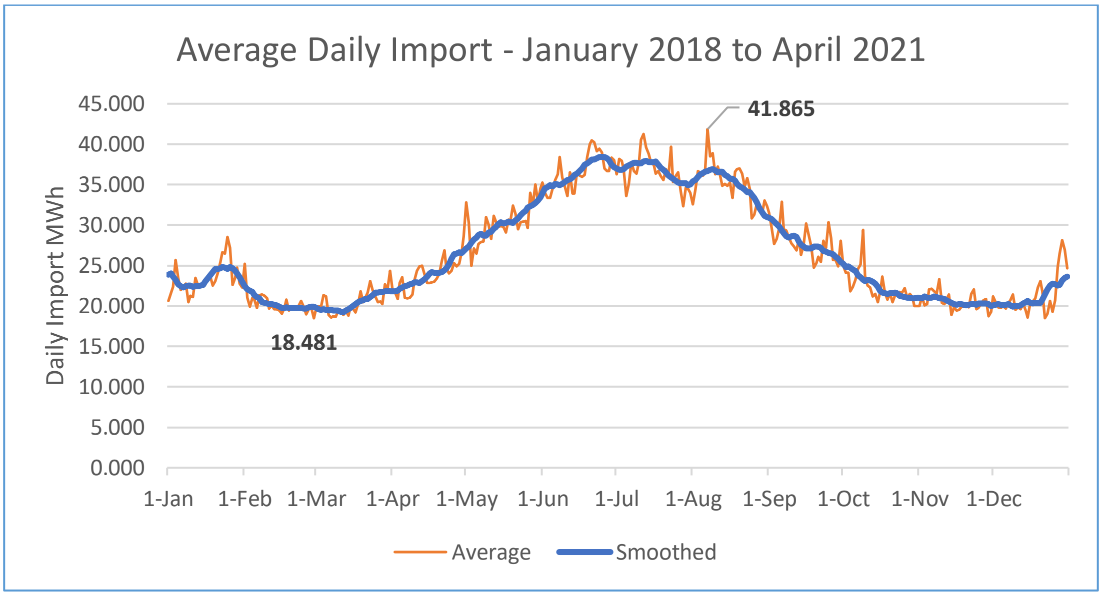
| Patrice Vale HV switch * | 2018 | 2019 | 2020 | 2021 Forecast | % Increase 2020-2021 |
|---|---|---|---|---|---|
| | MWh | MWh | MWh | MWh | |
| Imported electricity (actual [1]) | 9,525 | 9,699 | 9,963 | 10,083 | 1.20% |
| Self-generated (rooftop solar- est. [2]) | 3,577 | 4,068 | 4,673 | 5,524 | 18.21% |
| TOTAL DEMAND/CONSUMPTION: | 13,102 | 13,767 | 14,636 | 15,607 | 6.63% |
| Ave per day (MWh) | 35.90 | 37.72 | 40.10 | 42.76 | |
| Increase -Total Demand (Y-on-Y) | | 5.07% | 6.31% | 6.63% | |

1. AusNet interval data (January 1918 to April 2021)
2. UNSW Solar Penetration Data (2020) and APVI data

### *Imported Electricity:*

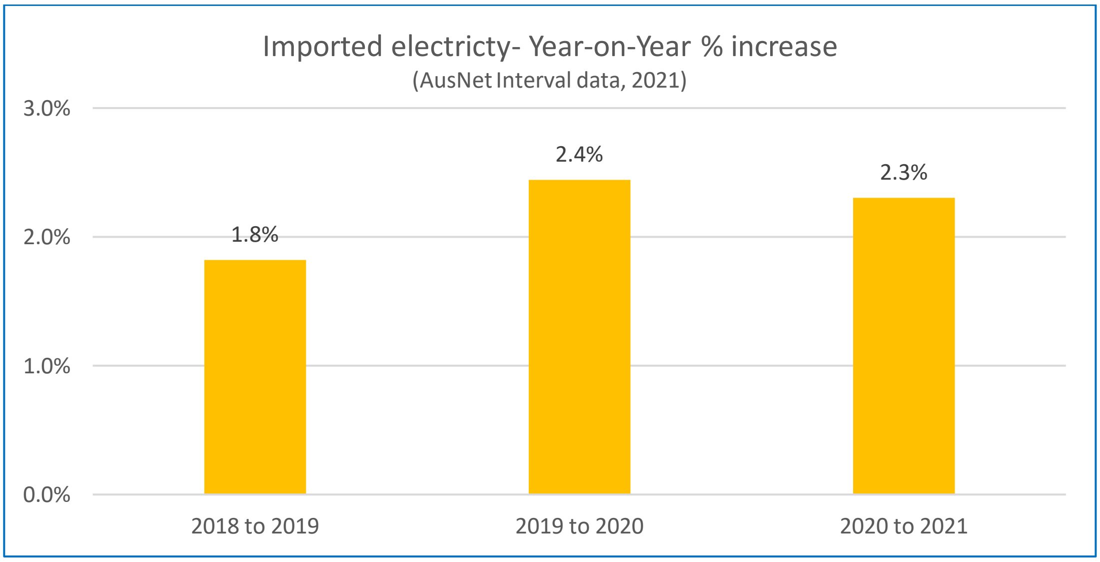
The chart below shows an annual profile of average daily electricity imported through the Patrice Vale HV switch from January 2018 to April 2021.

This shows that Yackandandah's daily electricity import is highest during the winter months and lowest during spring and autumn. Imports peaked at 41.865 MWh (August) and were lowest at 18.481 MWh in March.



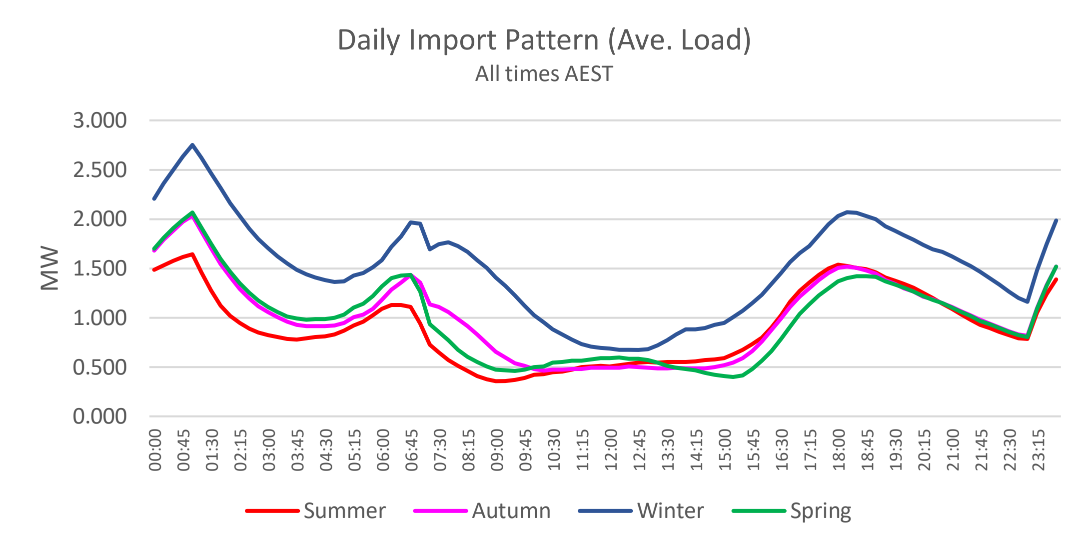

(NB: Above chart excludes local electricity generation)

The chart below shows the year-on-year growth rate of **imported** electricity into the Yackandandah AusNet 'loop' over the past three years:




The key fact that emerges from the above year-on-year increases in imported power is that, despite the high and rapid take-up of rooftop solar power in Yackandandah (which are not included in the above figures), the amount imported from the NEM is still growing at a significant rate. This growth is mostly driven by local development growth and an increase in the number of dwellings (see section 4.4).

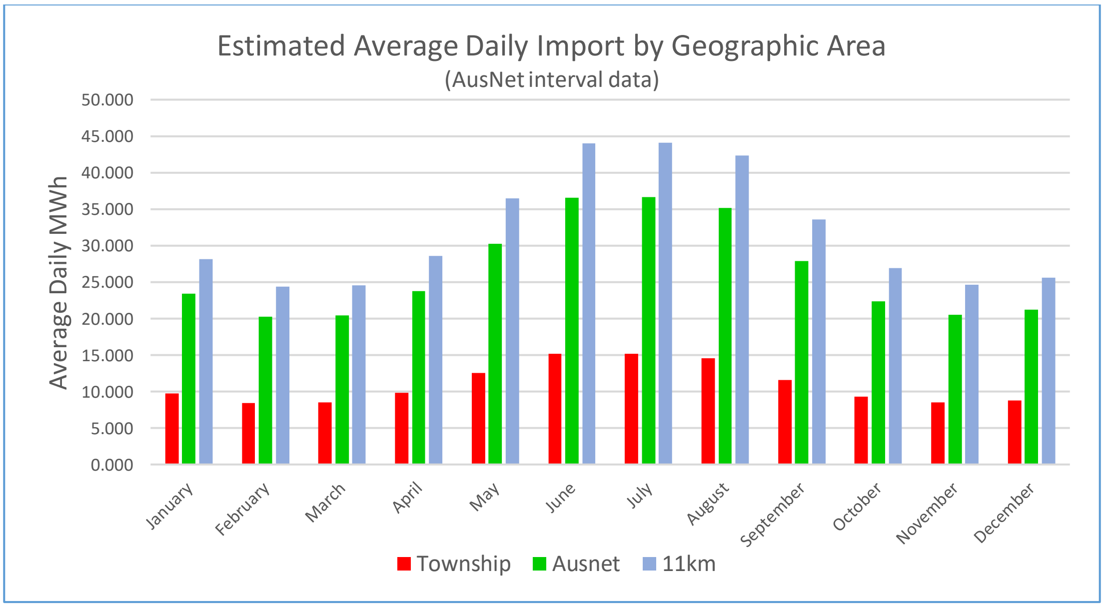
The chart below shows the average daily profile for electricity imported into Yackandandah (by season) over the past three years:




The daily electricity import pattern shows three daily import peaks:

- 1.00 AM - Hot water off-peak kicks in;
- 6.00 AM to 7.00 AM- morning consumption peak; and
- 5.00 PM to 9.00 PM – evening consumption peak.

The chart below show the estimated average daily import of electricity (by month) for each of the three geographic areas in the target 'footprint' area for this study:

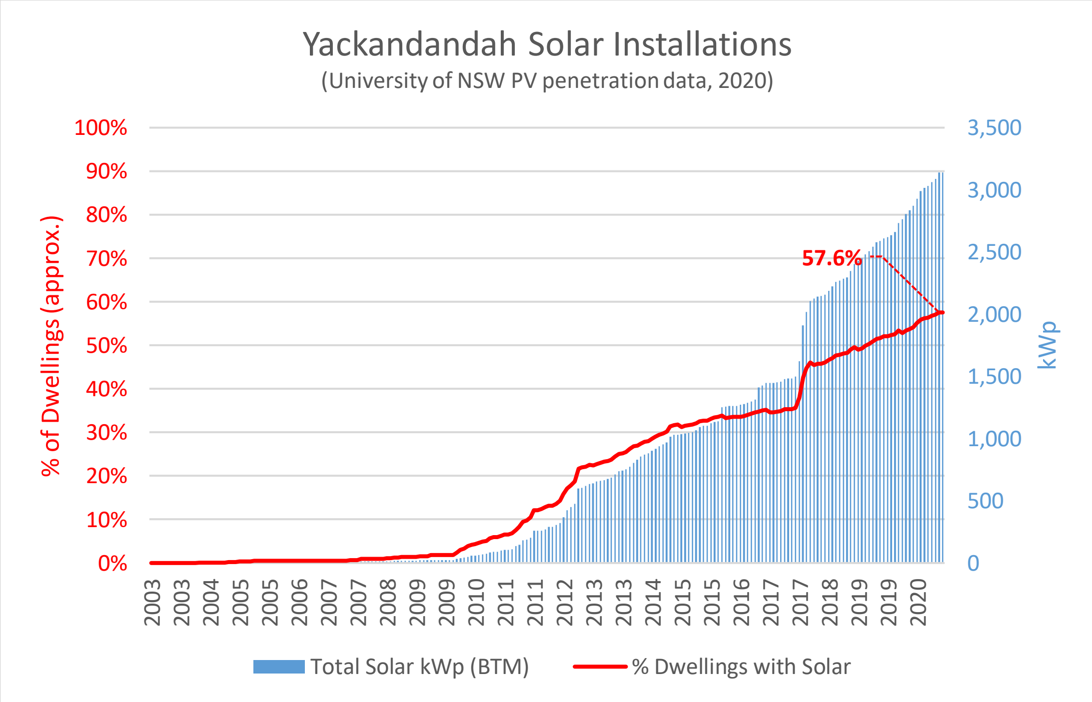



### *Interval Data Accuracy:*

It is noted that the original interval data provided by AusNet Services to TRY to inform this study was incorrect. This error was discovered about half-way through the project. The analysis in this report is based on the corrected data that was subsequently supplied by AusNet. This error had no impact on the choice of options for this study or their scoping and assessment. It had limited impact on the scope of inquiry undertaken and no impact of the contents of this report, the outcomes or findings.

### *Yackandandah Solar Generation:*

The level of solar generation within the Yackandandah area has been estimated based on generic photovoltaic data sourced from the Australian Photovoltaic Institute (APVI). In addition, rooftop PV penetration data by geographic area (locality) provided by the University of NSW has been sourced to inform the study. In addition, actual PV generation data (by property) within the Yackandandah valley catchment has been sourced from the distribution network operator AusNet Services. Together, these data sources have provided a basis for a reasonable estimate of the current level of solar generation within the Yackandandah AusNet 'loop'.




Based on PV Penetration data provided by the University of NSW, it is estimated that there are currently approximately 57.6% of households in Yackandandah with rooftop solar installations. Many of these were established in the early phase of subsidised installation (with a guaranteed 66c/kWh feed-in tariff and the maximum installations size was capped at a relatively small scale of 1.5 kWp).

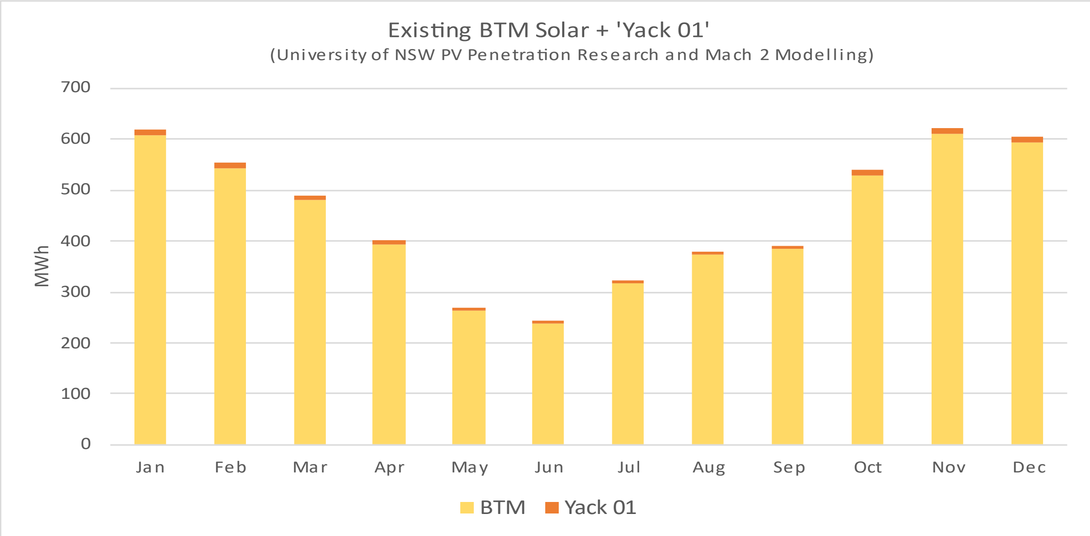
So, there are many household installations that remain at a relatively small scale. Many are expected to remain small until the expiry of the 66c/kWh feed-in tariff which will happen in 2024.

Taking account of all known factors, it is estimated that the existing Behind-the-Meter (BTM) rooftop solar installations (excluding estimated new BTM installations in 2021 but excluding Yack 01) in Yackandandah generate 5,486 MWh of electricity annually. That is an average of 15.03 MWh daily.

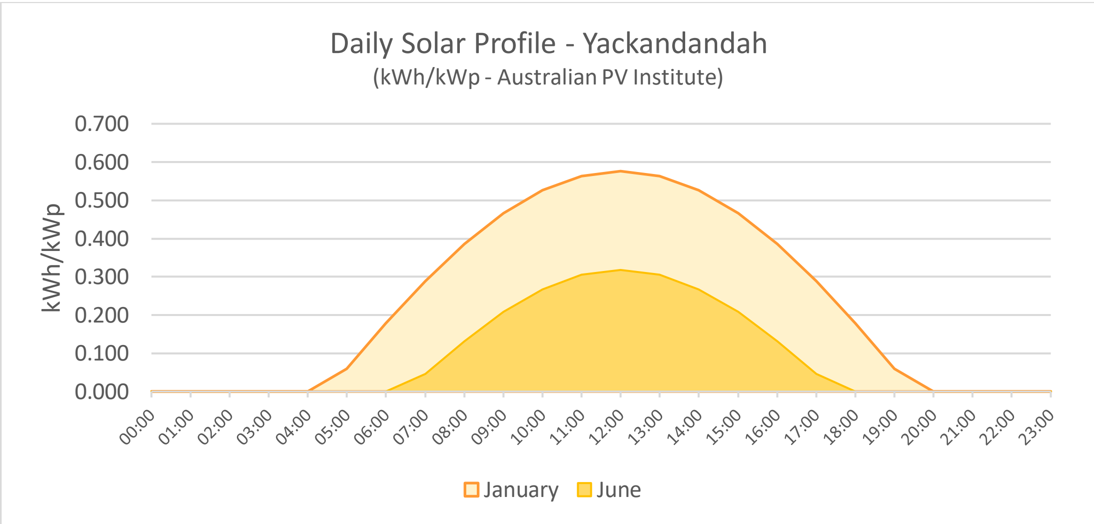
In addition, the recently commissioned **'Yack 01'** solar/battery facility established on the 'Agency of Sculpture' workshop in Back Creek Road is expected to generate about 96.78 MWh per annum (0.265 MWh daily on average). Recently commissioned, it will represent approximately 1.73% of total local power generation in Yackandandah.

The combined total of current Yackandandah solar production (including BTM rooftop and the new 'Yack 01' facility) will be 5,524 MWh in 2021 (assuming 'Yack 01' commences full operations from 1 September).

The assumed annual/monthly profile of the existing local generation is illustrated below:



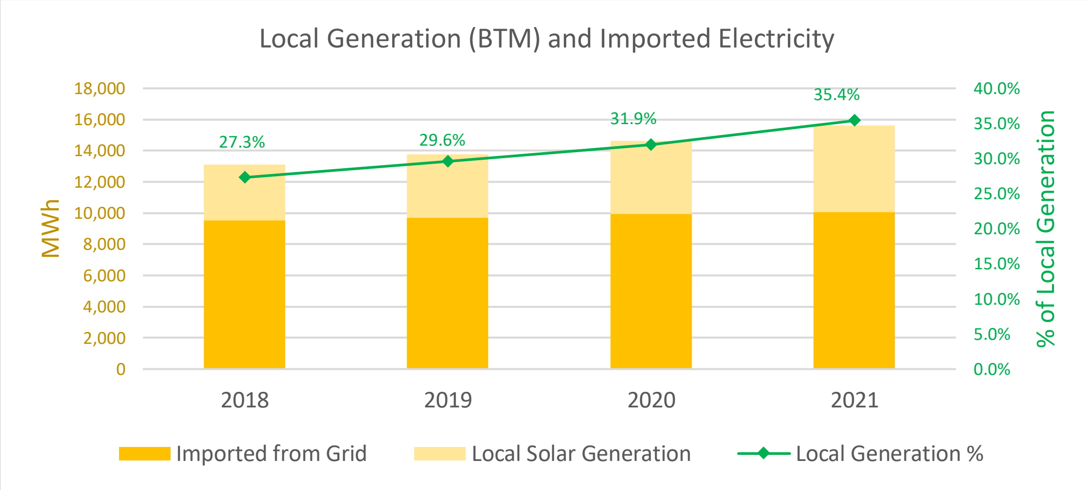

The daily profile of BTM solar generation (assuming a fixed/non-tracking array system) for average June and January days is illustrated below:




This chart is expressed as kWh generated per kWp (or the total rated kW 'peak' capacity of panels installed). This shows, the average daily solar PV yield in June is 41% of the average January yield. (The higher January yield is due to the increased daylight hours and more sunny days - not temperature).

### *Electricity Demand/Consumption- 2018 to 2021:*

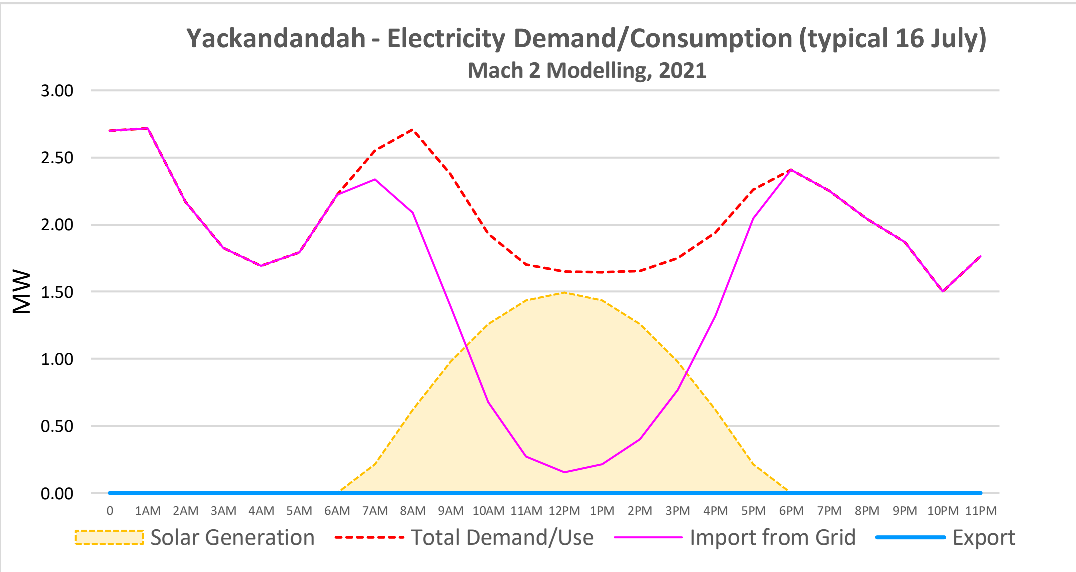
By adding the imported power to the locally generated power, the current total electricity demand/consumption has been estimated. Total estimated electricity demand/consumption/local generation in the Yackandandah AusNet 'loop' over the past 3 years (and estimated for 2021) is as follows:




As this chart shows, 64.6% of Yackandandah's current consumption is met by imported power from the grid, with the balance (35.4%) locally generated. The local generation % has increased over the past 3 years from 27.3% in 2018.

### *Profile -Average Winter Day (16 July)*

The estimated total demand/consumption/import profile for a typical winter day (July 16) is illustrated in the chart below:




Similar to the import profile addressed above, this demand/consumption profile has a number of features, including:

- The demand/consumption (red dotted line) spike that occurs at 1.00AM [This early morning load spike is met 100% from imported energy (pink line)]. As stated earlier, this is attributed to older-style (resistive) hot water storage systems.
- The other twice daily demand/consumption peaks (morning and evening).

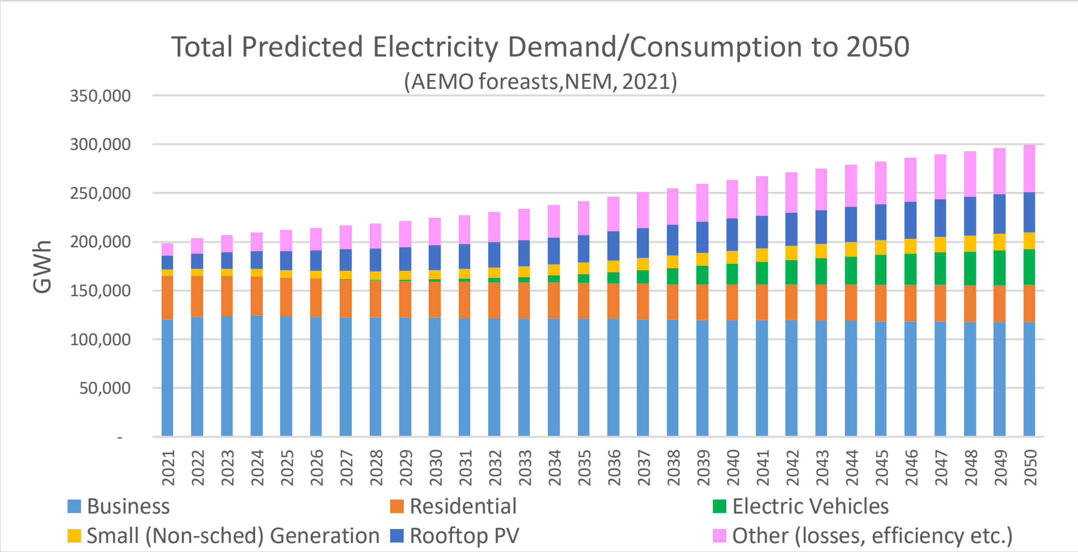
- Importantly, the graph illustrates that at no point (on this average 16 July day) does Yackandandah currently export any electricity (blue line) into the wider NEM grid. This is despite Yackandandah being known to have nation-leading levels of BTM rooftop solar take-up. The same is also the case (ie; zero grid export) for all 365 days in the year.
- Yackandandah's load (on this average winters day) peaks at about 2.7 MW. Across the whole year, the load peaks at 3.071 MW and averages 1.726 MW [4].

The above estimated levels of current demand/consumption and local generation for Yackandandah provide the baseline for developing all assumptions for this feasibility study regarding future demand /consumption and generation and estimating levels for future dates.

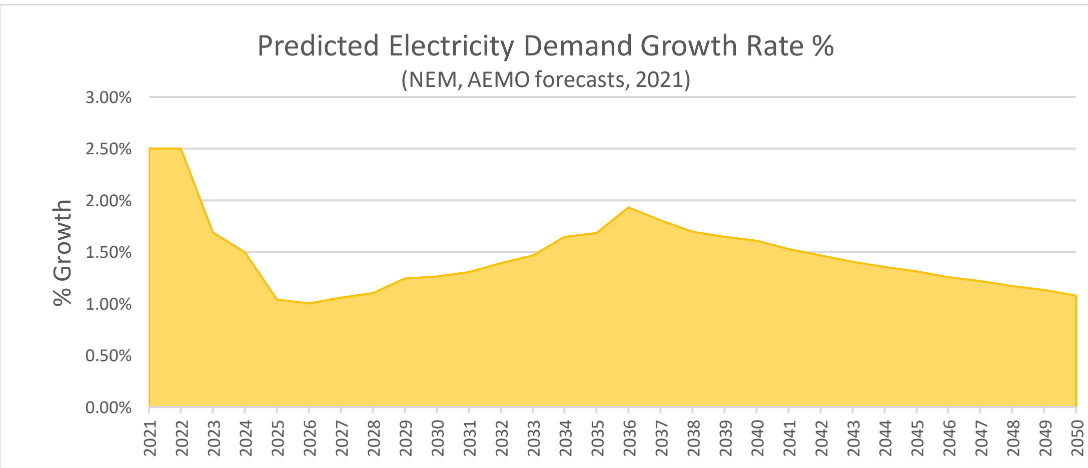
## 4.4 Forecast Future Demand/Consumption

### *Australian (NEM) Electricity Demand Forecasts:*

The following charts shows the current AEMO forecast for total electricity consumption within the National Electricity Market (the NEM comprising the Eastern Australian States) to 2050:

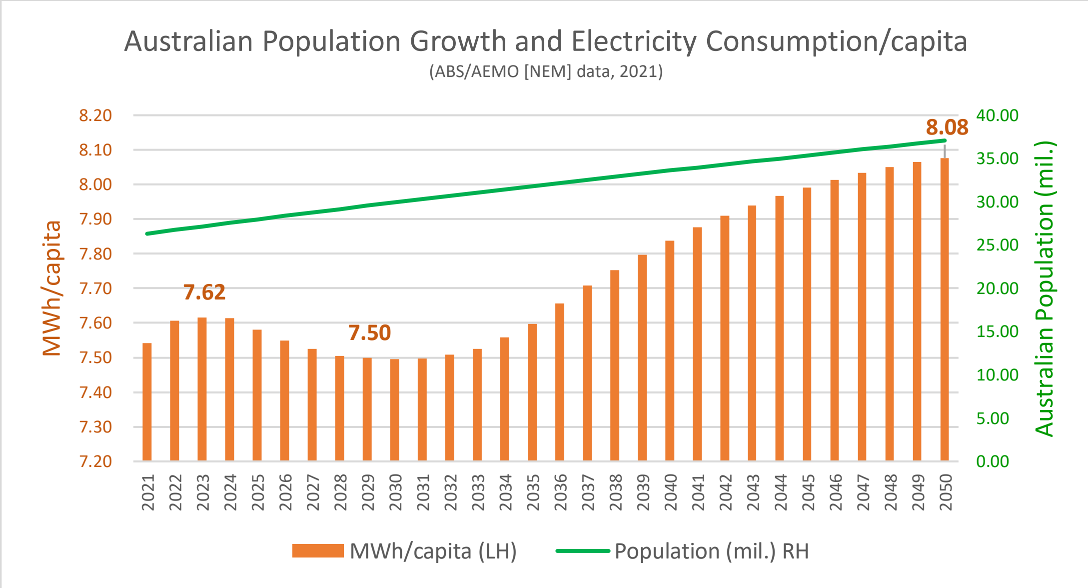



The key thing shown by the above chart is the forecast emergence, from about 2029 onwards, of electric vehicles (EVs) as a major user of electricity. Using the same data, the following chart shows the forecast year-on-year consumption growth rates (%) within the NEM to 2050:




The next chart shows the forecast Australian population growth together with electricity consumption per capita basis within the NEM to 2050:

[4] Electrical loads have been analysed to 1 hour average intervals. It is likely that these will be exceeded at times by short spikes for 0-59 minute intervals.




The above charts show the following energy demand dynamics (as forecast by AEMO) to be in play in Australia (within the NEM) over the next 30 years. These key factors are:

- The **rate of growth** in electricity consumption in the NEM is predicted to slow from the current 2.5% p.a. to about 1.0% p.a. in 2026. After that, the consumption growth rate is predicted to climb back up to 1.93% in 2036 and then decline again to 1.08% in 2050.
- Over this period, the Australian population is forecast by the ABS (mid-case scenario) to increase at a steady but gently declining rate from 1.62% in 2022 to 0.94% in 2050.
- The combined impacts of these factors are predicted to see electricity consumption per capita in the NEM increase initially to 7.62 MWh/capita per annum (in 2023), then decline to 7.5 MWh/capita (in 2029) and then increase again to 8.08 MWh p/capita by 2050. The increase in consumption p/capita from 2032 is mostly attributable to electric vehicle demand which is predicted to accelerate steeply from that time onwards. [5]

### *Yackandandah Growth:*

The following table shows the changes in population and number of dwellings in the local Yackandandah area over the past three census periods [6]:

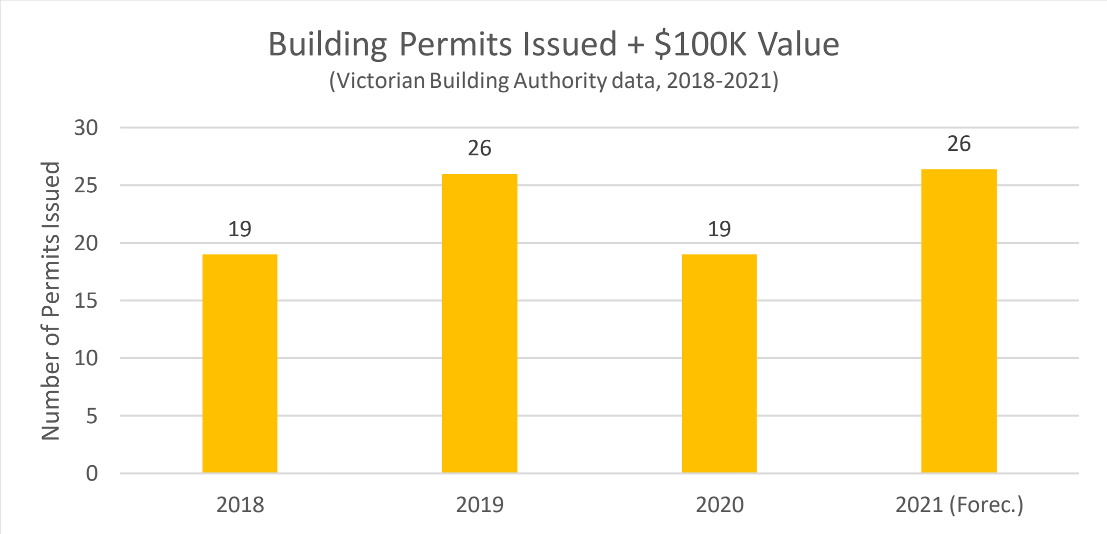
| | 2011 | 2016 | 2021 (Est.) |
|---|---|---|---|
| Population | 2,481 | 2,586 | 2,695 |
| Number of Dwellings | 958 | 1,053 | 1,189 |
| Persons/dwelling | 2.6 | 2.5 | 2.3 |
| Population Growth Rate (Y on Y) | | 0.83% | 0.83% |
| Dwelling Growth Rate (Y on Y) | | 1.90% | 2.46% |

Source: ABS Census data, 2011 and 2016 and projected forward to 2021

This shows that the pace of population growth in Yackandandah has been exceeded by the growth in the number of dwellings. With that, the average number of people per household has declined from 2.6 to 2.3 over a 10 year period.

[5] AEMO, Electricity Demand Forecasts, 2021
[6] ABS data for Yackandandah, Osbornes Flat, Allans Flat, Bruarong and about 50% of Staghorn Flat

Building development in the Yackandandah Valley has also been strong in 2021. The table below shows the number of building permits issued in the Yackandandah area over the past 4 years:

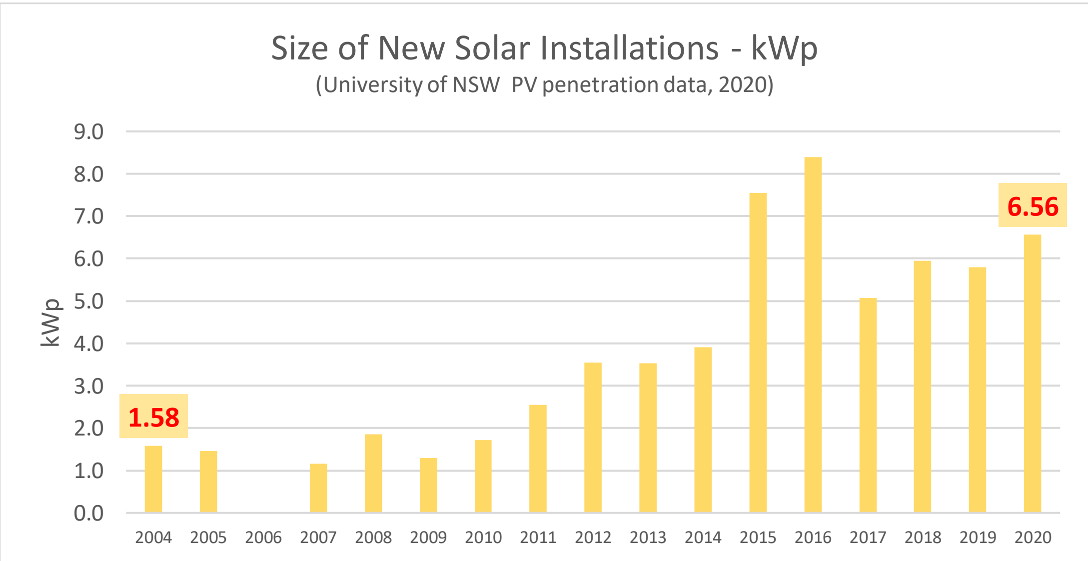



Indigo Shire has advised that building permit growth (YTD) so far in 2021 is running at significant growth over the 2020 (Covid year 1) figures. With the Twist Creek Road subdivision recently approved, together with significant ongoing in-fill development in surrounding semi-rural areas and increased demand for property in Yackandandah, a relatively high rate of subdivisional and in-fill development is likely to continue in the immediate future.

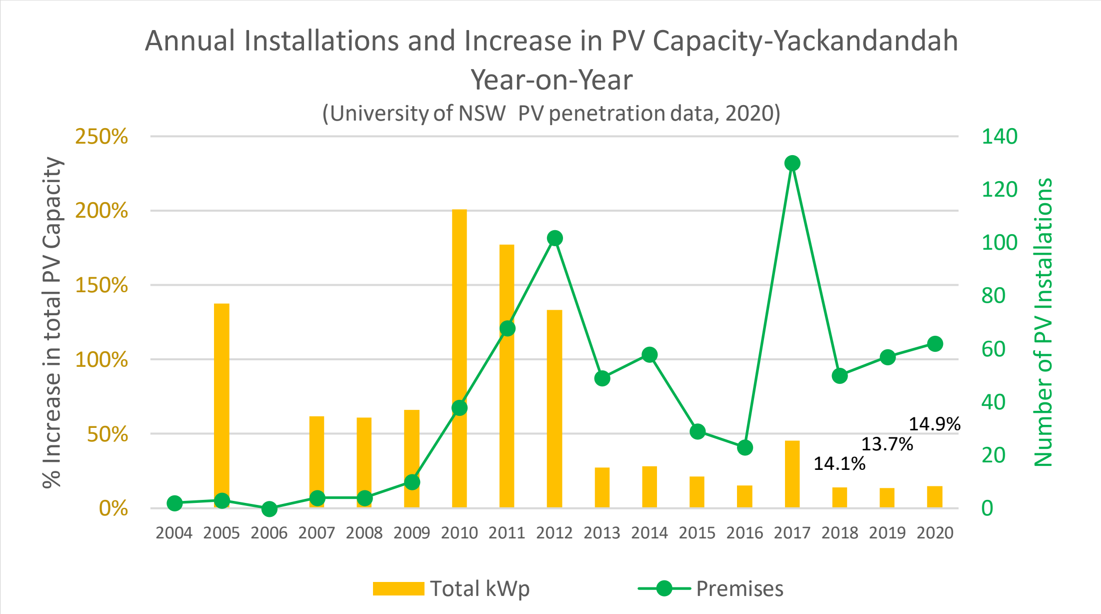
(NB: It should be noted that PV solar installations do not require building permits and Shire records do not address whether or not PV solar installations are included in domestic building projects. Therefore, this above data is contextual/indicative only).

### *Future Solar/PV Installations:*

The following chart applies UNSW solar PV penetration data to show the average size of new PV solar installations in Yackandandah since 2004. It shows that the average PV installation size has substantially increased from 1.58 kWp in 2004 to 6.56 kWp in 2020.



The next chart shows (using UNSW PV data) the number of new rooftop PV installations in each year since 2004 and the total estimated year-on-year PV production increase for Yackandandah.




This shows that the amount of solar generation capacity in Yackandandah is estimated to have increased by 14.1%, 13.7% and 14.9% in each of the last 3 years which is very significant. Over this time, the annual number of installations was 50, 57 and 62. Further underlying this trend is a shift to larger rooftop PV systems. The 2021 Clean Energy Australia Report states that the average small solar PV system installed in Australia in 2020 was 8.04 kWp in 2020. [7]

This local data is broadly consistent with more general (NEM-wide) forecasts published by AEMO.

The predicted rapid rate of BTM solar PV generation growth locally is attributable to a number of factors including:

- Increased awareness of and concern about the climate emergency within the Yackandandah community and the need to increase the use of energy from sustainable sources.
- Improved solar PV panel efficiency/yield ratings.
- Increased accessibility and reduced prices for domestic/rooftop solar installations (combined with a range of subsidy and incentive schemes).

One additional factor that needs to be taken into account is the level to which the distribution network operator (AusNet Services) will consider the grid sufficiently capable to allow increased levels of PV solar installation within it. In some situations (on SWER lines around Yackandandah, for example) it is understood that the current electricity grid has limited or no capacity for increased solar PV.

### *Consumption Growth Assumptions:*

The assumptions applied for this feasibility study take account of all know indicators, data and pointers (including the above discussion), to inform what are considered the likely future trends in local PV rooftop solar growth. It should be noted that, given the current dynamic and volatile state of renewable energy nationally and internationally, as well grid capacity limitations, these assumptions are by no means certain or conclusive.

[7] Clean Energy Australia Report, 2021, Clean Energy Council, 2021

In relation to future demand/consumption growth, the AEMO forecast increases (which vary over the next 30 years) has been applied plus an additional local development assumption of 3%. This additional overlay to the AEMO assumption reflects the fact that the recent actual/observed data for Yackandandah demand/consumption (AusNet interval data, 2018-2021 and UNSW solar PV penetration/production), suggests that Yackandandah's local consumption increases are likely to be higher than those predicted for Australia generally.

The reason for this is unclear. However, it may be attributable, at least partly, to higher consumptive behaviour patterns linked to/flowing on from an increased take-up of BTM renewable energy capacity and/or higher consumptive behaviour in middle to higher income households.

Work by Queensland University of Technology researchers (2019) identified this potential for 'unintended negative consequences' in terms of the consumptive behaviours of people who take up renewable energy initiatives. [8] This study cited earlier research in the US (Jacobsen, Kotchen and Vandenbergh, 2010) that found that households enrolling in green-electricity interventions increased their electricity consumption by 2.5%. It has not been in the scope of the current feasibility study to test these ideas or assertions in a local context. There is potential for further research into the future role of consumption/efficiency side measures in the transition to clean energy and the consumer behaviours that are likely to impact on this.

*PV Solar Growth Assumptions:*

In relation to solar PV growth, the AEMO forecasts for increased solar PV (small scale generation, high scenario) have been applied. In applying the AEMO growth assumptions, it is recognised that Yackandandah is already well-advanced in its level of rooftop solar penetration/take-up (57.6%) and so growth rates will inevitably level off in future years (and possibly earlier than for the NEM generally). However, it is also the case that in rural areas, many new rooftop installations are likely to occur on sheds and other utility-type buildings and, in a broader sense, this is likely to offset the declining available rooftop capacity.

# 5. Defining the 100% Goal

Defining the scope of the 100% goal was a key part of the feasibility study. Importantly, the consumption and production models developed for this study enable definition of the levels of generation and storage assets that are required to achieve the key thresholds of 100% gross and 100% net renewable. Equally, the models enable prediction when different target thresholds can be achieved with different scaled generation and storage options.

In addition to the target % of renewable energy achieved, the other critical aspects/goals to considered in the study are:

- 'Islandability'- is it possible and in what circumstances?; and
- Emergency resilience.

## 5.1 'Net' and 'Gross' Definitions

The main targets/ thresholds addressed throughout this study are defined below:

### 100% Net Renewable:

The pure definition of '100% Net' means Yackandandah would generate 100% or more of the power its uses (in net terms) over any given year.

For example, Yackandandah's consumption for 2021 is forecast to be around 15.7MWh. '100% net' is achieved if at least 15.7MWh is generated locally over the year.

However, this pure definition has been adjusted to reflect the fact that the energy currently imported through the NEM grid already includes a significant component of clean renewable energy.

[8] Effectiveness of Household Energy Efficiency Interventions in Advanced Economies: *What works and what doesn't*, *Queensland University of Technology*, Russell-Bennett, McAndrew, Gordon, Mulcahy, and Letheren (2019).

The adjusted definition applied for this study is '100% Net Renewable'. This is where electricity generated locally **plus** renewable energy imported from the NEM exceeds local consumption.

Using 2021 again as an example, approximately 31.3%[9] of electricity in the NEM will be renewable. Consequently, '100% Net Renewable' is achieved if at least 13.3MWh is generated locally during the year. So, of the 7.5MWh imported, 2.4MWh will be renewable.

Applying the '100% Net Renewable' threshold effectively means using the grid as Yackandandah's 'battery' to meet energy needs in generation troughs (when the sun isn't shining) and to export any surplus when local generation exceeds local demand.

### 100% Gross:

'100% Gross' means power is **never** imported into Yackandandah from the wider NEM grid. The modelling for this study applies a strict interpretation of 'gross' based on hourly consumption (as opposed to daily) [10].

This means, to achieve the 100% gross target, for every individual hour of the 8,760 hours in any given forecast year (to 2050), the sum of Yackandandah's total local renewable energy generation (for that hour alone) plus the calculated component of non-renewable power imported through the gid, needs to exceed total consumption (for that hour alone).

### Clean (Renewable) NEM Grid-Sourced Energy:

As stated, the modelling for this study takes into account the fact that a significant and growing component of the energy imported into Yackandandah from the wider NEM grid is from renewable sources.

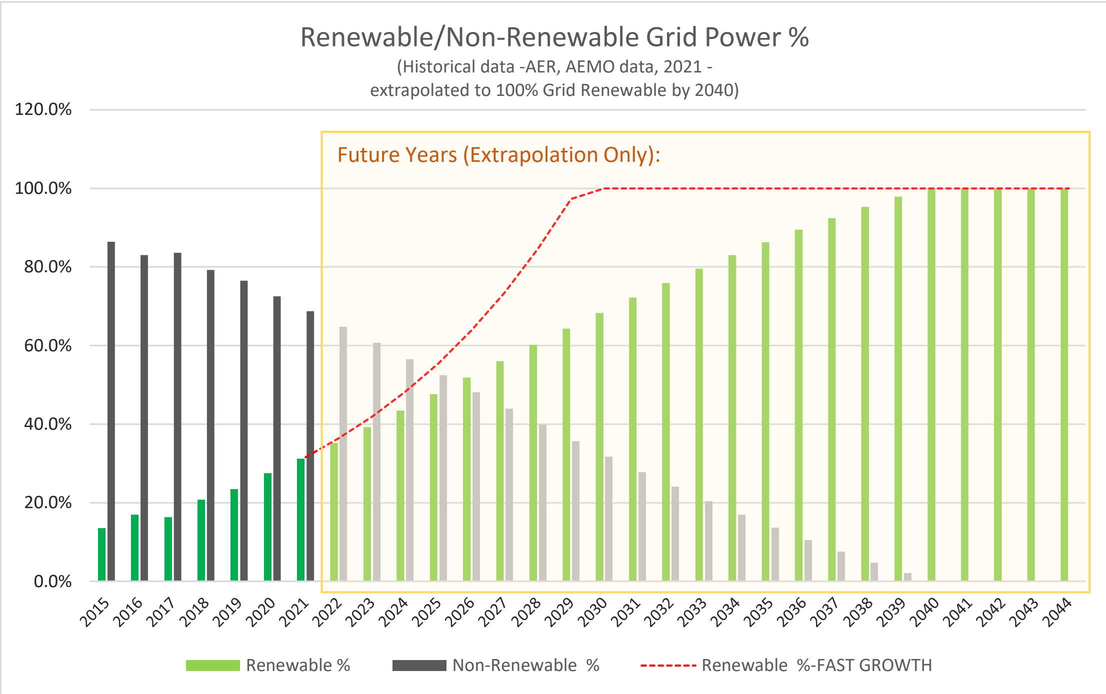
AEMO data shows that the amount of renewable energy generated in the NEM has increased by 15.1% each year over the past 2 years. If this current renewable generation growth rate is sustained into future years, the NEM would reach 100% net renewable by 2030. However, it is considered more likely that, as the NEM gets past 50% renewable and closer to 100% renewable, the pace of growth in renewable generation will decline. Of course, exactly where this ends up is tied up in a complex range of political and global issues and drivers that deem it too complex to attempt to predict for this study.

So, for the purposes of this study, it has been assumed that the share of renewable energy generated in the NEM will continue to increase in future years but at a reducing rate of growth. The rates of renewable energy generation growth that have assumed equate to the NEM being 100% renewable by 2040.

[9] Department of Industry, Science, Energy and Resources, Australian Energy Statistics, Table O3, Electricity generation in Victoria, by fuel type, physical units

[10] In practice, there are likely to be short demand spikes of 0-59 minutes throughout the year where peak load exceeds the intra-hour average.

Based on this assumption, the chart below shows the clean/renewable energy and non-renewable energy shares of grid-supplied power over the past 5 years and assumed to 2044.




## 5.2 'Islandability'

'Islandability' is a widely-discussed concept and goal in today's energy circles, especially in the context of micro-grids and Distributed Energy Resources (DER). It envisages a situation whereby a part of the existing electricity grid is able to be disconnected from the wider grid. This may occur permanently or only in certain defined circumstances (ie; an emergency). Either way, it implies that an area being 'islanded' from the wider grid means it could be allowed to continue in fully-charged operation independently.

In the Yackandandah context, this may apply to the full AusNet 'loop' from the Patrice Vale HV switch downstream. Otherwise, an islanding switch could be located at various other alternative points on the feeder line into the township along the Yackandandah-Wodonga Road. The Yackandandah town centre (ie; excluding the surrounding rural areas) could also theoretically be islanded. However, it is likely that this would require significant investment in switching and other infrastructure to make it capable of being isolated. The scope of these works has not been addressed as part of this study.

### *Front-of-Meter (FOM) 'Islandability'*

For the purpose of looking at potential 'islandability' scenarios for Yackandandah, it is being treated as the practical issue of what happens during an emergency situation where the wider grid is shutdown for any reason. The question addressed is how does the Yackandandah community continue to function and meet basic needs in such a situations.

Through this project, detailed discussions were held with Mondo and AusNet (the local Distribution Network Operator) regarding potential future scenarios for islanding. The consensus view was that there is much merit in this as a goal and that it is consistent with the wider aspiration of a grid that has more widely distributed energy generation and storage assets at the regional and community levels. It has also been noted through these discussions that Mallacoota, which is an isolated community in eastern Victoria, has had infrastructure upgrades that enable the township to be islanded.

However, discussions also identified significant barriers to achieving islandability in the short term. Most of these barriers relate to the current policies and rules that are in place that are aimed at protecting the network integrity, public health and safety and worker safety. Key challenges to be addressed to achieve a potential islandable micro-grid in Yackandandah include:

- Need to maintain failsafe communication mechanisms between the local (islandable) part of the grid back to the main distribution point managed by the distribution network operator (ie; in this case, the Wodonga Terminal Station [WOTS11] at Baranduda).
- Clarity in relation to role demarcation/levels of ongoing operational responsibility of the distribution network operator for operation of an islanded part of the grid when in islanded mode. In other words, when it's switched off at Patrice Vale, who is then going to make decisions and take actions in relation to its operation for that period it is in islanded mode?
- Clarity in relation to ultimate accountability of the distribution network operator for events, outcomes and decisions within an islanded part of the gid whilst it's in islanded mode. In other words, high voltage electricity has a significant risk profile: if some catastrophic event occurs in the Yackandandah part of the grid whilst islanded, who is ultimately responsible and accountable for this?
- In light of the above, what governance/contractual/financial/administrative arrangements are required to support a part of the grid operating in an islanded mode?

A further aspect to be considered in relation to this is how much energy is it reasonable to expect to be available to the local community when the local grid is operating in an islanded mode? For the purposes of this discussion, it has been assumed that, in an islanded mode, a range of energy consumption curtailment measures would apply. The lower the level of consumption within an islanded micro-grid, the longer the energy storage will last and the greater the level of resilience will be. Whilst specific consumption curtailment rules have not been addressed in this study, it is assumed that curtailment measures designed to reduce consumption to at least 50% of normal consumption levels would probably be applied.

This study also examines the potential role that back-up generators (operating FOM in an islanded grid) may play in Yackandandah.

### *Behind-the-Meter (BTM) 'Islandability'*

A different notion of islandability is Behind-the-Meter (BTM) 'islandability'. This refers to a scenario where community emergency resilience and response capability is improved by securing electricity supply to as many key/critical community facilities and assets as possible behind the meter. This can be done by either (or a combination of) BTM batteries and /or BTM back-up generators connected to specific premises.

In Yackandandah, under the leadership of TRY, much has already been done to improve and build community energy resilience to protect the community in emergency situations, with a focus on key community assets and facilities. These measures include:

- Batteries (combined with PV solar arrays) on public buildings, including the CFA and the public hall;
- Back-up generator facilities at numerous key sites (Yackandandah Health/aged hostel, YCDCo service station, CFA and SES).

In addition, the SES and CFA have several mobile generators that are available to be deployed by emergency services as needed.

The next level of BTM islandability/resilience beyond this would be to install batteries and back-up generators (or at least generator plug-in points) at more key (private) business premises. Target premises for this would include venues and businesses with food and catering capability, as well as emergency accommodation capability. These would include:

- Foodworks supermarket (existing rooftop solar array);
- Two hotels;
- Public hall;
- Bakery and cafes;
- Yackandandah Sports Park;
- Butson Park (YFNC); and
- Yackandandah Senior Citizens Centre.

#### *'Islandability' Options Summary*

The concept of implementing selected and targeted Behind-the-Meter measures to improve community energy resilience in Yackandandah is attractive. It needs to be considered in a 'value-for-money' context along-side other potential investments in grid-facing islandability options.

Subject to funding, a bespoke BTM asset islandability model is very achievable in the current grid operating context (ie; without the need to resolve the complex safety, governance and infrastructure challenges defined earlier). These are measures that can be pursued immediately, without complex structural, regulatory and network policy changes.

Further, the introduction of these BTM energy resilience measures is not mutually exclusive to the pursuit of other Front-of-Meter islanding scenarios (ie; those that do involve complex structural, regulatory and policy change) that may become more realistic in the future. In this sense, any community investment in immediate term resilience improvement through BTM measures is also worthwhile in the longer-term. Even in a future scenario where Yackandandah has a more universal FOM islandability structure in place (with all the required governance and safety/communication protocols also in place), there remains the possibility of local grid failure due to localised disasters. In these situations, an islanded local grid could still fail due to internal issues and, under this scenario, the investment in BTM asset islandability/resilience measures remain valuable.

In other words, local energy resilience is not an absolute destination: rather, it is more like a spectrum.

# 6. Site and Option Criteria

## 6.1 The Local Landscape

The landscape in and around Yackandandah is not ideally suited to the pursuit of the renewable energy asset-friendly sites being sought for this project. The landscape is generally undulating-to-hilly topography. It is very high quality agricultural production land mostly used for beef cattle and dairying.

Due to the progressive nature of the community, together with its close proximity to Albury-Wodonga, Yackandandah is also a highly sought after lifestyle /living location. The township has significant areas of rural living zoned land with smaller hobby farm style allotments (c.2-20 ha in size). Within these areas (as well as in rural zoned farm land), the Yackandandah Valley has a quite high rural density and there is significant in-fill development still underway.
Yackandandah is also widely regarded as being a beautiful rural township area. The local community places a very high value on the aesthetic values of the township itself, the surrounding valleys and the hills.

The combined impact of these factors means Yackandandah simply does not have available many large slabs of marginal rural land that is suited to the development of solar generation assets. Further, for those sites identified where there is potential, there is generally a high price associated with it and also a high opportunity cost for those sites.

From the point of view of developing pumped hydro assets, the local topography is generally suitable in a technical and mechanical sense (with relatively high hills surrounding the town). However, water access within these sites and land access/management issues remain a challenge.

## 6.2 Site Selection Attributes

The following table provides a summary of the main site identification/section attributes that have been applied for each of the two key asset types that are subject to this feasibility study:

| CRITERIA: | SOLAR/BATTERY SITES: | SOLAR/PUMPED HYDRO SITES: |
|---|---|---|
| Owner appetite/attitude: | Prepared to engage with proposal | Prepared to engage with proposal |
| Area: | Min. 3 ha | Min. 3 ha |
| Land use planning/zoning: | Farm/rural living/public use | Farm/rural living/public use |
| Amenity/Neighbours/Visual Impacts: | Distance from nearest dwelling | Distance from nearest dwelling |
| Topography: | Flat-to undulating/northern aspect | Flat-to undulating/northern aspect<br>Elevation/grade separation (>150m.)<br>Lateral distance (high to low)<br>Accessible penstock route |
| Water access: | NA | Water source required |
| Grid quality/location/access: | 22 kV line access (within 500m.)<br>Ideally:<br>- on the Yackandandah feeder from WOTS11 towards township<br>- within Yackandandah grid loop | 22 kV line access (within 500m.)<br>Ideally:<br>- on the Yackandandah feeder from WOTS11 towards township<br>- within Yackandandah grid loop |
| Opportunity Cost: | Ideally lower value/marginal land | Ideally lower value/marginal land |
| Public land access/barriers: | Development of renewable energy assets need to be established as a legal possibility subject to relevant applications/assessment processes etc. | Same as for solar/battery |
| Native Vegetation Impacts | Native vegetation assessment not within scope of this study. However, likely impacts were considered in a general/preliminary sense | Same as for solar/battery |
| Cultural land assessment: | Cultural land assessment not within scope of this study. All options subject to appropriate processes. | Same as for solar/battery |

## 6.3 Potential Site Identification

The site identification and selection process for this feasibility study proved to be somewhat iterative in nature. Through local knowledge, sites were identified that were considered to have the required technical attributes (size, topography, grid access/capacity etc. based on the above), and made personal approaches were made to numerous land owners.

Following this, the Project Control Group decided to publicly seek expressions of interest from the community for potential solar farm sites. This was publicised on the TRY websites and in the local community newspaper (Yackity Yak). This process also has the aligned goal of 'announcing this project' to the community in general terms and commencing the engagement process.

Expressions of interest for potential sites closed on 20 October 2020. The public invitation for Expressions of Interest provided a broad description of the key criteria. It also made clear that any proposition would be considered on a commercial/semi-commercial community ownership basis. In other words, the land was not being sought on a donated (free) basis. It was made clear that a future arrangement (either long-term lease or purchase) would need to include a level of compensation that at least reflects the current economic value of the land.

The outcome was that a total of 29 potential sites were identified where owners came forward to offer their land (or a part of their land) to be considered for use as part of a renewable energy installation.

Totally Renewable Yackandandah (TRY) and the Mach 2 Consulting team wishes to thank and acknowledges the generosity and positive attitude of all people who came forward and offered their land as part of this project.

The majority of the 29 potential sites identified did not satisfy all or some of the base requirements relating to size, grid access and/or topography.

*Owner Appetite:*

The key first threshold addressed was **land-owner interest/appetite**. The approach to landowners was couched not in terms of an absolute "yes" or "no" (which would be impossible at these early stages) but in terms of "…would you be prepared to entertain a proposition for a renewable energy installation?". Without at least a reasonable level of preparedness by the land holder to engage with and/or entertain a renewable energy proposition on their land, any other technical/land attributes of a site (topography, grid access etc.) were considered purely theoretical.

In some cases, the landholder discussions, initially, did not have a clear-cut outcomes which added delays to the process (ie: "we'll think about it"). In others, there were multiple owners and, in some cases (ie; with older owners), the wider views of extended family members/children /executors/will beneficiaries etc. had to be considered. The health and age of the owners also needs to be considered as part of approaches made.

There are also strong community perception issues associated with solar farms that needed to be considered. In some cases, concern was identified about the impact of a solar farm on the aesthetics of the landscape in the Yackandandah valley. This factor is expected to continue to be an issue, even in Yackandandah where there is a very high level of engagement with renewable energy as a concept.

*Approvals and Permits:*

With all sites (public or private) there would be a planning process and various layers of approvals, assessments and permits required. These are all treated as being part of an implementation process for any project that is pursued.

The other factor to be considered is with public land and land owned by public utilities (Crown land, Shire land, Parks Victoria and North East Water land). In these cases, the initial approach did not seek a categoric "yes" but rather, sought to ascertain whether or not there was a definite "no". In the case of public land, it was recognised that there would be detailed and complex approvals process to be navigated in the event a project proceeds.

So, in practical terms, what flows from this is a situation where all sites were, at differing times, at different places on a spectrum of interest, ranging from "Yes", to "Possibly consider" to "No".

*Grid Issues/Access:*

The grid access/grid quality issues are clearly of paramount relevance to this feasibility study. The resolution of these issues and determination of whether or not a particular site is suitable and what grid investment may be necessary to enable a renewable energy installation, can only be determined through the conduct of a grid study. This is like a preliminary feasibility assessment that must be done by the Distribution Network Operator (AusNet) for a fee. Grid studies were conducted by AusNet for this feasibility study for three locations.

## 6.4 Solar-Battery Site Attributes

For this project, it was decided that all potential projects would include a generation and storage component. With solar + battery sites, the key requirements related to the size, orientation and access to the land (ie; in addition to owner appetite, grid quality/access etc.).

A northerly orientation/aspect for the solar arrays and relatively flat land (already cleared with no shading ideally) was considered important. As with all options, the impact on local amenity, the location of waterway, planning considerations and the visual/landscape impacts are also important.

## 6.5 Pumped Hydro-Solar Site Attributes

With pumped hydro, the topography of the land (potential head) and the potential for water access are clearly key considerations, as well as grid access/capacity.

A key issue considered with pumped hydro is the means used to generate power behind the meter to pump water up during the day (ie; a solar array or wind) so that it doesn't need to use energy from the grid. The consideration of wind generation as an option was not included within the scope of this study. This means a viable pumped hydro site also need access to an area of land adjacent to the site to locate a solar array of sufficient scale to power the pumps.

Water access/availability is also a key issue: initial discussions with Goulburn Murray Water have confirmed this. Pumped hydro is deemed as a non-consumptive use of water, meaning that it works like a closed loop. However, there would be some losses in the system (from evaporation etc.) depending on storage/dam design. Despite this, the water will need to be purchased for any project and it needs to be purchased from within the local catchment which means it needs to be available. Further, on the small seasonal streams around Yackandandah, this would likely be a winter fill only permit (within the State-mandated 'sustainable diversion limits'). In addition to the water, a separate permit will be required to build any dams and storages.

## 6.6 Selected Sites for Study

Applying all the above criteria and considerations, four sites were selected for detailed assessment as part of this feasibility study (one of the sites has two scale options). These sites each have different features, merits and challenges that are addressed in this report. Selected sites are:

| SITE: | SCOPE: |
|---|---|
| 1. North East Water Wastewater treatment site<br>(North East Water-owned land, cnr. Osbornes Flat and Myrtleford-Yackandandah Roads) | Solar + battery |
| 2. Allan's Flat Waterhole site (private land off Allan's Flat Road) | Solar + battery |
| 3. Commissioners Creek Dam site (private /public land) | Solar + pumped hydro |
| 4. Leneva A (private land, Beechworth Road, Leneva) | Solar + pumped hydro |
| 5. Leneva B (private land, Beechworth Road, Leneva) | Solar + pumped hydro |

The various sites identified are detailed below.

# 7. Site Option Assessment

## 7.1 OPTION 1: North East Water Waste Water Treatment Site

This site is owned by North East Water which is a public utility. It is situated about 3 km south east of the town on the corner of Osbornes Flat Road and Myrtleford-Yackandandah Road. It is used as part of the waste water treatment facility operated by North east Water for Yackandandah. The site has a pivot irrigation facility installed that is used for the dispersal of treated waste water that comes from Yackandandah via the treatment plan (located on the north side of Osbornes Flat Road).

With a total area of 16.9ha, a pivot irrigator occupies less than half the total site leaving plenty of space for a solar array. It is mostly cleared and there are ample areas that are free of shading and clear of water ways etc. It is zoned residential living and, being currently used for waste water dispersal, grazing and hay production, it already has established buffer areas surrounding it. Soil conditions have not been assessed as part of this study but are not expected to present a barrier.

The grid capacity adjacent to this site is relatively good up to the boundary. It has been estimated that the facility proposed could be accommodated on this site with a grid investment of $490,000 [11] This investment would be for the installation of one new power pole, a single span of cable and an automatic current recloser (ACR).

An important consideration for this option is that the site is already used for a 'utility type' use and is in public ownership (albeit not designated for renewable energy use).

### *Option Configuration:*

| Component: | Rating: | Details: |
|---|---|---|
| Solar array | 1.63MWp | 4,940 x 330W fixed panels |
| Solar inverter | 1.5MW | 15 x 100 kW string inverters |
| Battery | 2.6MWh | |
| Battery inverter | 1.2MW | |
| Hours supply (@average load) | 1.5 | |
| Hours supply (@50% curtailed load) | 3.0 | |

### *Summary:*

The proposal to use this site, as developed for this feasibility study, is for a co-use arrangement that can accommodate both the ongoing waste water dispersal function along-side the proposed renewable energy use. The solar array and battery installation has been scoped so that it fits in along-side and would not interrupt the current pivot irrigator function. As envisioned in this proposal, the only change (compromise) to the existing on-ground use of the land by North East Water would be that it would be necessary to graze sheep rather than cattle (cattle are incompatible with solar panels). Most of the area is currently used for hay production (with the pivot irrigator area) and this could continue to be the case (depending on the size or an installation).

Despite this general site suitability, TRY has been advised that North East Water is not prepared to entertain a possible future co-use of the this site for a community renewable energy purpose. The rationale for this put forward by North East Water is that the future needs of Yackandandah and its growth patterns remain unclear and must remain the paramount priority

[11] Myrtleford Road Grid Feasibility Study, AusNet Services, May 2021

for the site. The argument advanced is that the site may be needed for future expansion of the waste water treatment function to meet the needs of a growing Yackandandah.

This site has been included as an option for this feasibility study (despite negative owner sentiment), based on the extremely high locational and site suitability merits it has as well as the existing 'public utility' use of the site.

## 7.2 OPTION 2: Allan's Flat Waterhole Site

### *Site Description:*

This site is located near the Allan's Flat waterhole approximately 8km north east of the Yackandandah township. It is about 500 metres (over the Yackandandah Creek and adjacent land) from the main 22 kV feeder line from the Wodonga Terminal Station (WOTS11) to the Yackandandah AusNet grid 'loop'.

The grid capacity in this location is relatively good due to the fact that it's located on the WOTS11 feeder, relatively close to the Wodonga Terminal Station. It has a thermal rating for that section of 4.6 MVA [12] (NB: This is subject to confirmation for the specific site and point of grid connection).

The land is in private ownership and in the farm zone. Visually, it is relatively hidden from view from all roads and in that sense is ideal. The land is mostly cleared. Soil conditions have not been assessed as part of this study but are not expected to present a barrier.

The owner has engaged with TRY positively regarding this proposal but final attitudes and appetite for a future renewable energy use remain uncertain and unresolved. It is understood that a compelling financial case (for the owner) would need to be made in order for this option to be realistically pursued.

[12] Commissioners Creek Feasibility Study, AusNet Services, February 2021

### *Option Configuration:*

| Component: | Rating: | Details: |
|---|---|---|
| Solar array | 2.25MWp | 6,818 x 330W fixed panels |
| Solar inverter | 2.0MW | Central inverter |
| Battery | 7.4MWh | |
| Battery inverter | 3.4MW | |
| Hours supply (@average load) | 4.3 | |
| Hours supply (@50% curtailed load) | 8.6 | |

### *Summary:*

This site is very well located in a local Yackandandah grid capability context, being situated towards the Wodonga Terminal Station end of the local (WOTS11) feeder line. In terms of the site topography and size, it also lends itself to a renewable energy installation of this type. Further, the size of the site (subject to owner attitude) has potential to locate an even larger installation than that embodied in this option.

The major barrier for this site is likely to be the ability to attract a level of owner engagement with a renewable energy use that is financially accessible and realistic.

## 7.3 OPTION 3: Commissioners Creek Dam Site

### *Site Description:*

This site is located north west of the Yackandandah township on the Yackandandah Road (towards Beechworth). The original concept for this option was for a pumped hydro installation using the existing decommissioned Commissioners Creek Dam as the lower storage. Under this concept, a new 'turkey nest' storage would be built at the top of the hill to the north east of the existing dam with a solar array either at the top or bottom of the hill to power pumping. The land on both sides of Commissioners Creek is in the same private ownership and the owners have been engaged fully in relation to this proposal.

The existing dam is situated on a crown land reserve with the control of this area resting with the leaseholder, North East Water and surrounded by land in private ownership.

The existing dam has been surplus to needs for North East Water for many years and no longer plays a role in the supply of potable water for Yackandandah. As part of this study, investigations were undertaken into the feasibility of using the existing dam as the lower storage as part of a pumped hydro facility. As a result, the conclusion has been reached that the barriers to using the existing lower dam are challenging. The issues include:

- Safety/integrity of the existing dam wall. This was lowered by 4 metres some 5 years ago as a result of a risk assessment conducted by North East Water. The risk assessment identified that the design and structure of the dam wall no longer complies with today's dam safety requirements.
- Land tenure. It is considered likely that the remedial works that would likely be required to upgrade the existing dam wall structure to meet current compliance thresholds would require the wall footprint to be extended beyond the current property boundaries into neighbouring land. This introduces a further layer of complexity to this proposition.
- Silting and contamination. It has been suggested that the existing disused dam would require desilting which may encounter issues with contamination.

To address/resolve these issues conclusively for this study would have required detailed engineering and environmental assessments of the dam itself and the wall structure and its suitability to be used for a pumped hydro storage. This level of assessment was not with the scope of this study.

*Option Configuration:*

As a result of the above, for the purposes of this study, this option was redefined and rescoped to include a new off-stream lower storage combined with an upper storage adjacent to an elevated solar array.

| Component: | Rating: | Details: |
|---|---|---|
| Solar array | 3.445MWp | 6,500 x 530W bi-facial single axis tracking panels |
| Solar inverter | 3.0MW | Central inverter |
| Battery | 0.5MWh | Pumping mode transition only |
| Pumped hydro energy storage | 10MWh | |
| Pumped hydro turbine size | 1MW | |
| Hours supply (@average load) | 5.8 | |
| Hours supply (@50% curtailed load) | 11.6 | |

The pumped hydro project (per this option) for this site has been scoped by the technical consultants to include the following components:

- Upper and lower off creek pumped hydro water storages of approximately 0.9ha each with capacity to store approx. 26Ml of water. A small diversion weir next to the stream would provide the necessary water capture to fill and replenish the necessary supply.
- Upper 'turkey nest' storage operating with a static head of 170m.
- An off-stream lower storage between Commissioner's Creek and Yackandandah Road would need to be constructed.
- 1MW four jet vertical shaft Pelton turbine and generator located adjacent the bottom reservoir.
- 2 MVA transformer.
- A 1.5MW array of pumps located adjacent the bottom reservoir (with step-changes enabled assisted by 500kWh battery)
- 800m of DN675 FRP pipe (or equivalent steel pipe) connecting the bottom reservoir, pump station and hydro turbine.

*Summary:*

This site is well located in proximity to Yackandandah township. The site has limited capacity for north facing solar PV arrays, especially at the lower part of the land. This requires solar arrays to located at the top of the hill with BTM energy transmitted to lower pump station for pumping use. Further, being on the far side of the feeder line into town, significant grid upgrade works would be required to enable the establishment of a new generation asset of this scale in the location. These works have been estimated to cost $870,000 by the Distribution Network Operator.

Soil conditions and suitability for dam construction have not been assessed as part of this study and would be an important consideration.

As noted, the use of the existing Commissioners Creek Dam has shown to be a complicated scenario. It would require much more engineering investigation if it were to be seriously pursued. The pumped hydro elevation/ head (170m) available at this site is adequate.

The availability of water for this purpose would be dependent on acquisition within the current defined sustainable diversion limits within the catchment. Goulburn Murray Water advises that water needs to be acquired from higher in the catchment and this further limits the ability to do this on this site.

Subject to the Distribution Network Operator approval, with appropriate switching and subject to detailed design, the proposed scheme could theoretically be configured to operate in Islanded mode to power the Yackandandah grid at times when the wider network had failed.

## 7.4 OPTION 4: Leneva Valley A (6.0 MW Solar + 8MWh Storage)

### *Site Description:*

This is the first iteration (version A) for the privately-owned Leneva site. It includes a smaller pumped hydro storage component as part of the project powered by a 6.0 MW solar array.

The Leneva site is located about 8 km north of Yackandandah (as the crow flies). It is located in the farm zone (City of Wodonga) on the northern side of the Baranduda Range. As such, it is on the Leneva AusNet feeder line and not within the Yackandandah AusNet grid 'loop'. This means that, as an option, it excludes the potential to achieve grid islandability for Yackandandah.

### *Option Configuration:*

| Component: | Rating: | Details: |
|---|---|---|
| Solar array | 6.0 MWp | 11,320 x 530W bi-facial single axis tracking panels |
| Solar inverter | 2.75MW | Central inverter |
| Battery | NA | Pumping mode transition only |
| Pumped hydro energy storage | 8 MWh | |
| Pumped hydro turbine size | 1 MW | |
| Hours supply (@average load) | 4.6 | |
| Hours supply (@50% curtailed load) | 9.2 | |

The pumped hydro project (per this option) for this site has been scoped by the technical consultants to include the following components:

- Upper and lower off creek water pumped hydro storages of approximately 0.5ha each with capacity to store approx. 13Ml of water. A small diversion weir next to the stream would provide the necessary water capture to fill and replenish the necessary supply.
- Upper 'turkey nest' storage operating with a static head of 280m.
- 1MW two jet horizontal Pelton turbine and generator located adjacent the bottom reservoir (with an operating maximum of 430 litres per second).
- A 3.0MW array of multi-stage pumps located adjacent the bottom reservoir (with an operating maximum of 860 litres per second)
- 4MVA transformer.
- 1,200m of DN600 FRP pipe (or DN600 steel pipe) connecting the bottom reservoir, pump station and hydro turbine (sized to minimise pipe friction).

### *Summary:*

There is excellent potential for this property to be used as a solar farm site combined with pumped hydro storage. It has reasonable access to the adjacent 22kV feeder line that comes out through the Leneva Valley from Baranduda. However, significant grid upgrade works would be required to accommodate an installation of the scale proposed. Grid upgrade works have been estimated to cost $1.5-$2.0 million. [13]

[13] Leneva Feasibility Study, AusNet Services, May 2021

It has ample areas with a northerly orientation, is mostly cleared and elevated (sheep grazing country) and has a very positive owner attitude/engagement for a renewable energy installation. Soil conditions and suitability for dam construction have not been assessed as part of this study and would be an important consideration.

Amenity and planning issues would need to be addressed (as with all options) but there is potential to locate assets well away from residences on this site.

For this option, the solar array is proposed to be located at an elevated location towards the rear of the property which means its visual impact will be minimal. Construction of suitable access tracks to the elevated areas will add to civil costs and on-site transmission costs are also higher due to the solar arrays a significant distance away from the pumping station.

From a pumped hydro perspective, this site (with elevation/head of 280m.) is regarded as very good. Further, there appears to be good options for off-stream storage reservoir locations.

The biggest disadvantage of this site is that it's outside the Yackandandah grid 'loop'. This means this site does not have the capacity for Yackandandah to be islandable unless it is connected through significant grid upgrade works (these have not been scoped or estimated as part of this study). This also implies that any installation on this site that is intended to supply 100% of Yackandandah's energy needs would, in practice need to do so as part of the wider electricity grid.

The availability of water for this purpose would be dependent on acquisition within the current defined sustainable diversion limits within the catchment. Goulburn Murray Water advises that water needs to be acquired from higher in the catchment. However, given the local catchment and ownership context of this particular site, water availability is expected to be reasonably resolvable.

Another advantage of this site is its potential to be co-located with wind generation. Whilst wind potential assessment was not included within the scope of this study, there appears to be anecdotal evidence that it may be viable. This would need to be addressed in more detail separately.

## 7.5 OPTION 5: Leneva Valley B (6.0 MW Solar + 30MWh Storage)

This option is exactly the same as the previous site/option but with a significantly larger pumped hydro component

### *Option Configuration:*

| Component: | Rating: | Details: |
|---|---|---|
| Solar array | 6.0 MWp | 11,320 x 530W bi-facial single axis tracking panels |
| Solar inverter | 2.75MW | Central inverter |
| Battery | NA | Pumping mode transition only |
| Pumped hydro energy storage | 30 MWh | |
| Pumped hydro turbine size | 1 MW | |
| Hours supply (@average load) | 17.4 | |
| Hours supply (@50% curtailed load) | 34.8 | |

### *Summary:*

Similar to option 4, this option has excellent potential as a solar farm site combined with pumped hydro storage. The merits and issues are mostly the same but the costs differ (see financial assessment section).

The other key difference is that this option has the capacity to store an amount of electricity equivalent to 17.4 hours of supply at Yackandandah average load (compared to 4.6 hours for option 4 (Leneva A).

However, not being part of the local grid, this capacity can only be delivered to Yackandandah via the wider AusNet grid. In the event of grid outage, the energy produced from this site would therefore not be available to the Yackandandah community.

# 8. Revenue Assumptions

## 8.1 The National Electricity Market (NEM)

The National Electricity Market (NEM) is made up of generators, transmission network service providers (TNSPs), distribution network service providers (DNSPs), electricity retailers and end-users. [14]

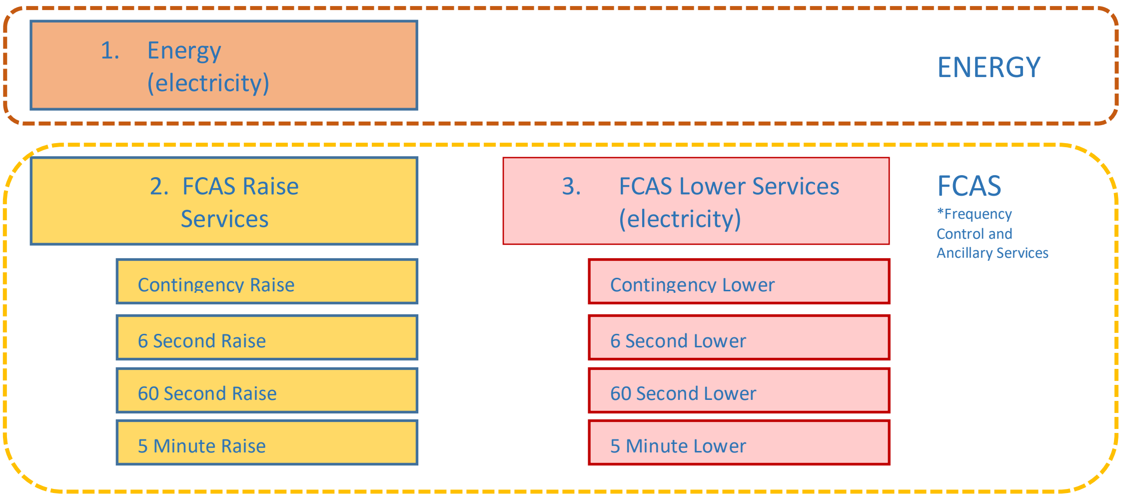
The NEM covers the eastern part of Australia - South Australia, Tasmania, Victoria, New South Wales, ACT and Queensland. The NEM wholesale market is where generators sell electricity and retailers buy electricity. Retailers then resell electricity to businesses and households within the NEM rules framework. There are around 30 retailers and over 100 generation companies in the NEM wholesale market.

Market participants can buy and sell electricity in the NEM wholesale market through the **spot market** and the **contract market**.

The Australian Energy Market Operator (AEMO) manages the electricity system so power supply and demand is matched and balanced to each other as closely as possible and simultaneously. The dynamics of the power system is such that the power supplied by generators must exactly match how much electricity is being used.

In the above wholesale market context, there are nine potential revenue streams available to a future operator of the various configurations of generation and storage assets contained in the various options described in this feasibility study.

These are illustrated below:




For each of the above services, AEMO publishes spot prices on their website at 5 minute intervals year round. Service providers/generators can bid into these markets.

## 8.2 Spot Energy Markets

The spot market is the mechanism that AEMO uses to match the supply of electricity from power stations with consumption. All electricity in the spot market is bought and sold at the spot price. The spot price tells generators how much electricity the market needs at any moment in time to keep the grid in balance.

[14] Australian Energy Market Commission, 'Transmission: Who Does What' (Information Sheet), 2013

When the spot price is increasing, more expensive generators (such as gas 'peakers' for example) may ramp up generation or ramp down or switch off when prices are lower. In other words, these agile quick response generators can 'cherry pick' the higher prices in the spot market. Grid-facing batteries can also sell into price peaks and have the added advantage of being able to charge up when the price is low (or even negative as often occurs).

There is very high price variability and volatility in spot markets. AEMO regulates the market - the highest spot price is set at $15,000 per MW and the floor price is set at $1,000 per MW.

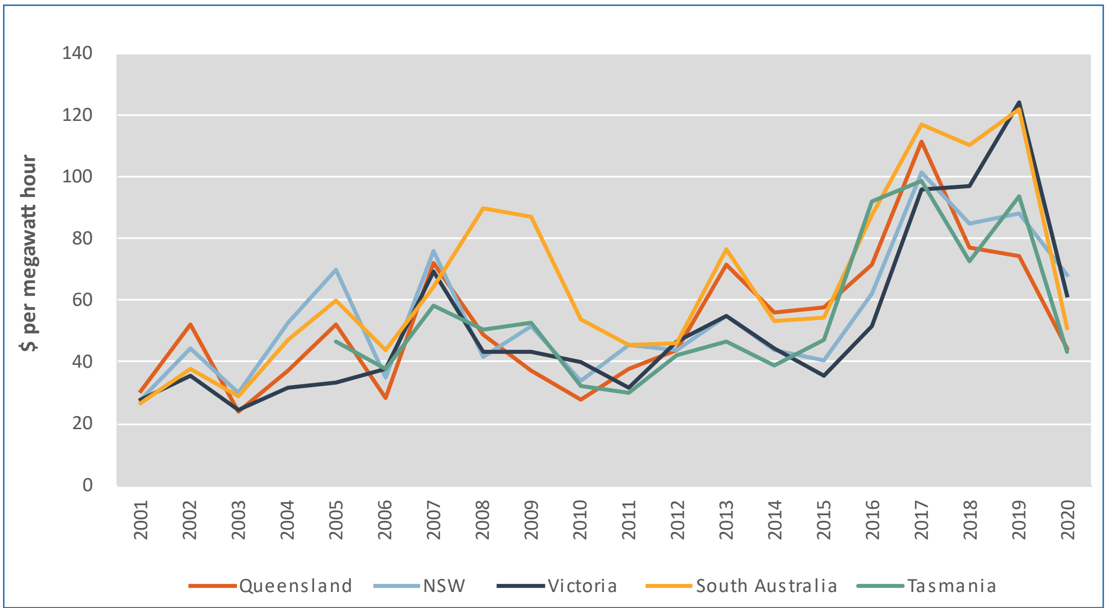
This wholesale spot market provides a basis and reference point for numerous other price hedging mechanisms, derivatives and contractual instruments such as power purchase agreements through which energy is commonly traded. These hedging and contractual mechanisms enable market participants to manage their risks. They provide increased 'line-of-sight' certainty over future energy costs for those market participants that don't want to be exposed to the volatility of the wholesale spot market. This provides a basis for enable retailers to offer customers more forward price certainty and stability which is a critical need in retail markets.

AEMO operates separate prices for each NEM region (States).

Wholesale energy markets tend to move in seasonal cycles and are linked to cooler and warmer weather. Historically, they have tended to rise in the fourth quarter and then peak in the first quarter next year with the summer conditions, then easing in the autumn and winter quarters.

The spot price trends over the past three years have been volatile and impacted by a number of significant events. These include the extremely hot 2019/20 summer with the bushfires, followed by a relatively cool 2020/21 summer and, of course, lower industrial demand due the Covid 19 pandemic. Before this, there was the closure of the Hazelwood Power Station (cheap bottom-of-market brown coal) took about 5% of Victoria's total power generation out of the system and also the Northern Power Station in South Australia closed (also brown coal). [15]

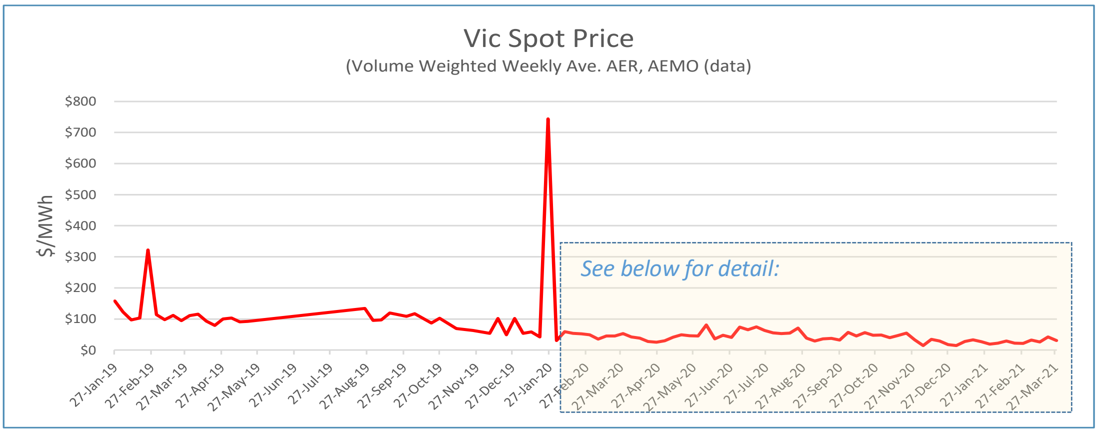
The following chart provides a long-term view of average (volume weighted) spot electricity prices in the different NEM markets. This shows the significant seasonal variation and the market-specific price variability that applies:

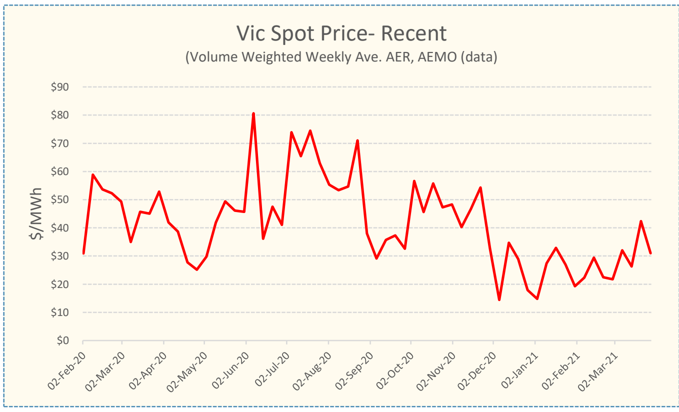



Source: AER, AEMO (data), 2021. Volume weighted average prices.

The above chart also shows the recent significant decline in spot prices that occurred in 2020. The following charts show the variability of the wholesale spot electricity price over the past 3 years throughout the NEM (Victorian price only):

[15] State of Energy Market, Australian Energy Market Regulator, June 2021



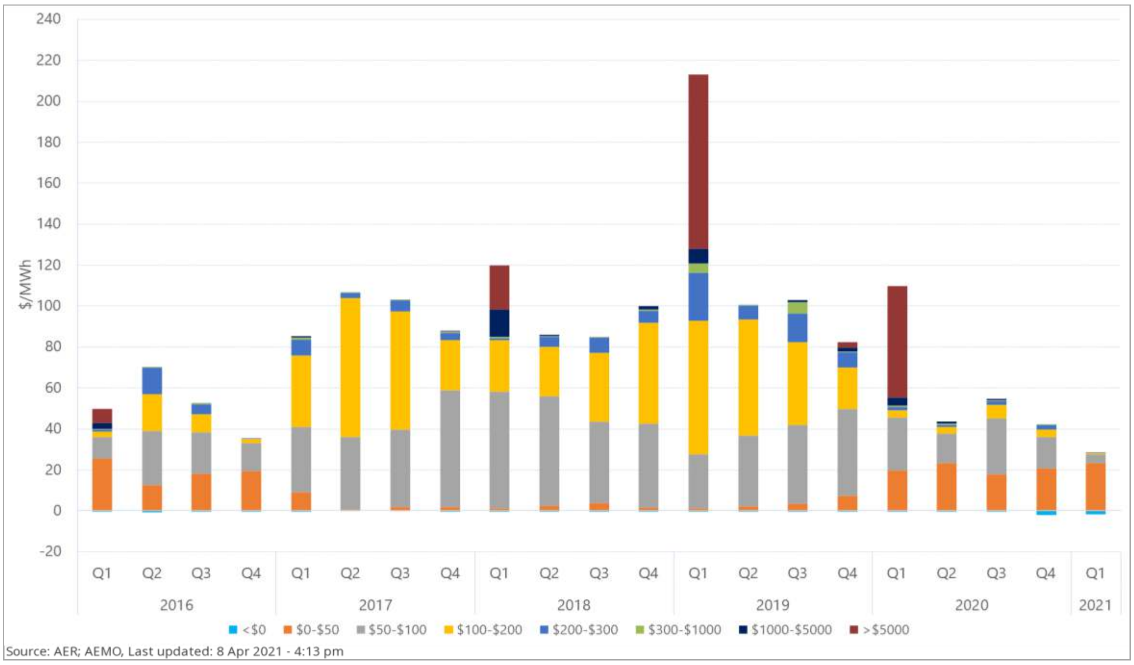

The above charts show that the average volume-weighted weekly spot price (Victoria) between February 2020 and March 2021 has ranged from $14/MWh to $81/MWh.

Further illustrating this recent price volatility, the average spot price (across all NEM markets) in Q2 2021 increased to $95/MWh (up by $40/MWh in Q2 2020). This price spike was attributed to outages at key generation facilities in Victoria reducing supply. [16]

[Note: The above charts are expressed in terms of MWh (not MW). That means at many points, within the analysis period, prices would have reached the regulated maximum spot price (for very short 'price spikes') under AEMO rules of $14,500/MW (the former maximum spot price cap that applied in this period)].

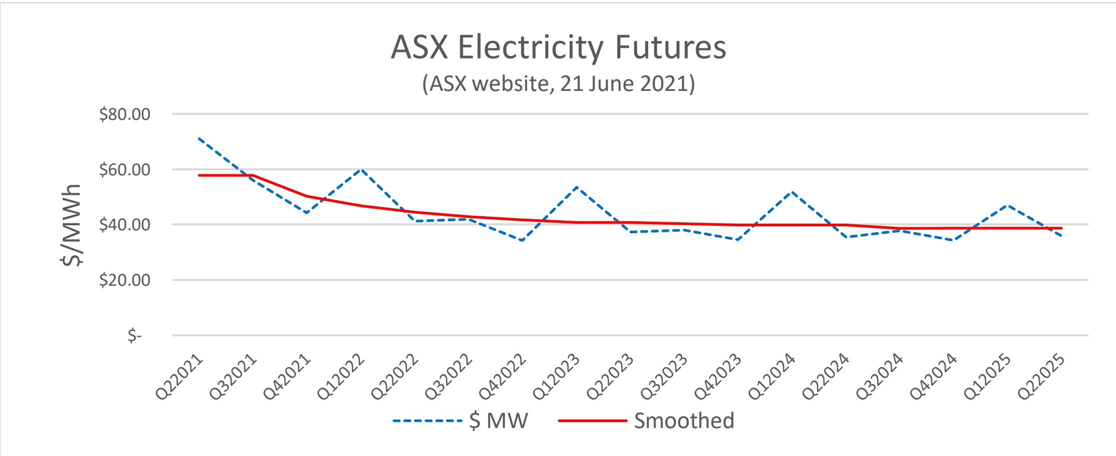
Below is a chart showing the volume weighted average spot prices for the Victorian NEM showing the relative contributions by price segment. This shows the low contribution to the average spot price spikes by high price spikes (over $5,000MWh) in recent quarters. It also shows the recent increased incidence of negative prices:

[16] Quarterly Spot Prices, NEM, AEMO Quarterly Dynamics Q2 2021




### *Future Spot Price Forecasts:*

In the context of the mixed indicator described above, the future of wholesale electricity prices, in a rapidly changing and disrupted market, is very difficult to predict. As a result, there are very few reliable sources of future market price trends. The following chart shows the current market for ASX electricity futures (out to 2025):




The futures market for electricity suggests that the recent steep decline in spot prices will slow over the next few years. Futures markets don't provide a reliable line of sight to actual future prices. However, they offer some insight to how investors and financial markets see future trends. It's also the case that financial instruments such as futures are heavily risk-weighted and so this needs to be taken into account. It indicates prices leveling off at around $40/MWh from about 2022 onwards (this equates to $0.04 /kWh).

## 8.3 Frequency Control and Ancillary Services (FCAS)

These are less-known potential revenue streams for grid-facing storage/generation installations. Ancillary services are used by the Australian Energy Market Operator (AEMO) to manage the power system safely and keep frequency in balance. These services are purchased by AEMO to keep the grid in balance and as close as possible to the target optimal frequency of 50 Hz.

In addition to wholesale energy prices (ie; electricity as described above), AEMO operates a market and publishes prices for the 8 different FCAS services (also at 5 minute intervals).

AEMO purchases these services from FCAS market participants (generators and battery operators) as it requires them through bids made into the FACS markets, to operate and maintain stability in the grid. AEMO then recoups the cost of FCAS from the wider group of energy market participants including retailers. There are different types of grid services including Network Support Ancillary Services (NSCAS) and System Restart Ancillary Services (SRAS).

In relation to FCAS, there are 8 different specific services which fall into the FCAS category:

- 4 x Load 'Raise' service (contingency, 5 second, 60 second and 5 minutes)
- 4 x Load 'Lower' services (contingency, 5 second, 60 second and 5 minutes)

In essence, licensed generators and battery/storage operators bid into these markets offering the capacity to raise or lower their load on the grid for different periods of time and with different lead times. That means where there is a frequency issue in a part of the grid that requires immediate load shedding (or load increase) to take place, this will be activated by AEMO through an automated system based on the prices bid into the market by FCAS participants.

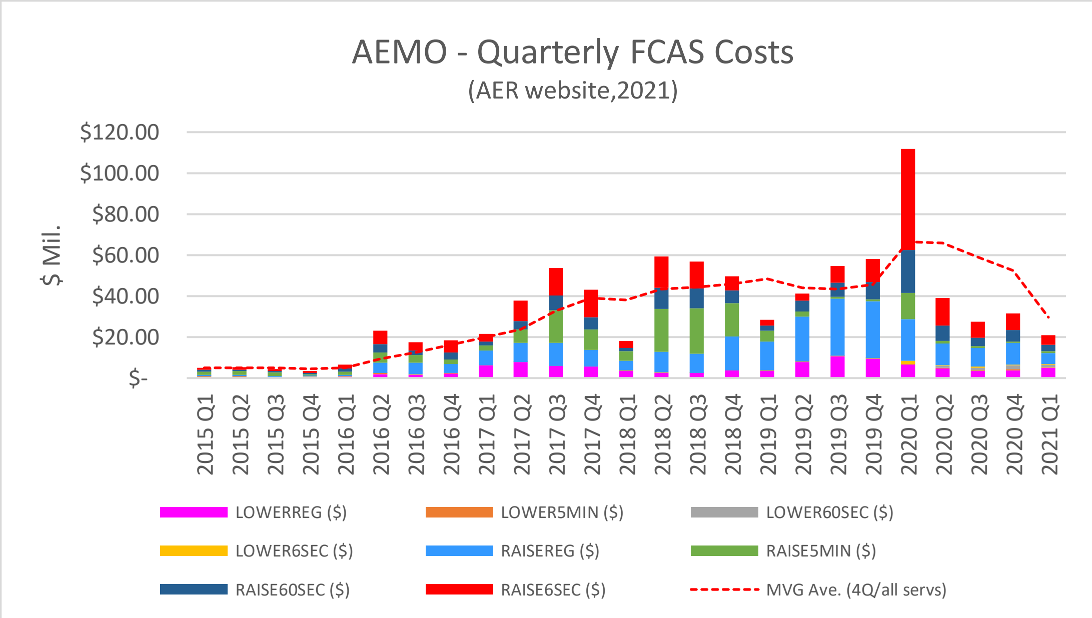
These services are purchased by the MW at market bid rates with a minimum bid level set by AEMO rules at 1 MW. That means that, presently, any small market participants with the potential to offer grid services at less than 1 MW are not able to do so based on current AEMO rules. The implication of this threshold for the options addressed in this feasibility study are that the owner/operator of the assets proposed would need to participate in FCAS market through a licensed market intermediary/aggregator.

The need for grid stabilising services has come much more to the fore in recent years with the increased penetration of renewable energy generation in the NEM. The establishment of the Hornsdale Battery in South Australia (like the prior break-down of the SA-Vic connector) has had a big impact on FCAS markets. However, the market for these services now appears extremely volatile with huge price variability and limited predictability. In December 2016, the cost of one type of FCAS (raise and lower regulation) was $502,320/MW but this fell to just $39,661/MW in December 2017 after the battery began operating. [17]

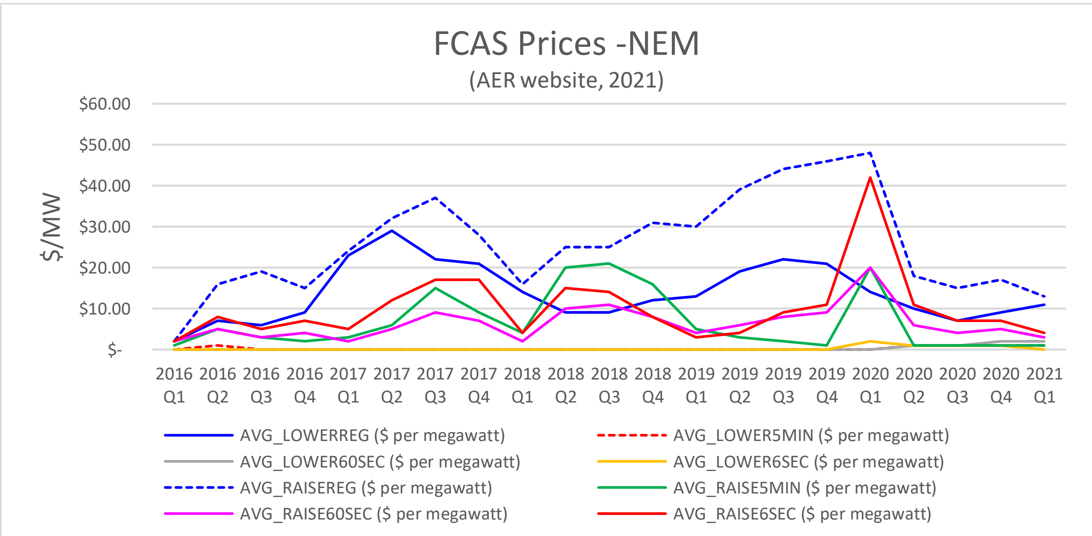
As a result, the long term need for (and market for) these ancillary services (excepting contingency type services for which a need will continue) into the future is also uncertain.

[17] 'Fully Charged: Renewables and Storage Powering Australia', Climate Council, 2018

As an illustration of recent FCAS trends, the chart below shows the quarterly cost to AEMO of the purchase of ancillary services over the past 3 years:




This chart shows the declining trend in the costs of FCAS procurement by AEMO quarterly over the past 12 months. It also illustrates the volatile nature of FCAS. Over the same period since 2016, the chart below shows the fluctuating nature of average prices of FCAS (by service).




Based on the ongoing volatility and uncertainty described above, the assumptions regarding FCAS as a reliable future revenue stream apply significant caution and conservatism.

## 8.4 Revenue Assumptions Applied

Taking into account all the factors discussed in relation to drivers of future revenue streams, the key financial assumptions applied (for all options) in this feasibility study are as follows:

| Revenue Stream: | Assumed Indexation % p.a. | Notes: |
|---|---|---|
| CPI | +2.0% | Applied to all future operating expenses |
| Spot Electricity Prices | 0% | 2020 actual hourly spot prices applied as base. Modelling assumes daily charge/discharge cycle for storage to maximise price yield and eliminate negative price events |
| FCAS | -5.0% | $20,000/MW p.a. |
| Large-scale Generation Certificates (LGCs) | -5.0% | At current market |

# 9. Financial Assessment of Options:

## 9.1 Financial Analysis Method

The financial analysis of options in this section addresses the predicted financial performance/outcomes for each option. To do this, mainstream financial and feasibility analysis techniques have been applied. This section does not address other factors and merits of the options such as environmental impacts and greenhouse gas emissions. These important aspects are dealt with separately later in the report.

This section examines only the financial outcomes of each option based on the various assumptions applied for this feasibility study. For each option, the following is provided:

- Capital/establishment cost estimates
- Income Statement – this details the predicted operating income, expense (including asset depreciation) and profit/(loss) for the first 10 years of the project's life.
- Project cash flows - this details all cash flows (capital and operating) relating to the project for the first 10 years of its life.

Whilst the tables in this report only show the first 10 years of the asset life, this feasibility assessment has been conducted based on a longer estimated project life cycle for the project of 30 years.

## 9.2 Option 1: North East Water Site

**Totally Renewable Yackandandah**

**Feasibility Analysis - North East Water**

*All figures ex GST*

| Capital Costs: | Notes: | | Estimate: |
|---|---|---|---|
| Solar Array | | | $2,453,831 |
| Battery | | | $1,123,194 |
| Electrical | | | $1,212,738 |
| Pumped Hydro Systems | | | $0 |
| Civils | | | $869,572 |
| General | | | $361,629 |
| Contingency | | 7.5% | $451,572 |
| **TOTAL:** | 1 | | **$6,472,536** |

| Income Statement | Notes: | Establishment | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Income:** | | | | | | | | | | | |
| Electricity - solar | 2 | $0 | $121,671 | $121,062 | $120,457 | $119,855 | $119,256 | $118,659 | $118,066 | $117,476 | $116,888 |
| Electricity - from storage | 2 | $0 | $63,924 | $63,605 | $63,287 | $62,970 | $62,655 | $62,342 | $62,030 | $61,720 | $61,412 |
| Grants | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Sales of LGCs | 3 | $0 | $84,645 | $80,413 | $76,392 | $72,573 | $68,944 | $65,497 | $62,222 | $59,111 | $56,155 |
| FCAS | 3a | $0 | $20,000 | $19,000 | $18,050 | $17,148 | $16,290 | $15,476 | $14,702 | $13,967 | $13,268 |
| Total: | | $0 | $290,240 | $284,080 | $278,186 | $272,545 | $267,145 | $261,974 | $257,020 | $252,274 | $247,724 |
| **Expenses:** | | | | | | | | | | | |
| Operations and Maintenance | 4 | $0 | $38,001 | $38,951 | $39,925 | $40,923 | $41,946 | $42,995 | $44,070 | $45,172 | $46,301 |
| Project Management (owner) | 5 | $300,000 | | | | | | | | | |
| Establ Expense (non-capital) | | $0 | | | | | | | | | |
| Rent | 6 | $20,000 | $20,500 | $21,013 | $21,538 | $22,076 | $22,628 | $23,194 | $23,774 | $24,368 | $24,977 |
| Insurance | 7 | $16,181 | $16,586 | $17,001 | $17,426 | $17,861 | $18,308 | $18,765 | $19,235 | $19,715 | $20,208 |
| Interest | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total: | | $336,181 | $75,087 | $76,964 | $78,888 | $80,861 | $82,882 | $84,954 | $87,078 | $89,255 | $91,486 |
| **Surplus/Deficit (cash):** | | **-$336,181** | **$215,153** | **$207,116** | **$199,298** | **$191,685** | **$184,263** | **$177,020** | **$169,942** | **$163,018** | **$156,237** |
| Depreciation | 8 | $289,764 | $289,764 | $289,764 | $289,764 | $289,764 | $289,764 | $289,764 | $289,764 | $289,764 | $289,764 |
| Earnings (before tax) | | -$625,945 | -$74,611 | -$82,648 | -$90,466 | -$98,079 | -$105,501 | -$112,744 | -$119,822 | -$126,745 | -$133,526 |
| Tax (@ 30.0% pa) | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Net profit after tax:** | | **-$625,945** | **-$74,611** | **-$82,648** | **-$90,466** | **-$98,079** | **-$105,501** | **-$112,744** | **-$119,822** | **-$126,745** | **-$133,526** |

**Return on Investment %** -1.15%

| Cash Flow | Notes: | Establishment | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Opening balance:** | | $0 | -$6,808,718 | -$6,593,565 | -$6,386,449 | -$6,187,151 | -$5,995,467 | -$5,811,204 | -$5,634,184 | -$5,464,242 | -$5,301,224 |
| **Cash inflows:** | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Grants | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Loan | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Operating income | | $0 | $290,240 | $284,080 | $278,186 | $272,545 | $267,145 | $261,974 | $257,020 | $252,274 | $247,724 |
| Total: | | $0 | $290,240 | $284,080 | $278,186 | $272,545 | $267,145 | $261,974 | $257,020 | $252,274 | $247,724 |
| **Cash outflows:** | | | | | | | | | | | |
| Capital costs | | $6,472,536 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Operating expenses | | $336,181 | $75,087 | $76,964 | $78,888 | $80,861 | $82,882 | $84,954 | $87,078 | $89,255 | $91,486 |
| Loan payments (principal) | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Tax | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total: | | $6,808,718 | $75,087 | $76,964 | $78,888 | $80,861 | $82,882 | $84,954 | $87,078 | $89,255 | $91,486 |
| **Closing balance:** | | -$6,808,718 | -$6,593,565 | -$6,386,449 | -$6,187,151 | -$5,995,467 | -$5,811,204 | -$5,634,184 | -$5,464,242 | -$5,301,224 | -$5,144,986 |

**NOTES:**

1. Site-specific preliminary capital cost estimates provided by technical consultants for this feasibility (as scoped for this option).
2. Income from sale of electricity into NEM spot market at 2020 ave. hourly prices optimised to maximise return. Future years indexed @0% p.a. for 10 Years
3. LGC price assumed @ $33 indexed @ -5% p.a.

3a. FCAS revenue prices based on advice from Mondo. Indexed @ -5% p.a.

4. O & M cost estimates provided by technical consultants for this feasibility.
5. Allowance only. Addresses costs to project owner/developer to initiate, plan and manage this project.
6. Allowance only.
7. Based on benchmark rate of $ 2500 per $1 mil. insured project/asset value.
8. Assumed asset life cycles include: inverters (10 years), batteries (15 years), solar panels (30 years) and pumped hydro equipment (30 years). Diminishing Value basis.

## 9.3 Option 2: Allan's Flat Site

**Totally Renewable Yackandandah**
**Feasibility Analysis - Allans Flat**

*All figures ex GST*

| Capital Costs: | Notes: | | Estimate: |
|---|---|---|---|
| Solar Array | | | $3,084,933 |
| Battery | | | $3,201,810 |
| Electrical | | | $2,315,155 |
| Pumped Hydro Systems | | | $0 |
| Civils | | | $806,353 |
| General | | | $577,980 |
| Contingency | | 7.5% | $748,967 |
| **TOTAL:** | 1 | | **$10,735,198** |

| Income Statement | Notes: | Establishment | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Income:** | | | | | | | | | | | |
| Electricity - solar | 2 | $0 | $134,860 | $134,186 | $133,515 | $132,847 | $132,183 | $131,522 | $130,864 | $130,210 | $129,559 |
| Electricity - from storage | 2 | $0 | $152,196 | $151,435 | $150,678 | $149,925 | $149,175 | $148,429 | $147,687 | $146,949 | $146,214 |
| Grants | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Sales of LGCs | 3 | $0 | $118,008 | $112,108 | $106,502 | $101,177 | $96,118 | $91,312 | $86,747 | $82,409 | $78,289 |
| FCAS | 3a | $0 | $20,000 | $19,000 | $18,050 | $17,148 | $16,290 | $15,476 | $14,702 | $13,967 | $13,268 |
| Total: | | $0 | $425,064 | $416,729 | $408,745 | $401,096 | $393,766 | $386,739 | $380,000 | $373,535 | $367,330 |
| **Expenses:** | | | | | | | | | | | |
| Operations and Maintenance | 4 | $0 | $60,678 | $62,195 | $63,750 | $65,344 | $66,977 | $68,652 | $70,368 | $72,127 | $73,930 |
| Project Management (owner) | 5 | $300,000 | | | | | | | | | |
| Establ Expense (non-capital) | | $0 | | | | | | | | | |
| Rent | 6 | $25,000 | $25,625 | $26,266 | $26,922 | $27,595 | $28,285 | $28,992 | $29,717 | $30,460 | $31,222 |
| Insurance | 7 | $26,838 | $27,509 | $28,197 | $28,902 | $29,624 | $30,365 | $31,124 | $31,902 | $32,699 | $33,517 |
| Interest | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total: | | $351,838 | $113,812 | $116,657 | $119,574 | $122,563 | $125,627 | $128,768 | $131,987 | $135,287 | $138,669 |
| **Surplus/Deficit (cash):** | | **-$351,838** | **$311,252** | **$300,071** | **$289,171** | **$278,533** | **$268,139** | **$257,971** | **$248,013** | **$238,248** | **$228,661** |
| Depreciation | 8 | $496,283 | $496,283 | $496,283 | $496,283 | $496,283 | $496,283 | $496,283 | $496,283 | $496,283 | $496,283 |
| Earnings (before tax) | | -$848,121 | -$185,031 | -$196,212 | -$207,112 | -$217,750 | -$228,144 | -$238,312 | -$248,270 | -$258,035 | -$267,622 |
| Tax (@ 30.0% pa) | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Net profit after tax:** | | **-$848,121** | **-$185,031** | **-$196,212** | **-$207,112** | **-$217,750** | **-$228,144** | **-$238,312** | **-$248,270** | **-$258,035** | **-$267,622** |
| Return on Investment | | | -1.72% | | | | | | | | |

| Cash Flow | Notes: | Establishment | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Opening balance:** | | $0 | -$11,087,036 | -$10,775,784 | -$10,475,713 | -$10,186,541 | -$9,908,008 | -$9,639,869 | -$9,381,897 | -$9,133,884 | -$8,895,636 |
| **Cash inflows:** | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Grants | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Loan | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Operating income | | $0 | $425,064 | $416,729 | $408,745 | $401,096 | $393,766 | $386,739 | $380,000 | $373,535 | $367,330 |
| Total: | | $0 | $425,064 | $416,729 | $408,745 | $401,096 | $393,766 | $386,739 | $380,000 | $373,535 | $367,330 |
| **Cash outflows:** | | | | | | | | | | | |
| Capital costs | | $10,735,198 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Operating expenses | | $351,838 | $113,812 | $116,657 | $119,574 | $122,563 | $125,627 | $128,768 | $131,987 | $135,287 | $138,669 |
| Loan payments (principal) | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Tax | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total: | | $11,087,036 | $113,812 | $116,657 | $119,574 | $122,563 | $125,627 | $128,768 | $131,987 | $135,287 | $138,669 |
| **Closing balance:** | | **-$11,087,036** | **-$10,775,784** | **-$10,475,713** | **-$10,186,541** | **-$9,908,008** | **-$9,639,869** | **-$9,381,897** | **-$9,133,884** | **-$8,895,636** | **-$8,666,975** |

**NOTES:**

1. Site-specific preliminary capital cost estimates provided by technical consultants for this feasibility (as scoped for this option).
2. Income from sale of electricity into NEM spot market at 2020 ave. hourly prices optimised to maximise financial return. Future years indexed @0% p.a. for 5 Years
3. LGC price assumed @ $33 indexed @ -5% p.a.

3a. FCAS revenue prices based on advice from Mondo. Indexed @ -5% p.a.

4. O & M cost estimates provided by technical consultants for this feasibility.
5. Allowance only. Addresses costs to project owner/developer to initiate, plan and manage this project.
6. Allowance only.
7. Based on benchmark rate of $ 2500 per $1 mil. insured project/asset value.
8. Assumed asset life cycles include: inverters (10 years), batteries (15 years), solar panels (30 years) and pumped hydro equipment (30 years). Diminishing Value basis.

## 9.4 Option 3: Commissioner's Creek Site

**Totally Renewable Yackandandah**

**Feasibility Analysis - Commissioners Creek**

*All figures ex GST*

| Capital Costs: | Notes: | | Estimate: |
|---|---|---|---|
| Solar Array | | | $3,560,300 |
| Battery | | | $720,000 |
| Electrical | | | $2,304,129 |
| Pumped Hydro Systems | | | $4,920,878 |
| Civils | | | $1,317,800 |
| General | | | $1,528,476 |
| Contingency | | 7.5% | $1,076,369 |
| **TOTAL:** | 1 | | **$15,427,951** |

| Income Statement | Notes: | Establishment | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Income:** | | | | | | | | | | | |
| Electricity - solar | 2 | $0 | $161,095 | $160,289 | $159,488 | $158,690 | $157,897 | $157,107 | $156,322 | $155,540 | $154,763 |
| Electricity - from storage | 2 | $0 | $194,554 | $193,582 | $192,614 | $191,651 | $190,692 | $189,739 | $188,790 | $187,846 | $186,907 |
| Grants | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Sales of LGCs | 3 | $0 | $146,157 | $138,849 | $131,907 | $125,311 | $119,046 | $113,094 | $107,439 | $102,067 | $96,964 |
| FCAS | 3a | $0 | $20,000 | $19,000 | $18,050 | $17,148 | $16,290 | $15,476 | $14,702 | $13,967 | $13,268 |
| Total: | | $0 | $521,806 | $511,720 | $502,058 | $492,800 | $483,925 | $475,416 | $467,253 | $459,420 | $451,902 |
| **Expenses:** | | | | | | | | | | | |
| Operations and Maintenance | 4 | $0 | $57,978 | $59,427 | $60,913 | $62,436 | $63,997 | $65,597 | $67,237 | $68,918 | $70,641 |
| Project Management (owner) | 5 | $300,000 | | | | | | | | | |
| Establishment Expenses (non-capital) | | $117,214 | | | | | | | | | |
| Rent | 6 | $30,000 | $30,750 | $31,519 | $32,307 | $33,114 | $33,942 | $34,791 | $35,661 | $36,552 | $37,466 |
| Insurance | 7 | $38,570 | $39,534 | $40,522 | $41,536 | $42,574 | $43,638 | $44,729 | $45,847 | $46,994 | $48,168 |
| Interest | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total: | | $485,784 | $128,262 | $131,469 | $134,755 | $138,124 | $141,577 | $145,117 | $148,745 | $152,463 | $156,275 |
| **Surplus/Deficit (cash):** | | **-$485,784** | **$393,544** | **$380,251** | **$367,303** | **$354,676** | **$342,348** | **$330,299** | **$318,508** | **$306,957** | **$295,627** |
| Depreciation | 8 | $661,584 | $661,584 | $661,584 | $661,584 | $661,584 | $661,584 | $661,584 | $661,584 | $661,584 | $661,584 |
| Earnings (before tax) | | -$1,147,368 | -$268,040 | -$281,333 | -$294,281 | -$306,908 | -$319,236 | -$331,285 | -$343,076 | -$354,627 | -$365,957 |
| Tax (@ 30.0% pa) | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Net profit after tax:** | | **-$1,147,368** | **-$268,040** | **-$281,333** | **-$294,281** | **-$306,908** | **-$319,236** | **-$331,285** | **-$343,076** | **-$354,627** | **-$365,957** |

Return on Investment -1.74%

| Cash Flow | Notes: | Establishment | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Opening balance:** | | $0 | -$15,796,521 | -$15,402,977 | -$15,022,725 | -$14,655,422 | -$14,300,747 | -$13,958,399 | -$13,628,100 | -$13,309,592 | -$13,002,635 |
| **Cash inflows:** | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Grants | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Loan | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Operating income | | $0 | $521,806 | $511,720 | $502,058 | $492,800 | $483,925 | $475,416 | $467,253 | $459,420 | $451,902 |
| Total: | | $0 | $521,806 | $511,720 | $502,058 | $492,800 | $483,925 | $475,416 | $467,253 | $459,420 | $451,902 |
| **Cash outflows:** | | | | | | | | | | | |
| Capital costs | | $15,427,951 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Operating expenses | | $368,570 | $128,262 | $131,469 | $134,755 | $138,124 | $141,577 | $145,117 | $148,745 | $152,463 | $156,275 |
| Loan payments (principal) | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Tax | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total: | | $15,796,521 | $128,262 | $131,469 | $134,755 | $138,124 | $141,577 | $145,117 | $148,745 | $152,463 | $156,275 |
| **Closing balance:** | | -$15,796,521 | -$15,402,977 | -$15,022,725 | -$14,655,422 | -$14,300,747 | -$13,958,399 | -$13,628,100 | -$13,309,592 | -$13,002,635 | -$12,707,008 |

**NOTES:**

1. Site-specific preliminary capital cost estimates provided by technical consultants for this feasibility (as scoped for this option).
2. Income from sale of electricity into NEM spot market at 2020 ave. hourly prices optimised to maximise financial return. Future years indexed @0% p.a. for 10 Years
3. LGC price assumed @ $33 indexed @ -5% p.a.

3a. FCAS revenue prices based on advice from Mondo. Indexed @ -5% p.a.

4. O & M cost estimates provided by technical consultants for this feasibility.
5. Allowance only. Addresses costs to project owner/developer to initiate, plan and manage this project.
6. Allowance only.
7. Based on benchmark rate of $ 2500 per $1 mil. insured project/asset value.
8. Assumed asset life cycles include: inverters (10 years), batteries (15 years), solar panels (30 years) and pumped hydro equipment (30 years). Diminishing Value basis.

## 9.5 Option 4: Leneva (A- Small)

**Totally Renewable Yackandandah**

**Feasibility Analysis - Leneva A (8 MWh)**

*All figures ex GST*

| Capital Costs: | Notes: | | Estimate: |
|---|---|---|---|
| Solar Array | | | $5,530,000 |
| Battery | | | $0 |
| Electrical | | | $2,792,748 |
| Pumped Hydro Systems | | | $4,683,723 |
| Civils | | | $2,292,000 |
| General | | | $1,614,996 |
| Contingency | | 7.5% | $1,268,510 |
| **TOTAL:** | 1 | | **$18,181,977** |

| Income Statement | Notes: | Establishment | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Income:** | | | | | | | | | | | |
| Electricity - solar | 2 | $0 | $330,629 | $328,976 | $327,331 | $325,695 | $324,066 | $322,446 | $320,834 | $319,230 | $317,633 |
| Electricity - from storage | 2 | $0 | $242,994 | $241,779 | $240,570 | $239,367 | $238,170 | $236,980 | $235,795 | $234,616 | $233,443 |
| Grants | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Sales of LGCs | 3 | $0 | $257,730 | $244,844 | $232,601 | $220,971 | $209,923 | $199,427 | $189,455 | $179,982 | $170,983 |
| FCAS | 3a | $0 | $20,000 | $19,000 | $18,050 | $17,148 | $16,290 | $15,476 | $14,702 | $13,967 | $13,268 |
| Total: | | $0 | $851,353 | $834,599 | $818,553 | $803,181 | $788,449 | $774,328 | $760,785 | $747,794 | $735,328 |
| **Expenses:** | | | | | | | | | | | |
| Operations and Maintenance | 4 | $0 | $115,636 | $118,527 | $121,491 | $124,528 | $127,641 | $130,832 | $134,103 | $137,455 | $140,892 |
| Project Management (owner) | 5 | $300,000 | | | | | | | | | |
| Establ Expense (non-capital) | | $117,214 | | | | | | | | | |
| Rent | 6 | $40,000 | $41,000 | $42,025 | $43,076 | $44,153 | $45,256 | $46,388 | $47,547 | $48,736 | $49,955 |
| Insurance | 7 | $45,455 | $46,591 | $47,756 | $48,950 | $50,174 | $51,428 | $52,714 | $54,032 | $55,382 | $56,767 |
| Interest | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total: | | $502,669 | $203,228 | $208,308 | $213,516 | $218,854 | $224,325 | $229,934 | $235,682 | $241,574 | $247,613 |
| **Surplus/Deficit (cash):** | | **-$502,669** | **$648,126** | **$626,290** | **$605,037** | **$584,327** | **$564,124** | **$544,394** | **$525,103** | **$506,220** | **$487,714** |
| Depreciation | 8 | $740,008 | $740,008 | $740,008 | $740,008 | $740,008 | $740,008 | $740,008 | $740,008 | $740,008 | $740,008 |
| Earnings (before tax) | | -$1,242,677 | -$91,882 | -$113,718 | -$134,971 | -$155,681 | -$175,884 | -$195,614 | -$214,904 | -$233,787 | -$252,293 |
| Tax (@ 30.0% pa) | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Net profit after tax:** | | **-$1,242,677** | **-$91,882** | **-$113,718** | **-$134,971** | **-$155,681** | **-$175,884** | **-$195,614** | **-$214,904** | **-$233,787** | **-$252,293** |
| Return on Investment | | | -0.51% | | | | | | | | |

| Cash Flow | Notes: | Establishment | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Opening balance:** | | $0 | -$18,567,432 | -$17,919,306 | -$17,293,016 | -$16,687,979 | -$16,103,653 | -$15,539,529 | -$14,995,135 | -$14,470,031 | -$13,963,811 |
| **Cash inflows:** | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Grants | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Loan | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Operating income | | $0 | $851,353 | $834,599 | $818,553 | $803,181 | $788,449 | $774,328 | $760,785 | $747,794 | $735,328 |
| Total: | | $0 | $851,353 | $834,599 | $818,553 | $803,181 | $788,449 | $774,328 | $760,785 | $747,794 | $735,328 |
| **Cash outflows:** | | | | | | | | | | | |
| Capital costs | | $18,181,977 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Operating expenses | | $385,455 | $203,228 | $208,308 | $213,516 | $218,854 | $224,325 | $229,934 | $235,682 | $241,574 | $247,613 |
| Loan payments (principal) | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Tax | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total: | | $18,567,432 | $203,228 | $208,308 | $213,516 | $218,854 | $224,325 | $229,934 | $235,682 | $241,574 | $247,613 |
| **Closing balance:** | | -$18,567,432 | -$17,919,306 | -$17,293,016 | -$16,687,979 | -$16,103,653 | -$15,539,529 | -$14,995,135 | -$14,470,031 | -$13,963,811 | -$13,476,096 |

**NOTES:**

1. Site-specific preliminary capital cost estimates provided by technical consultants for this feasibility (as scoped for this option).
2. Income from sale of electricity into NEM spot market at 2020 ave. hourly prices optimised to maximise financial return. Future years indexed @0% p.a. for 10 Years
3. LGC price assumed @ $33 indexed @ -5% p.a.

3a. FCAS revenue prices based on advice from Mondo. Indexed @ -5% p.a.

4. O & M cost estimates provided by technical consultants for this feasibility.
5. Allowance only. Addresses costs to project owner/developer to initiate, plan and manage this project.
6. Allowance only.
7. Based on benchmark rate of $ 2500 per $1 mil. insured project/asset value.
8. Assumed asset life cycles include: inverters (10 years), batteries (15 years), solar panels (30 years) and pumped hydro equipment (30 years). Diminishing Value basis.

## 9.6 Option 4: Leneva (B- Large)

**Totally Renewable Yackandandah**

**Feasibility Analysis - Leneva B (30 MWh)**

*All figures ex GST*

| Capital Costs: | Notes: | Estimate: |
|---|---|---|
| Solar Array | | $5,530,000 |
| Battery | | $0 |
| Electrical | | $2,792,748 |
| Pumped Hydro Systems | | $5,212,301 |
| Civils | | $2,292,000 |
| General | | $1,683,711 |
| Contingency | 7.5% | $1,313,307 |
| **TOTAL:** | 1 | **$18,824,068** |

| Income Statement | Notes: | Establishment | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Income:** | | | | | | | | | | | |
| Electricity - solar | 2 | $0 | $288,498 | $287,056 | $285,620 | $284,192 | $282,771 | $281,357 | $279,951 | $278,551 | $277,158 |
| Electricity - from storage | 2 | $0 | $296,463 | $294,981 | $293,506 | $292,038 | $290,578 | $289,125 | $287,680 | $286,241 | $284,810 |
| Grants | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Sales of LGCs | 3 | $0 | $246,510 | $234,185 | $222,475 | $211,352 | $200,784 | $190,745 | $181,208 | $172,147 | $163,540 |
| FCAS | 3a | $0 | $20,000 | $19,000 | $18,050 | $17,148 | $16,290 | $15,476 | $14,702 | $13,967 | $13,268 |
| Total: | | $0 | $851,471 | $835,221 | $819,652 | $804,730 | $790,424 | $776,703 | $763,540 | $750,906 | $738,776 |
| **Expenses:** | | | | | | | | | | | |
| Operations and Maintenance | 4 | $0 | $119,877 | $122,874 | $125,946 | $129,095 | $132,322 | $135,630 | $139,021 | $142,496 | $146,059 |
| Project Management (owner) | 5 | $300,000 | | | | | | | | | |
| Establ Expense (non-capital) | | $117,214 | | | | | | | | | |
| Rent | 6 | $40,000 | $41,000 | $42,025 | $43,076 | $44,153 | $45,256 | $46,388 | $47,547 | $48,736 | $49,955 |
| Insurance | 7 | $47,060 | $48,237 | $49,443 | $50,679 | $51,946 | $53,244 | $54,575 | $55,940 | $57,338 | $58,772 |
| Interest | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total: | | $504,275 | $209,114 | $214,342 | $219,700 | $225,193 | $230,823 | $236,593 | $242,508 | $248,571 | $254,785 |
| **Surplus/Deficit (cash):** | | **-$504,275** | **$642,357** | **$620,879** | **$599,951** | **$579,537** | **$559,601** | **$540,110** | **$521,032** | **$502,335** | **$483,991** |
| Depreciation | 8 | $761,411 | $761,411 | $761,411 | $761,411 | $761,411 | $761,411 | $761,411 | $761,411 | $761,411 | $761,411 |
| Earnings (before tax) | | -$1,265,685 | -$119,053 | -$140,532 | -$161,460 | -$181,874 | -$201,810 | -$221,301 | -$240,379 | -$259,075 | -$277,419 |
| Tax (@ 30.0% pa) | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Net profit after tax:** | | **-$1,265,685** | **-$119,053** | **-$140,532** | **-$161,460** | **-$181,874** | **-$201,810** | **-$221,301** | **-$240,379** | **-$259,075** | **-$277,419** |
| Return on Investment | | | -0.63% | | | | | | | | |

| Cash Flow | Notes: | Establishment | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Opening balance:** | | $0 | -$19,211,128 | -$18,568,771 | -$17,947,891 | -$17,347,940 | -$16,768,403 | -$16,208,802 | -$15,668,692 | -$15,147,660 | -$14,645,325 |
| **Cash inflows:** | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Grants | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Loan | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Operating income | | $0 | $851,471 | $835,221 | $819,652 | $804,730 | $790,424 | $776,703 | $763,540 | $750,906 | $738,776 |
| Total: | | $0 | $851,471 | $835,221 | $819,652 | $804,730 | $790,424 | $776,703 | $763,540 | $750,906 | $738,776 |
| **Cash outflows:** | | | | | | | | | | | |
| Capital costs | | $18,824,068 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Operating expenses | | $387,060 | $209,114 | $214,342 | $219,700 | $225,193 | $230,823 | $236,593 | $242,508 | $248,571 | $254,785 |
| Loan payments (principal) | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Tax | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total: | | $19,211,128 | $209,114 | $214,342 | $219,700 | $225,193 | $230,823 | $236,593 | $242,508 | $248,571 | $254,785 |
| **Closing balance:** | | -$19,211,128 | -$18,568,771 | -$17,947,891 | -$17,347,940 | -$16,768,403 | -$16,208,802 | -$15,668,692 | -$15,147,660 | -$14,645,325 | -$14,161,334 |

**NOTES:**

1. Site-specific preliminary capital cost estimates provided by technical consultants for this feasibility (as scoped for this option).
2. Income from sale of electricity into NEM spot market at 2020 ave. hourly prices optimised to maximise financial return. Future years indexed @0% p.a. for 10 Years
3. LGC price assumed @ $33 indexed @ -5% p.a.

3a. FCAS revenue prices based on advice from Mondo. Indexed @ -5% p.a.

4. O & M cost estimates provided by technical consultants for this feasibility.
5. Allowance only. Addresses costs to project owner/developer to initiate, plan and manage this project.
6. Allowance only.
7. Based on benchmark rate of $ 2500 per $1 mil. insured project/asset value.
8. Assumed asset life cycles include: inverters (10 years), batteries (15 years), solar panels (30 years) and pumped hydro equipment (30 years). Diminishing Value basis.

## 9.7 Commentary – Financial Assessment Only

Looking simply at the financial outcomes above for each option (ie; and not taking into account the broader community and climate considerations), there is no financial or business case for any of the options examined in this study.

Viewed through the lens of a straight commercial viability 'prism', and without external funding input, each of the options assessed will result in significant operating losses over the life of the project. Whilst all options will deliver positive operating cash surpluses for each year (following establishment), these surpluses are more than off-set by the depreciation expense associated with the degradation of the assets over their predicted life (30 years).

The scale of the predicted operating cash surpluses for each option is expected to reduce marginally each year over the asset lifecycle. This is due to the assumed solar generation/PV degradation and the assumed flat forward spot (wholesale) electricity prices (indexed annually at 0% per annum).

Further, income from the sale of LGCs and FCAS services is also expected to be volatile and declining (assumed decrease in prices of -5% per annum).

In the event that wholesale electricity prices increase in the coming years, then the financial outcomes for each of the options would be improved (see section 10.8 Sensitivity Analysis).

# 10. Overall Assessment of Options:

## 10.1 Overall Assessment Metrics and Criteria

Whilst the previous section has examined each of the options through the relatively narrow 'prism' of financial return only, it is important to note that there are many other and wider legitimate reasons and sources of adding value for any particular proposal. In particular, **environmental impacts** must be considered as absolutely core and central to the merits of and rationale for a proposal.

In this section, each of the options have been examined from a more holistic viewpoint, addressing the impact of each on the environment in addition to financial/ investment value measures. The key metrics applied for this analysis are:

***'Islandability':***

This is a threshold question – is Yackandandah potentially 'islandable' under this option?

***Energy Contribution/Outcomes:***

These are the project scope/size parameters in terms of the amount of energy and energy storage each option is expected to contribute. This is expressed as total MWp and MWh per annum for generation, and for storage capacity, MWh per annum and hours storage (at Yackandandah's average/curtailed load).

***Net Present Value (NPV):***

The Net Present Value (NPV) is a widely used capital investment evaluation tool/metric. It addresses the longer-term financial and commercial merits of an investment proposal, taking into account the long-term cost of capital. NPV aggregates all expected project cash flows (inflows and outflows including establishment and operating revenues/costs) over the investment horizon considered. NPV discounts predicted future net cash flows by a discount factor and returns a $ value as the NPV.

The assessed NPV horizons used for this feasibility study are 15 years and 30 years. An NPV horizon is generally selected by being aligned with an investment horizon. The total project life cycle for each option assessed is deemed to be 30 years for this assessment (per LCOE below).

As a rule of thumb, a project with a NPV of $1 or more is worthy of consideration based on financial merit/considerations. Prima facie, a project with an NPV below $0 would not proceed if it is viewed solely through the lens (or 'prism') of a commercial investment proposition. This is because NPV only considers financial/commercial decision-making criteria (ie; it does not include environmental impact considerations).

However, as stated earlier, there are other important strategic, community and environmental factors that should validly be considered and weighed into an investment equation.

The selected NPV discount factor is an important variable in NPV analysis. It is generally aligned to the cost of funds (borrowing rate) plus a risk factor and/or the weighted average cost of capital (WACC) [18]. On the 'flip-side' of risk, the strategic importance/criticality/value of a proposal can also be weighed into the choice of the NPV discount rate. For this study, a relatively low NPV discount factor of 5% to future net cash flows has been applied.

*Return on Investment:*

This is how much a project is expected to return (annual operating profit, taking account of tax, interest and asset depreciation) as a % of the total capital cost.

*Capital Costs- Generation and Storage:*

This is the up-front establishment costs for each of the options assessed. For this assessment, the generation and storage cost components of the total capital cost estimate have been separately attributed to each function. These costs include all capital and establishment costs including grid capacity upgrades but excluding owner-incurred project management costs (these are treated as operating costs for this assessment).

*Levelised Cost of Energy (LCOE):*

This is a widely used metric in grid-scale energy investment circles. It aims to provide (for comparative purposes across different technology and investment options) a view of the long-term cost of energy that is implied in a given project proposal over its expected life. The LCOE of a project can be regarded as the minimum price for which electricity generated by an asset needs to be sold in order for the project to break even. Selling the energy at below the LCOE implies a loss whereas selling it at above the LCOE implies a profit. Of course, like all such metrics of this type, it is indicative and assumption-based and therefore not conclusive in any respect.

LCOE includes all capital and operating cash costs but excludes revenues. Like Net Present Value, it discounts energy generated and costs incurred in future years by a discount factor. In this study, a discount factor of 5% has been used (same as the NPV discount factor used). The discount factor is applied equally to predicted future cash operating costs and future generation (MWh p.a.). A project lifecycle of 30 years has been used for all options.

For this analysis, capital reinvestments/upgrades have been allowed for/budgeted at intervening times throughout the 30 year project lifecycle (ie; inverter replacement is assumed to be required after each 10 years operation, a major pumped hydro plant upgrade is assumed after 20 years etc.).

Using this approach (ie; assuming the longer lifecycles overall and allowing for periodic intra-life asset upgrade/component replacement), it has been possible to approximately equalise the underlying differences that are generally considered to apply to different asset types (ie; the 30+ year life cycles generally associated with pumped hydro energy storage systems compared to 10-15 years for lithium ion batteries and 10 years for inverters).

*Towards 'Yack 100% Net Renewable':*

This is the predicted year, for each option, that Yackandandah would achieve the target of being 100% net renewable. (NB: The 100% gross target is not achievable within the analysis timeframe for any of the options addressed in the study).

[18] NSW Electricity Infrastructure Roadmap, Weighted Average Cost of Capital Report (National Australia Bank, 2020)- WACC for solar PV investments -4.99%

As stated earlier, an adjusted definition of Net Renewable is applied to recognise the current (and growing) renewable energy component withing the NEM electricity grid.

### *Greenhouse Gas ($CO_2$ eq.) Emissions Impact:*

This is how much the project options will impact the environment expressed in terms of tonnes of $CO_2$ equivalent reduced (ie; clean energy generated replacing other non-renewable imported energy) over the 30 year project lifecycle. The project cost per tonne of $CO_2$ equivalent is also provided.

## 10.2 Option Comparison

The table below provides a high-level comparison of each of the options.

**Totally Renewable Yackandandah**
**Feasibility Study - YACKANDANDAH MICROGRID**
**OPTIONS SUMMARY**

| | | |
|---|---|---|
| Yackandandah - ave. load: | 1.726 | MW |
| Peak load: | 3.071 | MW |
| Total Annual Consumption (2021 Est.): | 15,606 | MWh p.a. |
| Ave. Daily Consumption (2021 Est.): | 42.64 | MWh/day |
| Curtailed Daily Consumption (50% of ave.): | 21.32 | MWh/day |

| | Notes: | OPTION 1: | OPTION 2: | OPTION 3: | OPTION 4: | OPTION 5: |
|---|---|---|---|---|---|---|
| Location | | North East Water | Allans Flat | Commissioners Creek | Leneva A (Small) | Leneva B(Large) |
| Description | | Batt + solar | Batt + solar | PH + solar | PH + solar | PH + solar |
| Islandablility potential | 1 | Yes | Yes | Yes | No | No |
| FOM /BTM Solar Gen Capacity (MWp) | 2 | 1.63 | 2.25 | 3.45 | 6.00 | 6.00 |
| Total Generation p.a. (MWh) | | 3,061 | 4,226 | 6,479 | 11,268 | 11,268 |
| Storage - (MWh) | 3 | 2.60 | 7.40 | 10.00 | 8.00 | 30.00 |
| Storage (approx. hrs @ ave.load) | 4 | 1.5 Hrs | 4.3 Hrs | 5.8 Hrs | 4.6 Hrs | 17.4 Hrs |
| HW /Demand red'n progr (MWh p.a.) | | | | | | |
| Towards 'Yack 100% Renewable': | | | | | | |
| - Year 'NET zero' achieved | 5 | 2025 | 2025 | 2025 | 2024 | 2024 |
| - Year 'GROSS zero' achieved | 6 | NA | NA | NA | NA | NA |
| - Tonnes $CO_2$eq Saved/Reduced | 7 | 51,546 | 71,850 | 88,990 | 156,898 | 150,064 |
| Capital Cost - Generation ($mil.) | 8 | $4.296 | $5.577 | $6.938 | $10.411 | $10.419 |
| Capital Cost - Storage ($mil.) | 9 | $2.177 | $5.158 | $8.490 | $7.771 | $8.405 |
| **Total Cost - Capital ($mil.)** | | **$6.473** | **$10.735** | **$15.428** | **$18.182** | **$18.824** |
| Generation cost/MWp ($mil.) | 10 | $2.635 | $2.479 | $2.011 | $1.735 | $1.736 |
| Storage cost/MWh ($mil.) | 11 | $0.837 | $0.697 | $0.849 | $0.971 | $0.280 |
| Net Present Value ($ mil./10 years) | 12 | -$5.49 | -$9.17 | -$13.47 | -$14.66 | -$15.34 |
| Levellised Cost of Energy -LCOE (30 yrs) | 13 | $187 | $216 | $198 | $138 | $142 |
| Return on Investment (Year 1 Ops) | 14 | -1.15% | -1.72% | -1.74% | -0.51% | -0.63% |
| Viability 'Gap' ($ mil.) | 15 | -$5.49 | -$9.17 | -$13.47 | -$14.66 | -$15.34 |
| Viability 'Gap' (as % of Capital Cost) | | -84.9% | -85.5% | -87.3% | -80.6% | -81.5% |
| **Cost per tonne of $CO_2$eq ($)** | | **$125.57** | **$149.41** | **$173.37** | **$115.88** | **$125.44** |
| Ave. sale price achieved/MWh ($) | | $60.63 | $67.93 | $54.89 | $50.91 | $51.91 |
| Value of Total Emissions Saved ($ mil.) | 16 | $1.13 | $1.58 | $1.96 | $3.45 | $3.30 |

**NOTES:**

1 Theoretical potential only. Subject to all DNP policy and rules issues being addressed
2 New Front-of-Meter (FOM) generation capacity installed through this investment. Organic Rooftop PV generation growth is additional to this.
3 New FOM storage (Pumped Hydro and battery).
4 The number of hours Yackandandah could continue to be powered for (if islanded) at average load.
5 Net zero target - based on imported power adjusted to account for existing green power component (plus green growth per AEMO forecasts)
6 Gross zero- this is where there is not one hour in any day of the year where we import any power from the grid.
7 Based on 1.13Kg of $CO_2^{eq}$ per kWh of new green electricity generated attributable to project. Assessed up until grid energy is generated from 100% renewable sources (per AEMO).
8 Capital costs estimates - generation assets. Based on technical studies by Mondo, Boschetti Industries, Tamar Hydro and Ausnet Services.
9 Capital costs estimates - storage assets. Based on technical studies by Mondo, Boschetti Industries, Tamar Hydro and Ausnet Services.
10 Generation cost per MWp - captal costs attributed to solar generation assets.
11 Storage cost per MWh - captal costs attributed to battery (FOM and BTM) and pumped hydro storage assets.
12 Net Present Value (NPV). Includes all predicted operating and capital project cash flows over 10 years with a 5% discount rate applied.
13 Levellised Cost of Energy (LCOE). Total of capital & operating costs (excl. tax, interest and depreciation/amortisation) over project lifetime per MWh of energy (discounted)
14 Return on Investment (ROI). Year 1 Return (net) from operations as % of total capital investment in project.
15 Viability 'Gap'. The amount of grant funds that would be required for the project to deliver a $1 NPV (ie; to make it 'prima facie' commercially viable).
16 Notional value of $CO_2$ emmisions saved based on Australian Carbon Credit Unit Price (July 2021): $ 22.00

## 10.3 Commentary – Islandability

The goal of islandability is based on the idea that the local electricity grid in and around Yackandandah could be operated independently for the wider grid. This may, in theory, occur on a permanent basis or as a temporary response to emergency situations (see discussion in section 5.2).

The potential for islandability is a simple threshold question for each option: Yes or No. As the table above shows, all options except the two Leneva options (A and B) are potentially islandable.

However, the weighting or importance placed on islandability is highly subjective. It could be argued that Yackandandah is part of the wider Australian (and NEM) community and as such, it makes sense to continue to be part of and linked to the NEM and wider grid. In an emergency context, as discussed in section 5.2, this scenario differs.

Having the ability and local generation/storage capability to continue to supply electricity to the community when the grid fails (outside the local area) would clearly be of huge benefit to the community. Despite this, for this feasibility, it has been decided to address the islandability merits of the proposals along-side the various other criteria and merits.

## 10.4 Commentary – Financial Merit (NPV Assessment)

This analysis shows that all options considered in this study have a significant negative NPV (ranging from $5.49 mil. to $15.34 mil.). This suggests that, prima facie, none of these options would be pursued if the driving rationale was financial/commercial goals.

Of course, this NPV assessment reflects the full capital and operating costs of each of the project options. It does not take account of the potential for attracting government grants and philanthropic contributions towards projects (which is likely in fact to occur). Any such grants and contributions would change the financial investment equation as viewed from a local 'value' perspective.

The negative NPV figure provides an indication of the amount of grants/philanthropic contributions that would need to be available to a project in order for it to be considered financially viable (from a local investment contribution viewpoint). In other words, a $5 million grant towards a project would substantially change the investment merits of a proposal from a local viewpoint. This implies (and assumes) that the grant component of the project capital cost does not require the generation of a financial return.

(NB: It should be noted that any such external project funding contributions do not change the underlying financial feasibility of the proposal itself from an investment analysis viewpoint.)

## 10.5 Commentary – Towards 'Yack 100% Renewable'

The 100% renewable goal has been at the forefront of and intrinsic to the TRY narrative since its founding in 2014. Part of this study has been to address if, how and when this can be achieved and whether or not it is a realistic goal.

***100% Gross Target:***

Under any of the options considered for this study (and assuming demand/consumption continues at the current and projected rates), the 100% gross target is not achievable for Yackandandah under any of the options addressed in this study. Even for significantly higher-scaled assets that those assessed in this study, it would be considered very challenging. This is because the scale of assets required to meet Yackandandah's peak load (3.071 MW), together with the grid infrastructure upgrades that would be necessary to accommodate these, and to be able to generate and store sufficient energy to sustain the community through potentially extended periods of low solar generation in winter, would be very costly.

To achieve the 100% gross target, Yackandandah needs to generate and store sufficient energy locally so as it does not need to import any electricity from the grid (which is energy coming from various clean and non-renewable sources that cannot be controlled locally) on any single day of a given year. For each of the options addressed in this study, the threshold of 100% gross renewable is not achievable within the project timeframes (ie 30 years).

To illustrate the scale of the gross threshold, it would have meant that on 23 January 2020 (specifically, between 5.00 pm. and 6.00 pm. on that day), Yackandandah would have needed a local generation capacity to meet the peak load at that particular time of 2.23MW (peak load of 3.071 MW less 27.5% of existing clean grid energy). Further, to power Yackandandah through a 2 week period of winter weather (at an average load of 1.7MW with low solar irradiation averaging say 15% of rated capacity) as has recently occurred, about 450-500 MWh (indicatively) would need to be generated and stored. Based on indicative benchmark battery costs, this would represent an investment of somewhere over $300 million which is prohibitive.

Further, the following table shows (for each option assessed based on the demand and production modelling undertaken for this project), the number of days in each year when there would be any electricity (ie: >0watts) required to be imported from the grid:

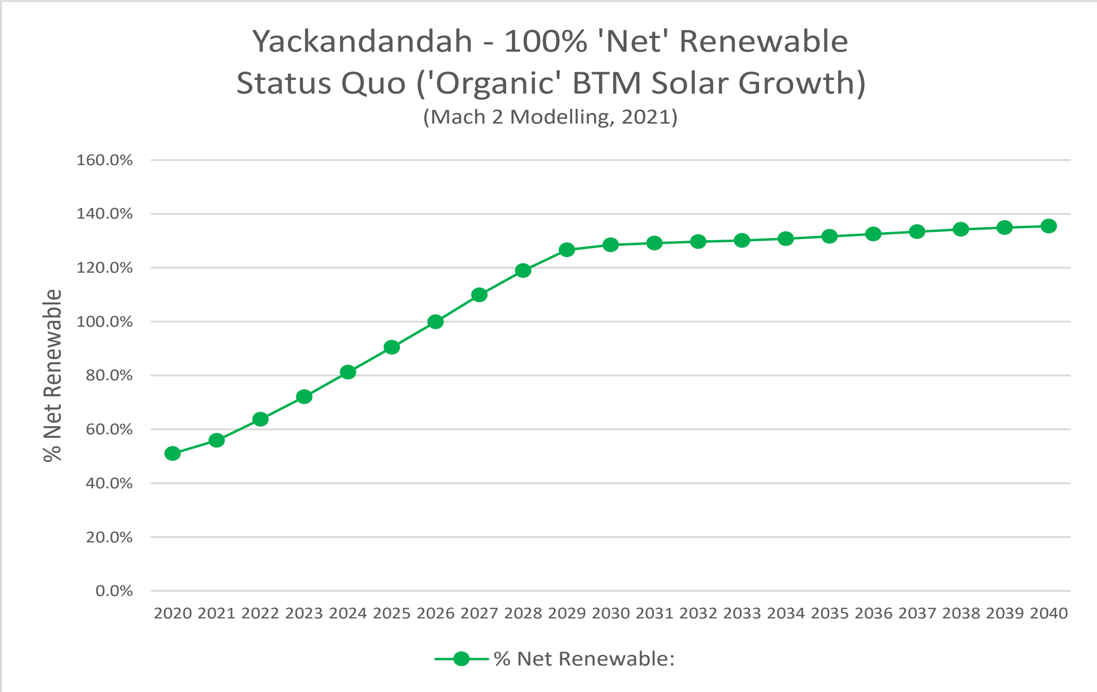
| 100% Gross Target: | Option 1<br>North East Water Site | Option 2<br>Allan's Flat Site | Option 3<br>Commiss's Creek Site | Option 4<br>Leneva Site (A) | Option 5<br>Leneva Site (B) |
|---|---|---|---|---|---|
| Days of Import >0 watts | 366 | 366 | 366 | 366 | 230 |

This table shows that the large Leneva B option is the only option to make any inroads towards the 100% gross target and, even then, (with a predicted 230 days of imported electricity), it's a long way off.

Taken together, the above analysis means the 100% gross target is extremely challenging.

### *100% Net Renewable Target:*

The chart below shows the 'status quo': this is the predicted progress of Yackandandah towards the 100% Net Renewable Target if **no additional front-of meter generation and storage capacity** (per the options addressed in this report) are established. This scenario essentially assumes that the current/predicted growth of BTM solar generation and FOM clean grid-sourced energy share will continue to grow 'organically'. This is based on the modelling undertaken by Mach 2 for this project and all the consumption and generation assumptions addressed above:




This illustrates that Yackandandah, with its current high level of solar penetration, (plus the recent addition of the 'Yack 01' solar-battery facility) combined with the continued high growth rate that is predicted for BTM solar generation, (at current consumption plus predicted demand growth), will achieve the target of 100% Net Renewable in **2027**.

(NB: The predicted 'flattening' of the above renewable energy growth curve in 2029 reflects the estimated reduction of small-scale PV generation growth after that time by AEMO).

As this is based on detailed modelling (including all the various local and NEM-wide assumptions that go with it), this outcome is by no means certain. However, it can be taken as a reliable indicator of the likely timeframe (+/- 1 year).

The table below shows the predicted timeframe for Yackandandah to reach the 100% Net Renewable Target under each of the **options** examined in this study (including the status quo 'organic' option). These are based on the modelling undertake by Mach 2 for this project and all the consumption and generation assumptions addressed above:

| OPTION: | Year 100% Net Renewable Achieved: |
|---|---|
| Status Quo ('Organic BTM Solar Growth only) | 2027 |
| Option A: North East Water Site | 2025 |
| Option B: Allan's Flat Site | 2025 |
| Option C: Commissioners Creek Site | 2025 |
| Option D: Leneva Site (A) | 2024 |
| Option E: Leneva Site (B) | 2024 |

All five options addressed are predicted to get Yackandandah to 100% net renewable in calendar year 2024-2025. As expected, the original TRY goal of being 100% renewable by 2022 does not appear possible at this stage.

There are a number of key things to note in relation to this analysis. Firstly, a significant contributor to the achievement of the 100% net goal is the assumed continuation of 'organic' BTM rooftop solar generation growth within Yackandandah (this has averaged 14.2% p.a. in the past three years in Yackandandah). This high level of BTM solar capacity growth is expected to continue to occur irrespective of whether or not any other additional grid-facing investments are made in Yackandandah. As the status quo option shows, this BTM growth alone would get Yackandandah to 100% Net renewable by 2027.

Secondly, in considering the adjusted net renewable target (as opposed to a gross target), it is only the amount of generation (not storage) included in the options that influences the timeframe for reaching the 100% threshold. Storage, whilst being critical in a commercial sense to 'time-shift' the supply of electricity (to maximise price yield), makes no difference to the timeframe of being 100% net renewable.

Thirdly, an interesting outcome of this study is that it shows the significant amount of energy that is spent in the pumping of water (in the pumped hydro options) to achieve energy 'time-shifting'. The site-specific pumped hydro configurations scoped for this feasibility study are estimated (by technical consultants Tamar Hydro) to have a 'round-trip' efficiency factor of an average of 67%. That means for every 0.67MWh of energy 'time-shifted' by the facility, a further 0.33MWh is consumed to achieve that. (Lithium-Ion batteries, for comparison, have an efficiency rate of about 95% so much less energy is lost through the process of storing the energy).

This fact underscores the complexity of assessing the various options and the different 'lens' that may be applied. If an owner of such a time shifting storage mechanism can achieve a premium price for the energy stored (in this case a premium of more than 33% is required), then it may be attractive in financial/commercial terms. However, the energy required to store that power is still expended and must be accounted for. Even though, under these scenarios, this energy is generated from a renewable on-site source, by using (spending it) to pump water it is not then available to be exported into the grid to offset what might otherwise be additional non-renewable energy to meet other needs.

In summary, the modelling and analysis conducted for this feasibility study shows that, under each of the options, the goal of 100% net is **achievable by 2024**. (This is based on commissioning of assets by the start of 2024).

## 10.6 Greenhouse Gas Emissions Impact (Tonnes $CO_2$eq. saved)

Clearly, in a climate emergency context, this goal must be considered paramount. The analysis undertaken for this study shows that the greatest contribution to greenhouse gas emission reduction is for the options with the largest generation components (Leneva A and B, each with 6.0 MW of solar generation). The reduction of $CO_2$ emissions is assumed to occur through the displacement of existing non-renewable energy that is sourced from the NEM grid. It is noted that, as the analysis recognises the current and growing contribution made by renewable energy in the wider NEM grid, the contribution of new local assets to offsetting the remaining non-renewable grid energy component (and the corresponding reduction to greenhouse emissions) will cease once the NEM grid achieves 100% renewable (assumed to be 2040 for this study based on AEMO forecasts).

Our analysis shows that each of the two Leneva options will generate 11,268 MWh of renewable energy each year. This leads to a greenhouse gas emission reduction of about 150-157,000 tonnes $CO_2$ equivalent (over the next 16 years).

The smallest emission reduction impact is the North East Water site (51,000 tonnes $CO_2$ equivalent over the next 8 years).

### *Environmental 'Value-for-Money':*

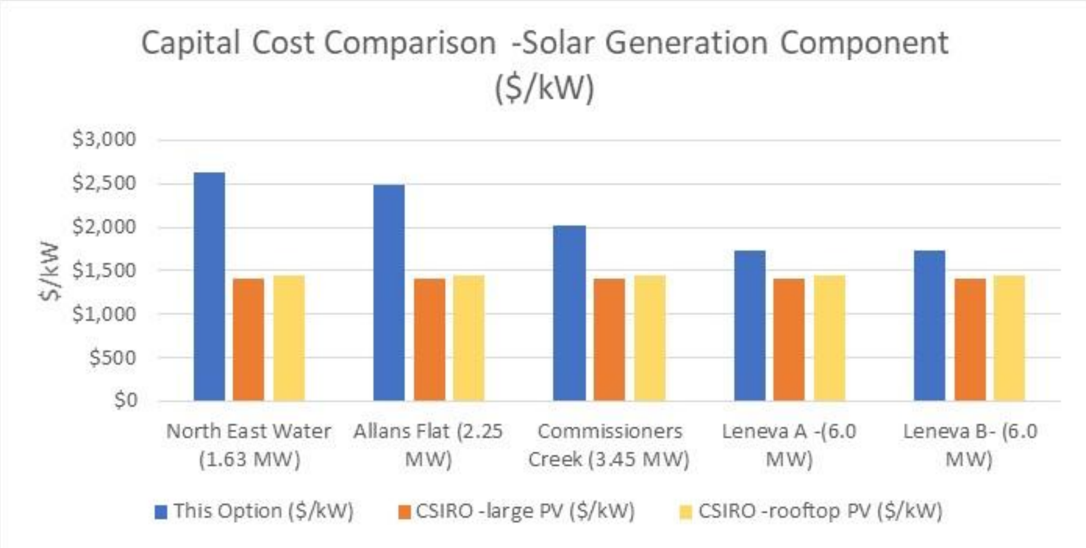
The best environmental 'value for money' options (Capital cost $ per tonne $CO_2$ eq) are also the two Leneva options and the North East Water option ($115-$125/t.$CO_2$ eq.) This indicates that these options have the biggest impact on greenhouse emissions for each $ of capital invested.

The most expensive option per tonne of $CO_2$ eq. emission avoided is the Commissioner's Creek site ($173/t.$CO_2$ eq.)

The current value of the total lifecycle greenhouse emission reductions for the Leneva options is estimated to be $3.3-$3.4 mil. (based on the July 2021 Australian Carbon Credit Unit Price of $22.00).

### *Capital Costs- Generation*

The up-front capital/establishment costs for each of the **generation components** of each option (compared to CSIRO benchmarks) are shown in the chart below:




The above chart indicates that the generation only components of all options assessed for this study (based on the site-specific capital cost estimates provided by the technical consultants) appear to be relatively expensive compared to CSIRO/AEMO benchmarks. [19] However, it also shows that, for the larger solar PV installation option (Leneva A and B at 6.0 MW), the cost per MW is lower than other options and closer to the benchmark rates. Despite this gap being narrower, the cost per MW for the Leneva site is still significantly (23%) higher that the CSIRO large PV benchmark.

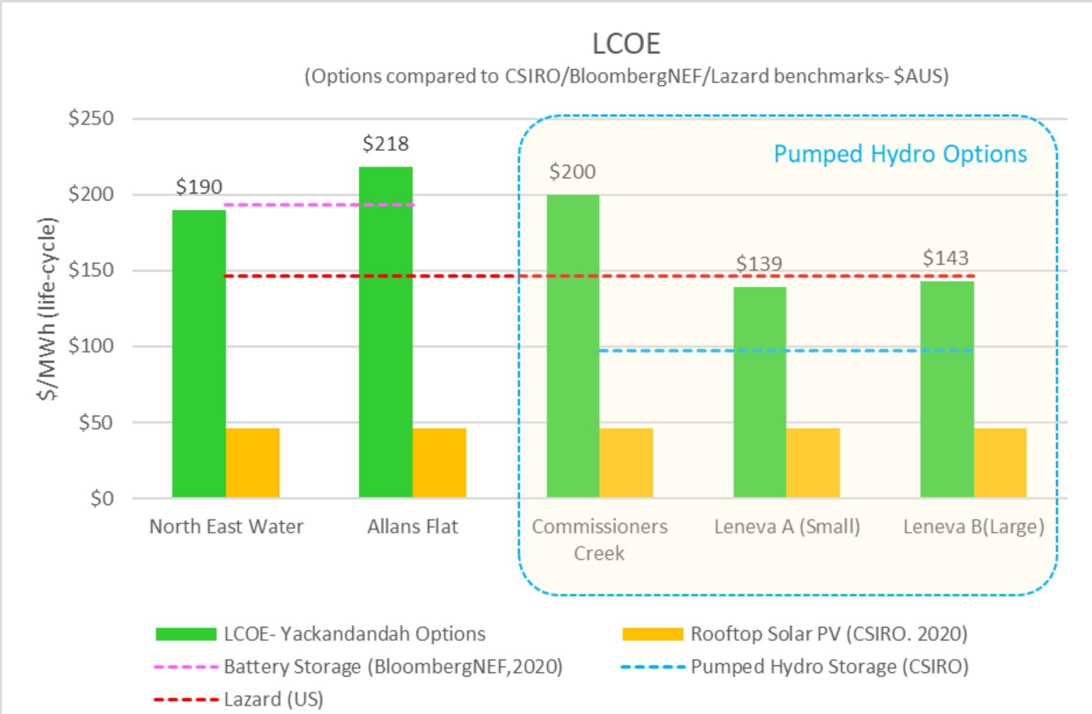
This outcome supports the notion that there are substantial scale economies at play in the construction of grid-facing solar PV generation installations of the scale contemplated in this feasibility study. The one-off 'flag-fall' type costs of establishing a grid point-of-connection are a key component of the cost basis and these weigh heavily on the options considered in this study.

The relatively high capital costs of the options (combined with relatively low forward wholesale electricity prices), are the major 'drag' on the expected financial outcomes of the project options (NPV etc.).

## 10.7 Levelised Cost of Energy (LCOE)

The options assessed for this feasibility study are expected to have an LCOE ranging from $139 to $218 per MWh of energy generated over each project's full life cycle. This is shown in the chart below (compared to CSIRO, Bloomberg and Lazard benchmarks):

[19] GenCost 202-21, CSIRO, December 2020




This chart indicates that, based on a pure LCOE basis, the two battery options (North East Water and Allan's Flat) are comparable to the BloombergNEF battery benchmark. [20] The Three pumped hydro options are relatively expensive options on an LCOE basis compared to the CSIRO benchmark. [21] The Lazard benchmark is an international (US-based) research benchmark across various storage technologies (including batteries and pumped hydro). Compared to the Lazard benchmark, the two Leneva options appear relatively good value for money.

Taken together, these LCOE benchmark comparisons would seem to indicate that the scale economies associated with pumped hydro storage are substantial. In this context, the relative scale of the options considered in this feasibility study is small.

(NB: The CSIRO Rooftop solar PV benchmark is not directly relevant to the options considered. It is provided in this chart for contextual purposes only).

## 10.8 Sensitivity Analysis

The table below provides a detailed sensitivity analysis of each of the options addressed in the feasibility study. This is done based on the NPV of each of the options based on various different operational (revenue/spot price) and capital cost assumptions/scenarios. (NB: Given that the base case scenarios for all options already have significantly negative NPV, this sensitivity analysis has been focused only on improved assumptions/scenarios).

[20] New Energy Outlook 2020, BloombergNEF, 2020.

[21] GenCost 2020-21 [Consultation Draft], CSIRO, December 2020/Reserve Bank of Australia Bulletin, March 2020.

| SENSITIVITY ANALYSIS: | OPTIONS: (10 Year NPV –$ mil.) | | | | |
|---|---|---|---|---|---|
| Scenarios: | Option 1: North East Water | Option 2: Allan's Flat | Option 3: Commiss'ns Creek | Option 4: Leneva A | Option 5: Leneva B |
| **Lower Capital Costs:** | | | | | |
| 1. 20% lower than estimated | -$4.198 | -$7.026 | -$10.387 | -$11.026 | -$11.574 |
| 2. 30% lower than estimated | -$3.551 | -$5.953 | -$8.844 | -$9.208 | -$9.692 |
| **Increased Future Spot Prices:** | | | | | |
| 3. 10% p.a. price increase | -$4.517 | -$8.181 | -$11.604 | -$11.910 | -$12.491 |
| 4. 20% p.a. price increase | -$3.230 | -$6.855 | -$8.924 | -$8.131 | -$8.633 |
| **Combination Scenarios:** | | | | | |
| 5. 20% lower capex/10% price increase | -$3.222 | -$6.034 | -$8.518 | -$8.273 | -$8.726 |
| 6. 30% lower capex/20% price increase | -$1.287 | -$3.635 | -$4.296 | -$2.676 | -$2.986 |

### *Sensitivity Analysis- Commentary:*

The modelling undertaken for this feasibility study is highly sensitive to the assumed wholesale (spot) electricity price and the estimated capital costs.

The above analysis shows that, even if significant year-on-year wholesale price growth (10% and 20% is applied) combined with lower-than-estimated capital costs, each option still has a negative NPV. Further, reduced capital cost scenarios are considered in the table above (20% lower-than-estimated and 30% lower-than-estimated).

This shows that with either increased spot prices or reduced capital costs (or both), the NPVs for all options examined are negative. As stated earlier, this means that (prima facie) and taking account only of the financial/investment merit of the proposition in isolation (ie; excluding environmental outcomes), none of the options is worthy of progressing.

The likelihood of achieving lower-than-estimated capital costs in the order of 10-15% for these options is considered reasonably good, given the typically risk-averse nature of preparing cost estimates for projects of this type. But, reduced capital costs in the order of 20-30% would seem very optimistic and should not be factored into project planning.

In relation to achieving better-than-assumed wholesale spot price rises into the future, the same situations applies. It is possible that the recent reducing trends driving spot prices may stabilise and marginal future increases may in fact occur. However, based on the present volatility, dynamics and observable evidence in the energy sector, it appears unlikely that sustained year-on-year price increases of 10-20% will occur and if they do, they will be short-lived.

(NB: It should be noted that the above financial assessment takes into account the full capital and operating costs of each of the project options. It takes no account of the potential for government grants and philanthropic contributions towards projects which is likely in fact to occur. Any such grants and contributions change the financial investment equation as viewed from a local 'value' perspective. However, these external contributions do not change the underlying financial feasibility of the proposal itself from an investment analysis viewpoint.)

# 11. Other Potential Technologies

## 11.1 Wind Generation

Wind generation was not included as an option considered in the scope of this project. However, it is discussed in a summary fashion in this report as wind energy may potentially be worth consideration in and around Yackandandah for a number of reasons.

Whilst Yackandandah is generally not renowned as being a high wind area, there appears to be a reasonable level of wind resource (albeit a 'low wind' level of resource) on some of the higher peaks around the town. Subject to detailed resource assessment, this level of wind resource may prove to worthwhile/feasible if it is combined with other (solar) generation and storage assets in a multi-asset renewable energy facility. In other words, whilst the level of local wind resource in this area is clearly lower than that existing elsewhere, it may be of a level that could make a valuable contribution to such a multi-dimensional asset. However, this is based on generic wind resource data for this area only, rather than specific wind resource assessments and is as yet untested.

Equally, given the public attention that wind generation is likely to attract and perceptions/concerns that have arisen elsewhere about visual/landscape impacts, noise and health impacts near wind installations, these issues need to be considered and the community engaged about any proposals for wind generation.

These perception issues aside, a key reason why wind might be considered in a Yackandandah context is that it has a flatter diurnal generation profile that complements the typical solar generation profile. Further, Yackandandah already have a high level of solar (BTM) generation and this is expected to continue increasing.

In other words, it appears that the diurnal generation profile of wind fits 'hand-in-glove' with solar generation as it generates power across more hours in the day and through periods when solar irradiation levels are low.

## 11.2 Vehicle-to-Grid (V2G) Storage

Another possibility considered in a summary sense (ie; no detailed assessment) in this study is that of using electric vehicles (EVs) for energy storage (vehicle-to-grid) rather than (or combined with) other dedicated BTM household batteries or FOM batteries/pumped hydro. This model emerged as an idea when it was publicly announced that a feasibility study had been funded by the Federal Government for a V2G project in a closed fleet situation (ACTEW-AGL) looking at. V2G models are also known to be under investigation in Europe and elsewhere.

The V2G hypothesis is that instead of (or as part of) having separate BTM household batteries, and assuming that the community is heading towards EVs in a general sense for transportation anyway (as all forecasts and AEMO data shows), why not bring that transition forward and establish a 'community fleet' of Yackandandah EVs as the 'the community battery'?

With increasing EV battery sizes (now up to and over 60kWh), such an approach would assume that a typical EV might have, say 30-50% of its accessible charge (on average) still available for household use and grid export each evening peak. This also would require investment in grid-interactive bi-directional charging capability and associated control systems.

There may be an argument to say Yackandandah is better off investing in EVs in the community (through a community bulk-buy and subsidy scheme), rather than in a 'big front-of-meter' community battery (as contemplated in this study). The key V2G questions are how would Yackandandah, as a community, do this and through what entity/contractual instruments? (purchase subsidy, lease, rental etc.). Another key issue is how would the community fund it and does it represent value for money on a $ per kWh (grid accessible) basis?

There is also the issue of whether the export of power from a household battery (or a V2G-enabled EV) is possible from a regulatory viewpoint.

Such a scheme relies on the EVs being charged from renewable sources (during the day) and a % of the EV charge being still available to support local demand during the daily peaks. So, understanding these aspects, as well as likely driver use and recharging behaviours, would be a key to any future V2G storage project.

In this context, with the increasing EV take-up that is probably going to occur and accelerate in any case, a local scheme would just bring this change on earlier than would otherwise occur. But such a 'bring-forward' type initiative may also community in order to get the level of storage needed to be 100% renewable.

Further, it's probably not a binary 'either-or' type of equation, but more likely a combination of the two approaches (BTM + FOM).

There is also the added 'bonus' benefit of reduced $CO_2$eq emissions reductions that would be brought about (brought forward) by the removal (theoretical) of (say) 100 internal combustion engine (ICE) cars from the road by such a scheme.

### 11.3 Other Technologies

Other potential future technologies include:

- Hydrogen generation (storage)
- Vault Energy Crane (storage).

The Project Control Group has decided not to pursue these emergent/leading edge technologies at this stage.

# 12. Community Engagement

The process of community engagement commenced in December 2020. However, the engagement methods applied ended up being dictated by the onset of Covid 19. This meant that face-to-face contact was limited.

The key engagement sessions occurred in December 2020. This included:

- Town Hall Meeting (3 December 2020)– ***'A Spring Conversation about Renewables'***
- Listening Posts (7 and 8 December)- a series of 30-40 minute drop-in conversations over 2 afternoons

An estimated 45-50 people from the Yackandandah community participated in these sessions. In addition, the project was summarised on the TRY website and feedback was invited through social media. A series of postcards were commissioned and distributed to participants outlining the energy use profile and options being considered.

The main focus on these sessions was to inform the community that this project was underway and to find out people's views, more generally, in relation to renewable energy. It was also a goal to broaden community interest beyond that group that was already engaged with TRY and to seek to widen the number of potential sites that were able to be considered for this project.

The key outcomes of the initial engagement process were:

- The Yackandandah community continues to be generally well engaged in the pursuit of renewable energy as a goal and works towards making Yackandandah 100% renewable.
- The community appreciates that, even though Yackandandah already has a high level of take-up of roof-top solar, it is still importing a significant (and growing) amount of energy.
- There was much discussion about the implications of Yackandandah's energy demand/use and import profile.

- It was widely agreed by people who participated in engagement sessions that TRY's future plans need to include substantial demand/efficiency initiatives to address the consumption side profile (it was noted that demand-side efficiency measures did not fall within the scope of the current feasibility study).
- There was substantial discussion about perceptions associated with solar and wind generation, and in particular, concerns about the visual/aesthetic impacts of solar and wind generation installations on the surrounding landscape. There was a broad acceptance from those present that a level of visual/aesthetic impact of any measures was inevitable and a factor the community need to accept as part of the renewable energy equation.
- There was discussion about the need to address the energy consumption/inefficiency associated with older resistive hot water systems and the resultant 1.00 AM consumption peak. Bulk purchase schemes and subsidies were discussed as way to address these issues.
- Throughout the engagement process, various other emergent technologies were raised and discussed. It was made clear to community members throughput this process that the focus of this feasibility study was on established and proven mainstream technologies of batteries, pumped hydro storage systems and solar PV generation.
- In relation to wind turbines, the prospect was discussed of there being wind turbines built on some of the hilltops surrounding Yackandandah. Whilst no specific sites were proposed, those participating in the sessions demonstrated a general preparedness to engage with this as an idea.

This process of community engagement has been led directly by the TRY Committee, with consultant support in relation to technical analytical advice.

In addition to the specific engagement sessions for this feasibility study, numerous one-on-one discussions have been held with many community members through the normal community discourse. Conversations have also taken place with numerous landowners about the possibility of using some of part of their land for a renewable energy installation.

Through these discussions, it is clear that there remains a level of concern within the community about the visual impacts on the Yackandandah landscape of solar farms. This appears to emerge from wider publicity associated with very large solar farms proposed for areas near Glenrowan and Culcairn (NSW). These solar farms are 100- 300 MW facilities which is vastly bigger than those considered in this study.

Overall, another emergent theme among the community was that people are very appreciative of the efforts by TRY to address the complex community renewable energy issues on their behalf.

*Ongoing Community Engagement:*

It should also be noted that the process of community engagement led and facilitated by TRY is continuing on. At the time of production of this report, further community engagement activities and processes are being planned in relation to the options, findings and directions in this report, and directions for renewable energy more generally (see Appendix B).

# 13. Ongoing Analysis of Other Options

The process of option development and analysis continues for TRY and the community beyond this study. At the time of issue of this report, further options continue to be addressed and analysed. The outcomes of these assessments will be reported to the project funder and the community separately to this report (see Appendix B).

# 14. Potential Community Ownership Models

The brief for this project required the consultants to address the question of possible models and structures for community ownership of any new energy infrastructure/assets envisaged in the options contained in this report.

As the focus of this study is to address the feasibility of community-scale/grid-facing assets, the focus of this section is on legal structures that may be available/suitable for these. In this sense, it is noted that the ownership of any behind-the-meter generation/storage assets is not considered as part of this discussion because ownership of assets in this case is most likely to rest in the private domain and there would be no need for institutional structures for the community to invest through.

By way of context, this section also addresses the possible legislative and policy moves and changes that may influence or change the ease with which structures can be set up for a community to invest through.

## 14.1 Australian Local Power (Consequential Amendments) Bill 2021

The capacity of local communities to engage more meaningfully with and establish local renewable energy infrastructure, and the current structural barriers to this, has been on the political agenda for some years.

On 21 February 2021 the Member for Indi, The Hon. Helen Haines MP, introduced a private members bill into the Australian House of Representatives [the Australian Local Power Agency (Consequential Amendments) Bill 2021]. The Bill, which remains before the Parliament, seeks to establish a new **Australian Local Power Agency** (ALPA). Hearings and submissions are currently underway on the Bill.

The main focus of the proposed ALPA would be on facilitating the establishment of and financing of 'community energy projects' that will benefit local communities. Its purposes would be to:

- support the development of community energy projects in Australia;
- increase the competitiveness of renewable energy supplied by community energy projects; and
- ensure that regional communities share in the benefits of renewable energy.

It is envisaged in the Bill that ALPA would have an investment function, a financial assistance function and a technical expertise/assistance function. 'Community organisations' are defined broadly in the Bill to include not-for-profit bodies, community groups (both incorporated and unincorporated) and councils. It also includes for-profit organisations and companies with a 'wide' membership of other community organisations and/or members of a community.

So, in this way, the Bill does not constrain the activities of ALPA entirely to the not-for-profit domain. It envisages engagement of ALPA with communities through for-profit entities (which may include social enterprises) as long as they are demonstrably, through their structure and membership, community based. This is a very positive feature of the Bill and ensures that the pathway remains open for members of a community to realise a level of financial return (along-side community benefit) from any investment they may choose to make into community renewable energy projects.

At the date of this report, the Bill was still in the process of parliamentary consideration and its likely future is unknown. If enacted, it is expected that ALPA would make a tangible contribution to addressing significant structural and financial barriers that currently exist to establishing community-scale renewable energy projects. It is also expected that it would seed ideas and lead to the formation of new businesses and entities that are focused on the facilitation and building of new community-scale grid-facing renewable energy assets.

## 14.2 Types/Models of Community Investment

There are various models and mechanisms available that can enable or provide a pathway for a community to invest in renewable energy generation and storage assets. This section explores various corporate or other contractual/financial structures and mechanisms through which individual members of the Yackandandah community/families (and/or local companies and organisations) could take a direct financial stake/buy shares in (or otherwise establish a contractual financial relationship with) an entity that could develop, own and/or operate future renewable energy assets.

### *Direct Equity (Member or Shareholder):*

Equity means a structure through which members of a community would invest directly in a project by buying shares (ie; becoming a member) in the company or entity that develops, owns and/or operates the asset. In this sense, equity is literal or legal ownership of the entity itself through shares.

Such an entity could be a public company, private company or a distributing cooperative. Equity (or shares) generally limits a holder's potential liability (or exposure to debts of the entity) to the issue price of the shares. That means a shareholder can't lose any more than that initial (fully paid) buy-in price. But equity generally sits last in the queue when an entity is wound up or liquidated (voluntarily or otherwise) and so that risk level is relatively high.

Such an entity is managed by a board under the Corporations Act. But subject to this, equity brings with it a channel for members 'having a say' in the business. This 'say' (and ultimate control of the entity) is exercisable by members (in totality) through voting rights on the floor of general meetings.

(Examples of equity models are described below including Indigo Power Ltd, YCDCo. Ltd and Solarshare Ltd.)

### *Debt:*

Debt is another form/avenue of community investment and there are many different types of debt (debentures, notes, fixed interest etc.). Debt is not really a literal form of 'ownership' of the entity: it is more of a financial contractual relationship between the community member (the debt holder) and the entity. Debt can be secured or unsecured- it depends on what's offered and the needs/appetite of the investor.

This means a structure can be set up through which members of a community can invest, in the form of debt, in a project. Under such a scenario, they would actually be lending money to the company or entity that develops, owns and/or operates an asset on the terms agreed. But they would not be a part owner (or member/shareholder) of that entity.

(An example of this is the community of Shoalhaven in NSW who were recently invited to invest in the 3MW Shoalhaven Solar Farm at Nowra -see discussion below).

### *Contractual/Other Indirect Relationships:*

There are various companies and models in existence where people in a defined community can 'buy' a stake in community energy assets developed by the company. The types of schemes that fit into this category vary greatly and caution needs to be exercised to understand exactly what it is.

Under this type of arrangement, similar to debt, participants do not get a legal share in the entity itself. The relationship is separate and through whatever contractual instrument is used.

Further, it is acknowledged that, in the wider public debate about 'community ownership' of renewable energy resources, there are numerous other less literal forms of 'ownership' that may validly be considered. This includes mechanisms through which the broader benefits of community scale renewable energy may flow through to the wider community, even where there may not be any formal legal financial/contractual relationship with the developer/owner/operator entity.

These pathways/mechanisms for informal 'community ownership' are important. For example, members of the Yackandandah community and/or local community-may be members of TRY and support it through their volunteer efforts. Where TRY attracts donations and grants and invests/channels these resources directly into projects (such as 'Yack 01' with Indigo Power Ltd.), this creates a strong sense of community ownership of the outcome (even in the absence of any direct relationships between the community members and the project/entity).

## 14.3 Existing Yackandandah Organisations

There are three existing community-based organisations in Yackandandah that could possibly play a role in the development of community-owned renewable energy infrastructure. To varying degrees and in different ways, each could be considered as an entity that could initiate, facilitate, develop and/or own and operate renewable energy assets. This discussion addresses the suitability of these existing organisations to play such a role and the types of role they may play.

By way of context, the following is an illustration of the different roles at different project stages that are addressed in this section:


### *Totally Renewable Yackandandah (TRY):*

TRY is an incorporated association and governed by a volunteer committee. Its role is primarily as a community advocacy group and change agent. It has led the wider community debate and role in Yackandandah in relation to the pursuit of the 100% renewable goal. It is widely acclaimed as a model for community led environmental change.

TRY has a strong and proven capability to attract grants and philanthropic funding for projects and is able to contribute these towards projects as it sees fit. It can (subject to the specific conditions/circumstances), and as occurred with the 'Yack 01' project, contribute/make available such funds towards projects.

Incorporated associations are legally able to trade following the review of Victoria's Associations Incorporation Act in 2012 but trading is not the intent of the Act. However, TRY does not have a business-oriented structure and was not set up for that. Further, as an incorporated association, TRY has no share capital, no capacity to directly raise equity capital and no capacity to return dividends to members.

Clearly, TRY has a crucial community leadership role to play in any future renewable energy project in Yackandandah. This should continue to be primarily in the advocacy, facilitation, funding attraction and community engagement realms, rather than directly in development, asset ownership or operation. TRY does not have a legal or institutional structure that is appropriate to being a developer, owner or operator of renewable energy assets. Its role may also be in the role of raising and channelling funds it has secured through to other appropriate entities as the developer/owner under terms that it sees will maximise the long-term benefit to the community.

As occurred with the ownership structure for the 'Yack 01' solar/battery facility, it is also appropriate for TRY to take a direct equity stake in assets developed, owned and operated by other entities (such as Indigo Power Ltd. and/or other suitably capable community or commercial entities). All these matters are, of course, subject to TRY's own risk assessment and due diligence processes and of the of entities that may be the recipient of such contributions.

*Indigo Power Ltd:*

Indigo Power Ltd is an unlisted public company incorporated under the Corporations Act. It has a small but broad-based membership. It is a community-owned social enterprise with a focus generally covering the north eastern areas of Victoria, the greater Hume region and southern NSW.

As a public company, Indigo Power Ltd has the capacity to issues shares, raise equity capital and pay dividends to its members. It is currently operating as a community energy retailer of electricity (using Energy Locals as a 'white label' service provider).

Indigo Power is the developer and owner/operator of the 'Yack 01' community solar/battery facility in Back Creek Road, Yackandandah which is a small grid-facing generation/storage asset (commissioned September 2021). A significant enabling equity contribution towards establishing this project was made by TRY through the issue of a special non-distributing class of 'community' shares to TRY by Indigo Power Ltd.

Apart from 'Yack 01', Indigo Power does not have significant experience and capability in the establishment of large grid-facing assets (of the scale contemplated in this report). However, Indigo Power Ltd has stated that it strategically aspires to extend its operations beyond the current scope of being a retailer and possibly into the generation and storage sectors. It is also currently engaged in various other State and Federally funded micro-grid/storage projects in other parts of Victoria.

Small community-scale projects, such as those contained in the options addressed in this report, present the ideal opportunity for Indigo Power to realise a move into the generation/storage development/ownership space. The requisite skills and capabilities for building, owning and operating grid-scale assets can be (and would need to be) procured through the employment of staff or contractual arrangements, for any such development project undertaken by Indigo Power.

Indigo Power, having a larger geographic 'footprint' and membership base than Yackandandah alone, may need to consider or look at establishing internal project 'ring-fencing' financial/equity arrangements for the establishment of any assets that are specifically Yackandandah-only focused. This of course depends on whether or not any Yackandandah-specific project can be shown to be for the broader benefits of its membership or whether those benefits will flow to the Yackandandah community only. Subject to the Corporations Act, this may be achievable (in a similar manner to 'Yack 01') through the issue of a specific 'Yackandandah Class' of shares or through the formation of a project-specific subsidiary entity to quarantine some of the risks and benefits.

Whilst all such matters and considerations ultimately need to be decided in the context of a specific project situation and needs, Indigo Power is structurally well-suited to be a developer, owner and operator of assets contemplated in this feasibility study. Such an active 'developer' type of role could be played by Indigo Power alone and, in terms of capital raising, it has a successful recent track record in this regard. But this would also require capability building for Indigo Power given the current lack of depth in its project development experience and in-house technical expertise. A direct development role by Indigo Power may be preferable through a joint venture arrangement with a suitably experienced and capable commercial (or community-based) renewable energy developer/operator.

*Yackandandah Community Development Co. Ltd (YCDCo.):*

YCDCo Ltd. is also a local unlisted public company with a specific Yackandandah community focus and broad-based membership. It has over 700 local members and operates the local service station, hardware/ rural supplies store and the community newspaper ('Yackity Yak'). Like Indigo Power, it is also a community-owned social enterprise but is structured differently and with a different type of company constitution.

As a public company, it also has the capacity to issues shares, raise equity capital and pay dividends to its members. As such, it has the capacity to provide a vehicle/avenue for community investment into new community energy assets (subject of course to YCDCo's own risk assessment and due diligence processes).

Being currently involved in the energy/fuel space (service station), the extension of this into renewable energy generation could be seen as an appropriate strategic 'fit' for its role.

Equally, (like Indigo Power) it does not currently have in-house the requisite skills and capabilities for building, owning and operating grid-scale assets. These capabilities would need to be procured, through the employment of staff or contractual arrangements, for any renewable energy development project.

YCDCo Ltd is technically suited (in terms of its corporate/institutional structure) to be the developer, owner and operator of assets contemplated in this feasibility study. However, YCDCo Ltd. is not presently involved or capable in renewable energy specifically and it couldn't be considered core business for it. It has had past success in capital raising in the early 2000's and its broad local membership gives it strong local reach, through its existing membership, into the Yackandandah community. In practice, any direct active development role would probably need to be played as part of a joint venture with another suitably capable/experienced joint venture partner and probably also along-side Indigo Power Ltd.

## 14.4 New Entity Structure Options (Cooperative or Company)

In the event that one (or a combination of) the existing Yackandandah organisations is not considered suitable (or decides not to) take a lead role in the development of local renewable energy assets, then a new community-based specific-purpose entity could be formed to do it.

This section addresses the main structure options that are available in the event that a new local community entity was to be formed for this purpose.

The table below shows the main incorporation/structure options:

| | LEGAL STRUCTURE/ENTITY: | | |
|---|---|---|---|
| **PARAMETERS/VARIABLES:** | **Incorporated Association** | **Cooperative** | **Company** [1] |
| Relevant Law | Associations Incorporation Reform Act 2012 | Cooperatives National Law 2013 | Corporations Act 2001 |
| Minimum number of members required | 5 | 5 | 2 |
| Maximum number of members | NO | NO | Proprietary – NO<br>Public - 50 |
| Instrument governing the entity and setting out the governance arrangements | Adopted Rules | Adopted Constitution | Adopted Constitution |
| Separate legal entity? | YES | YES | YES |
| Can borrow funds? | YES<br>(technically) | YES | YES |
| Can issue shares to raise capital? | NO | YES | YES [2] |
| Can distribute profits to members as financial dividends? | NO | YES<br>(Distributing only – limitations apply) | YES [2] |
| Can provide non-dividend incentives to members? | NO | YES | YES |
| Can apply funds to the benefit of the general community and community organisations? | YES | YES | YES |
| Audit required? | NO | YES *<br>* Turnover /net asset thresholds apply | YES *<br>* Turnover /net asset thresholds apply |
| | | | |

**Notes:**

1. General description only – parameters vary for proprietary and public companies.
2. Different provisions apply to different types of companies – these are not articulated in detail in this report.

If a new community entity was set up, with a requirement to raise capital, the main options are as an unlisted public company (like Indigo Power and YCDCo.) or a cooperative. An incorporated association is not considered appropriate in this context.

Both the company and cooperative models enable wide community-based membership. A public company structure provides the maximum financial flexibility but is also the most onerous in terms of the set-up, corporate oversight and compliance. A cooperative, on the other hand, is relatively easy to establish and is philosophically well-aligned to the notion of collective pursuit of shared community goals. But it has significant limitations in its ability to distribute profits to members.

### *Companies (Corporations Act):*

There are various types of company that are available as a path to incorporation under the Corporations Act 2001. There are broadly three types of company considered relevant in this current context (ie; there are others that are not considered relevant and therefore not addressed):

- Proprietary (private) company limited by shares;
- Public company (unlisted); and
- Company limited by guarantee.

A **proprietary (or private) company** can either be limited by shares or unlimited with a share capital. It must have at least 2 and no more than 50 members. A company limited by shares is the most common type of proprietary company in the business sector. In this case, it means the personal liability of each shareholder is limited to the 'par' or nominal value of the shares they have purchased.

It can issue shares and pay dividends to members within the defined but generally liberal limitations of the Corporations Act. Voting is **one vote per share** at general meetings. Private companies are a widely understood and used legal mechanism for business and in the general community. They are simple and widely used for commercial 'for-profit' purposes and for specific projects and joint ventures. The compliance levels for small private companies are relatively easy to meet (subject to various asset and turnover thresholds) though the fiduciary responsibility of directors is high.

A **public company** (unlisted) can have an unlimited number of members (ie; it is not capped at 50). The main differences with a public company are that there are much higher disclosure and compliance requirements that apply to the company and to directors. These relate to any fund raising (through the issue of shares) which is closely governed by the Corporations Act and there is a higher level of financial reporting and accountability defined through financial review and audit requirements. Like a private company, the personal liability of each shareholder is limited to the 'par' or nominal value of the shares purchased. Voting is **one vote per share** at general meetings.

A company that is '**limited by guarantee'** does not have a share capital. In other words, it doesn't issue shares to it members. Rather, the members are effectively 'non-financial members'. There are different requirements that apply for companies limited by guarantee of different sizes. A company limited by guarantee is generally a structure used for 'not-for-profit' and community organisations.

#### *Cooperatives (Cooperatives National Law):*

Another possible pathway to community ownership could be through the establishment of a new specific-purpose entity set up as a cooperative (incorporated under the Cooperatives National Law Act 2013).

A co-operative is a democratic organisation owned and controlled by its members for a common purpose and benefit. A number of 'Cooperative Principles' that must be adhered to are described in the Cooperatives National Law. Co-operatives are traditionally based on the values of mutual self-help, shared responsibility and equality. Voting at member meetings in a cooperative is based on one vote per member irrespective of the number of shares they may own (in companies voting is based on the number of shares owned).

This is a relatively simple and low cost path to creating a separately incorporated legal entity where there is a shared purpose or need. There is a requirement that cooperative members are 'active' in the cooperative and the rules need to specify an 'active membership' test and threshold.

There are two types of cooperatives – **distributing** and **non-distributing**- for which there are different rules and disclosure requirements. A **non-distributing** cooperative is much the same as a **distributing** cooperative except it cannot distribute any of its profits to members.

It means that people who are likely to buy shares in a non-distributing cooperative (and to a lesser extent a distributing cooperative too) need to see value from that investment coming to them directly (or to the community in which they live) through means other than through financial dividends. This is because there are limitations on the ability of a distributing cooperative to distribute financial dividends to members and non-distributing cooperatives cannot do it at all.

## 14.5 Joint Venture Structures/Options

As referred to above, another possible pathway to community ownership is through the establishment of a joint venture between a local entity (ie; either Indigo Power Ltd and/or YCDCo. Ltd.) and other suitably experienced/capable renewable energy/development companies.

Alternatively, TRY has the legal capability to enter into a commercial joint venture and could itself seek to establish a joint venture with a technically capable third-party commercial organisation. However, the likelihood of a commercial partner entering into such an arrangement with a community-based organisation is considered low.

A joint venture scenario creates a pathway to bring in other (more experienced and capable in grid-scale projects) project partners at the equity/ownership level. Equally, a debt structure could be used in a joint venture to open the path for community investment. How this would work in practice (and the respective roles and equity held by partners, debt holders etc.) is very situation-specific and not able to be contemplated in any detail in this feasibility study.

But conceptually, if a pumped hydro project was being developed, then an entity such as Tamar or Snowy Hydro could be considered as a joint venture partner. If it is wind or solar or battery (or hydrogen fuel cells for that matter), the appropriate partners with the requisite experience and knowledge specific to that sphere of renewable energy would be appropriate to partner with.

However, having a reputable local entity 'at the table' is also extremely important. The local entity, in a joint venture context, brings to the project the critical 'currencies' of community connections, trust and goodwill.

In contemplating a significant joint venture such as those addressed in this study, another key consideration is the shared aspirations, vision and values. Generally, joint venture projects require a significant alignment of values in order to be successful. In other words, the joint venture relationship needs to go much deeper than technical capability and experience alone. Normally, these broad matters would be expressed at the early stages and formalised through a Heads of Agreement or Memorandum of Understanding. Ultimately, such joint venture matters would likely require a formal Shareholder Agreement to be out in place.

Another aspect to be considered is how the prospect of a joint venture might (or is likely to) look through the eyes of a proposed joint venture partner. In this regard, the scale of the project and its potential benefits to the would-be joint venture partner will be viewed alongside the assessed risks in the joint venture. Those risks will include the obvious financial risks but also other governance and community perception/reputational risks and benefits that a joint venture would expose them to. In this context, any joint venture company will want to be clear on exactly who in Yackandandah it is they are dealing with and the depth of their financial and business capability as well as the legal instruments and agreements that define and set the parameters for a business relationship.

## 14.6 Summary

With the likes of Indigo Power Ltd and YCDCo. Ltd. already in existence locally, there does not appear to be a compelling rationale to establish another new separate community-based entity (with a wide membership base) in Yackandandah to develop, own and/or operate renewable energy assets. This, of course, assumes that one of the existing entities is willing to take on such a direct development/ownership role and within parameters that all other stakeholders /funders are happy with.

In other words, if neither YCDCo or Indigo Power are prepared to entertain a developer/owner role in a project (within broadly agreeable parameters), and there is a broad base of community support/appetite for it, the formation of a new project-specific entity becomes a viable option or necessity for this.

In terms of the breadth of role for an existing local entity, this is likely to be as the 'local' partner in a joint venture with a suitably experienced/capable (and willing) partner.

This experienced/capable partner could be any of a number of commercial organisations or social enterprises that have been established for community-scale renewable energy development purposes elsewhere (see examples in section 13.7 below).

In terms of suitability to play a 'local partner' role in a joint venture (or to lead a project individually), Indigo Power Ltd is considered the most appropriate entity for this. This is because of its unlisted public company structure, its strong local community roots in Yackandandah, its demonstrated capacity for capital raising and the fact that it is already operating and trading in the grid-facing generation and storage business.

## 14.7 Other Community Ownership Examples

There are various other companies and structures already in existence in other parts of Australia that have established vehicles for local community investment into renewable energy. These include:

**Shoalhaven Solar Farm- Debt Investment Example:**

In July 2021 members of the community of Shoalhaven in NSW were invited to invest in the 3MW Shoalhaven Solar Farm at Nowra. The investment vehicle used is a proprietary (or private) company, Shoalhaven Solar Farm Pty Ltd. This company is a wholly-owned subsidiary of Kin Power Group Pty Ltd. (trading as Flow Power). A Canadian pension fund (OPTrust) is the controlling owner of Kin Power Group.

In this case community investment occurs through the issue of debt ($6,250 unsecured loan notes over 5 years at 5%) to community members. Those who choose to invest are offered a fixed annual loan repayment (including principal and interest) over the 5 year term.

Under such a debt investment, the assets and control of the entity itself remain wholly with the company itself (through the directors) and, ultimately with the controlling entity members /shareholders (ie; not the community loan note holders).

The level of security attached to such an investment depends on the debt and contractual instruments used which in this case is unsecured notes.

**SolarShare (ACT)- Equity Investment Example:**

SolarShare is an ACT-based unlisted public company based in Canberra through which anyone who wants to be part of the shift to the renewable energy economy can participate and invest (ie; legally, it is the same structure as Indigo Power Ltd. and YCDCo. Ltd.).

SolarShare engages people who previously have had no or limited access to solar power market, such as renters or those without a roof for solar panels. It is open to all others as well. SolarShare's website states that anyone who wants to move towards greening of the power grid and ethical investment is welcome. It is a member-owned business designed to encourage members to have a closer connection with the activities of the enterprise. The company's vision is for people to share a connection with their energy supply, their investment, their community and the environment.

The Company's 'flagship' project is Canberra's Majura Valley 1MW solar farm that is expected to power 250 homes. Community investments from $500 up to $10,000 were invited.

Investment in this project is in the form of equity (ie; through the issue of 'stapled securities'). The SolarShare model is to use wholly-owned subsidiary proprietary companies as project development vehicles, of which the Majura Valley project is the first. The 'Stapled securities' model described in the Offer Information Statement means that investors are issued with one ordinary share (for $0 each) with each project-specific class of share (at $10 each) and these shares are tied (or 'stapled') together. This structure means the investors are becoming members of SolarShare itself (the holding company) rather than the specific project (subsidiary) company. Further, by holding both ordinary shares and specific asset shares, the company is able to substantially quarantine the specific project financial benefits (or otherwise) to the ACT class of shareholders.

This model is highly replicable: the company can pursue other projects in other parts of Australia and keep the projects substantially separate. It also means that the company retains control over the ownership and operations of the specific assets. The ability of the local specific asset class shareholders to exercise input and/or influence over the local project is through the broader company structures and processes.

# 15. Conclusions:

The conclusions reached, based on the analysis undertaken for this feasibility study are:

*Community Appetite for Renewables:*

- The engagement process undertaken by TRY in parallel with this feasibility study confirms that the Yackandandah community is highly engaged with renewable energy as an idea and aspiration. The fact and existence of a global climate emergency is widely understood and accepted, though certainly not universally.
- TRY, as the lead community-based voice and advocacy vehicle in relation to renewable energy locally, enjoys broad-based trust within the Yackandandah community.
- There are legitimate concerns within the community about the possible impacts that renewable energy projects and installations may have on the landscape and on the visual amenity and aesthetics of the area. However, despite this, there appears to be a widespread acceptance that for Yackandandah to achieve anything approaching a level of energy self-sufficiency in the future, some level visual impact on the landscape is going to occur.
- The extent to which people accept this as a necessary part of the price that the community needs to pay for renewable energy (or, alternatively, consider it too high a price), is highly subjective and varied.
- There are also concerns (and mixed views) about the need to protect the high quality rural land in and around Yackandandah for agricultural production and whether or not it is appropriate to use such quality land for renewable energy generation purposes.
- Taken overall, most people within the Yackandandah community are balanced and realistic about a renewable energy future. They are likely to engage positively with significant new renewable energy initiatives and projects that are proposed/pursued as long as they continue to be engaged by trusted community-based parties along the way (such as TRY and Indigo Power).

*National Demand/Consumption*

- Electricity demand across the NEM is expected to grow between now and 2050.
- Over the next 8-10 years, that demand growth is expected to be met/off-set mostly by new rooftop PV generation. Then, from about 2030 onwards, most demand growth will be due to increased EV take-up.
- With population growth, electricity consumption per capita is expected to decline marginally over the next 8-10 years and then increase again when EV use starts to grow.
- AEMO estimates that about 31.3% of total electricity generated in the NEM in 2021 is from renewable sources.
- This renewable energy component/share of power generated in the NEM grid grew by an average of 15.1% over each of the past 2 years. The renewable energy share of generation in the NEM grid is expected to continue to grow in future years, but possibly at declining rates as it gets over the 50% threshold and closer to 100%.

*Yackandandah Demand/Consumption:*

- Yackandandah's average electrical load across the whole year (24/7) is about 1.726MW. The peak load is about 3.071MW.
- Yackandandah currently uses about 15,606 MWh of electricity per year. That's an average of 35 kWh per household each day.
- Of total use, about 5,524 MWh, or 35%, comes from solar PV generated on rooftops. That's relatively high compared to other places across Australia. It reflects the fact that Yackandandah is estimated to already have 57.6% of households with rooftop solar.

- But despite this high rooftop solar take-up, the total amount of power Yackandandah consumes/uses (including the power imported from the grid) is still growing. Yackandandah's total electricity demand increased by an average of 5.4% in each year over the past 3 years.
- All this indicates that Yackandandah's rate of increase in electricity consumption compared to Australia (in the NEM) generally, even with a high rooftop solar take-up, is relatively high. This appears to be mainly due to local development and growth patterns and a reduced number of people per household.
- In 2020 and 2021 (YTD) specifically, the available data suggests that energy consumption in Yackandandah may have been increased by the Covid 19 Pandemic whilst it actually decreased across the NEM more generally in this time. This reflects the increased number of people working and schooling from home at this time and the fact that Yackandandah has limited industrial/commercial demand for energy which is a key driver for total demand decreases in the wider NEM.
- About 60% of Yackandandah's increased consumption each year is currently being met by new growth in rooftop PV capacity. But the other 40% needs to come in from increased imports of power through the grid.
- Interestingly, even with Yackandandah's nationally acclaimed high level of solar PV take-up, there wasn't a single 15 minute period in the past 3 years where electricity was exported from inside the Yackandandah Valley to the wider NEM grid.
- What this means is that whilst people with rooftop solar PV systems obviously exported energy from their homes into the local grid regularly, this energy was consumed by neighbours and new demand for energy locally. So, Yackandandah was still importing more energy from elsewhere for 100% of this time!
- The increases in consumption in Yackandandah may also be driven, in part, by an unintended consequence of high/increased renewable energy uptake. That is, an increased tendency by the community to consume electricity (and /or to acquire electricity consuming consumer products) driven by the perception that the energy is 'free' or more readily available/accessible.
- Rooftop PV generation in Yack has grown rapidly by over 14% each year for the past 3 years.
- This rapid growth is due to the combined effects of cheaper solar PV installation costs, increased generation yields per panel, increased average system size and increased community take-up. The average size of a rooftop solar PV system in Australia is now over 8kW.
- The modelling (applying a combination of NEM-wide and local assumptions) indicates that without doing anything else, the total amount of energy Yackandandah generates from rooftop solar is expected to double by 2026 and then triple by 2033. By 2050, rooftop solar generation is expected to have increased by nearly 5 times 2020 levels.
- The extent to which local network capacity might act as a brake on this predicted growth depends on the extent of ongoing investment into network capacity upgrades and this is presently unknown. The current investigation being undertaken by AEMO into moving towards dynamic export limits (rather than fixed limits) would also help to offset any such network capacity constraints into the future.

*100% Renewable Target:*

- The achievement of a <u>100% net renewable energy target</u> by Yackandandah is realistic and achievable by the mid-to-late 2020s. This means that Yackandandah would still use the NEM grid to supply power when the sun doesn't shine and export it when there is a local generation surplus. However, it does not appear possible or realistic to achieve this by 2022.

- Achieving a **100% gross renewable target** for Yackandandah is extremely challenging. Hitting a 100% gross target means Yackandandah would never import a single watt of electricity from the grid on any day or hour through the year!
- This is unlikely to be realistic any time within the timeframe of this feasibility study (30 years) without the installation of significant new generation (wind, solar and back-up motorised generation) and storage assets that are of a scale well beyond those contemplated in the options assessed for this study.
- Based on modelling for this study, if Yackandandah continues on as it is currently going and relies just on 'organic' behind-the-meter solar PV growth (ie; no new front-of-meter generation and storage assets are built), the community will achieve 100% net renewable by 2027.

*Limited Site Options Around Yackandandah:*

- The four sites around Yackandandah that were selected for this study have different merits and disadvantages. However, for this study, a key attribute applied was the land-owner appetite to engage with a proposal to establish a renewable energy installation.
- A key outcome from this study is confirmation that the relatively small scale landholdings/higher density land use, combined with the high quality of productive agricultural land around Yackandandah all conspire to make it more difficult to find local sites suitable for renewable energy installations (ie; at 2-3MW scale).
- This difficulty is somewhat compounded by the need for a renewable energy installation to recognise and respond to widely-held community concerns about the visual and aesthetic impacts of such assets on the surrounding landscape (allowance for visual/line-of-sight and distance buffers from surrounding residences).
- These factors mean the opportunity cost (as well as the actual financial cost) for using local land for renewable energy purposes is relatively high in Yackandandah and suitable sites with sufficient space are very hard to find.

*'Islandability':*

- 'Islandability means being able to 'turn off the switch' somewhere along the main feeder line coming into Yackandandah and continuing to operate a fully charged grid on this side of it.
- The goal of Yackandandah being capable of being 'islandable' in a grid shut-down situation is a complex goal. It is tied up in a range of governance, accountability, policy, regulatory and community safety / compliance issues that relate to the current operation of the grid within the NEM.
- In order to achieve islandability, there are three things that need to be achieved:
  a) Sufficient grid-facing generation and storage capacity would need to be built inside the local grid 'loop' to be able to power Yackandandah (without energy import from external sources) for a reasonable period of time at a reasonable load (say, 4 hours at a 50% curtailed load);
  b) To these storage and generation assets would need to be added grid-facing motorised back-up generation capacity (possibly powered by locally sourced 100% renewable biodiesel) to meet the defined curtailed load requirements extending beyond the other internal generation and storage capacity (ie; beyond 4 hours);
  c) The asset ownership/stewardship, governance, accountability, communication and other related grid management and administrative protocols and structures would need to be fully agreed and resolved. In other words, define exactly what happens if, when, and by whom. This would need to be done in close collaboration with AusNet Services as the existing DNSP responsible for the grid in and around Yackandandah.
- If Yackandandah aspires to be a fully islandable sub-grid, it would need to install grid-facing back-up diesel generation capacity to meet extended low solar generation

periods. That's because the size of battery storage needed to power the community through several weeks of low solar PV generation is likely to be cost prohibitive. (Possibly in excess of $300 million). Diesel generators can be powered by biodiesel which is regarded as a carbon-neutral fuel.

- Adding wind generation to solar into the equation would alleviate this significantly because wind generation has a different and complimentary daily profile to solar (and extends beyond daylight hours).
- Whilst this is a complex and multi-dimensional task, detailed definition for how the operational and management arrangements of a future islanding scenario would work should be pursued through an ongoing dialogue with AusNet Services in preparation for the time when this becomes a practical possibility (from an electrical perspective) in terms of the intra-loop generation and storage assets.

*'Scale Economies' for Grid-Facing Renewable Projects:*

- The five core options (on four sites) considered for this feasibility study could generally be considered to be smaller/'community-scale' grid-facing (or front-of-meter) assets. Considering these options (and the capital cost estimates prepared for them), it is clear that significant economies of scale apply in the establishment of grid-facing renewable energy installations.
- These scale economies mean that the larger the installation, the cheaper it is likely to be on a $/MW basis. This means on $ per MW basis, the smaller/community-scale installations required for Yackandandah's level of demand/consumption are significantly more expensive than the larger (say 30-40 MW+) scale systems. Further, the smaller schemes addressed in this study are more expensive (based on LCOE) compared to larger options. These economies of scale are particularly evident with pumped hydro storage schemes (compared to batteries and PV solar systems).
- These scale economies are substantially associated with the 'flag-fall'-type establishment costs of getting access to and onto a suitable site for even a smaller grid-facing facility. In other words, these 'flagfall' costs for larger scale projects, whilst higher overall, are typically much less if considered on a $/MW basis.
- Further, most options considered for this study require significant up-front investment in grid upgrades (estimates for these works were provided by the DNSP AusNet Services). There is also considerable uncertainty remaining about the extent of these grid connection costs as the DNSP will only provide a reliable quote with a full grid connection application. This situation continues to be a barrier to reliably establishing likely future costs for community scale energy proposals.

*Financial Merit/Considerations:*

- On a LCOE basis, the predicted life-cycle costs of energy produced by each of the five options is relatively expensive. In a climate emergency context, this does not mean these options should not be considered. However, it does suggest that thought should be given to other options available to achieve Yackandandah's goal of being 100% renewable (ie; behind-the-meter options with similar or comparable outcomes).
- Further, the NPV of each of the options is significantly negative. The NPVs for the five options considered range from (-$5.0 mil.) to (-$16.0 mil.). This is significant.
- A negative NPV means that, prima-facie, the investment proposition is not worthy of being pursued, based on financial outcomes alone. It is noted that this NPV metric is solely concerned with the financial/investment merits of the proposal. It excludes the important strategic, community and environmental factors that need to be considered as well.
- This means that the options assessed in this study would only be attractive to investors/owners (on a financial/commercial basis) if a majority of the required capital

funding was made available from external sources (grants/philanthropy etc. where there is not an expectation of a return on investment).

- In the consultant's opinion, the key contributing factors for the lack of financial viability of the options assessed in the study (on an NPV basis) are:
  a) The relatively high capital costs (on a $/MW basis) for each of the options assessed, including grid capacity upgrade costs (due to the relatively small scale of the proposals and the underlying scale inefficiencies discussed above);
  b) The currently low (and potentially declining) wholesale 'spot' electricity prices that apply in the current NEM market;
  c) The predicted reducing role of (and prices for) LGCs as a long-term revenue stream for grid-facing renewable energy assets; and
  d) The volatility and uncertainty that appears to apply to FCAS as a reliable long-term revenue stream for grid-facing energy storage assets (at the scale addressed in this report).
- On this basis, (and in the absence of majority external/grant capital funding support), there would need to be a significant increase in the wholesale price of electricity in the future in order for any of the options addressed in this study to be considered financially feasible.
- All of the above financial analysis and conclusions is done through the specific 'lens' of financial /investment merit only. Whilst important metrics to consider, the options addressed in this study ought not be assessed solely through the narrow confines of this prism alone.
- However, the financial/investment merit assessment is very important from the point of view of a future developer/owner of any of the assets. Any such developer/owner entity, irrespective of their mission and goals, will need to conduct its own due diligence and feasibility assessment of a proposal in the context of its own strategic position, priorities and *raison d'etre*.
- In practice, this means that a local community-scale grid facing generation-storage asset in Yackandandah will need substantial grant funding support (in the order of $5-8 million minimum) in order to be viable (depending on project scope).

*Greenhouse Emissions/Environmental Impact:*

- As stated, in a climate emergency context, it is important to consider the wider-than-financial merits of the proposals at hand.
- Each of the options considered in this feasibility study will make a significant contribution to the global environment through carbon emission reduction (tonnes of $CO_2$ equivalent) reductions. This impact has been assessed based on the assumption that renewable energy produced locally will replace non-renewable energy that is currently imported into Yackandandah daily to meet growing demand.
- The options considered for this study are estimated to result in emissions savings of 51,000 to 157,000 tonnes of $CO_2$ equivalent over the assessed 16 year timeframe (assuming a 100% renewable energy NEM by 2040).
- This is significant: across the five options, it equates to about 42 to 132 tonnes saved/reduced for each current household in Yackandandah.

*Value for Money - Behind-the-Meter Options:*

- Given the underlying financial 'stress' (based on the NPV assessment) that weighs on the financial feasibility of each of the grid-facing options assessed in this study, there is merit in considering other ways of achieving the same (or similar) renewable energy and emergency resilience outcomes for Yackandandah.

- Indeed, this feasibility study provides a strong and research-based context for looking at other potential pathways. It provides a sound and rational foundation for the community of Yackandandah (as well as potential Government project funders) to identify which option/direction offers the best value of a $/MW and $/tonne $CO_2$equivalent basis.
- A comprehensive package of behind-the meter options that can deliver similar energy, greenhouse gas emission reductions and community energy resilience outcomes should be developed.
- In addition, exploration of potential sites for and the scope of a grid-facing installation (or installations) should also be continued.

*Community Ownership Pathways/Models:*

- Local community ownership can play an important role in bringing renewable energy projects to fruition and may be considered as part of a future community-scale/grid-facing project. However, of itself, community ownership is not considered to be an essential component or goal of renewable energy projects where they are able to proceed with commercial investment.
- In this case, TRY is the local, trusted organisation to lead, facilitate and engage in relation to such a project.
- In terms of the project development, ownership and operations roles, Indigo Power Ltd., being a local unlisted public company (with a track record in capital raising), is the most appropriate local partner for this. However, this role is likely to be exercised in partnership/joint venture arrangement with another suitably experienced/capable renewable energy organisation.

# 16. Recommendations

Our recommendations are:

a) That Yackandandah pursue a strategic direction involving a package of bespoke, multi-dimensional behind-the-meter initiatives, including:
   - energy consumption/demand efficiency/reduction programs (including a resistive hot water service replacement program);
   - targeted/strategic community facility-based BTM generation/storage capacity building; and
   - a 'top-up' community subsidy scheme to encourage BTM generation/storage take-up.

b) That the exploration of potential installations and sites in and around Yackandandah (including smaller solar/battery sites at the North East Water site, Allan's Flat site and other identified potential sites) for the establishment of grid-facing solar/ battery assets be continued. (NB: Further exploration of three identified potential sites has already been initiated by TRY as an extension of the work already completed and the results of this will be provided separately to this report (see Appendix B).

c) Additionally, investigations should be undertaken into options and possible funding opportunities for the inclusion of grid-facing back-up motorised generators to improve emergency resilience.

d) That the scoping and investigative processes (including refinement/ 'right-sizing' of the project scope parameters) for the establishment of an appropriately scaled, generation and storage 'Community Renewable Energy Park' on the Leneva site be continued in association with Indigo Power Ltd., landowners, the DNSP and potential project partners.

e) That the exploration of the structure and governance/accountability/communication protocols and arrangements that would need to apply to enable Yackandandah to be islanded under a future grid shutdown scenario continue with AusNet Services.

# APPENDIX A: Glossary

| Abbreviations and Glossary: | Definition |
|---|---|
| ACR | Automatic Circuit Recloser |
| ACCP | Australia Carbon Credit Price |
| AEMO | Australia Energy Market Operator |
| ALPA | Australian Local Power Agency |
| APVI | Australian Photovoltaic Institute |
| BESS | Battery Energy Storage System |
| BTM | Behind-the-Meter |
| CFA | Country Fire Authority |
| $CO_2$ eq. | Carbon Dioxide Equivalent |
| CPI | Consumer Price Index |
| DER | Distributed Energy Resources |
| DN | Diameter Net |
| DNSP | Distribution Network Service Provider (*same as DNO below) |
| DNO | Distribution Network Operator (*same as DNSP above) |
| EV | Electric Vehicle |
| FCAS | Frequency Control and Ancillary Services |
| FOM | Front-of-Meter |
| ha | Hectare (10,000$m^2$) |
| HV | High Voltage (referring to 22kV) |
| ICE | Internal Combustion Engine |
| kV | Kilovolts |
| kW | Kilowatt |
| kWh | Kilowatt hour |
| kWp | Kilowatt (peak) |
| LCOE | Levelised Cost of Energy |
| LGC | Large-scale Generation Certificate |
| Ml | Megalitres |
| MW | Megawatt |
| MWh | Megawatt hour |
| MWp | Megawatt (panel) |
| NEM | National Energy Market |
| NER | National Electricity Rules |
| NPV | Net Present Value |
| PCG | Project Control Group |
| PHESS | Pumped Hydro Energy Storage System |
| PoC | Point of Connection |
| PPA | Power Purchase Agreement |
| PV | Photo Voltaic |
| REFCL | Rapid Earth Fault Current Limiter |
| ROI | Return on Investment |
| SES | State Emergency Service |
| SWER | Single Wire Earth Return |
| TRY | Totally Renewable Yackandandah |
| UNSW | University of New South Wales |
| V2G | Vehicle-to-Grid |
| WACC | Weighted Average Cost of Capital |
| WOTS | Wodonga Terminal Station |
| WOTS11 | Wodonga Feeder 11 |
| YCDCo | Yackandandah Community Development Company Ltd. |

# APPENDIX B: Ongoing/Additional Research and Analysis

The following items of ongoing research and analysis are continuing to be undertaken by TRY. These are part of and integral to the wider TRY renewable energy goals but are separate to and outside the scope of this feasibility study.

The additional/ongoing research projects are:

1. Assessment/Analysis of additional Potential Battery Sites; and
2. Final Community Engagement Report.

The outcomes of these additional projects will be reported to the funder and the community separately.