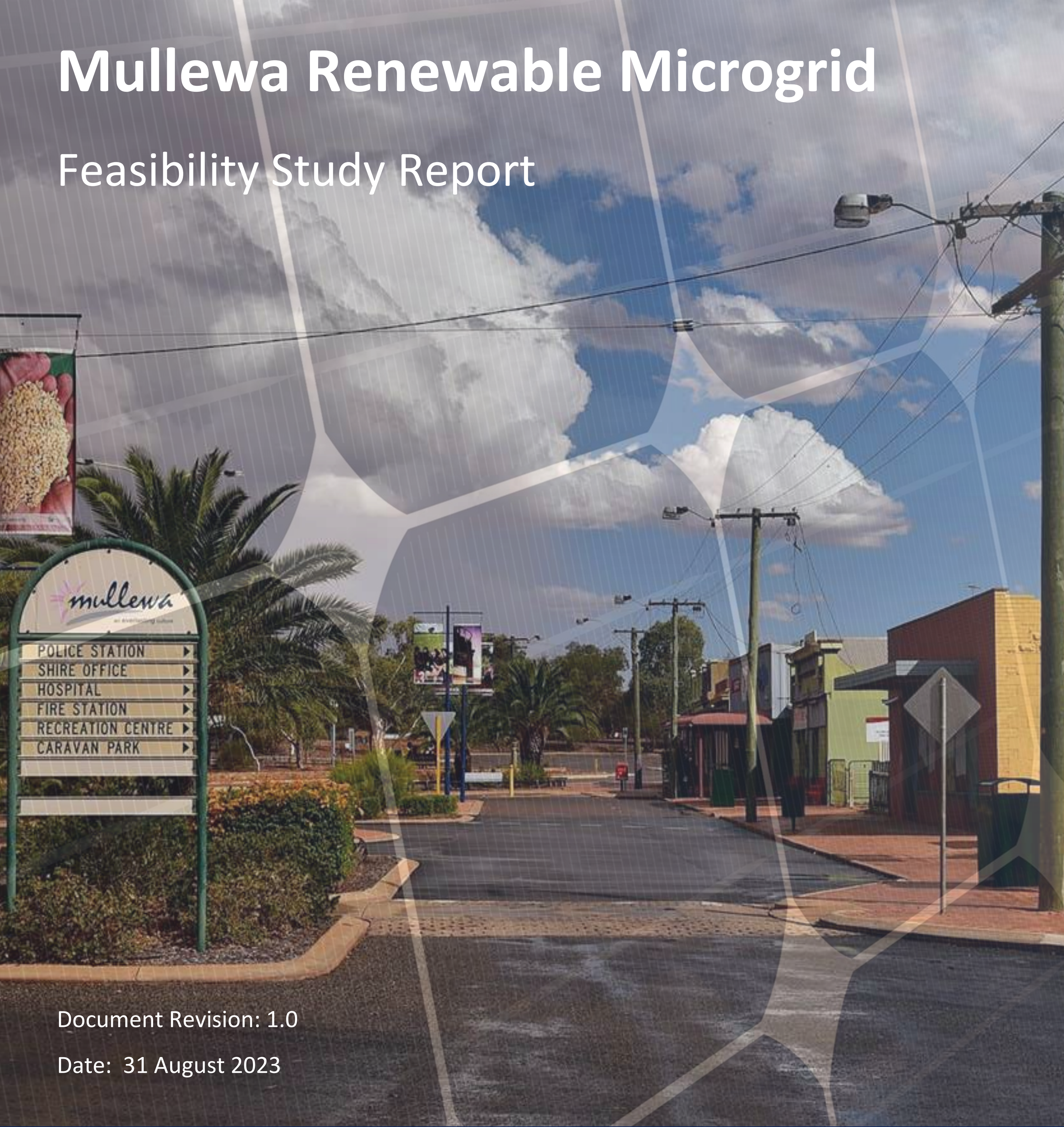
Mullewa Renewable Microgrid

Feasibility Study Report



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sunrise
energy group

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ABBREVIATIONS

AEMO	Australian Energy Market Operator
AES	Alternative Energy Services
AOS	Alternative Options Strategy
ARENA	Australian Renewable Energy Agency
BESS	Battery Energy Storage System
CBH	Cooperative Bulk Handling
CGG	City of Greater Geraldton
CMD	Contracted Maximum Demand
CMS	Customer Main Switch
CPI	Consumer Price Index
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CT	Current Transformer
DC	Direct Current
DER	Distributed Energy Resources
DPLH	Department of Planning, Lands and Heritage
DSOC	Declared Sent Out Capacity
EFTPOS	Electronic Funds Transfer at Point of Sale
EMN	Embedded Network (Microgrid)
EMNOP	Embedded Network (Microgrid) Operator
EOPA	Energy Operators (Powers) Act 1979 (WA)
EPWA	Energy Policy WA
ERA	Economic Regulation Authority (WA)
ERG	Emergency Response Generator
ESOO	Electricity Statement of Opportunities
ESS	Essential System Services
ETAC	Electricity Transfer Access Contract
EV	Electric Vehicle
FCAS	Frequency Control Ancillary Services
FEED	Front End Engineering Design
FFR	Fast Frequency Response
FID	Final Investment Decision
GHI	Global Horizontal Irradiance
HV	High Voltage
IRR	Internal Rate of Return
JDAP	Joint Development Assessment Panel
LGC	Large-scale Generation Certificate
LiDAR	Light Detection and Ranging
MEEDAC	Midwest Aboriginal Employment and Economic Development
MO	Microgrid Operator
MWDC	Mid-West Development Commission
NAQ	Network Access Quantity
NCESS	Non Co-optimised Essential System Services
NCS	Network Control Service
NDA	Non-Disclosure Agreement
NER	Neutral Earthing Resistor
NMI	National Metering Identifier
NOJA	Brand of Recloser
NOM	Network Opportunity Map
NZE	Net Zero Emissions
PPA	Power Purchase Agreement
PPC	Power Park Controller
PV	Photovoltaic
REIWA	Real Estate Institute of WA
RGS	Renewable Generation and Storage
RMC	Remote Monitoring and Control
ROI	Return on Investment
SAFD	Step-away From Decarbonisation
SCGZ	Galvanised Steel Conductors
SLD	Single Line Diagram
SPS	Stand-Alone Power System
STC	Small-scale Technology Certificate
SWIS	South-West Interconnected System (WA's main electricity grid)
TDL	Temperature Dependant Load
UPS	Uninterruptable Power Supply
VPP	Virtual Power Plant
VT	Voltage Transformer
WA	Western Australia
WEM	Wholesale Electricity Market (WA)
WP	Western Power
WPN	Western Power Network
YSRC	Yamatji Southern Regional Corporation

1 PREFACE

With the current upheaval being seen in the energy sector, driven by the need to decarbonise, it is an exciting time to be exploring the possibilities around the deployment of renewable microgrids at the fringe-of-grid, and the role they can play in this overall transition to a new energy landscape.

Recent forecasts for increased energy demand in the SWIS from the 2023 WEM ESOO [13] (ref. Figure 1-1) suggest there are serious challenges ahead in meeting this demand, as reflected in the capacity shortfalls being predicted.

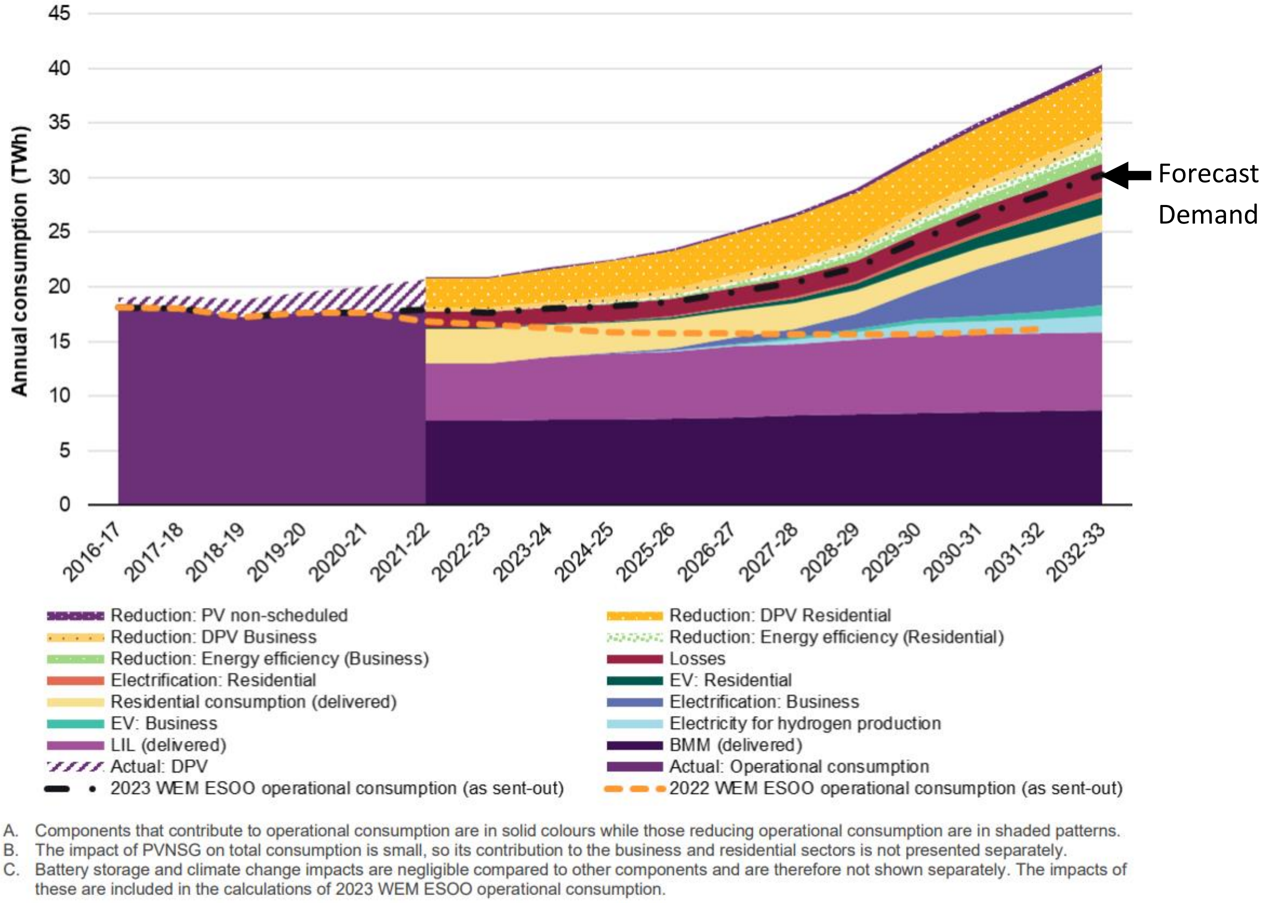


Figure 1-1: Forecast consumption in the WEM (source: 2023 WEM ESOO [13], Figure 15)

These challenges are focussing attention on the transmission work that will be necessary to connect new generation capacity, however what also needs to be understood is that this generation will be consumed via the distribution network, and so although there are challenges, Sunrise Energy Group (Sunrise) believe this also opens up possibilities in the distribution network, e.g. to harness as much as possible of the existing distribution network, through innovative solutions, to make a significant contribution in the grid transformation process that supports a decarbonised energy system.

Integral to this will be utilising the distribution network to deliver renewable generation close to where it is consumed in the least capacity restricted areas of the network, which includes most of the fringe-of-grid. This inherently improves reliability of supply to these areas and supports them in their transition to the “electrify everything” goal and also contributes to the overall SWIS decarbonisation objective plus delivers savings to the entire SWIS through the reduction in lines losses (which can be significant).

Unlike what is being seen in the east of Australia, where grid transformation driven by new transmission can see opposition from the affected local communities, this multiple small scale approach where the benefit to the local area is clearly evident, is typically supported and welcomed by these communities.

It is in this context that the impetus to conduct this study, to test and prove these concepts, was derived, and which Sunrise believe the outcomes from the study, has achieved.

For Sunrise, the job doesn't finish with the completion of the study as we aim to pursue this development through to execution and operation of a pilot demonstration in Mullewa that will provide a proof-of-concept that enables this model to be rolled out to other fringe-off-grid communities looking for improved power reliability and the associated benefits this brings.

2 INTRODUCTION

The Mullewa Renewable Microgrid Feasibility Study (the Study) involved a 21 month examination into the viability of deploying a renewable energy microgrid in the fringe-of-grid town of Mullewa, a town in the City of Greater Geraldton located in the mid-western Region of WA, approximately 450km north of Perth, ref. Figure 2-1 .

Figure 2-1: Mullewa location within Western Australia

Mullewa has an estimated population of approximately 450 and its location (relative to the SWIS) and the network connections of the Mullewa township can be seen in Figure 2-2.

The Project has been completed by Sunrise Energy Group Pty Ltd (Sunrise), in collaboration with Enzen Australia Pty Limited (Enzen), a developer of a digital twin for the Mullewa network.

The Electricity Networks Corporation, trading as Western Power (Western Power) and the Electricity Generation and Retail Corporation, trading as Synergy (Synergy) have also have had involvement in the Study.

Collaborating and providing support to the Study has in no way been a commercial commitment or solution preference on Western Power's part, particularly given its work on other regional reliability and network augmentation projects. Similarly, Synergy is not a party to the Study and has made no commercial commitment. Its role in the Study is only to provide data, engage the community (as requested), and to provide support to Sunrise. All statements, opinions, modelling and outcomes set out in this report are wholly those of Sunrise Energy Group, and do not reflect and may not be attributed in any way to Synergy or Western Power.

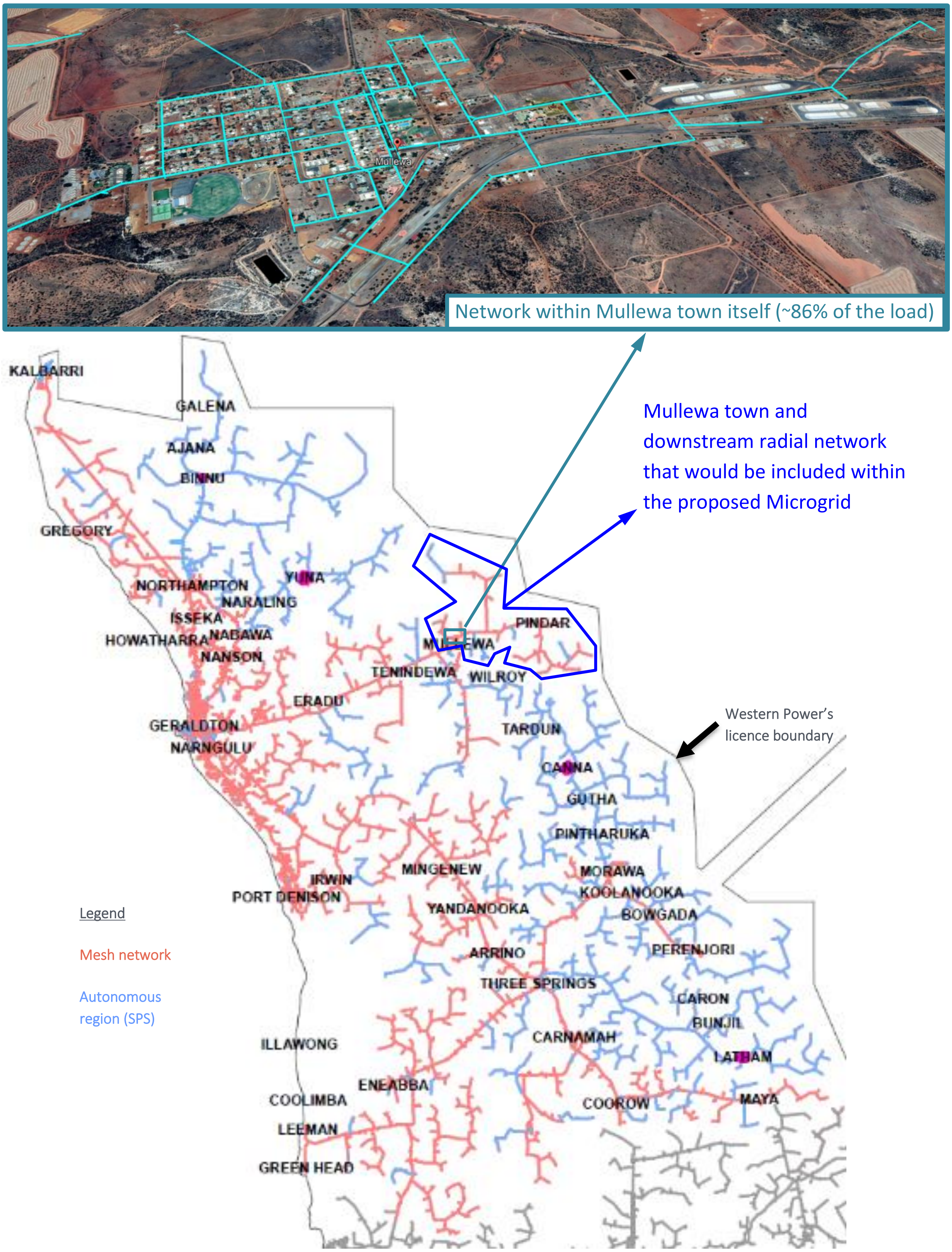


Figure 2-2: Mullewa town and downstream radial network in relation to the SWIS

The Study was initiated as a result of the initial question of: "*How do we solve the 'problems' of fringe-of-grid towns on the SWIS with a replicable model*"? The problems being:

- the low reliability of these towns, typically on long radial feeders
- the subsidisation of these towns by the rest of the SWIS
- the uncertainty surrounding long term sustainability of a grid supply (given Western Power identifying fringe disconnection as part of their "Grid Evolution" discussions).

This led to Sunrise applying for funding to complete a Microgrid Feasibility Study at a specific location, and entering into a Collaboration Agreement with Enzen, Western Power and Synergy in respect to the nature and scope those parties have agreed to collaborate and provide support to the Study.

In 2019 Western Power provided a list of ten worst performing locations, which included Mullewa. From this list Mullewa was selected as the location for the Study. Mullewa is located at the end of a 100km radial feeder, which has suffered from poor reliability, has significant line losses and dated infrastructure.

The Study aims to develop a commercially sound, technically and economically feasible solution to significantly improve energy reliability, improve amenity for Mullewa residents and to retain and attract business to the town. The objective is that the model is replicable at other fringe of grid and potentially off-grid sites around WA and Australia, with key learnings and knowledge disseminated as part of the Study.

The Study scope includes modelling the use of renewable energy generation such as solar panels or wind, supported by battery energy storage systems (BESS), which would be distributed to the town via the microgrid solution. Innovative technology and software will play a key role in automation and control. Key activities focus on engaging with the Mullewa community to develop the best solution for its needs, while equally ensuring that the solution is technically, commercially, and financially feasible and viable.

The study was executed in 6 phases:

- Phase 1 – Establish Digital Twin of the Target Network
  - Capture/collection of data describing various attributes of the network and represent in a digital environment that can be used as a tool in the efficient management of that infrastructure.
- Phase 2 – Model Technical/Commercial Solutions
  - Development of a technical solution that reduces outages and improves reliability and model under different commercial assumptions to establish the most viable solution.
- Phase 3 – Test Future Scenarios on Proposed Solution
  - Run the proposed solution through a series of potential scenarios that could occur over the long term.
- Phase 4 – Community Engagement
  - Engage with the community to understand their appetite for a Microgrid reliability solution, understand their priorities in relation to service from the system and test the reception of the proposed solution.
- Phase 5 – Development Activities
  - Undertake development activities to prepare the proposed solution for investor readiness for upscaling.

- Phase 6 – Document Results and Seek Investors
    - Prepare documentation that records all the results that were obtained from the modelling process. The documentation will be used when engaging with potential investors to portray the benefits of the Project.

3 DEFINITION OF MICROGRID

In order to execute a study around a "Microgrid solution", it is a good idea to have a definition of what a Microgrid is. The answer to this is not as obvious as it may seem, and in exploring this, it was evident that the term Microgrid does not have a unique/fixed definition and has widely been used to describe several different small electrical grid configurations.

After looking into the varying definitions that have been applied and in consultation with the other participants in the study, for the purpose of this study the following, relatively loose definition, has been selected:

In the SWIS, a microgrid is a section of the Western Power network that:

a) is still connected to the meshed network (grid)
b) has the ability to be islanded as an autonomous system, and
c) Includes local renewable generation and storage

4 SUMMARY

The outcomes from the Study are:

- It is feasible to deliver a technically and commercially viable Renewable Microgrid Pilot Project in the town of Mullewa, with this conclusion supported through detailed commercial modelling and significant development activities including thorough FEED work and associated fully costed estimate, culminating in the submission of a development application to the City of Greater Geraldton and regional JDAP, and submission of an Alternative Options proposal to Western Power for a reliability service.
- The selection of an “in-front-of-the-meter” commercial model over an “embedded network style” model was based on avoiding current policy/regulatory hurdles, despite commercial and other benefits recognised in the study for the “embedded network style” model and development of a pathway through these regulatory hurdles.
- This Microgrid would significantly improve the reliability of power supply to the town.
- This Microgrid would contribute to reduction in line losses in the SWIS benefitting all customers in the SWIS by reducing overall operating costs.
- The development of a renewable microgrid in Mullewa has the support from the local community through to the WA Minister for Mines and Petroleum; Energy; Hydrogen Industry; Industrial Relations.
- There are funding grants available that the pilot project is eligible to apply for, on the completion of this feasibility study, and investors interested in renewable energy projects exist, that would enable the execution of the pilot project, which is estimated to offer an IRR close to 9%. Key to executing the pilot project will also be Western Power acceptance of the Alternative Options Proposal.
- The production of a digital twin for the Mullewa network has validated that this is in fact an achievable construct and demonstrated the potential value for this technology in terms of managing an electricity network and improving the operating efficiency.
- Lessons learnt while completing the Study (ref. Section 13) which, in addition to those that will be learnt from executing and operating an actual microgrid pilot project in Mullewa, should assist in reducing the risks and cost of a repeatable model applied to other fringe-of-grid towns in the future.

The integration of the proposed Microgrid is shown in Figure 4-1 and comprises the following main features:

- 1.1MW solar array and 3MWh battery co-located.
- Connection point site located adjacent to the solar array and approximately 1.5km from existing Western Power HV powerline. This is the site where the protection and automation controls are located that initiate the islanding of the Microgrid on loss of the grid supply and then allows the town load to be taken up by the Microgrids renewable generation and storage infrastructure, controlling the operation until the grid power is restored.
- One 750kVA diesel genset located at the connection point site.
- Two 600kW wind turbines located approximately 1.3km from the connection point.
- Automated recloser for islanding of the Mullewa network and associated downstream radial line. Located approximately 3.4km by line of sight from the connection point with radio communication between the recloser and the connection point.
- Western Power Network Control Communications implemented via combination of mobile radio (4G) and satellite communications.

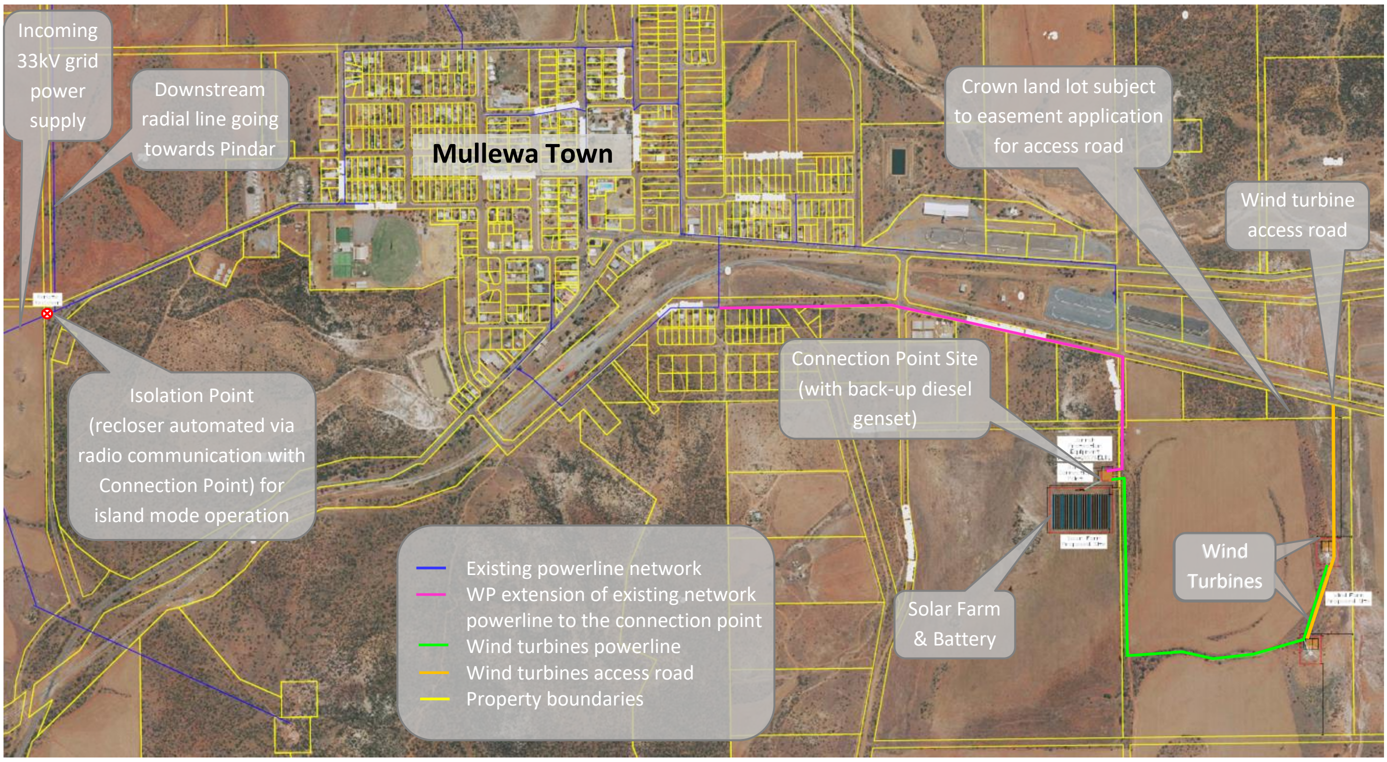


Figure 4-1: Layout showing the integration of the Microgrid infrastructure

The commercial model is based on generating income through:

- Sale of the generated energy via a long-term offtake agreement with a retailer or via a 3rd party service in the WEM at the balancing market price.
- Sale of the LGC certificates earnt from the renewable generation.
- Charging Western Power an annual fee for a reliability service, that would involve automatic islanding off the Mullewa network and uptake of the load by the Microgrid on loss of grid supply. The fee is based on WP power waiving the network tariff for the renewable generation connection point (if WP preferred, the network tariff would still apply but be added to the fee charged for the reliability service).
- Capacity credits earnt from the reserve capacity market for the combined renewable generation capacity, battery capacity and diesel generation capacity.

Execution of the project after achieving FID is expected to take 13 months (ref. project execution schedule under Appendix A) with the critical path driven by the long lead delivery of connection point equipment and the connection point site construction and then system commissioning.

Risks and Opportunities associated with the project have been evaluated and summarised under Section 12, with the top risks being:

- Western Power not accepting the Alternative Options Proposal for the reliability service.
- Inability to secure funding form ARENA necessary to de-risk the project and make-up the difference in capital associated with the first-off nature of a pilot project.

In terms of opportunities the most promising is estimated to be an opportunity to transition the Microgrid at some point in the future, to an “embedded network style” Microgrid that would incentivise the Microgrid Operator to encourage development in the region that would grow the load and by association the town and opportunities in the town.

Sunrise are also keen to look at some of the opportunities for demonstrating agrivoltaics at small scale rural solar farms, and the possible benefits that this can provide for the local communities.

Ref. Table 16 for a list of other identified opportunities.

5 MULLEWA

The following section provides an overview of the Mullewa township with an attempt to put into context the value of a reliable power supply for this community. Mullewa's solar and wind resources are also examined.

5.1 Demographics

Mullewa is a small town in the Mid-West region of Western Australia, it is a vibrant, diverse and resilient community, rich in both natural and cultural heritage. Mullewa is well known for an abundance of wildflowers in spring, and it is one of the few places in the world that the wreath flower grows. The surrounding areas of Mullewa produce wheat and other cereal crops and the town is a receival site for Cooperative Bulk Handling (CBH) at the towns railyard.

Mullewa has an estimated population of approximately 450, with the most recent Census data indicating Aboriginal and/or Torres Strait Islander people comprising 34% of the Mullewa population. The top five industries by employment in Mullewa are:

- Grain growing (11.6%)
- Local government administration (11.6%)
- Arts education (9.9%)
- Primary education (9.1%)
- Hospitals (8.3%).

Census data in 2021 indicates Mullewa has a lower proportion of its population in the labour force (39.4%) compared with average national levels (61.1%). The average unemployment rate of 9.3%, which is considerably higher than the Australian and WA average. The average household income was also much lower than the national average, documented to be $828 weekly compared to $1,746 in Australia. However, the census data shows that 53.4% of the community own their own home or own with a mortgage. This is considerably higher than the national average (31.5%) but could be attributed to the lower average cost of homes in the town (average $102k according to REIWA).

Technicians, trade workers / labourers and community and personal service workers make up 51.5% of the labour force in Mullewa.

Population decline of about 20% since the 2016 census and limited economic activity are likely to impact on local business and services to the community.

5.2 Health

Health care services in Mullewa include a Hospital, Medical Centre and a Pharmacy and they are all co-located on the same site. In 2016, the State Government announced plans to build a new Health Centre to replace the ageing Mullewa Hospital. As of August 2023, the new Health Care Centre has not progressed from the planning stages. In February 2023 the Health Minister Amber-Jade Sanderson advised that the construction on the Mullewa Health Centre would begin sometime after upgrade work commences on the Geraldton Health Campus, which is still in the expression of interest stage.

The unplanned power outages documented in section 7.1 can have a significant impact on healthcare services. In a 2019 ABC News report [7] the Mullewa town doctor, GP Nalini Rao had described the power supply to Mullewa as "fourth world" after she had to dispose of vaccines for the third time in as many years. Dr Rao said the electricity outage in 2019 cut power to the surgery's refrigerator and a backup system also failed. In the same year, the Geraldton mayor Shane Van Styn, also echoed the doctor's frustrations saying that the yearly power problems were creating "great hardship" for the community during summer, and there were no alternative sources of power.

Since the Emergency Response Generator (ERG) was installed in 2019 there have been 10% less outages recorded in the town. However, the total number of hours power has been out has actually increased by an average of 19 hours annually (ref. Table 3 in Section 7.1).

5.3 Education

There are two schools in Mullewa. Mullewa District Schools serves kindergarten through to year 12 students and Our Lady of Mount Carmel is a Kindergarten to Year 6 Catholic Primary School.

Energy reliability can impact on the quality of education that can be provided at schools, and in particular in regions like Mullewa that are relatively remote and experience high temperatures. Reliable energy enables the provision of a comfortable learning environment as well as consistent access to the internet. Energy interruptions may require school closures or at least impact on attendance rates and limit access to online curriculum and resources.

5.4 Employment Opportunities

With employment levels currently below national levels, there are direct employment opportunities that may come with deployment of a renewable microgrid as well as the indirect opportunities through potential to attract and grow businesses in the town because of an increase in the reliability of power supply.

Table 1: Employment opportunities from microgrid implementation

Scope	Employment Opportunity
Construction, operation, and maintenance	Opportunities for direct employment including indigenous labour to undertake project construction works and maintenance
Energy related skill development	Opportunities for creating career paths through upskilling and training community members in energy related skills including operation and maintenance of project components
Local primary production business stimulation	Opportunities for local businesses to operate without interruption, increasing their output and in turn their number of employees
Hospitality, tourism, and other services	Opportunities to maintain or increase services to holiday rentals, increased visitation resulting in more expenditure in local hospitality business. Ability to maintain EFTPOS, mobile and landline phones, cooking facilities and online business so business able to remain open. Less food spoilage.

5.5 Solar Resources

Figure 5-1 below shows the daily and annual global horizontal irradiance (GHI) that can be used to generate power on a kilowatt hour per square metre basis. It is evident that Australia has high levels of irradiance with much of Australia's daily average levels exceeding 5.4 on the GHI index.

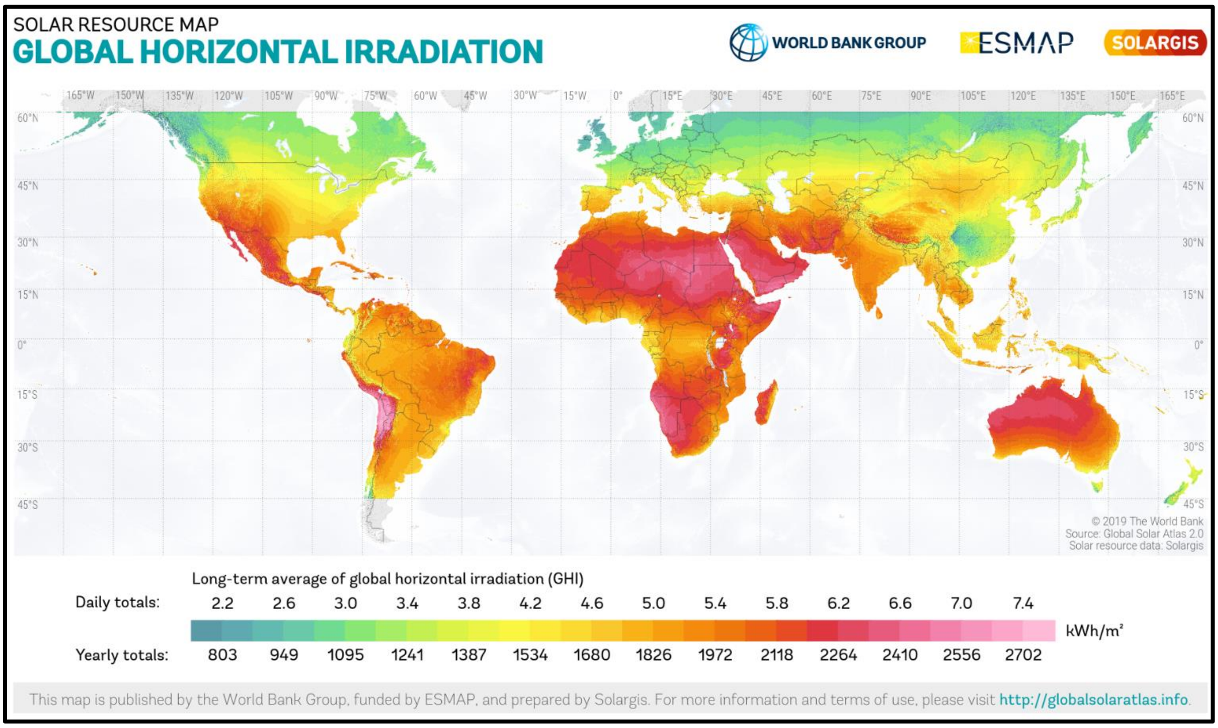


Figure 5-1: Global Horizontal Irradiation (GHI): Long-term yearly average of daily and yearly totals

Analysis of the Mullewa GHI data (ref. Figure 5-2) from PVSyst software shows that it has better than average levels with seasonal variance. The annual total generation capacity based on the GHI in Mullewa is 2,129.5 kWh per square meter.

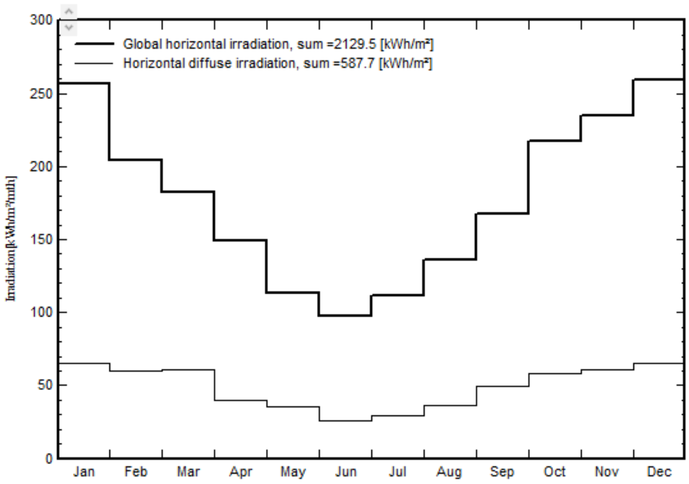


Figure 5-2: Extract from PVSyst showing the average monthly energy production based on GHI for Mullewa

The daily data for Mullewa in PVSyst shows a similar seasonal pattern with the values in Figure 5-3 below shows the daily irradiance of one day, in kWh/m²/day.

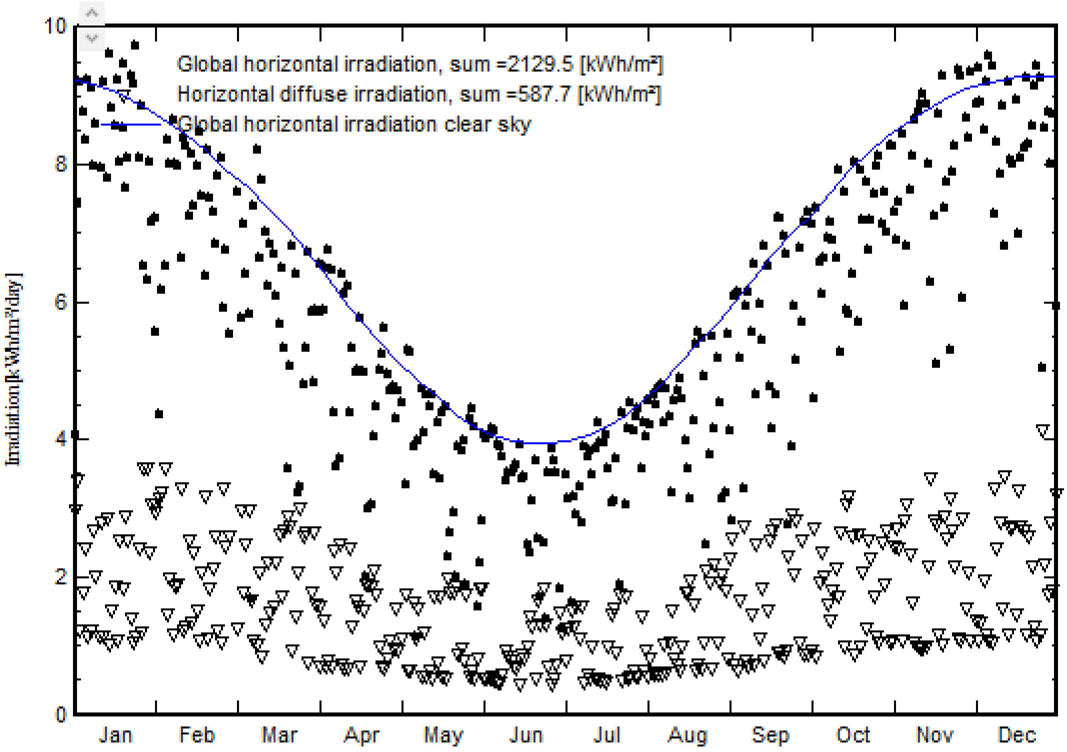


Figure 5-3: Extract from PVSyst showing the average daily energy production based on GHI for Mullewa

5.6 Wind Resources

From a simple assessment of the wind resources in the mid-west region of WA, based on mean wind speeds and comparisons with existing wind farms (ref. Figure 5-4) Mullewa appears to having a potentially viable wind resource.

Wind speed data at the Mullewa specific site is not available so to evaluate the wind resource further, a theoretical dataset was constructed by BlairFox and a high-level desktop analysis used to estimate the combined annual energy yield of the turbines to be 2.982GWh. The estimation is based on various factors, including the predicted wind speed and direction, the height of the turbines, and the turbine specifications. Figure 5-5 shows the predicted wind speed distribution around Mullewa.

This estimated energy yield equates to a capacity factor of 28%. Typical values could be expected to vary between 25 and 45%. Although on the low side, 28% would still be a reasonable supplement to onsite Solar, particularly if it has a complimentary profile. Without specific site measurements however, this is not possible to confirm. Predicted summer and winter daily averages (ref. Figure 5-6) don’t show a complimentary profile in terms of seasons, however over the day it looks more complimentary, even with a slight increase in generation in summer during peak demand times between 4 & 9pm.

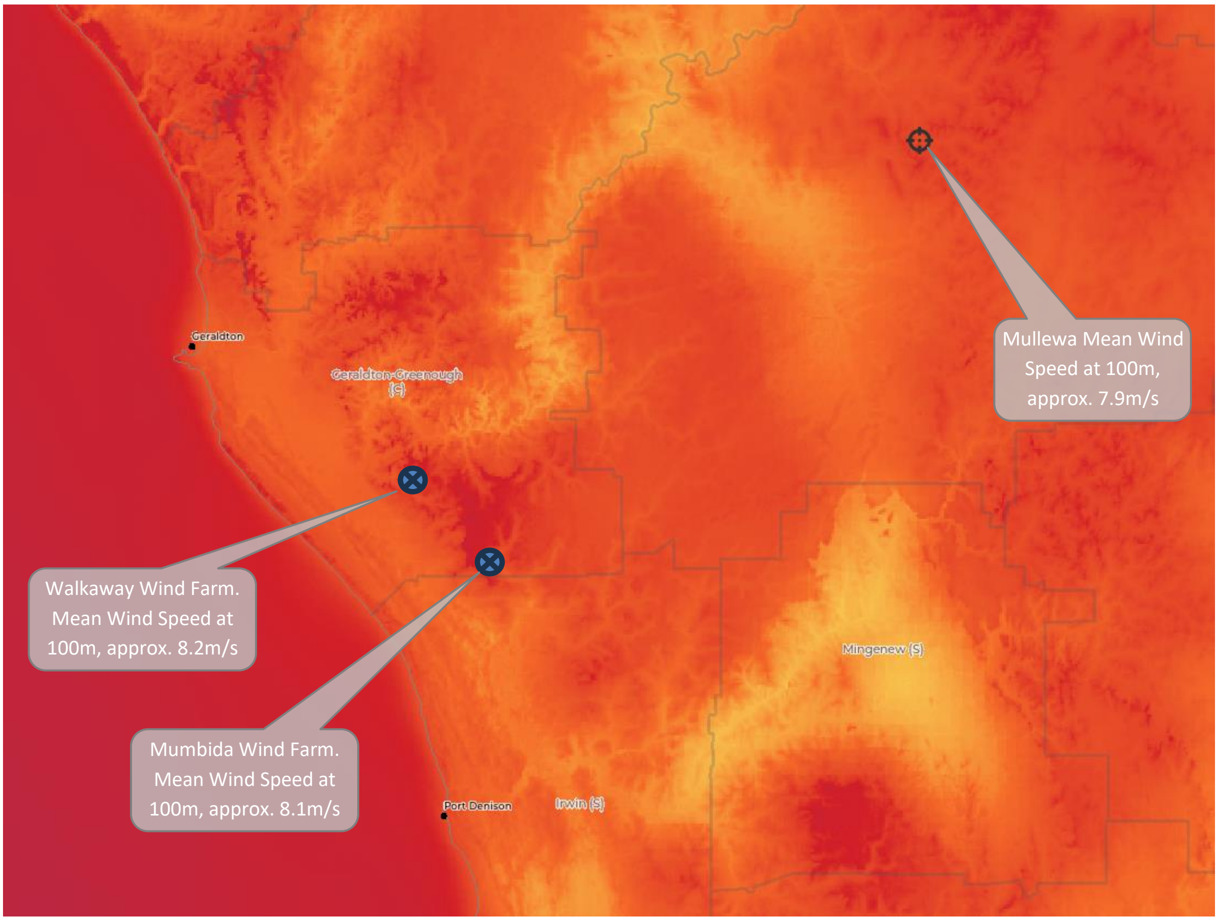


Figure 5-4: Mean Wind Speeds at 100m in WA Mid-West area according to the Global Wind Atlas (globalwindatlas.info/en)

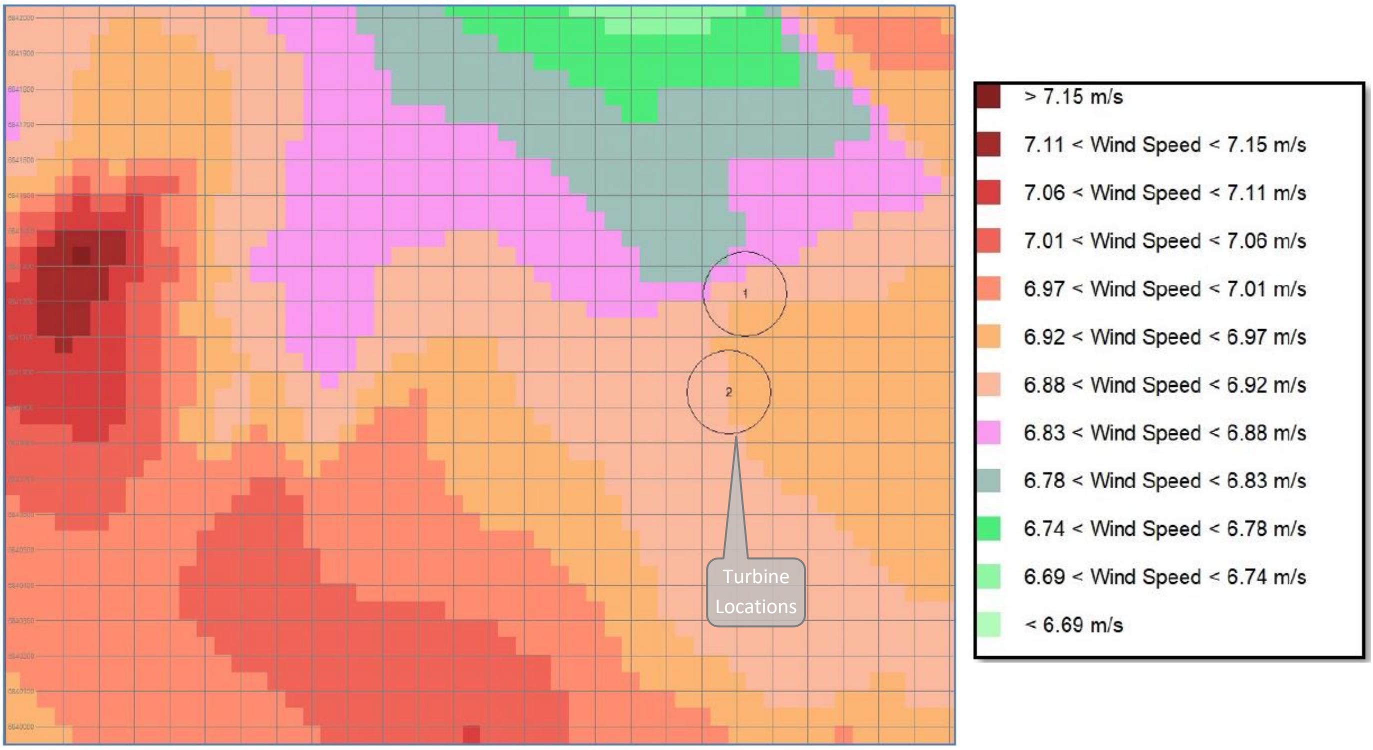


Figure 5-5: BlairFox predicted annual Wind Speed Distribution at Mullewa. Grid spacing is 100m

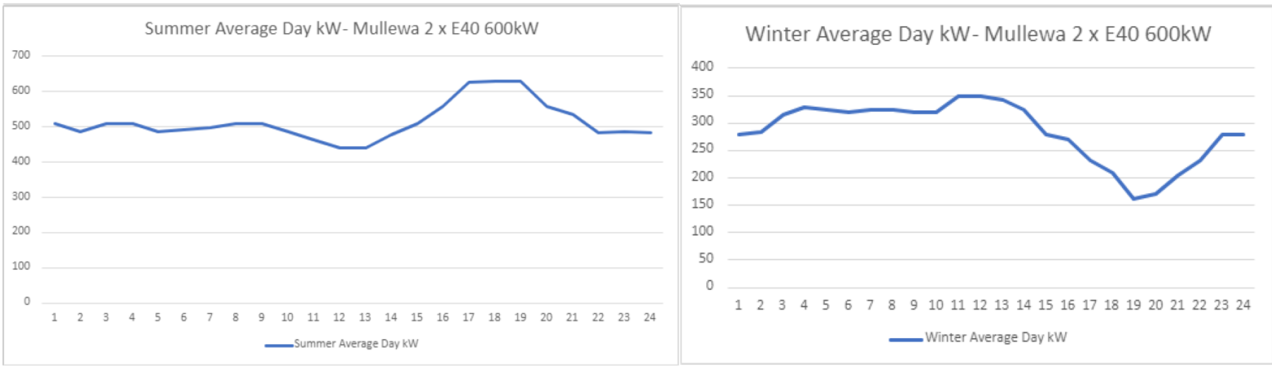


Figure 5-6: BlairFox predicted daily average wind generation profiles

6 PHASE 1 – DIGITAL TWIN

6.1 Data Access

The value of a digital twin is fundamentally tied to the richness of it's underlying dataset. For the Mullewa digital twin this data was mostly coming from Western Power and Synergy. Both WP and Synergy have responsibility for the security of their data and so it was realised early on that it was necessary to establish a collaborative agreement between WP, Synergy, Sunrise (study owner) and Enzen (digital twin producer) to ensure satisfactory levels of protection in place to facilitate handover of the data.

Establishing this agreement was not a trivial matter and took several months due to negotiations around the various commercial sensitivity issues and NDA's and settling on the final terms before being signed by all parties. Even if a complete digital twin is not an objective, the energy modelling required to size a renewable brownfield microgrid and evaluate the commercial viability requires access to the meter data which would still require a formal agreement with Synergy and Western Power which should be planned for. The alternative would be to have to go to each of the individual customers and obtain their permission in writing to access their data, and this approach was required for the five contestable customers that were not with Synergy and it took considerable time to obtain their permission and then receive the data.

6.2 Input Data

6.2.1 Network Topology and Asset Data

The network topology data and asset data was provided by Western Power and handed over directly to Enzen for incorporation in the digital twin. LiDAR data was also required for producing a digital twin, and was provided by Western Power via their LiDAR services contractor.

In terms of asset data, Western Power provided some technical details and some age data, however did not provide inspection, condition or maintenance data. Although this would have provided for a more richer experience with the digital twin it was still sufficient to support a working model and give a good example of the potential benefits.

The expectation is that once Western Power become more familiar with the operation and potential benefits of a digital twin there would be motivation to build out the capability by adding additional data.

6.2.2 Outage Data

Western Power provided outage data from January 2015 through to June 2023. This period includes the time at which the emergency response (diesel) generator (ERG) was installed, March 2019, and so enables an evaluation of the impact of this action on the reliability in Mullewa as discussed in Section 7.1.

Data was also provided by Westen Power on the operation of the ERG from March 2019 through to March 2022, identifying the periods in which it operated and for how many hours in each instance.

6.2.3 Customer Meter data

Western Power provided the following data in February 2022 for the Mullewa township and the downstream radial connections:

- 322 NMIs
- 284 NMIs that are current Synergy customers

- 224 in the Mullewa township “Mullewa” connections
- 60 outside the Mullewa township “Radial” connections
- 5 with other retailers (contestable customers)
- 1 “extinct” NMI
- 31 vacant properties
- 1 currently moving out (soon to be vacant)

Synergy confirmed the number of Synergy customers and provided a more detailed breakdown of these NMI’s:

- 284 NMIs
- 83 Business with 18 on a home business plan (K1)
- 6 contestable customers
- 201 Residential
- 13 Interval enabled
- 184 Interval capable (not enabled)
- 87 Not interval capable
- 10 different tariff products, with the vast majority (198 customers) on the A1
- 0 customer with a battery

The breakdown in terms between Mullewa and the Radial was:

Mullewa

- 47 Business with 4 on a home business plan (K1)
- 177 Residential
- 40 with a solar system
- 228 kW panel capacity

Radial

- 36 Business with 14 on a home business plan (K1)
- 24 Residential
- 4 with a solar system
- 21kW panel capacity

6.2.4 Meter Consumption data (or network consumption data if no time of use available)

Synergy provided annual meter consumption data totals broken down by commercial and residential loads and also by Mullewa town versus radial loads. The load attributed to contestable customers was provided. They also provided the interval data as a yearly load profiles in half hourly readings.

Obtaining interval data for the 5 non-Synergy contestable customers was a more difficult and long process. Western Power had to first obtain permission from non-contestable customers to provide their contact details to Sunrise. Each customer then had to be contacted individually by Sunrise to explain what their data would be used for and then ask them to sign a Western Power form giving Western Power permission to hand over their interval data. Eventually all of the 5 non-Synergy contestable customers agreed and their interval data was obtained.

6.3 Data Manipulation

6.3.1 Network Topology and Asset Data

Asset data required alignment of the pick ID data before matching to Fugro 3D model data.

Schema “point cloud” (terrain and height) was classified to get it into poles and wires and vegetation, ref. Figure 6-4. Vector overlays were added to the point cloud engine to bring into one visualization with contextual information.

Dashboards and reports (ref. Figure 6-3) were built to profiles like age, type of carrier etc. For example 30% of the SCGZ conductor is 25 years of age. Because condition was not available for the network age profiles had to be used as a proxy to profile assets for reliability. This could be further enhanced if inspection / last inspected data or possibly current working loads of the poles etc. was provided as could be used to simulate a profile for a better reliability outcome.

6.3.2 Meter Data

In terms of the energy modelling it was decided the best compromise in terms of resolution versus efficiency was to model the loads broken down by contestable customers (all within the Mullewa town) and then non-contestables broken into those in Mullewa town and those on the radial network. Residential and non-contestable commercial customers data was merged and Synergy contestable load extracted.

These loads accounted for the installed rooftop solar and so the amount of solar that would have been generated from the installed capacity was estimated and backed-out of the load data so that the data represented the full load before the rooftop solar was accounted for, allowing the rooftop solar to be modelled separately.

A rooftop solar split between contestable and non-contestable customers was not available and so an approximate 50/50 split was assumed based loosely on satellite data showing rooftop installations.

6.4 Loading of Data Sets

6.4.1 Network Topology and Asset Data

The Network Topology and Asset Data was processed by Enzen and prior to establishing the final digital twin it was initially loaded into an intermediate database format accessible from google earth (ref. Figure 6-1 and Figure 6-2) and also via a data dashboard supporting a number of different report formats (ref. Figure 6-3).

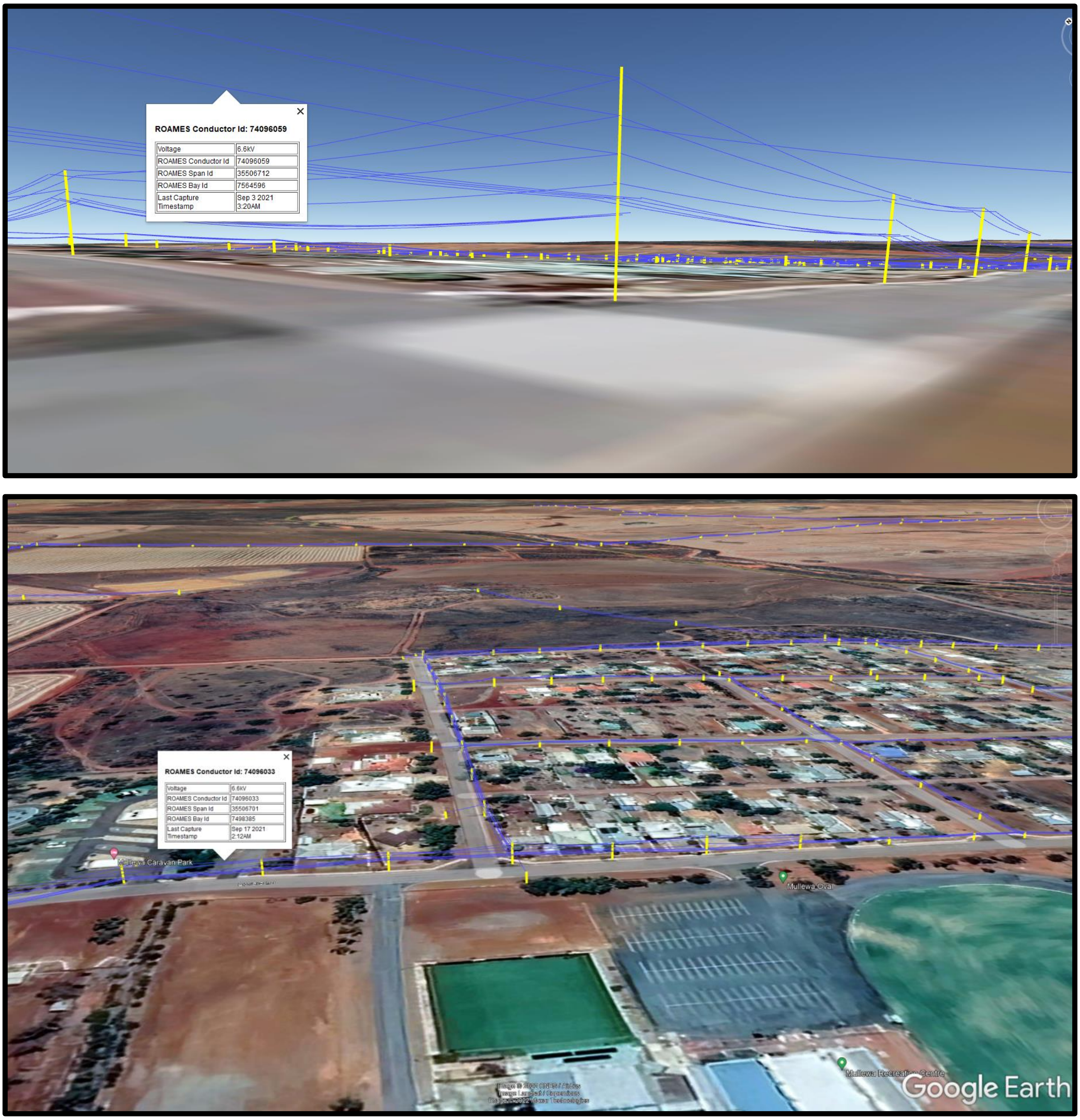


Figure 6-1: View of asset data overlayed onto Google Earth

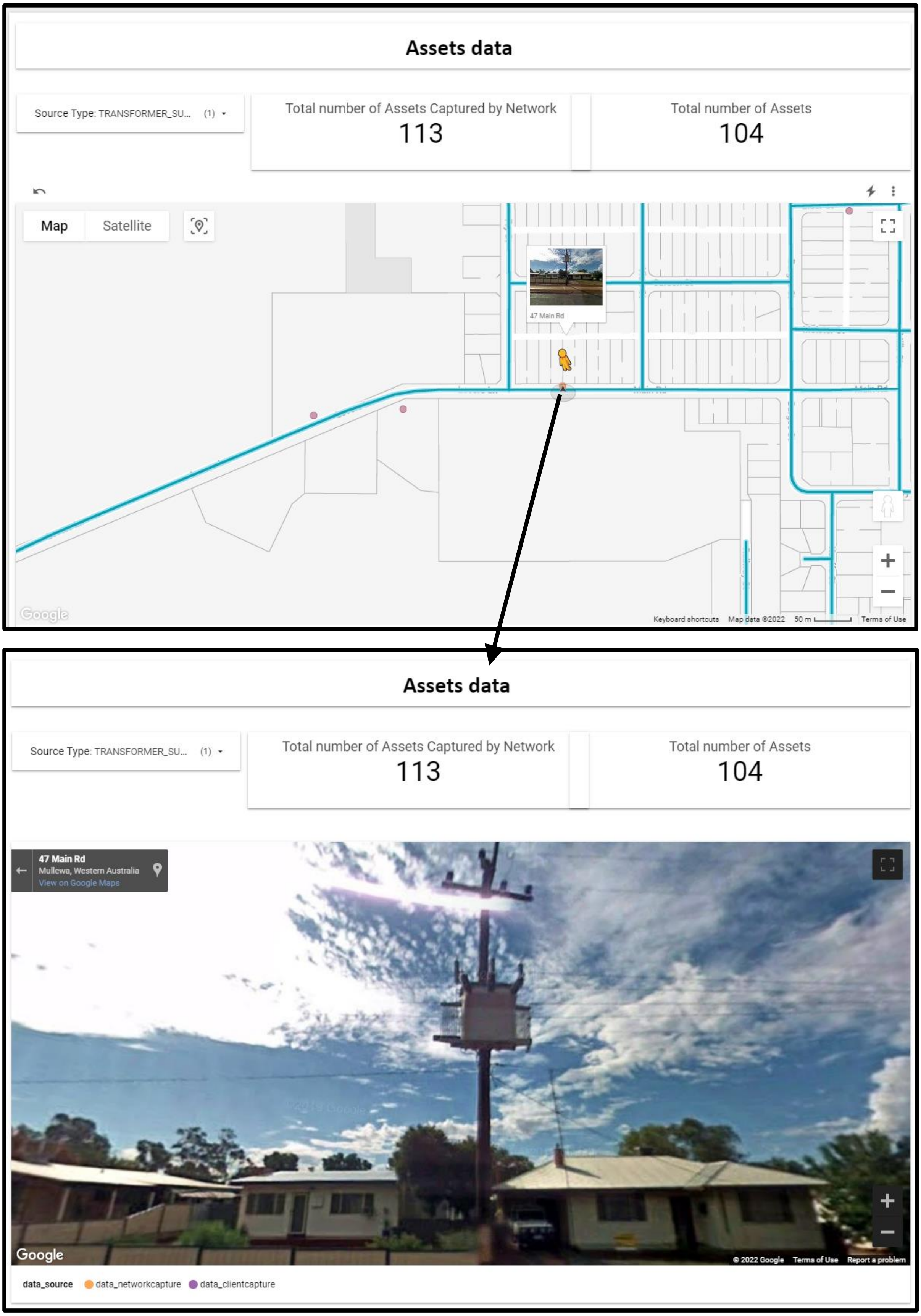


Figure 6-2: Locating a specific asset using Google Streetview

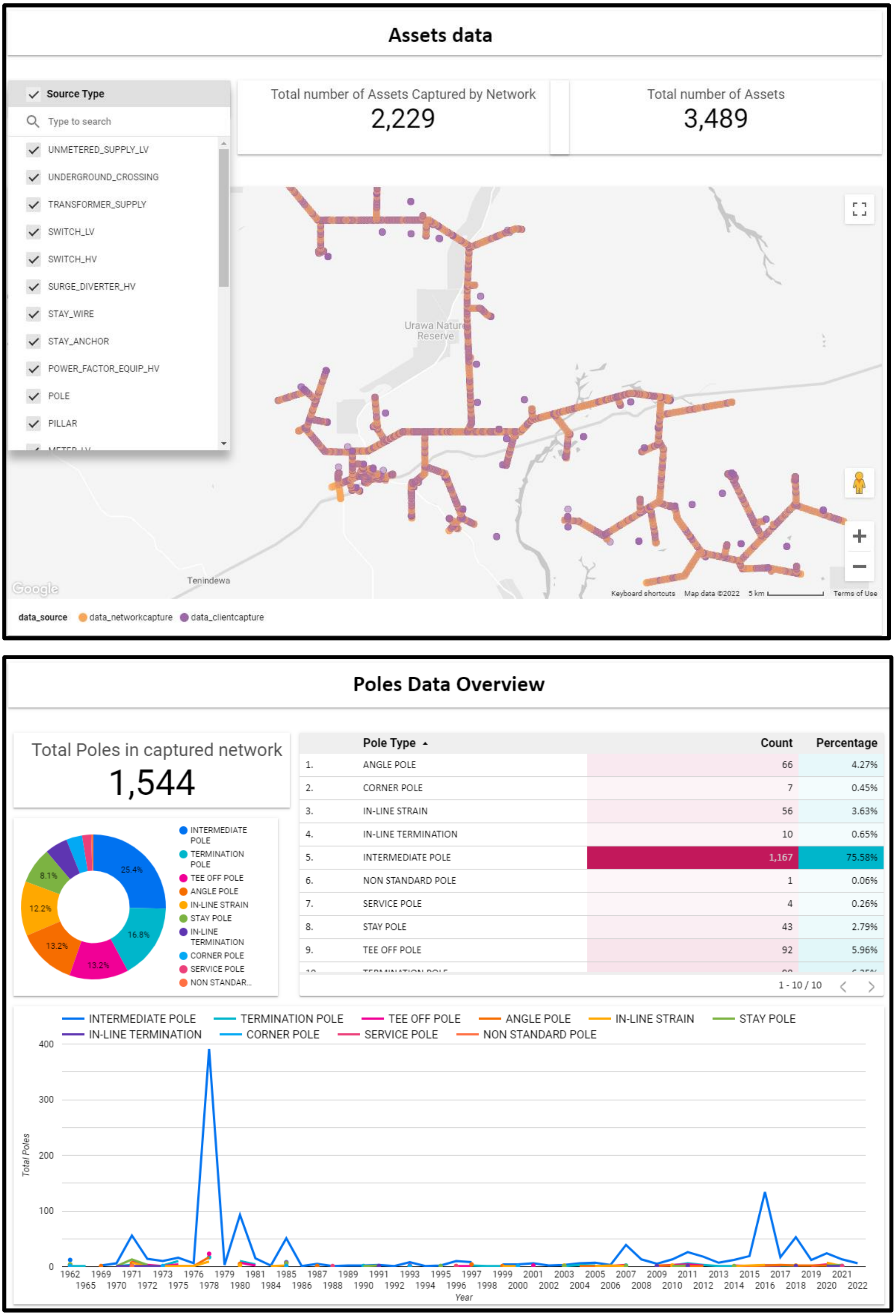


Figure 6-3: Examples of different data dashboard views for presenting of the asset data

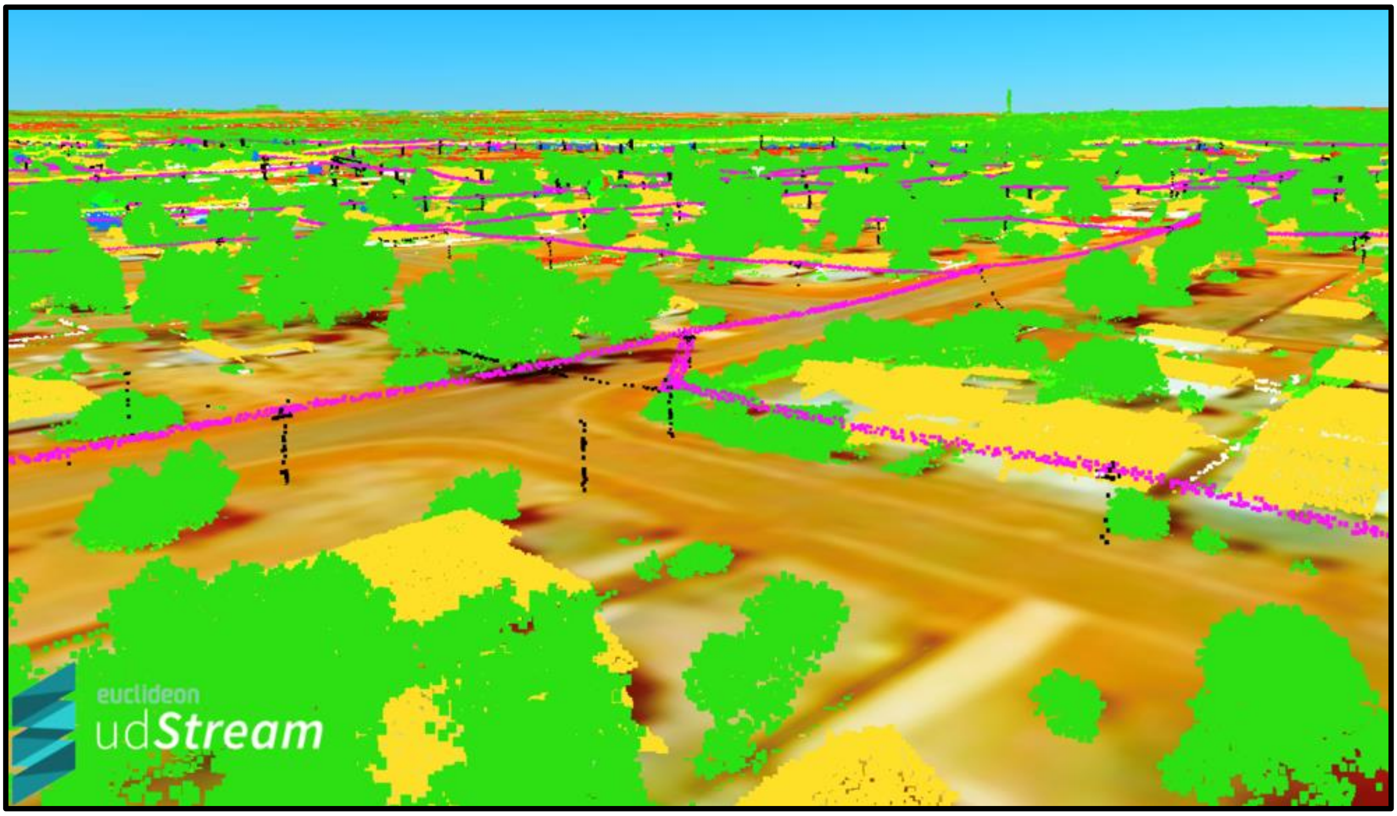


Figure 6-4: Sample of point cloud data. Power poles in black, conductors in pink and vegetation in green

6.4.2 Meter Data

From the manipulated data the following datasets were loaded into the GridCog modelling tool:

- Non-Contestable Customer Load Profile for the Town (866MWh annual consumption)
- Non-Contestable Customer Load Profile for the radial network (355MWh annual consumption)
- Synergy Contestable Customer Load Profile (542MWh annual consumption)
- Non-Synergy Contestable Customer Load Profile (440MWh annual consumption)

Datasets were not created and loaded into GridCog for the rooftop solar generation. This was calculated internally within GridCog based on the rooftop solar capacity.

6.5 Data Validation

6.5.1 Network Topology and Asset Data

During a site visit to Mullewa in April 2022, the digital twin in its intermediate format, accessible via google earth and preliminary data dashboard was available to do a spot check against some of the physical assets in the town. Several checks against asset numbers available on the power line poles was performed and found to match up against the data in the digital twin dashboard.

What was discovered however were some anomalies in the conductors reported in parts of the digital twin. The digital twin was showing changes in line voltages at certain locations where there were no transformers actually present. This discovery was fed back to Enzen for review. The explanation for the anomalies was due to use of “ROAMES® World” (not an authorized source of network voltage data) to fill in some of the gaps in the data. After recognizing this the anomalies were corrected.

The basis of the Enzen proposal for the digital twin was that the Mullewa twin would be built on the back of the much larger model being developed for TasNetworks, covering all of Tasmania. The TasNetworks digital twin was a much larger undertaking than expected and developing the model took Enzen considerably longer than expected with the resulting knock-on effect impacting significantly on the delivery of the Mullewa digital twin. The digital twin has been presented to Sunrise and a presentation is being planned for Western Power and Synergy for some time in September 2023.

6.5.2 Metering Data

As means of checking whether the Synergy load data and that obtained from the 5 non-Synergy contestable customers accurately reflected the total load for the town, Western Power were able to provide data from the nearest recloser on the incoming line to the town. The data from the recloser resulted in a total annual load for the town of 2694MWh whereas the Synergy + 5 non-Synergy contestable load added up to only 2203MWh for a year, leaving 491MWh per year unaccounted for. It is estimated that streetlights would account for somewhere in the order of 40MWh per year with the remainder associated with unmetered consumption.

The representation of the metering data and the actual modelling performed on the basis of this data was reviewed together with Western Power and Synergy during a workshop at Western Power in October 2022, Ref. Appendix A for a copy of the workshop presentation. The feedback from this was positive with no corrective actions recorded.

7 PHASE 2 – MODEL SOLUTIONS

7.1 Analysis of Technical Problems (Outages and Root Cause)

The technical problems with the current energy situation in Mullewa is a lack of reliability which is essentially a result of it being a radial network. Any failure along the almost 100km of above ground distribution line can lead to an outage of power and this is only exacerbated by an ageing network.

With 100km of exposed line susceptible to failure the typical root causes and their likelihood of occurring (based on the past history provided in the Western Power outage date) are given in Table 2.

Table 2: Causes of interruptions to the Mullewa power supply

Cause of Interruption	Pre ERG	Post ERG	Total	Total as a %
Equipment Failure	21	22	43	34%
Unknown	22	16	38	30%
Emergency Outage for Hazard	8	6	14	11%
Wind or Wind Bourne Debris	6	6	12	10%
Lightning	2	5	7	6%
Vehicle	3		3	2%
Bird	2	1	3	2%
Customer Installation or Appliance	2		2	2%
Machine or Tool	1		1	1%
Animal	1		1	1%
Fire		1	1	1%
Human Error		1	1	1%

Equipment failures topping the list at 34% correlates reasonably well with the assessment in the Western Power NOM2022 [6] which states that generally less than a third of outages are directly controllable by Western Power and the remainder due to windborne debris, extreme weather events or caused by a 3rd party.

When talking of solving reliability it is in relation to the reliability of the feed from Geraldton that supplies Mullewa and the downstream radial. Solving this means providing power to the town and radial when a fault somewhere along the 100km of line from Geraldton to Mullewa disrupts the grid supplied power. Faults within the town that may impact a portion of the town or faults downstream of the town which may impact customers on the radial line, is not solvable within the scope of a microgrid proposal.

More detailed outage data was provided by Western Power as part of the actual study, as referred to in Section 6.2.2. This outage data includes the number of customers affected and the cause of the interruptions. With the number of customers affected identified, a judgement can be made as to whether the fault was upstream of downstream of the town. Also when analysing the data in relation to reliability, planned outages could be ignored. Where the number of customers affected was less than the 290 NMI's identified (excluding extinct and vacant properties) then it was assumed the fault lay downstream of the entry point of the town ie. within the town or on the radial network and so these outages were discounted when considering outages that may be addressed through implementation of a microgrid. The data also identified outages associated with transmission or generation failures where the number of customers affected exceeded 18000 and so evidently not associated with the reliability of the 100km radial feed to

Mullewa and so these were also disregarded from a reliability review perspective (although a Microgrid with local renewable generation and storage would also solve outages related to those causes as well).

Table 3: Interpretation of outage data in terms of reliability pre and post installation of the Emergency Response Generator (ERG)

	Pre ERG		Post ERG	
Data period (days)	1525 (Jan 2015 – Mar 2019)		1466 (Mar 2019 – Apr 2023)	
No. of outage events over the data period	68		58	
Ratio of events to the data period	4.5%		4%	
Event Durations *	Until Initial Restoration	Until Final Restoration	Until Initial Restoration	Until Final Restoration
Total outage hours over the data period	180	459	199	633
Average outage hours per event	2.7	7	3.4	11
Max during the period (hrs)	15	24	30	94
Max difference between Initial and Final	23		78.4	
No. of events as % of total below 1 hr duration	49%	25%	70%	49%

* Note, as an outlier event, the outage resulting from cyclone Seroja in April 2021 was not accounted for in the durations data

Evaluating the data in terms of reliability, Table 3 expresses this from the perspective of number of outage events, and also in terms of outage durations. In terms of the number of events there is no significant change pre and post the ERG installation. Similar for most of the outage duration metrics, there is nothing to suggest any improvements since the ERG installation, in fact it could be argued the data suggests a possible decline in reliability. If these two perspectives aren't looked at in isolation, and the number of outage events that have a duration below 1hr considered, it appears that this is where the provision of the ERG may have resulted in some positive results.

The ERG can only react to an outage and so in essence doesn't solve reliability but can mitigate the consequences. This is evident in that essentially there are still the same number of outages of the main 100km radial feed supplying Mullewa pre and post ERG. Even though there is not a reduction in total outage hours observed, the number of instances where outages have been kept below 1 hour has increased since the ERG was installed.

The main thing that can be concluded from this is that the ERG has a limited effect on reliability, merely reducing the consequences of outages, without solving the reliability issue – meaning another solution is required.

What is not evident from this data is what the reliability would have been like if the ERG had not been installed. The ERG operating data provided gives an indication of this. It showed that between March 2019 and March 2022 it operated for a total of 611 hrs across the two generators, 416 hrs of which are assumed to be associated with cyclone Seroja in April 2021. The ERG has therefore clearly had a positive impact on the town of Mullewa, even if it is not a complete reliability solution. It also reinforces the value of local generation in whatever form it takes.

7.2 Identification of the Network Limitations Inherent in a Radial Network

The network limitations inherent in a radial network come down to its susceptibility to a single point of failure. In a meshed network the interconnections within the system allow for alternative energy distribution routes should single failure occur (or potentially more – depending on the complexity of the mesh).

7.3 Risk Exposures that Cannot be Mitigated due to System Architecture

All of the above possible root causes for outages in Mullewa can be mitigated by a change to the system architecture whereby generation and associated storage is installed locally and the local network islanded from the SWIS on loss of gird supply. This mitigates the reliance of such a long section of line that is susceptible to a single failure. On detection of failure along the incoming grid supply line the microgrid can go into island mode, operating on self-generation and battery storage (with diesel generation as a last means of resort for extra long outages). Also mitigated to some extent would be risks in the form of external forces impacting on the cost and service of electricity supply to Mullewa – generating a significant portion of the energy locally will provide more control and certainty of the supply and reduce lines losses for the SWIS.

Risk exposure that cannot be mitigated by the system architecture are:

- physical risks to the microgrid, ie. outages within the microgrid itself or on the downstream radial (due to natural forces or accidents) that cause outages, not for the whole town but to those downstream of the faults.
- risks in the form of societal forces that could lead to depopulation of the town and subsequent reduction of load.
- risks in the form of external forces impacting on the cost and service of electricity supply to Mullewa.

7.4 Range of Potential Technical Solutions Applied in the Model

At a high level the technical solutions applied to a Microgrid model are essentially what is described in the adopted definition of a microgrid (ref. Section 3), which is a technical solution that incorporates local renewable generation and storage to reduce the dependency on the grid and can island the Microgrid on loss of the grid supply and then support the town on the local generation and storage until grid supply is restored. This sounds relatively straightforward but is actually technically challenging and requires significant innovation to achieve, which is described in greater detail in Section 10.2.4

More specifically, within this high level outline of the technical solutions, the potential renewable generation solutions considered were solar PV generation and generation from wind turbines. In terms of storage a lithium ion battery was considered for providing an instantaneous (essentially) short term reliability solution, but as a solution for possible long terms outages, diesel powered generation was considered.

Initially technical solutions for islanding the microgrid and controlling the embedded generation to support the load, were considered on the assumption that the generation and storage would be co-located with the grid connection/isolation point, given the protection and controls at the connection/isolation location would need technically compliant communications via fibre optic connection. Technical solutions using radio compliant communications were also considered in order to remove this constraint of having to co-locate the connection/isolation point with the generation/storage.

7.5 Improvements in Performance and Reduction in Risk Achieved form the Technical Solutions

The technical solutions describe in Section 7.4 would achieve the following performance benefits and risk reductions:

1. Local renewable generation
    - Improves the performance of the entire grid in terms of reduced CO_2 emissions by displacing grid power, of which 65% is still on average (based on the last 12 months) generated from hydrocarbons.

- Reduces overall line losses for the SWIS by generating a significant portion of the energy where it is consumed (ref. Line Loss Calculations by Jarrah Solutions under Appendix G).
- Improves the performance of the 100km radial supplying Mullewa by reducing the load on it, hence freeing up capacity for others.

2. Combination of Solar and Wind Generation.
   - Typically the solar and wind generation profiles are complimentary in that often when the sun isn't shining there's a good chance the wind is blowing and vice versa which improves the performance of the Microgrid.
   - Provides a general reduction in risk by not having to rely on a single source of generation.
3. Battery Storage
   - Can improve the performance of the Microgrid by helping timeshift the generation profile to better match the load profile and hence reduce the amount of grid consumption.
   - Can reduce the risk of upstream grid outages impacting the microgrid by supporting near to instantaneous changeover to island mode operation.
   - Provide frequency stability when running in island mode
   - Reduce reliance on diesel (non-renewable) generation during island mode. Excess generation can be used to charge the battery and defer the possibility of having to operate on diesel.
4. Diesel Generation
   - Diesel generator improves the reliability performance by providing long term energy storage. In the event of a long duration grid supply outage during periods of low renewables generation leading to battery depletion the diesel generator switches on to recharge the battery.
   - Also reduces the risk from renewable generation or battery failures as the diesel generation can support the load directly if necessary.

7.6 Baseline Technical Solution

The proposed baseline technical solution is:

- Solar PV generation and co-located BESS
- Back-up diesel generation co-located at the connection point
- Compliant radio communications between connection and grid isolation point

7.7 Initial Commercial Screening

The approach taken by the study was to perform an initial high-level screening of several commercial models against a baseline technical solution, the objective being to confirm which of these models would be best suited to achieve a viable commercial outcome. That model would then be subjected to a more thorough analysis to refine the model and size the renewable generation and storage that would form the basis for the development activities.

There are at least four different commercial models that could theoretically be applied to introduce renewable energy generation and storage to fringe-of-grid towns such as Mullewa. These are:

- Model 1 – "As-Is" Model

- Model 2 – "As-Is + Network Control Services (NCS)" Model (further defined later on as Non-Co-optimised Essential System Services "NCESS Microgrid" model and then subsequently as Alternative Options Strategy "AOS Microgrid" model)
- Model 3 – "Microgrid" Model (further defined later on as Embedded Network "EMN" Microgrid model)
- Model 4 – "Local Geographical Virtual Power Plant (VPP)" Model (not necessarily falling within the Microgrid definition, however explored based on feedback from Synergy and Western Power)

The baseline technical solution to which the first three models was applied, was a Solar PV array together with a BESS. Because of the difference in how the models operate commercially, the best commercial outcome from each of the models may be achieved with different energy generation/storage arrangements. A mix of different generation and storage scenarios was therefore evaluated for each model. 25 scenarios made of 5 different solar farm sizes and 5 different battery sizes were applied to the first three models. The sizes were:

- Solar Farms: 0.5MW, 1MW, 2MW, 3MW & 4MW
- Battery Storage: No Battery, 1MWh, 2MWh, 3MWh & 4MWh

Even though the VPP commercial model was not strictly a Microgrid solution, there was still deemed to be merit in evaluating this a comparison to the other models. Due to the nature of a VPP the baseline technical solution differs from the other three models in that the Solar PV is based on a collection of small individual residential rooftop systems as opposed to a large single PV array and instead a single large BESS, the VPP is based on a collection of small residential size batteries. The number and size of the individual systems was modelled to achieve the equivalent combined solar generation and storage as used for the other three models (and identified above), except that only a combined 0.5MW and 1MW of Solar was considered as there was not sufficient residences in Mullewa to produce solar generation greater than this in a VPP context.

7.7.1 As-Is Model

An as-is commercial model is the simplest arrangement for provision of local generation & BESS to the Mullewa community and represented in Figure 7-1.

The features of such a model would primarily consist of a connection of the generating assets and BESS to the network and a commercial arrangement (PPA) with an energy retailer to purchase the power generated, whereby the retailer paid agreed rate for the locally generated energy consumed and then on-sold it at a mark-up to its customers.

To evaluate this model an assumption for a plausible PPA rate is based on other agreements that Synergy have in place for purpose of energy from local solar generation. It should be noted however that purchasing solar generation is not a particularly attractive model for Synergy, given they already have access to excess solar generation in the grid at a low price. Therefore this model may come up against some difficulties with the practical implementation in terms of even securing a PPA.

In addition to a PPA other revenue in this model would come from sale of LGC's and Generation Capacity Credits. At the time it was assumed Generation Capacity Credits could typically generate about $100k per MW of a nominal generation capacity which typically would be based on the greater of 20% of Solar Generation Capacity and Battery Storage/Discharge Capacity (the lower of: battery storage divided by 4, versus inverter capacity).

Expenses include asset operating costs, Insurance & Network Tariff costs (RT1, Entry Service Tariff).

Capital costs will be for Generation and storage assets and the grid connection.

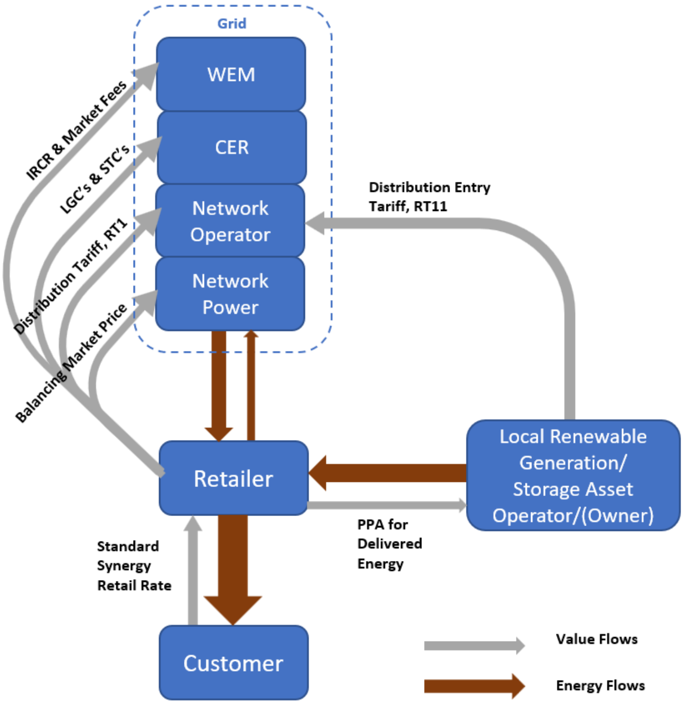


Figure 7-1: Representation of "As-Is" Model

7.7.2 As-Is + NCS (NCESS/AOS Microgrid) Model

A network control service (NCS) scenario would involve the likes of Western Power compensating the supplier of local generation and BESS for providing Network services, such as UPS or voltage control service. In effect this would be subsidising the cost of the electricity, making an arrangement with a retailer more attractive. The As-Is Model with NCS added, is represented in Figure 7-2.

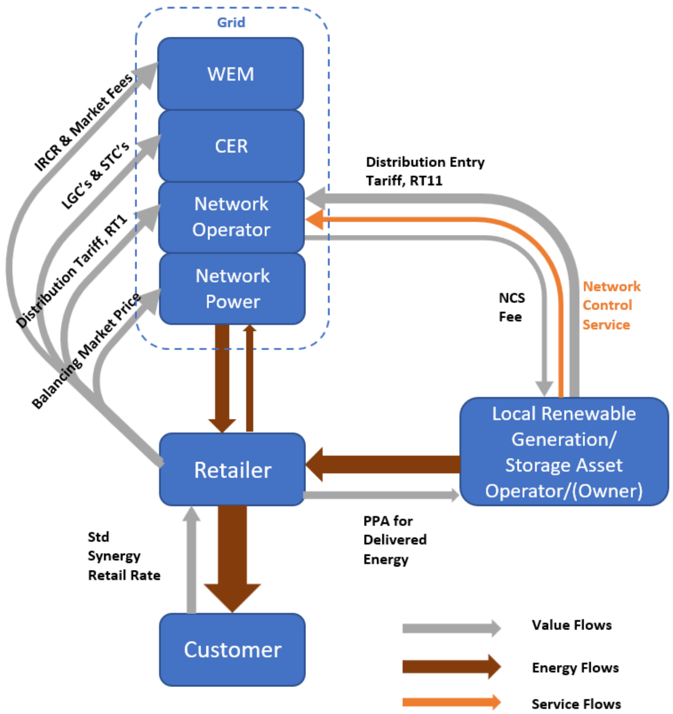


Figure 7-2: Representation of "As-Is" + NCS (NCESS/AOS Microgrid) Model

For this high level analysis it was kept simple with an NCS fee based on retaining 50% of the BESS capacity available for a UPS service.

Less energy will be sold during peak-rate hours because half of the battery capacity is reserved for UPS and so not available for shifting energy generation during off-peak times over to use during peak times. Revenue, expenses and capital costs are the same as for model one except for the reduction in revenue due to less generation being sold at the more profitable peak rate. This however, is more than compensated for by the additional revenue from the NCS fee.

7.7.3 Embedded Network (EMN) Microgrid Model

The difference between the above two models and the EMN Microgrid model is that a master meter would be installed at the entry point to the town (and downstream network) and then the solar generation and storage connected behind this meter, as part of what would now perform as an embedded network, as represented in Figure 7-3.

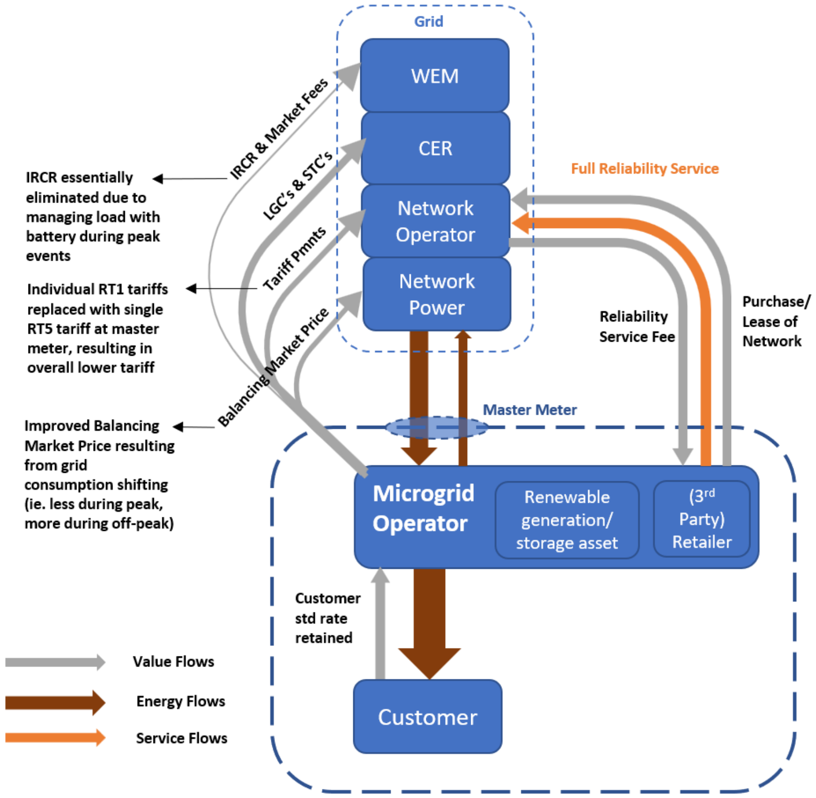


Figure 7-3: Representation of EMN Microgrid Model

From the perspective of Western Power all of the small individual loads are now consolidated as one single load service via the master meter, with only the energy in excess of what can be locally generated behind the meter being subject to network tariffs. As a single larger load a new network tariff would also apply, RT5 likely, but may be other better suited tariffs depending on the size of the local generation and how much was not consumed locally and available for export.

Under this model the Microgrid Operator (MO) would now not only be responsible for the single consolidated network tariff, but also the WEM market fees and any IRCR charges, LGC & STC liabilities and via a nominated retailer the purchase of extra power from the grid not supplied from local generation and sale of energy to all the consumers. For this service the retailer would earn a % of the energy sold. Having control of the energy flow within the microgrid means the operator would have the ability to manage the battery to reduce DSOC and hence RT5 Tariff expenses and avoid IRCR changes.

7.7.4 Local Geographical Virtual Power Plant (VPP) Model

A virtual power plant is the organisation and aggregation of individual distributed energy resources (DER) to generate and store electricity at a local level. Typically, this is connecting rooftop solar and individual batteries via smart communications and control technology so that the individual assets can be managed as what appears to the network as a single large energy entity to leverage the benefits associated with this for an improved outcome for the individual participants.

7.7.5 Results/Conclusion

The results from this initial screening was presented to Western Power and Synergy at Workshop in June 2022. The presentation from workshop can be found in Appendix A. Figure 7-4 is an extract from that presentation and shows the results from the analysis of the 25 different scenarios applied to the first three models and 10 scenarios applied to the geographical VPP model. The different models are compared for commercial performance based on their simple payback (in years), ie. the number of years that would be required to payback the initial capital costs based on the estimated annual net revenue.

Scenarios		Model 1 "As-IS"			Model 2 "As-Is + NCS"			Model 3 "Microgrid"			Model 4 "Geographical VPP"			
Solar Farm Size	Battery Size	Capital Cost	Net Revenue	**Simple Payback**	Capital Cost	Net Revenue	**Simple Payback**	Capital Cost	Net Revenue	**Simple Payback**	No. of 5kW Systems to give equivalent output to stated Solar Farm Size	Capital Cost	Net Revenue	**Simple Payback**
MW	Mwh	$million	$1000's	**Years**	$million	$1000's	**Years**	$million	$1000's	**Years**		$million	$1000's	**Years**
0.5	0	$ 1.9	$8	219	$ 1.9	$8	219	$ 3.9	$217	18	140	$ 1.9	$82	24
1	0	$ 2.9	$92	32	$ 2.9	$92	32	$ 4.9	$305	16	280	$ 2.6	$81	33
2	0	$ 5.0	$130	38	$ 5.0	$130	38	$ 7.0	$408	17				
3	0	$ 6.9	$170	41	$ 6.9	$170	41	$ 8.9	$428	21				
4	0	$ 8.8	$211	41	$ 8.8	$211	41	$ 10.8	$449	24				
0.5	1	$ 2.4	$21	116	$ 2.4	$12	202	$ 4.4	$289	15	140	$ 2.9	$125	24
1	1	$ 3.7	$107	34	$ 3.7	$98	37	$ 5.7	$368	15	280	$ 3.6	$129	28
2	1	$ 6.1	$137	45	$ 6.1	$128	48	$ 8.1	$458	18				
3	1	$ 8.5	$172	49	$ 8.5	$163	52	$ 10.5	$474	22				
4	1	$ 10.7	$209	51	$ 10.7	$200	53	$ 12.7	$491	26				
0.5	2	$ 2.7	$35	78	$ 2.7	$42	65	$ 4.7	$299	16	140	$ 3.9	$160	25
1	2	$ 4.0	$146	27	$ 4.0	$153	26	$ 6.0	$378	16	280	$ 4.6	$178	26
2	2	$ 6.4	$161	40	$ 6.4	$168	38	$ 8.4	$460	18				
3	2	$ 8.8	$187	47	$ 8.8	$194	45	$ 10.8	$476	23				
4	2	$ 11.0	$224	49	$ 11.0	$231	48	$ 13.0	$493	26				
0.5	3	$ 3.1	$50	62	$ 3.1	$60	51	$ 5.1	$306	17	140	$ 4.9	$107	46
1	3	$ 4.3	$186	23	$ 4.3	$196	22	$ 6.3	$386	16	280	$ 5.6	$252	22
2	3	$ 6.8	$200	34	$ 6.8	$211	32	$ 8.8	$459	19				
3	3	$ 9.1	$216	42	$ 9.1	$227	40	$ 11.1	$475	23				
4	3	$ 11.4	$238	48	$ 11.4	$249	46	$ 13.4	$492	27				
0.5	4	$ 3.4	$64	53	$ 3.4	$79	43	$ 5.4	$314	17	140	$ 5.9	$126	47
1	4	$ 4.7	$225	21	$ 4.7	$240	19	$ 6.7	$394	17	280	$ 6.6	$271	25
2	4	$ 7.1	$240	30	$ 7.1	$254	28	$ 9.1	$458	20				
3	4	$ 9.5	$256	37	$ 9.5	$270	35	$ 11.5	$474	24				
4	4	$ 11.7	$273	43	$ 11.7	$287	41	$ 13.7	$491	28				

Figure 7-4: Results from Commercial Models High-Level Analysis

Model 3, the EMN Microgrid model, achieves the best performance with several models (highlighted in green) outperforming Model 2, the next best model. As would be expected the additional income from NCS fees result in Model 2 outperforming Model 1 and then the VPP Model 4 is behind Model 1.

The distinction in how models 1&2 function differently from Model 3 is evident from how the better performing commercial scenarios for Models 1&2, are achieved via different solar/battery combinations than for Model 3. Models 1&2 benefit from a large battery size as the main income is from energy sold and with a much higher rate available during peak. The larger battery means more energy can be transferred to peak rate selling times, hence the better outcome. The energy sold in Model 3 is sold at a flat rate so the value of the battery in impacting revenue from energy sales is not as significant, and so the impact of the battery size on the outcome is not as significant. In addition to best Model 3 scenario there are also several scenarios which still out perform the other models (highlighted in green).

It's not unexpected that Model 4, the VPP performs poorly by comparison as it is fundamentally unable to compete due to:

- Installation of numerous roof top solar systems and associated individual batteries is cost prohibitive compared to a single installation.
- The energy generation profile of fixed rooftop installation (compared to single access tracking) is of limited value, given the current excess of rooftop solar generation in the SWIS.
- The smart communication and control technology required for each DER asset is relatively new and expensive.

Looking in general at these four models a list of pros and cons was established, as presented in Table 4.

The conclusion drawn from the initial screening was that Model 3 the EMN Microgrid model was identified as the model with the best opportunity for commercial success and so a more detailed analysis of this model and associated scenarios would be performed to refine the commercial modelling, size the generation and storage and test for robustness.

The feedback from workshops with Western Power and Synergy, was that although the high level modelling identified the commercial promise of Model 3, the study should not necessarily rule out Model 2 at this stage given this model had a more straight forward path towards implementation and it could be useful to understand the commercial mechanisms of the Model 2 in more detail and possibly reveal ways for improving its commercial performance. Based on this both Model 2 and Model 3 were taken forward to the next stage of more detailed modelling using the GridCog energy modelling software.

Table 4: Pros and Cons of the four models from initial commercial screening

	Model 1	Mode 2	Model 3	Model 4
Pros	Easy - no regulatory changes required / status quo maintained Western Power revenue increase from new Solar Farm connection	Same as "As-Is" Model, plus can support the town during outages (ie. increased reliability of power supply) and slight commercial improvement due to increased revenue from NCS's	Increased reliability of power supply in Mullewa Most attractive commercial model for investors (demand & supply combined) Positioned to enable disconnection from the grid in the future, should that occur. Reduces Western Power exposure to maintaining ageing infrastructure, if network sold. If leased WP would be paid for the upkeep.	Increased reliability of power supply in Mullewa
Cons	No significant improvement in reliability Difficult to implement as not attractive to investors because: High risk – no certainty over future of grid connection (required to export excess generation) Longer payback period compared to Microgrid model Unlikely to gain approval above 1MVA DSOC Most commercially viable scenarios require larger batteries – with inherently greater commercial exposure (e.g. Batteries have limited life and replacement costs have not been accounted for in the analysis). Requires a retailer to underwrite, of which they have little incentive to do (uncontracted solar power already available today – likely at lower cost as at larger scale).	Same as "As-Is" model, except that as this scenario can support the town during outages, reliability issues is no longer a concern. Western Power have already installed diesel generators to do this (ie. support town during outages) – so may be better suited to towns with no emergency generation. Western Power costs increase to fund the NCS service. May be constrained to 1MVA DSOC	Some challenges to navigate on some regulatory requirements Synergy uses less wholesale energy to supply Mullewa Reduces Western Power tariff revenue (offset by embedded network services income & asset sale/lease) May be constrained to a 1.5MVA CMD & 1MVA DSOC	Difficult to implement as not attractive to investors because: VPP model relies on selling services to the market – however currently only Synergy can sell services to residential customers. High risk – no certainty over future of grid connection (required for services to support VPP model) High risk - uncertainty over future revenue opportunities, e.g. FFR/FCAS/ESS, Wholesale Demand Response Mechanism Longer payback period compared to Microgrid model Some challenges to navigate on some regulatory requirements Reduces Synergy revenue – with no reduction in commercial risk Reduces Western Power tariff revenue – with no reduction in responsibility Not proven (e.g. for grid forming, meaning centralized battery/inverter may still be required to provide these services) and no obvious provider in the market

7.8 Detailed Modelling

7.8.1 GridCog Modelling Tool

The GridCog modelling software provides techo-economic modelling, tracking and optimisation of distributed energy projects. Projects can span multiple markets, multiple sites and multiple distributed energy resources. It has 3 main parts which are:

- Planning for pre-project techno-economic modelling
- Tracking for post-deployment performance management
- Library for managing reusable modelling inputs

The tracking part allows for tracking of delivered commercial and environmental value against pre-project baseline, project baseline and optimal operations. The Mullewa Feasibility Study is “pre-delivery” and so it is the planning and library parts of GridCog that have been used for the Study. However, with a pre-project baseline model having been developed for Mullewa, implementing the GridCog tracking features would enable a means of assessing the value of the project post-delivery and support the ongoing optimisation of the operation of the Microgrid.

In the planning tool, a project has a baseline scenario representing the business-as-usual electricity supply arrangements. Alternative scenarios with different market pricing assumptions, different load assumptions, different combinations of and sizes of different energy resources, different commercial models and different asset and control strategies, can then be created and examined relative to the baseline scenario.

GridCog supports many kinds of energy resources, including solar, storage, wind, electric vehicles, load flexibility and gensets and enables these resources to be co-optimised to deliver the maximum commercial and environmental value.

The GridCog library provides a repository of modelling inputs that includes load profiles, network tariffs, retail tariffs, markets and market prices (with the WEM included), DER assets, project costing assumptions (capex and opex), demand response contracts and control and utilisation schedules. Some of the library items are generic, produced and maintained by GridCog such as many of the network and retail tariffs (including Western Power and Synergy tariffs) and markets and market prices (including the WEM). User generated library items are also possible for all library categories.

7.8.2 Modelled Scenarios

The baseline Scenario (existing case) for Mullewa is simply the present arrangement which is the Mullewa town and downstream radial electricity supply being provided by a combination of rooftop solar (for those that have it) and directly from the SWIS, via a 100km radial line coming from Geraldton. The energy supplied to customers from the SWIS is via a retailer according to the applicable bundled tariff, with the retailer then covering the energy costs, network tariff costs, market fees, certificate charges and IRCR charges. It also accounts for the emergency response generator (ERG) that has been located at Mullewa and estimated cost of this to Western Power.

The baseline scenario is useful to compare the two Microgrid scenarios that are modelled as possible solutions for Mullewa, and these are:

- Renewable Generation & Storage + Network Control Services (RGS + NCS) Microgrid
  (update in terminology from “Existing Case + NCS” Microgrid used during the initial commercial screening)

- Embedded Network (EMN) Microgrid

The distinct features of these scenarios that separate them from each other is represented graphically in Figure 7-5.

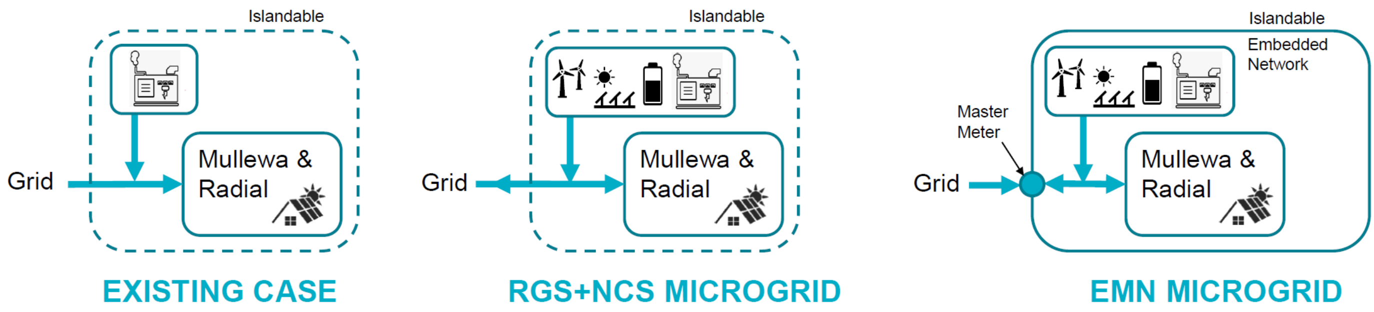


Figure 7-5: Representation of the 3 scenarios modelled in detail using GridCog

7.8.3 Participants

As part of assessing the impact of the different models it is necessary to understand how the different participants are affected. For this modelling exercise the following participants have been accounted for:

- Network Operator, Western Power (Network)
- Non-Contestable Customers (Customer)
- Contestable Customers (Contestable Customer)
- Retailer for Non-Contestable Customers, with the assumption this entity will fulfill the role of the Microgrid Retailer (Microgrid Retailer)
- Retailer for Contestable Customers (Contestable Retailer)
- Representative for costs associated with the unmetered load (Recloser Load)
- Representative for costs associated with estimated streetlight use (Streetlight Retailer)
- Microgrid Operator (Microgrid Operator)
- Representative for costs associated with Line Losses (Line Losses)

7.8.4 Modelling Parameters

Parameters used in the modelling were:

- Model Lifetime: 20 Years
- No CPI increase predictions applied
- Assumed Load Growth: 1.33% per annum (based on projections for Geraldton of 8% over 6 years) after 1st year.
- 278 Non-contestable NMI's, 11 Contestable NMI's
- Existing 249kW rooftop split equally between contestable and non-contestable customers.
- Time constraint (between 4&8pm) on 1.5MW export limit only applicable in first 3 years of operation. Based on the assumption of being be subject to NAQ during this period (despite discovering later on from conversation with AEMO that this might not be the case, ref. Section 10.3.3)
- Generating Capacity Credits available to RGS+NCS scenario after first 3 years of operation (despite discovering later on from conversation with AEMO that may be eligible from project start, ref. Section 10.3.3).
- No change in cost to Mullewa customers. The premise for the Microgrid is not to provide a direct commercial benefit to the residents of Mullewa but a reliability benefit. Where there is potential for a commercial benefit

the intent is to deliver this to the entire SWIS, ie. to contribute to the overall reduction in costs of the SWIS which would impact all customers including those in Mullewa.

- For EMN Microgrid scenario, no reduction in retailers (Microgrid Retailer Participant) revenue for non-contestable customers compared to existing case.
- For EMN Microgrid scenario, no reduction in contestable retailer revenue compared to existing case.
- For EMN Microgrid scenario, no reduction in revenue for Western Power from RT5 tariff and network lease income, compared to existing case of RT1/RT2 tariffs less NCS cost of existing diesel gensets.

7.8.5 Loads

The annual consumed loads used in the modelling are based on the data collected from Synergy, Western Power and direct from non-Synergy contestable customers with total annual loads as defined in Section 6.4.2. The load profiles from which these totals arise, are from actual raw data sources and so these actual profiles are what have been used as the load profiles for the modelling. The total peak load according to the combined load profile is 522kW.

7.8.6 Asset Sizes

For each of the two Microgrid scenarios the following asset sizes were modelled:

- Solar: 500kW, 750kW, 1000kW, 2000kW, 3000kW
- Wind: 0, 600kW, 1200kW
- Battery (2hrs): 0, 2300kWh, 4600kWh
- Diesel Generation: 750 kVA (for back-up only so single size selected sufficient to support peak load)

7.8.7 Asset Data

Details on the Asset data including costs and performance are summarised in Table 5

Table 5: Asset Data used as input to Grid Cog Modelling

Asset	Generation (first year)	Capacity Factor	Performance	Capex	Annual Opex
Existing Rooftop Solar	428 MWh / 249kW DC	19.6%	89% derating factor, 0.4% degradation per year	N/A - existing	N/A
Solar Farm	2289 MWh / MW DC	26.1%	89% derating factor, 0.4% degradation per year	$2.16m/MW	$16k pa + Ins. @ 1% of Capex + $5k/ha for land
Wind Farm (2nd hand refurbished turbines)	1630 MWh / 600kW Turbine (GridCog prediction prior to BlairFox assessment (ref. Section 5.6)	30.9%	17.25% losses, 1.6% degradation per year	$1.86m/MW	$30k for connection + $35k/turbine + Ins. @ 1% of Capex + land @ $5k/turbine
BESS	Lithium battery, 2hr duration		90% depth of discharge, 85% round trip efficiency, 2% degradation per year	2300kWh @ $826/kWh 4600kWh @ $717/kWh	Ins. @ 1% of Capex
Microgrid Diesel Genset	750kVA diesel generators and transformer (for back-up only, so operation not modelled)			$360k	N/A
Existing ERG	2x500kVA diesel generators and transformer			N/A	$210k
Streetlights	Approximately 160 streetlights in Mullewa			N/A	$12k income to EMN MO
Grid Connection	1.5MW export constraint (export between 4pm-8pm only, first 3 years only)			$1m	$55k + Ins. @ 1% of Capex
Embedded Network (EMN only)	Based on ownership retained by Western Power with network lease by the Microgrid Operator (MO)			N/A	$56k for lease + $40k general (paid to Network Operator

7.8.8 Network Tariffs

Network tariffs [1] used in the modelling were as follows:

- Non-Contestable Customer: RT1 (applied to each NMI)
- Contestable Customers / Unmetered Load: RT2 (applied to each NMI)
- RGS+NCS Model: RT11 (based on 1.5MW DSOC and 92km to Geraldton substation)
- EMN Model: RT5 (based on <1kVA half hourly CMD and so distance charges don't apply)

7.8.9 Energy Costs and Retail Tariffs

The following assumptions were used in the modelling for retail tariffs and energy costs:

- Non-Contestable Customer: Synergy A1, applied to each NMI
- Contestable Customers / Unmetered Load: Synergy L1 (for loads <50MWh/yr), applied to each NMI
  - (Note: Contestable customers generally use >50MWh/year, which would mean in terms of standard Synergy tariff L3 would apply. L3 tariffs however are considered to be significantly higher than what is realistically available to contestable customers in the market, and so the L1 tariff is adopted as a better reflection of realistic prices for contestable customers).

- RGS+NCS Model: Sale of energy based on the balancing market price
- EMN Model: Sale and purchase of energy based on the balancing market price

Synergy were approached for indicative rates that could be used for wholesale supply and purchase of energy however at that stage the feedback was that the balancing market price would be a suitable proxy for contract rates.

7.8.10 Certificates, Market FEES and IRCR Charges

Income earnt from sale of certificates and charges associated with certificate obligations were based on the following pricing assumptions:

- LGC Certificates:
  - From 2022: $50 per certificate
  - From 2025: $44 per certificate
  - From 2026: $38 per certificate
  - From 2027: $32 per certificate
  - From 2031: $15 per certificate equivalent (this is based on there being a replacement scheme after 2030, or if not, then to reflect the expected resulting increase in the wholesale energy price if no replacement scheme)
- LGC Obligations: 18.54% of certificate price
- STC Obligations: 28.8% based on STC price of $38

Market Fees were based on a cost of $6/MWh, with $1.4004 towards Admin fees and the remainder towards ancillary services)

IRCR Charges were based on a cost of $114,134.15/MW with TDL ratio of 1.6. This is taken from the published rate for 2020-21 capacity year and is expected to remain at this level for the foreseeable future.

7.8.11 Line Loss Assumptions

The line feeding Mullewa from the Geraldton substation is approximately 92km long. An estimate for the line loss factor was requested from Western Power however they were not able to provide this input. Although not a very detailed approach, in lieu of anything else, an estimate of 25% was assumed based loosely on a simple review of line loss factors reported for some of the other “long distance” radial distribution lines in the Western Power 2020/21 Loss Factor Report [2] as seen in Table 6.

Table 6: Reported loss factors for other "long distance" distribution lines

Information from WP Loss Factor Report		Fed From Substation	Approx Line Length	%loss per km
Distribution Line	**Loss Factor to apply in 2020/21**			
Bremer Bay Wind Farm	1.3643	Albany	181 km	**0.20%**
Evolution Mining (Mungarri) Pty Ltd	1.091	Black Flag	34 km	**0.27%**
Northen Star (Kanowna) Limited	1.0878	Boulder	27 km	**0.33%**
Paddington Gold Mine	1.0476	Black Flag	20 km	**0.24%**

As part of the FEED work conducted under Phase 5 of the study, Jarrah Solutions who were engaged to do the HV design (including automation and protection systems) performed line loss calculations (ref. Appendix G). Due to the early stage of the project development Western Power were unable to provide all the input data necessary for Jarrah to calculate a specific line loss figure. However, based on some broad assumptions, Jarrah were able to demonstrate that the operation of renewable generation in Mullewa at the end of a long feeder can have a significant impact on lines losses. On the assumptions made in the calculation, a reduction in losses of 162kW was calculated during export of renewables at 100% of installed capacity and a reduction in losses of 58kW during export of renewables at 20% of installed capacity.

7.8.12 Network Control Services

The assumptions used in the modelling for costing the Network Control Services were:

- Existing Case - Rental of existing back-up diesel gensets by the Network Operator is deemed an NCS for current existing case (estimated at $210k pa).

- RGS+NCS Microgrid - The Microgrid would operate an NCS in the form of access to reserved 50% of battery capacity (paid at $95k/MWh pa for reserved storage) and permanent back-up diesel to support the town in event of grid failure. Based on this service Western Power could demobilise the current ERG installation.

- EMN Microgrid - The microgrid will manage their resources (including permanent diesel back-up) to support the town+radial in event of grid failure and so no formal NCS service required. Based on this, Western Power could demobilise the current ERG installation.

7.8.13 Capacity Credits

At this location the network is currently congested and so because of the NAQ regime capacity credits are deemed to not be applicable for the first 3 years of operation, based on ERA Triennial review of the effectiveness of the Wholesale Electricity Market 2022, discussion paper [9].

Beyond the first 3 years of operation Generation Capacity Credits are available to for the RGS+NCS scenario and calculated as per Table 7.

It should be noted that it was discovered later on from conversation with AEMO that it was likely a NAQ would not apply and likely that Capacity Credits could be assumed to apply from project start, ref. Section 10.3.3.

Table 7: Basis for application of Capacity Credits

<table>
<tr><th colspan="3">Combinations of Assets seeking Capacity Credits</th><th>Resulting Capacity Credits</th></tr>
<tr><td colspan="3">Wind + Solar < 1MW, Battery < 4MWh or < 1MW</td><td>0</td></tr>
<tr><td>Wind + Solar > 1MW</td><td colspan="2">20% of Capacity Sum</td><td rowspan="3">Maximum of these x $100,000/MW pa</td></tr>
<tr><td>Battery Storage > 4MWh*</td><td>¼ of Size MWh</td><td rowspan="2">Minimum of these two</td></tr>
<tr><td>Battery Inverter > 1MW</td><td>Size MW</td></tr>
</table>

* Where an NCS service reserves % of the battery, then only unreserved portion of this storage is considered in terms of being available for earning capacity credits

It was not possible to include an algorithm that defines this logic in a single GridCog model. Therefore 3 separate projects were run in GridCog to allow comparisons between the different cases based on the correct application of Capacity Credits.

7.8.14 Modelling Results

Figure 7-6 shows the results from GridCog for performance of the various scenarios (from the Microgrid Operator perspective), correlating to the different asset sizes (as indicated in the two highlighted scenarios), in terms of cashflow (vertical axis) and emissions reduction (horizontal axis).

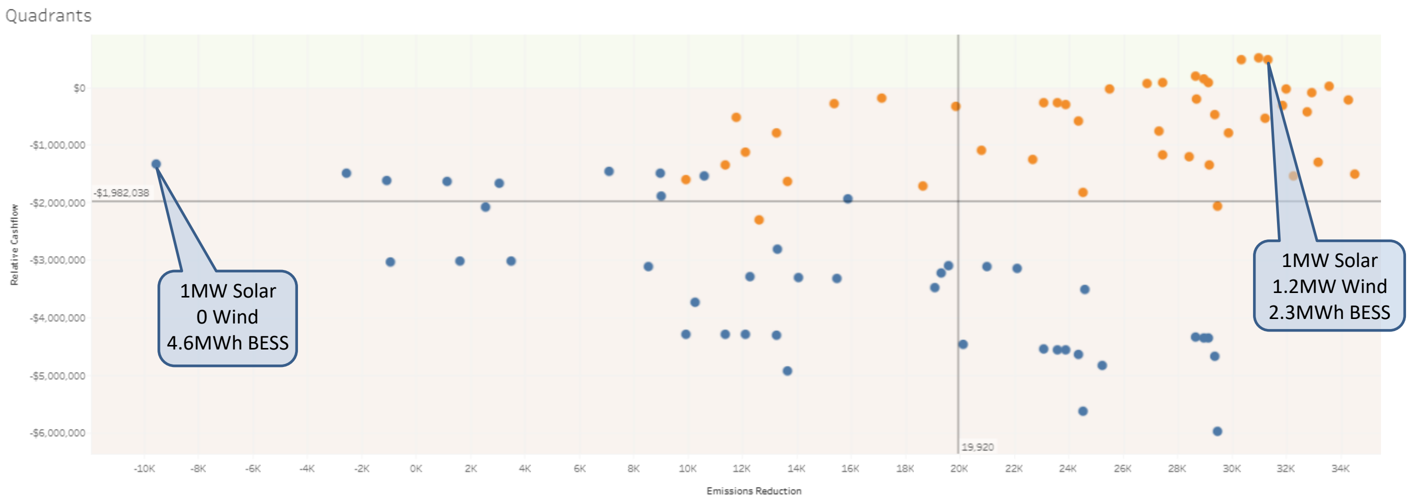


Figure 7-6: GridCog comparison of the performance of the different scenarios for the two different models

The orange dots represent scenarios from the EMN model and the blue dots scenarios from the RGS+NCS model, and so gives a good indication of the general performance of the two different models, with only EMN model scenarios achieving a positive cashflow.

In addition to the graphical representation of the results shown in Figure 7-6, GridCog can provide a summary table of performance which can be ranked in terms of relative cashflow, ROI and emissions reduction. The rankings according to these categories are shown in Figure 7-7.

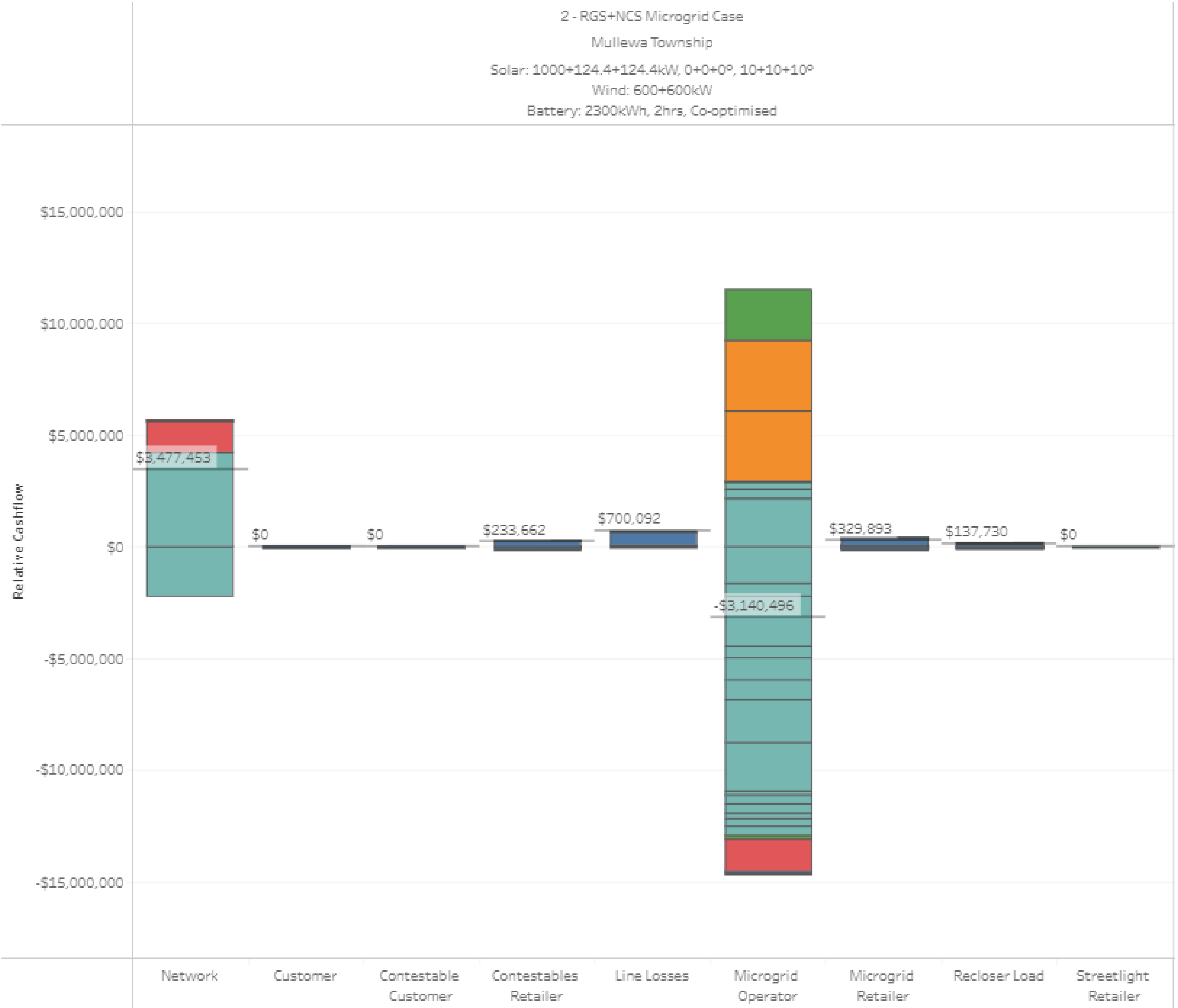
Figure 7-7: GridCog rankings for positive cashflow scenarios

The results above are from the Microgrid Operator perspective. As per the modelling parameters there were several conditions set pertaining to the performance of other participants. Figure 7-8 shows the relative cashflow results (relative to current operation today) for all of the participants in the model. For both the RGS+NCS and EMN models it can be seen that these conditions, ie.

- No change in cost to customers
- Retailers are no worse off
- Network operator is no worse off

are met across both the RGS+NCS and EMN models. What is observed is that the Network Operator would be significantly better off in RGS+NCS model which is in most part because not only does it retain all of the tariffs from all of the individual customers, but is also paid a tariff from the Microgrid Operator on the export of the renewable generation.

Figure 7-8 also provides an indication of the potential savings for the SWIS if current line losses were in the order of 25% as assumed for this exercise. In both models this is in the order of high hundreds of thousands, which is significant – particularly if this is considered to be indicative of similar fringe of grid towns and similar savings could be replicated across all of these via a repeatable Microgrid model.


2 - RGS+NCS Microgrid Case
Mullewa Township
Solar: 1000+124.4+124.4kW, 0+0+0º, 10+10+10º
Wind: 600+600kW
Battery: 2300kWh, 2hrs, Co-optimised
Relative Cashflow
$15,000,000
$10,000,000
$5,000,000
$0
-$5,000,000
-$10,000,000
-$15,000,000
$3,477,453
$0
$0
$233,662
$700,092
-$3,140,496
$329,893
$137,730
$0
Network
Customer
Contestable Customer
Contestables Retailer
Line Losses
Microgrid Operator
Microgrid Retailer
Recloser Load
Streetlight Retailer

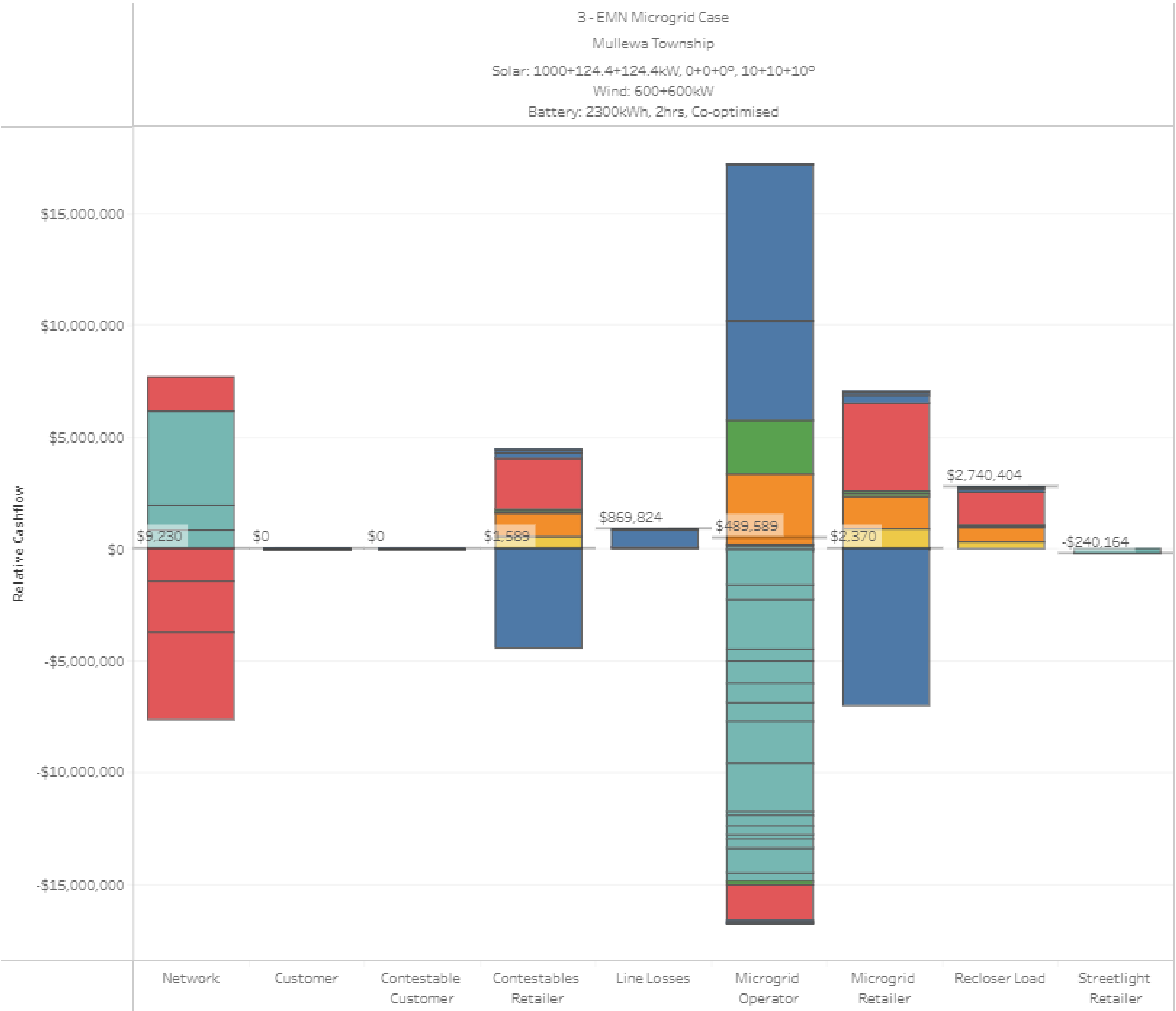


Figure 7-8: Relative cashflow results (relative to current operation today) for RGS+NCS (upper) and EMN (lower) Microgrid Models based on asset sizing of 1000kW Solar, 1200kW Wind & 2300kWh battery

7.9 Baseline Best Commercial Model

Based on the modelling results the best commercial model is the Embedded Network (EMN) Microgrid model. Within the EMN model there were a few combinations of asset sizes that showed similar overall performance. From these, the selected combination of asset sizes chosen as the basis for moving forward with, was that with 1000kW of Solar, 1200kW of Wind and 2300kWh battery. Even though the modelling indicated that in some rankings there may have been a potential for small gains with less solar capacity than the 1000kW, the EMN model incentivises growing the load, and a 1000kW would provide the ability to support such growth. It is significantly cheaper to put in a little extra generation during the initial build, while already mobilised on site, than installing at a later date.

8 PHASE 3 – TEST FUTURE SCENARIOS

8.1 EMN Microgrid Model

Future scenario testing was performed prior to obtaining the feedback that government policy would not support an EMN Microgrid model. At that time, based on the modelling that had been performed, the EMN model was the selected model to develop and so it was the EMN Microgrid configuration of 1000kW of solar, 1200kW of Wind and 2300kWh battery that was tested against future scenarios. This modelling was performed in GridCog again. The scenarios tested were:

- Loss of the radial load, ie. the load on the radial powerline downstream of the Mullewa town.
- Increase in the amount of Rooftop Solar
- General reduction in load
- General increase in load
- Introduction of a constant load
- Introduction of EV charging
- Step-away from decarbonisation (SAFD)
- Variation in wind generation

Details of the assumptions used and how these were implemented in the GridCog model for each scenario, are described in the following sections with a summary of outcomes provided in Section 8.1.9.

8.1.1 Loss of Radial Load

This scenario is based on the possibility of the radial load reducing due to the disconnection of properties from the radial network because of the Western Power policy of continued roll-out of SPS's for single remote loads at the end of long radials, for which properties downstream Mullewa are a prime candidate for.

Two scenarios were considered:

- Scenario 1: Radial loads drops 20% per year until zero after 5 years

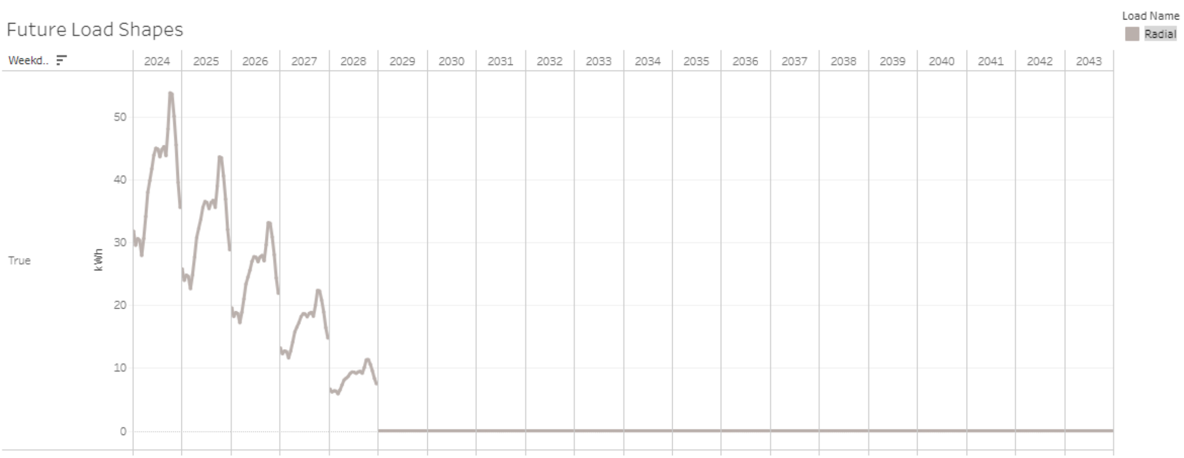


Figure 8-1: Grid Cog input representing the radial load dropping by 20% per year over 5 years

- Scenario 2: Radial loads drops 5% per year until zero after 20 years

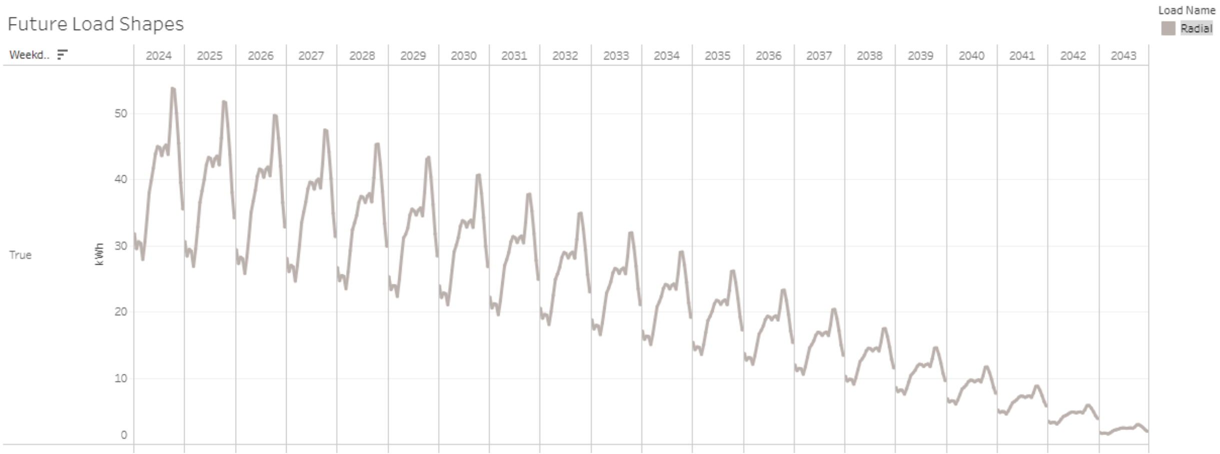


Figure 8-2: GridCog input representing the radial load dropping by 5% per year over 20 years

8.1.2 Increased Rooftop Solar

The assumption for rooftop solar in Mullewa today and estimate future uptake modelled is given in Table 8.

Table 8: Estimate of rooftop uptake for future scenario

	Total Combined	Non-Contestable Customers (NC's)	Contestable Customers (C's)
No. of Customers	289	278	11
No. with Rooftop Solar (base case)	44	39 (estimate)	5 (estimate)
%	15%	14%	45%
Solar Rooftop generation (base case)	249kW	124.5kW (estimate)	124.5kW (estimate)
Estimated uptake in Solar over 20 year life		3% (8 customers) per year over 5 years up to max of 29% (79 in total)	9% (1 customer) per year up to max of 73% (8 customers) in 3 years
Max rooftop solar after years		252 kW	200 kW

The generation profile of this estimated increase in rooftop solar is represented for both the Non-Contestable and Contestable customers in Figure 8-3.

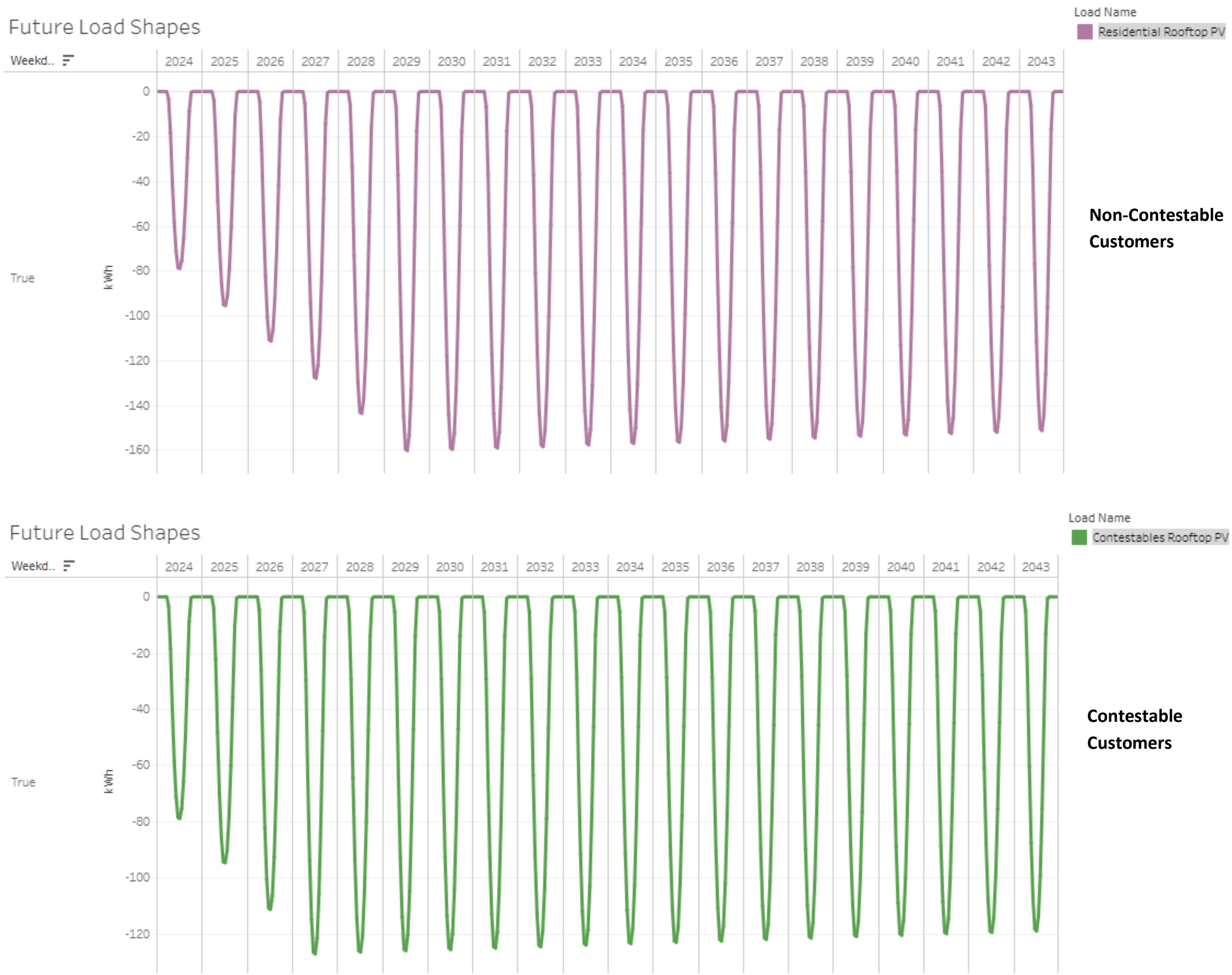


Figure 8-3: GridCog input representing future rooftop generation scenarios for Non-Contestable and Contestable Customers

8.1.3 General Reduction in Load

The basis for considering a general reduction in load is population decline and the resulting adjustment to the load profile is according to the following assumptions:

- Same profile shape
- Same variation applied to both Contestables and Non-Contestables
- General 1.33% annual growth no longer applied

Two scenarios were considered:

- Scenario 1: Load declines by 10% per year for 5 years

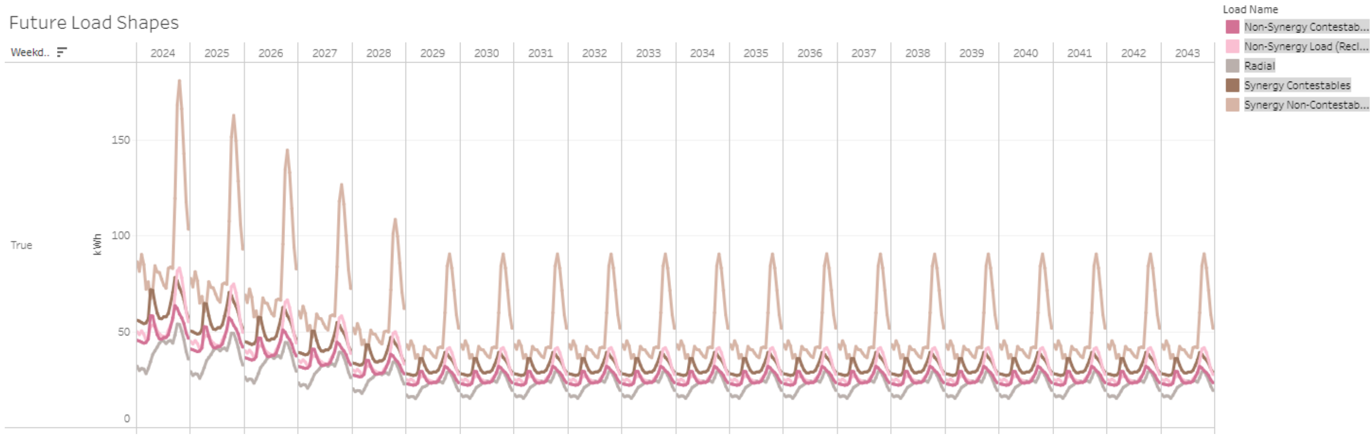


Figure 8-4: GridCog input representing reduction in load by 10% per year over 5 years

- Scenario 2: Load declines by 2% per year for 20 years

Figure 8-5: GridCog input representing reduction in load by 2% per year over 20 years

8.1.4 General Increase in Load

The basis for considering a general increase in load is population increase and through the "electrification of everything" principle (although not including vehicles). The resulting adjustment to the load profile is according to the following assumptions:

- Same profile shape
- Same variation applied to both Contestables and Non-Contestables
- Load from "electrification of everything" assumes that appliances currently operating on gas will be changed over to appliances operating on electricity. Mullewa Farm Supplies (Distributor of the Kleenheat 45kg gas bottles) estimates that they would go through approximately 200 of the 45kg bottles per year. There is approximately 2205MJ (613kWh) of energy in a 45kg bottle which equate to 123MWh for 200 bottles consumed over a year. Assuming this amount of energy was displaced directly by electricity it would mean a 4.5% increase on the current load estimate of 2694MWh per year.

Two scenarios were considered:

- Scenario 1: Annual growth goes from 1.33%pa to 10%pa over 5 years then back to 2% for remaining years

Figure 8-6: GridCog input representing increase in load by 10% per year over 5 years, then reducing to 2% per year for remaining years

- Scenario 2: Annual growth goes from 1.33%pa to 3%pa over 20 years

Figure 8-7: GridCog input representing increase in load by 3% per year over 20 years

8.1.5 Introduction of a Constant Load

The basis for considering the introduction of a constant load is the possibility of some type of small mining operation setting up in the area. With Mullewa being on the doorstep of significant mining operations further east and north and having access to the port of Geraldton via railway and road it could be (with access to reliable energy added to that) an attractive area for locating final processing operations looking to export a product to market through Geraldton.

Two scenarios were considered on this basis:

- Scenario 1: Small mine with 1MW load begins operations after 2 years and continues over the project life

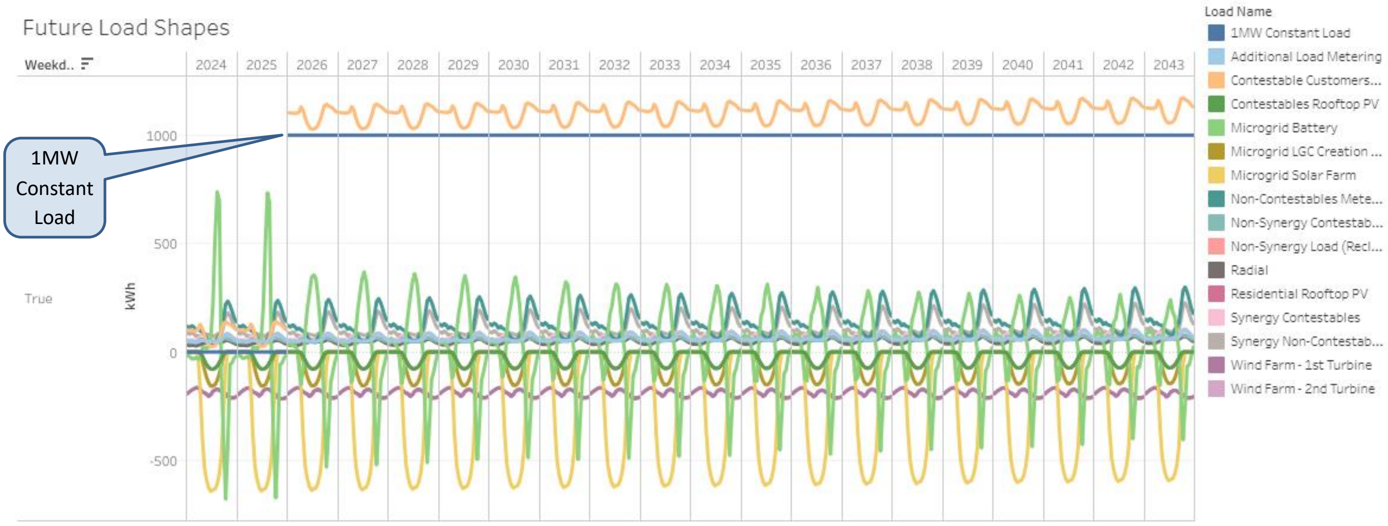


Figure 8-8: GridCog input representing an additional 1MW constant load from year 3 for the life of the project

- Scenario 2: Small mine with 1MW load begins operations after 2 years and shutdowns after 5 years of operation

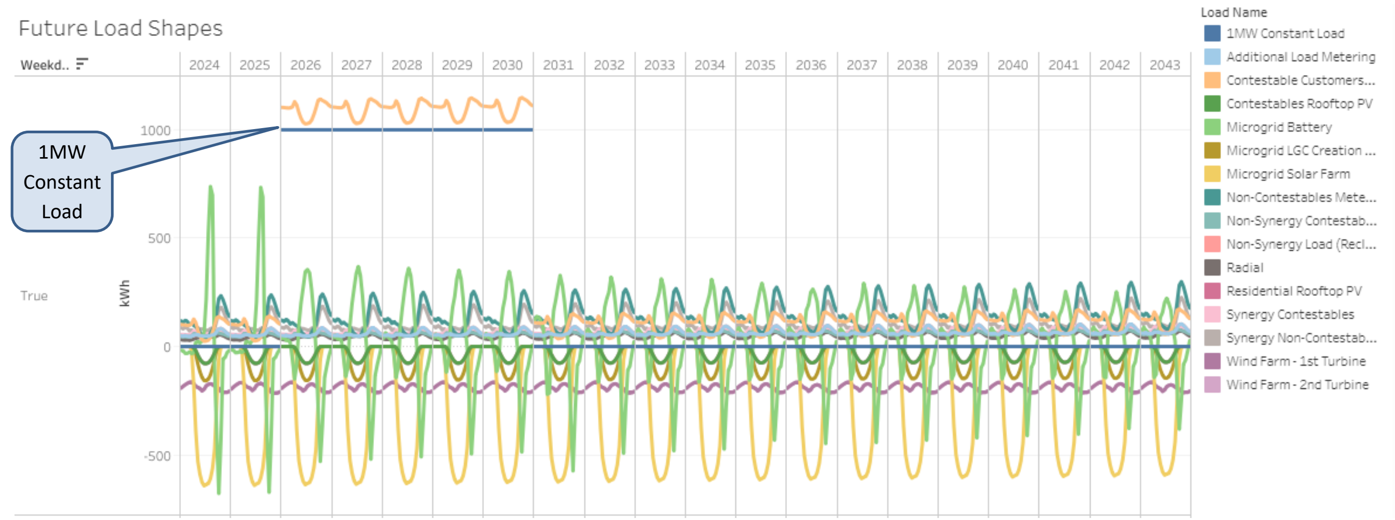


Figure 8-9: GridCog input representing an additional 1MW constant load from year 3 for a period of 5 years

8.1.6 Introduction of EV Charging

The modelling for introduction of EV Charging is based on the following assumptions:

- Load will comprise of mostly residential slow charging occurring at night with some visitor quick charging occurring at midday. This seems to correlate with current trends showing main charging peaks for electric vehicles to be at night (ie. during off-peak power) or around middle of day (ie. when excess solar available) [3].

- From Mullewa 2021 Census: 186 people in Mullewa in driving age (17-79). Assume 75% of these drive and have access to one vehicle means a possible 140 vehicles could become electric. According to Census there is 171 registered vehicles. Assuming some of these not actually in regular use, 140 vehicles appears to be a reasonable assumption for vehicles currently in use in Mullewa.

- Assume yearly growth in electric vehicles results in corresponding growth in yearly load,
- Assume the % of vehicles changing to electric is per Table 9.

Table 9: Estimated uptake of EV's in Mullewa for future scenario (also reflected in Figure 8-10)

By Year	2029	2030	2037	2041
% of EV's	7%	21%	43%	65%
No. of EV's (accounting for growth in total no. of vehicles)	10	33	71	114

- Assume 60kWh battery with 5.5kWh consumed per day per vehicle, so 11 day recharge cycle and 10kW chargers.

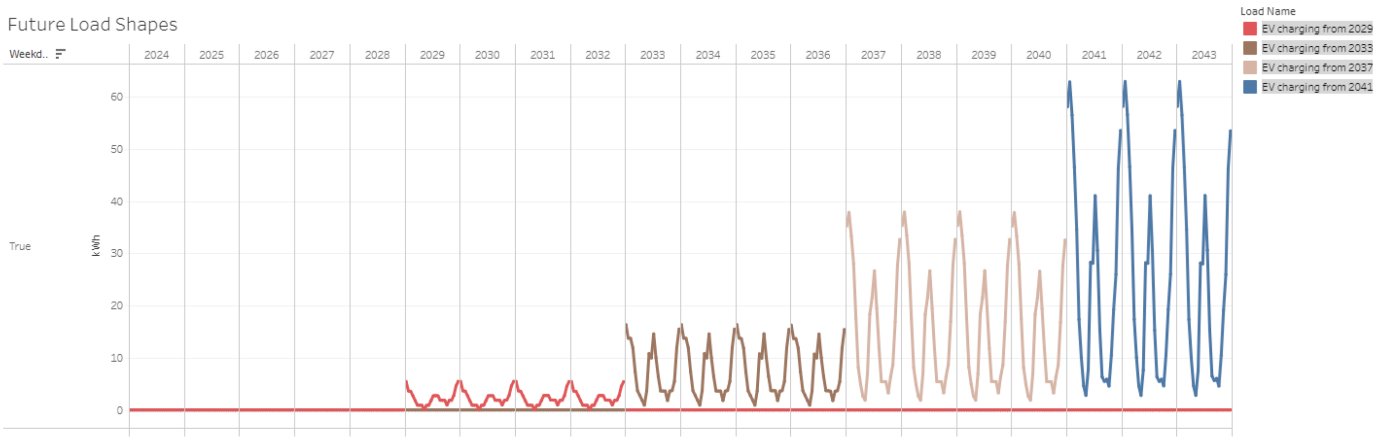


Figure 8-10: GridCog input representing the additional load for future EV charging scenario

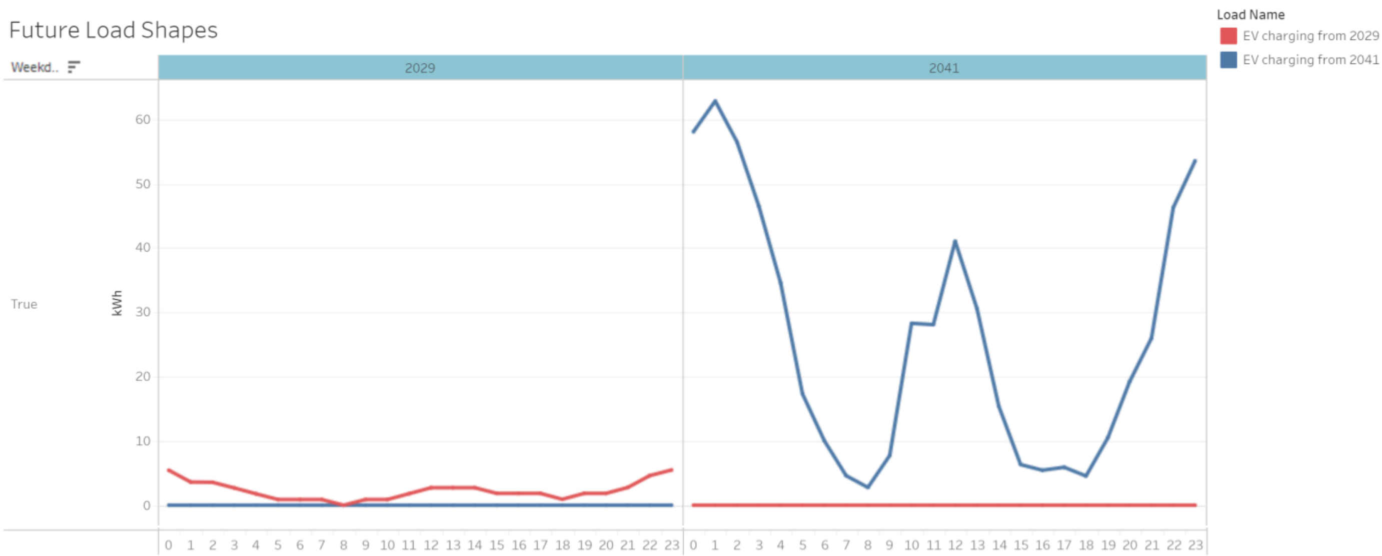


Figure 8-11: Comparison from 2029 and 2041 of modelled average daily load profile from EV charging

8.1.7 Step-Away from Decarbonisation (SAFD)

The premise of this scenario is that there is a shift from the current decarbonisation trajectory, towards maintaining the current mix of carbon and renewable energy. The assumptions resulting from this are:

- Wholesale prices get cheaper, goes down by: Scenario 1: 10% and Scenario 2: 20%
- LGC's prices trend down and go to zero after 2030 as per the following table:

Table 10: Assumed LGC prices for a future scenario based on a step-away from decarbonisation

From Year	Base Case LGC Prices, $/MWh	Revised LGC Prices for SAFD Scenario, $/MWh
2022	$50	$50
2025	$44	$40
2026	$38	$25
2027	$32	$10
2031	$15	$0

8.1.8 Variation in Wind Generation

The solar generation software data tools are accepted as being reasonably accurate and site acquired solar data is typically not required for project validation.

For wind generation however, 12 months of site acquired data is often obtained in order to validate predicted output.

Given no site data has been recorded, predicted wind input has been varied by +/-10% and +/-20% to understand the impact on the model performance.

8.1.9 Summary of Results

All of the scenarios described in preceding sections were input into GridCog based on the selected base case model with the results summarised from the perspective of the Microgrid Operator in Table 11.

Table 11: Summary of Future Scenarios Testing

Future Scenario	Difference in Cashflow from Base Case of +$0.5m			
	Scenario 1		Scenario 2	
Loss of Radial	20% drop pa over 5 years **-$0.99m**		5% drop pa over 20 years **-$0.62m**	
Increase in Rooftop Solar	Increase non-contestables approx. 20% pa over 5 yrs until approx. twice what it is today (so going from 14% of total customers to 29%) Increase contestables approx. 20% over 3 years until approx. 1.6 times what it is today (so going from 45% of total customers to 73%) **-$0.89m**			
General Reduction in Load	Decline by 10% pa over 5 years **-$2.70m**		Decline by 2% over 20 years **-$1.60m**	
General Increase in Load	10% increase pa over 5 years then back to 2% for remaining years **+$2.17m**		3% increase pa over 20 years **+$0.85m**	
Introduction of a Constant Load 1MW Load	Occurs after 2 years and remains for only 5 years **+$2.39m**		Occurs after 2 years and remains for life **+$16.5m**	
Introduction of EV Chargers	7% of vehicles are EV's in 2029 increasing to 21% by 2033, then 43% by 2037, then 65% in 2041 **+$0.22m**			
Step-Away from Decarbonisation (SAFD)	LGC prices trending down with 10% reduction in wholesale prices **-$1.89m**		LGC prices trending down with 20% reduction in wholesale prices **-$2.20m**	
Variation in Wind Generation	10% less generation **-$0.47m**	20% less generation **-$0.95m**	10% more generation **+$0.46m**	20% more generation **+$0.90m**

The outcomes summarised in Table 11 demonstrates the sensitivity of the commercial outcome for this model to the microgrid load. This is as expected as the design of the EMN model means the performance is intrinsically linked to the load. This is one of the key areas where the EMN model differs from RGS+NCS model. The RGS+NCS model is decoupled from the load as all of the generation is sold via long-term contracts or in the WEM at balancing market price and so even if the microgrid load goes up or down the microgrid provider will still receive the same income for the energy generated with long-term contract. The balancing market price may be impacted by the total SWIS load, but not the local microgrid load.

This inherently means there is more risk associated with the EMN model, but the flip side is that there is also much greater opportunity to succeed commercially with the Microgrid Operator incentivised to grow the load (which in this case means grow the town of Mullewa) in order to improve commercial performance. This potential for significant growth can be attractive to investors, which are needed in order to develop such projects.

Also as would be expected it is clear any deviation in the performance of the wind resource from that estimated will impact the commercial performance of the EMN Microgrid, however not as significantly as in an RGS+NCS model where revenue is mostly based on sale of energy generation and so any variation in generation quantities will more directly impact commercial performance.

8.2 RGS+NCS Microgrid Model

With an RGS+NCS the income is independent of the microgrid load and there is little value in testing future scenarios associated with potential changes in load. Since the RGS+NCS model was selected as the model to progress based on considerations outside the commercially modelling done, the interest was to investigate mechanisms for affecting the commercial outcome of this model, the objective being to understand which of these to pursue in order to form the basis of a proposal for a feasible model. The resulting scenarios tested were:

- Scenario 1: As part of an NCS agreement for improving reliability the Microgrid Operator is not subject to a network tariff. This is a reasonable expectation given a signification portion of the generation is consumed locally and the export will reduce the line-losses on the Geraldton-Mullewa line.
- Scenario 2: there is no NAQ restriction on earning capacity credits or limiting export to 4pm-8pm every day in first 3 years.
- Scenario 3: Assigned Capacity credits increased to reflect the possibility of earning increased credits from battery capacity and from the diesel genset. Resulting estimated capacity credits income: $162k pa.
- Scenario 4: Changing the basis for the NCS service fee to Western Power based on estimated cost for current ERG. Resulting estimated NCS fee: $210k pa.
- Scenario 5: Could only get an agreement with a retailer for an off-take agreement to purchase the generation if the agreed price was based on retailer paying 30% under balancing market price.
- Scenario 6: Scenario 1+2+3+4+5

8.2.1 Summary of Results

In the original GridCog modelling the RGS+NCS model for 1000kW Solar, 1200kW and 2.3MWh battery achieved a cashflow result over 20 years of -$3.1million (ref. Figure 7-8).

The summary of results in Table 12 show the impact of the different scenarios on the cashflow for the Microgrid Operator relative to the original -$3.1 million.

Table 12: Summary of results from the different scenarios modelled for RGS+NCS Microgrid Model

Scenario	Scenario Short Description	Relative change to original RGS+NCS cashflow
1	No network tariff	+ $1.5 million
2	No NAQ	+ $0.9 Million
3	Increase in Capacity Credits	+ $2.0 million
4	Increase in NCS fee	+ $2.0 million
5	Lower than balancing marker price offered by retailer for off-take agreement	- $1.9 million
6	Combination of above scenarios	+ $4.7 million

The conclusion from these results was that if it was going to be feasible to deliver a commercially viable RGS+NCS type Microgrid model, given the downsides associated with likelihood of not being obtain balancing market price for the energy sold (Scenario 5), the measures in Scenarios 1 to 4 would need to be looked into in further detail to understand what would likely be achievable in a investment ready commercial model.

9 Phase 4 – Community Engagement

9.1 Community Engagement Plan

The plan for engaging with the community involved engaging with community representatives as well as directly with the individual Mullewa residents.

Local community representatives engaged with were the City of Greater Geraldton (CGG), The Mid-West Development Commission and MEEDAC.

In terms of the overall SWIS community of which Mullewa belongs, the representatives engaged with for the SWIS were Synergy, Western Power, Energy Policy WA (EPA), the Economic Regulatory Authority (ERA) and the Minister for Mines and Petroleum; Energy; Hydrogen Industry; Industrial Relations, the Honourable Bill Johnston (noting that if a solution in Mullewa is to become a repeatable model, then these representatives would be impacted by what is implemented in Mullewa).

Engagement directly with Mullewa residents consisted of direct contact with specific landowners in relation to securing land for the Microgrid infrastructure, direct contact with specific business owners in relation to obtaining their energy consumption data and formal information session held at the local Mullewa Community Hall.

The timeline in Figure 9-1 shows the timing of the more formal engagement activities.

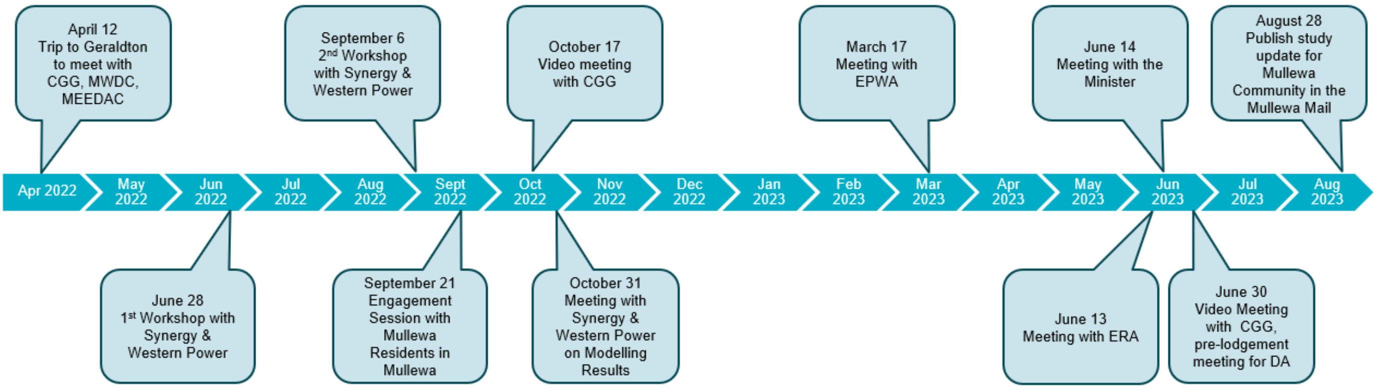


Figure 9-1: Timeline of formal engagement activities

9.2 Engagement Events and Associated Materials

All of the presentations produced for the different engagement sessions can be found in Appendix A.

The following sections summarise the engagement process for the differing forums.

9.2.1 CGG, MWDC and MEEDAC

Meetings held during April 2022 in Geraldton with CGG (ref. Figure 9-2), MWDC and MEEDAC were essentially introductory sessions to inform these organisations about the content of the feasibility study and hopefully obtain initial impressions on how a Microgrid in Mullewa might impact on the local community and surrounding areas.

Figure 9-2: Photo from the trip to Geraldton for meeting with City of Greater Geraldton representatives (while in Geraldton also met with MWDC and MEEDAC representatives)

Follow up meeting with the CGG was in the form of a general update and towards the end of the project a more specific meeting around the lodgment process for the development application.

9.2.2 Synergy and Western Power

With Synergy and Wester Power as paid contributors to the Study there has been continual engagement over the life of the Study, including weekly catch-ups with the Study appointees of these organisations. The formal engagements in the form of Workshops and review meetings have provided the Study access to insights and advice from several senior representatives.

The first workshop presented Sunrise's initial high-level screening of different commercial models, main considerations in terms of regulations, and suggestions for roles/services these organisations might play/provide in a Microgrid model applied to Mullewa, and in general, to other fringe-of-grid towns.

The second workshop presented a strawman model based around an EMN type Microgrid with the intent of testing if it would fit within the Western Power and Synergy strategy execution approach and strategy execution timing. This was considered important because solving fringe-of-grid / adopting Microgrids is not something that can be done in a vacuum. The strawman model is presented in Figure 9-3.

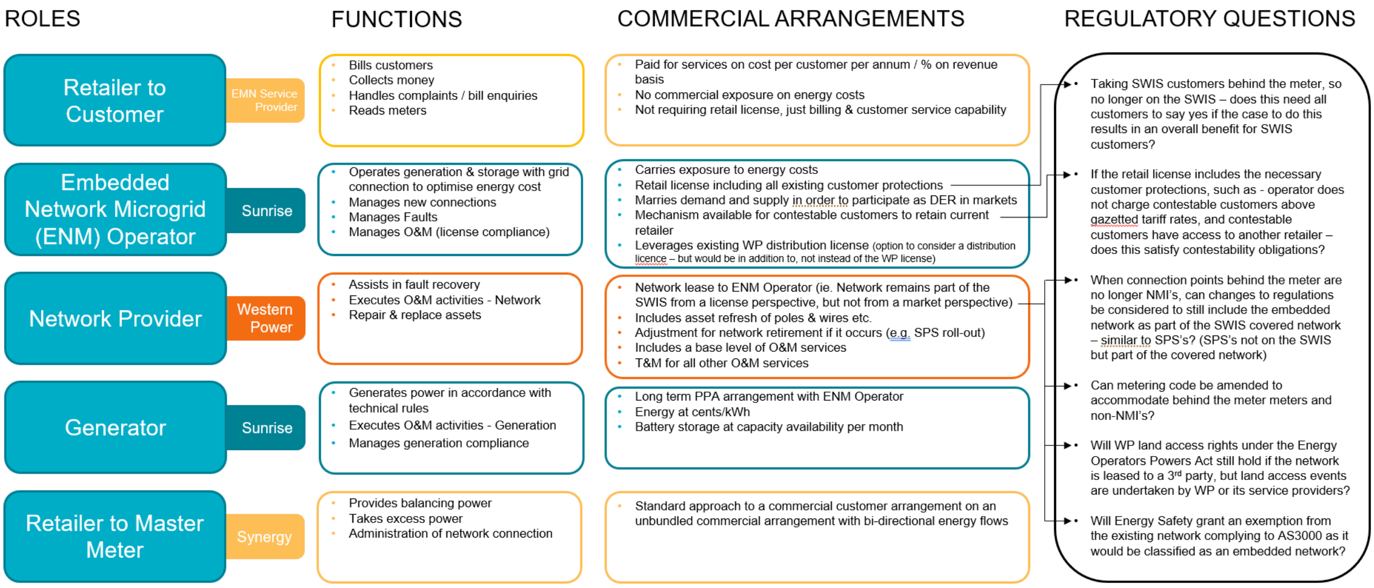


Figure 9-3: Proposed strawman model for driving regulatory reform

In the third meeting with Western Power & Synergy the results from the commercial modelling in GridCog (as described in Section 7.8) for both the RGS+NCS and EMN Microgrid Models were presented.

Sunrise also attempted to formally engage with Western Power by issuing a position paper to facilitate agreement on a set of principles, which Sunrise could then use to base the pricing of a reliability service under an Alternative Options Proposal.

9.2.3 Mullewa Township

The direct engagement with the Mullewa community was a collaborative exercise, executed together with Synergy and Western Power. The community engagement expertise within Synergy was harnessed to direct and promote the engagement process.

Advice was sought from the Mullewa Community Resource Centre, who also assisted in promoting the engagement session and providing the venue. The event was advertised in the September issue of the "Mullewa Mail" (ref. Figure 9-4) and via a letterbox drop. It was held on Wednesday evening, 21st September 2022.

Synergy, Western Power and Sunrise all presented at the event. Including a questions and answers session, it lasted over an hour. 14 residents registered their attendance at the event, which according to feedback from the community resource centre was a reasonable turnout for Mullewa.

Synergy led the introduction to the session and provided an overview of Synergy's purpose, vision and strategy with particular focus on their roadmap to zero emissions. Western Power explained what they do in relation to the overall SWIS and also provided some feedback on the performance of the ERG at Mullewa as well as some insight as to how they see the grid evolving and planned upcoming works. The Sunrise presentation (ref. Figure 9-5) was specifically focused on the Study, explaining the objectives and key activities of the study plus explaining what a Microgrid is and what it could look like (in terms of infrastructure) in Mullewa and intended outcomes from implementation of a Microgrid at Mullewa and possible opportunities. Ref. Appendix A for the complete presentation.

MULLEWA DISTRICT OFFICE UPDATE

SEPTEMBER 2022

City of Greater Geraldton Mullewa

The month of August was a fabulous time to have been in Mullewa with the wildflowers colouring the country side and the various events that were held including the Mullewa Polocrosse Carnival, Outback Bloom (Mullewa's Wildflower Festival) and the Mullewa District Agricultural Show.

September is also a very good time to enjoy all of the wildflowers that are blooming in this Wildflower Country region that Mullewa is a part of.And especially now that the famous wreath flowers are blooming not far past the historical town of Pindar.

This year's Polocrosse Carnival in Mullewa was held on the weekend of 13 and 14 August.
While Saturday 13 August was a wet and dreary day but during the next day the Sun was shining by the time of the finals and the various teams of riders were able to display their talents. The Mullewa teams of riders were winners of the B and E Grade senior competitions.In the A grade final, the South Midlands team showed their strengths in defeating the Walkaway team.

Mullewa's four day wildflower festival called Outback Bloom was held from 25 to 28 August. This festival in its 35th year was a truly wonderful event with the Mullewa Town Hall looking like an outback bush scene with over 130 specimens of wildflowers showing the biodiversity of this region. Plus there were a number of events held each day of the festival with guest speakers, participants of the show being able to learn some new skills such as paper flower making and using the cameras on their phones to photograph wildflowers, and even guided tours of Mullewa's bush trails. A total of 1078 people visited the four day show.

Mullewa's Agricultural Show was held this year on the last Saturday in August. Over 100 volunteers were involved over four days to produce a wonderful agricultural show with a wide range of activities held inside and outside at Mullewa's Recreation Precinct with a fantastic fireworks display to finish to close out the Show. The Show's organisers are now looking for ways to improve the Show. They are seeking feedback from members of the community and visitors to make these annual show even better. Please take the time to click on the link below and fill in their survey. As they are saying, "You can help us to make the 2023 Mullewa Show even better". The survey closes Friday 24th September. https://www.surveymonkey.com/r/TW7NGFZ

MULLEWA FOOTBALL CLUB COLTS, INTO THE FINALS

Out of the Mullewa Football Clubs four teams (League, Reserve, Colts and Women) that played this season in the Great Northern Football League.

The Mullewa Colts Team in fourth position at the end of the regular season has made it to the grand final with their game against Towns to be played at 9.00am on Saturday 10 September at the Town's Oval in Geraldton.

MAIN ROAD WORKS TO RE-COMMENCE

Main Roads WA has informed the City of Greater Geraldton that while work to wi den the Geraldton-Mt Magnet Road was suspended during the winter period, road works will be re-starting in October and then the estimated completion will mid-December of this year.
The road works will occur from about 23.2 kms from Geraldton and finish about 94.6 kms from Geraldton.

SYNERGY ENERGY GROUP STUDY

There will be an opportunity during this month for community members to have a say on the future of Mullewa's Energy requirements. On Wednesday 21 September from 5.30pm in the Mullewa Community Resources Centre at 8 Jose St, Mullewa, representatives of Sunrise Energy Group will be in Mullewa for a question and answer session.

Sunrise Energy Group, an emerging renewable energy company based in Perth, is doing an initial feasibility study into potential renewable energy microgrid options for Mullewa. Synergy and Western Power are supporting Sunrise's study, as part of our support for the Western Australian State Government's commitment to reach net zero greenhouse gas emissions by 2050. Together, we're leading the way to cleaner, more decentralised energy for remote and regional energy users, and a decarbonised future for a stabler grid and more affordable electricity for all Western Australians.

Sunrise's study will perform data analysis of how Mullewa uses energy, then use that information to model technical solutions. Throughout the process, they'll share any knowledge, findings and developments with the whole community as well as investors and other stakeholders interested in improving energy reliability in Mullewa.

As a first step, Sunrise, Synergy, and Western Power representatives invite all Mullewa residents to join them in a Community Engagement Session. Come and find out more about the study's objectives and community options, and be part of Mullewa's energy future.

Rod McGrath
Mullewa District Office Manager
9956 6643

Figure 9-4: Page 3 of the September issue of the Mullewa Mail advertising the community engagement event under "Synergy Energy Group Study"

Figure 9-5: MD of Sunrise, Neil Canby, presenting on the Mullewa Microgrid Feasibility Study to residents of Mullewa

9.2.4 EPWA, ERA & The Minister

Sunrise produced a Paper for EPWA for the purpose of introducing EPWA to the Mullewa Microgrid Feasibility Study, and in doing so, test the State's support for the EMN Microgrid model – proposed by Sunrise as the most promising model to implement for solving the "problems" of fringe-of-grid towns on the SWIS.

The paper was well received by EPWA and was the means through which meetings with EPWA, the ERA and the Minister were facilitated, with the objective to understand the level of support for the EMN Microgrid model, including the support for amendments to the regulations that would be needed for it to proceed.

The paper and presentation to EPWA focused on what were considered to be the two most feasible options for a Microgrid "solution" at Mullewa (and more generally, any fringe-of-grid town with reliability issues), ie. the RGS+NCS (re-termed as "NCESS" for the EPWA Paper) Microgrid commercial model and the EMN Microgrid commercial model and why the EMN Microgrid option was the best option to pursue.

Engagement with the ERA included similar discussions to what was had with EPWA, however also focused in more detail on the regulatory versus commercial challenges between the two models and pathways for implementation with Western Power, considering the outcomes from the recently published AA5[4] in terms of reliability performance.

Engagement with the Minister was on the recommendation of EPWA, with the intent being to introduce the study findings to date, and inform the Minister of the feedback that been received from EPWA and the ERA, and ascertain whether this was reflective of the government's current position.

9.3 Feedback from Community Engagement to the Project

9.3.1 CGG, MWDC and MEEDAC

Feedback from all three organisation was positive with the CGG referring to the possibility of synergies with other commercial developments being proposed in the area, such as a prospective iron ore project that was looking to pipe iron slurry to Mullewa from a mine east of Mullewa and then decant it in Mullewa and then transport the ore from

Mullewa to Geraldton port via rail. The council also conveyed it's willingness to contribute with community engagement in Mullewa and were the ones originally recommending the Mullewa Mail newsletter as an effective means of communicating with the residents of Mullewa. In later engagement with the CGG, particularly during pre-lodgment discussions around the development application, the CGG were very engaging and open to considering requests for locating assets in road reserves and/or other CGG land holdings (prior to settlement of the final locations) and were looking forward to receiving the application.

The MWDC noted that with a Microgrid in Mullewa resolving the energy issues, then if the access to water could also be improved it could definitely open up the potential for new industries at Mullewa, such as market gardening, which was noted would fit well with Sunrise's agrivoltaic aspirations for the solar farm.

MEEDAC were also positive towards proposals that could improve access to energy and/or water in Mullewa and interested in the possibility of increased employment opportunities that could come with a Microgrid for Mullewa.

9.3.2 Synergy and Western Power

Feedback from the 1st workshop was that although the initial commercial screening might indicate an advantage of the EMN model, the regulatory issues associated with this model and principle, may prove challenging to overcome and so Sunrise should not discount the RGS+NCS Model at that stage. Western Power also expressed in response to the EMN Microgrid model proposition, that selling the network was an unlikely scenario. Accordingly a concept based on leasing the network was developed with future modelling work reflecting the leased network concept.

In the 2nd workshop Western Power affirmed they were not looking to solve reliability issues of fringe-of-grid towns with externally owned/managed brownfield site, behind-the-meter microgrid solutions and despite them having a high focus on the mainstream operation of the business there was still an opening for proposals from the private sector where they could be shown to be of value.

Synergy also affirmed their current focus on the immense decarbonisation transformation work to be undertaken, however that there was still room for working with the private sector to deliver feasible microgrid solutions and did not have a specific position on Synergy retaining "ownership" of the customer relationship under certain Microgrid models, beyond that which was defined by the current regulations.

In regard to feedback on support for progressing the EMN model, Synergy and Western Power re-affirmed their involvement in the study was limited to providing input to Sunrise for Sunrise's investigation of the feasibility of different models and would not support one model over another at this stage. Despite acknowledgement of the results from the GridCog modelling presented in the 3rd meeting, this feedback did not change, including the recommendation to continue to pursue the feasibility of both models.

What Western Power did affirm was that there was no intention of disconnecting Mullewa from the grid, however some of the remote single properties that were fed from the radial line downstream of Mullewa, may be eligible at some point for inclusion in the SPS program.

Other feedback received from Western Power outside of these formal engagements was that in addition to the installation of the ERG's, significant works had been undertaken on the feeder line from Geraldton to Mullewa and so the reliability in Mullewa 2023 had improved since the initial conception of addressing the reliability of Mullewa via a renewable microgrid towards the end of 2020. It was acknowledged however the reliability was not only related to the state of the infrastructure but also exposure to weather and accidental events, exposure to which would always be greater on long rural feeders (according to Western Power NOM2022 [6] generally less than a third of outages are directly controllable by Western Power and the remainder due to windborne debris, extreme weather events or caused by a 3rd party), and that the study for Mullewa was in the context of providing a repeatable model for fringe-of-grid towns with reliability issues and so the specific value of a Microgrid solution as a reliability service was not lost based on Mullewa's latest reliability performance.

Feedback from both organisations was also provided on their understanding of the regulatory challenges associated with implementing a EMN Microgrid model (ref. Section 10.4), together with possible avenues for addressing some of them.

Western Powers feedback to Sunrise's position paper around pricing principles for a reliability service, was that Western Power had no basis to formally respond to these outside an actual formal Alternative Options Proposal submission.

9.3.3 Mullewa Community

After the presentation there were 22 questions/statements recorded during the formal question and answers part of the engagement. Given Synergy and Western Power were present, a significant number of these were about matters related to these organisations - around current operations and future plans. Questions and statements more specific to the Microgrid Study are shown in Table 13. A lot of the participants remained after the formal part of the engagement ended with several informal discussions occurring as presenters mingled with those that stayed on for refreshments.

Table 13: Questions/statements and answers around the Microgrid Study during Mullewa Township Engagement Session

Question/Statement	Response
There's a mine site 25kms away which will be up and running in 12 month's time, why don't you do a collaboration or early trial with its battery system (Vanadium Flow)? Seeing as there are supply issues; it will take forever to get products otherwise.	It's early days for this technology & using a battery of this size. We would monitor it to see if it could be utilised and if appropriate could have a look; don't want to only focus on this battery option and throw out the other options available.
Supply chain issues will hinder the project?	Yes there are global supply issues
Wind turbines: How do you select for the area? How long do they last? How tall are they?	Turbines; 20/30/40 yrs old in market currently; Albany is 20 yrs old and just refurbished them, hoping to get another 50 years out of them. Height depends on its purpose; Warradarge; 5 MW turbine x 120 m pole & 70m blades on top. Offshore they're twice that height. Mullewa doesn't need a 5MW size; small turbine or a refurbished one (30-40 in WA) 15-20 yrs old- 600Kw size with smaller turbine blades.
Solar panels: What does this look like?	1MW farm; 2Ha of land; 2000 panels
Solar panels: life expectancy?	Residential; Poly or Commercial; Mono; 30 yrs degradation, 85%
Solar panels: do higher temps create lower efficiency?	Rooftop solar creates heated backing which traps heat and can make the panels less productive. Ground solar; tracks allow the panels to breathe and reduce the temperature behind the panels; so they can be used in hot climates.
Have you got Federal funding for this project? Who is responsible for its maintenance?	Private funding will be required to implement the project. Sunrise job to maintain and have the on-going responsibilities for the infrastructure
Many of us have paid for our own infrastructure and the costs of power are still increasing; what's to stop costs increasing again 20 years & the microgrid isn't working by then and we have to connect back to the aging network that hasn't been maintained?	There will be an incentive for the private enterprise to keep spending on power that will benefit the customers; there are regulations and license agreements that protects customers from these scenarios.
Will the project model the population decline as we have seen? What about the farming properties? Will they benefit?	Immediate plans are with the township with the hope to pick up farmers in the future. Any oversupply will go back into the grid to benefit the greater community.
Will you get Government funding for the costs to build and operating and maintaining the microgrid? Or is it private funding you require?	ARENA has a fund for renewable microgrid projects; which are repeatable e.g. can contribute funds to help de-risk first-off projects that are repeatable.
Power has improved with the ERG, but if it's not on it's no good	N/A

What we can see from the types of questions and statements and the general consensus from the Synergy, Western Power and Sunrise representatives was that the poor reliability had definitely had a detrimental impact on the community, but there was some recognition that Western Power had been making efforts to address this, however outages still occurred and if a Microgrid in Mullewa was a solution to this then it would be welcomed. There was some obvious curiosity around what a renewable microgrid would look like and function, however no specific objections.

To enable the community to continue to engage with the study an email address was created (Mullewa.engagement@synergy.net.au) giving a single point of contact for any matters related to the study. Nothing has been received via this address at time of issuing the report.

There was some interesting feedback from landowners while trying to source locations suitable for placing the Microgrid infrastructure. A number of landowners had been approached by large Australian and international companies looking for land for large scale renewable generation (wind) projects in an attempt to secure vast swathes of land and discussing levels of compensation that a small local Microgrid Operator could not compete with. This was not something that had been anticipated and hindered the process of securing land for the Microgrid. Fortunately some of the local landowners understood that a local microgrid would not be competing for the same land that would be suitable for a large scale wind farm, and appreciated how a local renewable microgrid would be in service and support of their town, and hence saw the merit in contributing through agreeing to lease areas of their land.

Feedback from local farmers in regards to the ground conditions on the lot secured for the solar farm, was used for identifying a target area in which to conduct the geotechnical survey (ref. Section 10.2.3).

9.3.4 EPWA

The feedback received from engagement with EPWA was:

- They were supportive of innovative attempts to solve reliability for fringe-of-grid towns.
- They appreciated the effort to look beyond typical NCESS solution that they agree is already doable from a regulatory standpoint.
- They accepted Sunrise preference for the EMN Microgrid model, despite the increased risk, primarily because of its attraction to investors through the potential for growth.
- They see the main hurdle for ministerial support for an embedded network (EMN) microgrid model would be the premise of making residential customers contestable.
- Based on above EPWA would suggest the “NCESS type” model would be the most workable solution to implement at this stage.
- In terms of a pathway for implementing an “NCESS type” model with Western Power, would be more appropriate to go through the Alternative Options pathway rather the NCESS process. NCESS requires certain triggers in order for WP to go out to market to procure a service, whereas the Alternative Options pathway is to allow WP to consider unsolicited proposals.
- Commented that part of the point of the Alternative Options pathway was to make it easier for WP to support/implement solutions such as the “NCESS type” model, but to date it hasn’t seemed to have had the results hoped for in terms of encouraging WP action.
- Accepted that a lease agreement with WP as the basis for the embedded network was not unreasonable and akin to any other areas of their business where lease / sub-contract agreements were used.
- Recommended engagement with the Chair of the ERA around the identified barriers for the EMN Microgrid model.
- Recommended engagement with the minister on the merits of the EMN Microgrid model, suggesting emphasising the aspects of the model where we are not looking to change established premises, such as the universal tariff, as well where changes would be required - and be able to explain the positives of these.
- Qualified that Sunrise understood that, as it currently stands, an EMN Microgrid model would require the consent of all customers in order to be implemented.
- Explained that the developing Alternative Energy Services (AES) Framework was initially going to be targeting smaller existing style embedded networks such as strata, caravan parks etc. and so probably not appropriate for operating an embedded network (of this nature) under at this stage - so agreed obtaining a retail licence was a suitable premise for EMN model proposal for now.

- Looking forward to seeing the final report given that it will include an investigation of legal/regulatory matters that others have skimmed over.
- There are further changes coming through around reliability standards (separate to what ERA are doing) that EPWA feel will help build the case for deployment of fringe-of-grid solutions.

9.3.5 ERA

The feedback received from engagement with the ERA was:

- They were interested to understand what Sunrise saw as the WP incentive for an NCESS Model. Sunrise suggested WP don’t necessarily have the resources to solve reliability in the timeframe expected, and so by transferring the risk to the MO as part of NCESS agreements, could avoid reliability penalties.
- In an NCESS model where the MO would “take-over” operation of the network in an islanding scenario (ie. on loss of feeder supply) – ERA was interested in WP position on this. Sunrise explained that this had not been discussed in detail with WP at this stage, but expect WP would be amenable to this, given it would only be under fault conditions.
- Appreciated the physical aggregation achieved under an EMN Microgrid model and the benefits of this (e.g. over VPP) in terms of implementing DER.
- Saw merit in the EMN Microgrid model in how it allows the possibility of implementing tariffs that incentivised power use to match the local generation profile.
- Appreciated that renewable generation from a solar farm within an EMN Microgrid model was a more equitable application of renewable generation than rooftop solar.
- The reasons for more visibility sought by the ERA from WP, in terms of rural reliability, was to get outcomes such as that produced by this study.
- When looking at the apparent customer benefits being seen with residential greenfield microgrids, the question around can we ensure a solution that is in the best interest of the customer with brownfield microgrids, should perhaps be reframed as can we best serve the interest of customers without offering this type of service.
- Confirmed that customer protections would not be a concern for an EMN Microgrid model as they would be maintained via the MO having to have a retail licence.
- Believed there had to be thought given to new models to address the fringe-of-grid problems and that we were not going to reap the benefits of new technologies based on existing regulations/policies.
- Did not see that having to make regulatory amendments to accommodate an EMN Microgrid model as a significant impediment to the implementation of such a model – in fact the ERA was looking at ways to change the regulatory frameworks to get innovative solutions.
- The ERA is taking seriously the decision (as expressed in requirements put in place in AA5[4]) that WP are to meet the reliability requirements.

9.3.6 The Minister

The feedback received from engagement with the Minister was:

- He believed the NCESS model was a workable solution, comparing it to what is being done at Walpole (only storage/generation was solved differently).
- His feedback on the EMN Microgrid model was that it would require the purchase of the network at cost and compensation of Synergy for the loss of their customers, and so would likely be uneconomic on that basis.
- He supported more renewables, including at Mullewa.
- Given the recent AA5[4] release he could see how Western Power may be interested in an Alternative Options Proposal based on a NCESS type model.

9.4 Feedback to the Community from the Project

Weekly meetings with the Western Power and Synergy representatives for the study has provided continual feedback to both organisation throughout the study period, with this direct path for communication into both organisations proving a valuable resource.

The Mullewa Mail newsletter was again used as means of communicating to the residents of Mullewa, with an article on the current status of the Study published in the September issue. Emails were also sent to the MWDC and MEEDAC with a status update and CGG were up to date on the status based on the submission of the Development Application

9.5 Adjustments to Technical and Commercial Solution Based on Engagement Feedback

The general feedback received from all those engaged was positive to a renewable microgrid in Mullewa that could improve the reliability of power supply to the township.

In terms of the feedback that was the most impactful in terms of adjusting the technical and commercial solution, this came from the Minister. Without the minister's interest in exploring the possibilities of the EMN model, there would not be the support necessary for working through the regulatory challenges necessary to implement this model, making it unfeasible at this point in time.

Accordingly, the direction of the study was adjusted to focus on how to implement an alternative model, falling back to the NCESS (formerly RGS+NCS) commercial model (based on feedback from EPWA and acceptance from Western Power to apply for a reliability service via the Alternative Options Strategy [5], this was then re-termed to "AOS Microgrid Model"). Although the major infrastructure could be same for both models this did have some impact on the technical solution as well, with an adjustment required in relation to the connection point detail. Because the AOS Microgrid model is based on "in-front-of-the-meter" generation connection as opposed to generation co-located with the load behind a town master meter, the connection point site had to be relocated from the west side of town where it was adjacent to the incoming feeder line from Geraldton, to being co-located with the generation which had been placed east of the town.

The other feedback which had a significant impact on the technical solution, and by association the commercial feasibility, although not the commercial model, was from landowners who were engaged in regards to use of their property for locating the Microgrid infrastructure. An assessment of land around Mullewa was made based on minimising capital costs through locating Microgrid infrastructure in one location and as close as possible to a connection point. Based on this, discussions were held with a local land owner. The land owner was supportive of the Microgrid concept to improve the reliability of power supply in Mullewa, and initially positive to locating infrastructure on their land however on reviewing the terms proposed, had reconsidered what it would mean to have solar panels and a wind turbines located on their property and so decided not to proceed. The impact of this on the technical solution meant finding less than optimum locations for the infrastructure. In the terms of an EMN Microgrid model which was the basis for the commercial model at that time, it meant the connection point site and generation/storage site would not be co-located which impacted on communications technical solution between these two sites. When not co-located (or nearby located) the cost for fibre-optic communications is prohibitively expensive and so alternative solutions had to be sourced. The other impact on the alternative locations was that longer powerlines were required between the wind generation and connection point and the connection point was not nearby any existing western power powerlines and so an additional capital expenditure allowance had to be made for Western Power to extend their network up to the connection point.

9.6 Summary of Proposed Solution as an Outcome of Community Engagement

From the engagement process and resulting feedback, it was evident that the AOS model would be a lower effort, lower disruption pathway to realising a renewable microgrid project in Mullewa, hence the AOS Microgrid Model was selected as the basis for the commercial solution. This model is based on generating income through:

- Sale of the generated energy to either a retailer via a long-term offtake agreement or at the WEM balancing market price via a 3rd party.

- Sale of the LGC certificates earnt from the renewable generation.

- Charging Western Power an annual fee for a reliability service, that would involve automatic islanding of the Mullewa network and uptake of the load by the Microgrid on loss of grid supply. The fee is based on WP waiving the network tariff for the renewable generation connection point (if WP preferred, the network tariff would still apply but be added to the fee charged for the reliability service).

- Capacity credits earnt from the reserve capacity market for the combined renewable generation capacity.

The technical solution resulting from the adoption of the AOS Microgrid model and engagement with land owners, leading to the selected infrastructure location was:

- 1.1MW solar array and 3MWh* battery co-located.
  * Note the modelling work was based on multiples of a 2.3MWh battery as this was the base size available from preferred supplier, however during the course of the study the supplier updated their base size to 3MWh.

- Connection point site located adjacent to the solar array and approximately 1.5km from existing Western Power HV powerline.

- One 750kVA diesel genset located at the connection point site.

- Two 600kW wind turbines located approximately 1.3km from the connection point.

- Automated recloser for islanding of the Mullewa network and associated downstream radial line. Located approximately 3.4km by line of sight from the connection point with radio communication between the recloser and the connection point.

- Western Power Network Control Communications implemented via combination of mobile radio (4G) and satellite communications.

10 PHASE 5 – DEVELOPMENT ACTIVITIES

10.1 Plan for Development Activities

It was planned early on that prior to development activities being able to be undertaken, suitable locations would need to be sourced for where the Microgrid infrastructure would be situated. In addition to the reasons discussed in Section 9.5, there were also the practical constraints associated with locating wind and solar infrastructure. For solar this is typically land that doesn't require significant clearing and ground conditions favourable to direct piling (though this is often difficult to ascertain prior to conducting a geotechnical survey). For wind the most significant factor is proximity to noise sensitive land uses and existing infrastructure. Following the WA Governments recommendation in their position statement on renewable energy facilities [10] meant looking for sites that were at least 1.5km from noise-sensitive dwelling (e.g. residences). Other sources recommending 200m setbacks from roads and infrastructure also impacted on the search for suitable turbine locations. Because of these factors acquiring land was not straight forward and significant time was put into assessing sites and eventually securing land via signed heads of agreement so the development activities could commence.

The plan for development activities was to undertake an actual front end engineering design (FEED) study together with Sunrise's delivery partners:

- Douglas Partners: Geotechnical survey of the solar farm site
- Avora Energy: Solar farm design and construction (including battery installation), connection point site construction and wind turbine civil works
- BlairFox: Wind turbine equipment specification, procurement and installation
- Jarrah Solutions: HV design, including the connection point site design and equipment specification. Includes protection, controls, automation and communication.

The Geotechnical survey was the first activity to be initiated as the results are necessary input into the solar farm design. The other activities were conducted in parallel according to specific scopes of work, with Sunrise managing interfaces and ensuring sharing of design inputs/outputs across the various contributors as required.

The FEED study would deliver design details sufficient for:

- producing a fully costed estimate for the development, to a level of detail suitable for potential investors to review
- putting together the development application
- producing the proposal to Western Power for the reliability service
- establishing generation data an energy retailer could use as the basis for an take-off agreement.

With an EMN Microgrid model as one of the models being investigated, it was understood that if this was the model to be progressed to development it would be necessary to develop a proposal for solving the regulatory challenges associated with this specific model. Despite the EMN model not being progressed at this stage, it is still considered a viable solution and hence the plan to utilise Laval Legal to investigate the regulatory challenges was not changed. In terms of the AOS model there are no regulatory constraints stopping this being done today – the most likely reason it hasn't is due to the lack of interest from a commercial return perspective, which is the main challenge with the AOS Microgrid model.

10.2 Technical Development Activities

10.2.1 Network Connection Agreements

The network connection process typically follows three stages, the enquiry stage, the application stage and the request for approval to operate. The enquiry phase has been initiated as part of the study, which was in the form of a proposal submission under the Western Power Alternative Options Strategy [5], introduced as part of the changes made to the Access Code in September 2020 to support the delivery of the State Government's Energy Transformation Strategy which includes providing greater opportunity for third parties to provide efficient non-network solutions to Western Power.

The Alternative Options Proposal submitted (ref. Appendix I) was a proposal for the provision of a reliability service to Western Power based on the operation of a Microgrid as described in Section 9.6. The connection point will be a HV substation and the design and location of this are defined in Section 10.2.4.

An allowance for completing the second and third stages of the connection process have been included for in the cost estimate.

10.2.2 Development Approvals

A planning report (ref. Appendix H) was developed as the basis for the submission of a development application to City of Greater Geraldton and Regional JDAP and is currently under consideration by these two bodies.

The planning report explains the Mullewa Renewable Microgrid proposal and qualifies it against both local and State planning frameworks.

The submission was made on the August 25th 2023 after obtaining the written consent of the land owners on which the Microgrid infrastructure will be located.

In addition to the planning approval, an application has been submitted to the Department of Planning, Lands and Heritage (DPLH) for an easement on crown land to facilitate an access road to the wind turbines (ref. Figure 10-2). The application has been processed by the DPLH and is currently with the Midwest Gascoyne Land Management Team for review.

An Activity Notice has also been sent to the Yamatji Southern Regional Corporation (YSRC) to obtain feedback on whether there may be any Aboriginal heritage issues associated with the construction sites.

10.2.3 Geotechnical Studies

A single-axis solar array was the basis for design. This type of solar array tracks the sun from east to west by fixing the solar panels to a rotating horizontal tube, with the tube supported by a line of steel pillars (piles) embedded in the ground. Typically these piles have an embedment depth of 1-2m depending on the ground conditions. The specific ground conditions at the installation site will therefore determine the design and construction details and accordingly can have an impact on the estimated cost. In the first instance if the ground permits (e.g. non-rock conditions) the pile will be driven into the ground. If there is significant rock then typically the piles will be installed in pre-drilled holes and grouted/backfilled.

A geotechnical survey is therefore required to establish the ground conditions. A survey will typically include test pits from which an understanding of the strata can be obtained (is it sand, rock, clay etc.) as well as Dynamic Penetrometer Tests which provide feedback on loads associated with pile driving. In addition to this thermal and electrical resistivity measurements are made which are used as inputs in earthing grid design and trenched cabling design.

The general area represented by site locations in Figure 10-1 identified as proposed solar farm area and future solar farm area was chosen based on a site survey and feedback from local farmers as the location with the lowest potential for significant rock. The proposed solar farm area was initially selected as the preferred location based on an attempt to optimise the overall Microgrid infrastructure costs, including accounting for possible future expansion.

A geotechnical survey was conducted on the solar farm site with the report presented in Appendix C. As can be seen from Figure 10-1 the survey was not restricted to the preferred location as the ground conditions needed to be understood before this could be decided. The survey was planned to be conducted with an initially preliminary investigation that covered the proposed future area as well as the preferred location. The detailed survey would then be conducted in an area selected based on the feedback from the preliminary investigation. The preliminary investigation didn’t conclude any significant differences between the future and preferred areas and so the detailed investigation was carried out for the preferred area.

The main finding from the survey was that there was rock present at a number of locations above a 2m depth and so this resulted in the recommendation from the tracking system designer that pre-drilling would be required for all piles (ref. Mullewa Solar FEED Report under Appendix E).

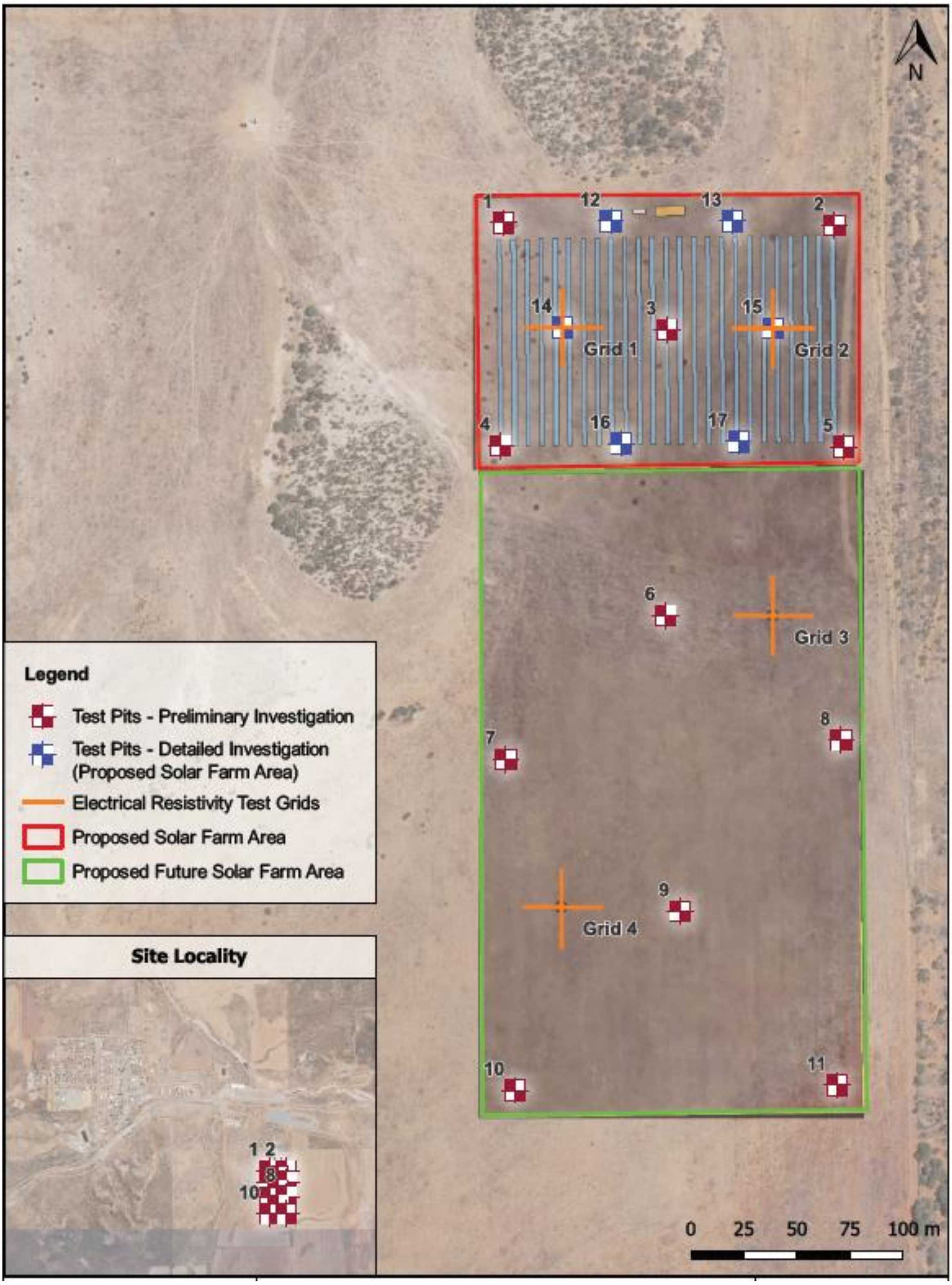


Figure 10-1: Geotechnical Site and Test Locations

10.2.4 Design

The front end engineering design of the Microgrid is presented in the FEED reports from Avora (Mullewa Solar FEED Report) and Jarrah Solutions (Mullewa Microgrid – FEED Report) with input from BlairFox on wind turbines specification, procurement and construction.

The Microgrid layout resulting from the FEED Study is shown in Figure 10-2, with a summary of the Microgrid technical details as follows:

- Solar farm installation consisting of:
  - 1.1MWDC single axis tracking solar array
  - 25 row, 81 module NEXTracker tracking system
  - 2,025 panels, 550W Longi bi-facial
  - One FIMER PVS980-CS 3.5MVA skid fitted with a 1045kVA-L+IN PVS980-58 solar inverter, 2091kVA-I type bi-directional BESS inverter and 3.5MW 33kV 2-winding transformer
  - One SAFT 3MWh BESS container
  - Underground connection to Connection Point
- Wind farm installation consisting of:
  - Two refurbished second hand Enercon E40 600kW wind turbines on 76m towers
  - Turbine transformers
  - Turbine sub metering
  - Overhead powerline from wind turbines to the Connection Point
  - Crane hardstands
  - Access road
- Connection Point / HV Substation installation (ref. Figure 10-3) consisting of:

  Overhead:
  - 3 x 33kV reclosers
  - 2 x fused switches
  - 3 x air-break switches
  - 1 x metering unit for renewable energy credits and controls
  - 1 x 63 kVA power transformer
  - Connection to the existing 33kV high voltage Western Power network via Customer Main Switch (CMS) in compliance with the ERA technical rules

  Ground:
  - 1 x protection and automation container, including Jarrah Solutions proprietary Energy Management System (EMS) with Power Park Controller (PPC), fitted out for radio communications with the automated recloser.
  - 1 x switchable neutral earthing transformer to create an earth reference when the Microgrid is supplying power to Mullewa in islanded mode (grid disconnected).
  - 1 x 1.0 MVA step-up transformer

- 1 x 750kVA Prime Power Cummins Diesel Generator
- 1 x 4,000 litre self-bunded diesel fuel tank
- Fence with access gates
- Security camera
- Access Road

Underground:

- Earthing mat
- Earthing rods
- Earth Grid

- Western Power installation works (WP Scope):
  - Extension of the existing overhead powerline network out to the Connection Point, incorporating a WP metering unit.
  - Standard NOJA type recloser at Microgrid Isolation Point (protection settings, design, configurations and interface equipment, e.g. radio communications for automation, will be by the project)

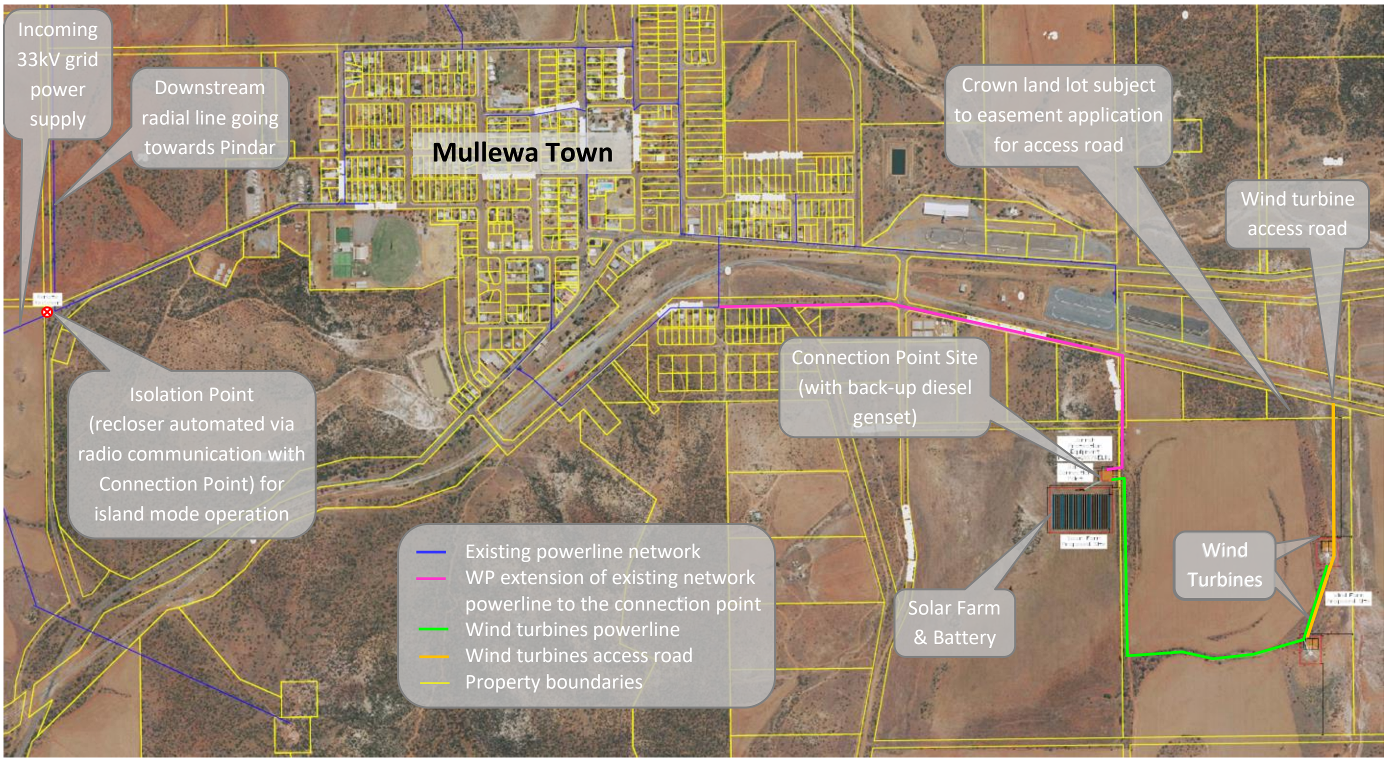


Figure 10-2: Microgrid Site Overview (ref. Appendix E for the complete drawing) – note: excludes the extent of the downstream radial network that is incorporated within the Microgrid islanded network (ref. Figure 2-2 for extent of downstream radial network)

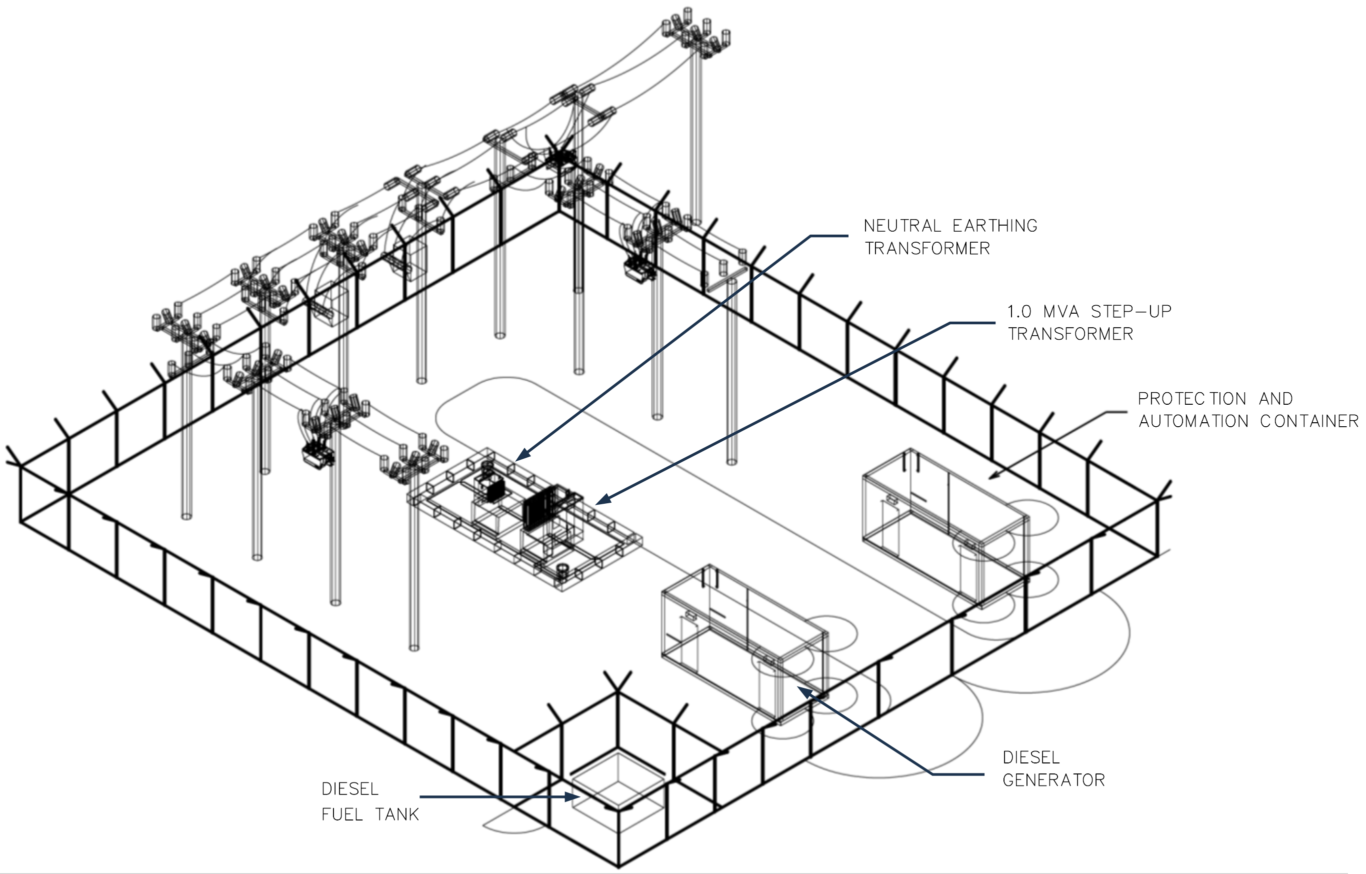


Figure 10-3: Isometric view of the Connection Point / HV Substation site (ref. Jarrah FEED Study – Appendix F)

The electrical design is defined in the Single Line Diagram (SLD) included in the Jarrah Solutions FEED Report (ref. Appendix F). The following paragraphs relating to operation, protections and communications are also extracts from the Jarrah Solutions FEED report.

Operation

The Mullewa microgrid will be designed and created to provide the following two services:

Grid Up Mode

The Mullewa microgrid will operate in an arrangement that is typical of a renewable grid-connected generation site. A connection point will be required, and the ERA technical rules requirements will apply at this grid connection. A DSOC (export limit) will be sought from WP to allow renewables from the microgrid (and on occasion, when called on by AEMO, from battery and diesel as well) to export power into the grid. Hence if there is an excess of power, over and above the town of Mullewa's needs, then this Microgrid will supply power to other customers between Mullewa and Geraldton. Neither the battery or diesel generator will be supplying (generating) power at the time of full solar and wind generation. The CMD (import limit) will be selected as a negligible amount to supply auxiliary loads at the microgrid. The CMD will not need to be selected to charge the battery as the charging of the battery will be performed by a combination of wind and solar generation. In grid-up mode, the source of power to the grid will be through a retail supply agreement. The diesel generator will not be expected to operate in Grid Up mode (except if called upon by AEMO due to generation capacity shortfall across the SWIS) and the neutral earthing transformer will not be connected in Grid Up mode.

Grid Down Mode

In the event of a power outage, the Mullewa microgrid will automatically become islanded from the grid and power will be supplied from a combination of the solar farm, wind turbines, BESS and diesel generator. The BESS will be utilised for frequency control and system stability services.

The automated detection and switching system at the connection point for the Microgrid will have the following features:

- Detection of an unplanned outage of the grid supply.
- Starting of the Microgrid and automated establishment of a 33kV earth reference.
- Disconnection of Mullewa from the grid (a new Western Power recloser will be required).
- Restoration of power to Mullewa from the Microgrid in under one minute
- Watch and wait for the restoration of supply from the grid. Following restoration, and after waiting a period of time to check for stability, the Mullewa Microgrid will automatically synchronise back onto grid supply in a seamless manner, and then isolate the 33kV local earth reference.

The "Grid Down Mode" would typically be an unplanned event however it could also be a planned event. For an unplanned event, the high level control philosophy is described within the logic diagram in Figure 10-4 below.

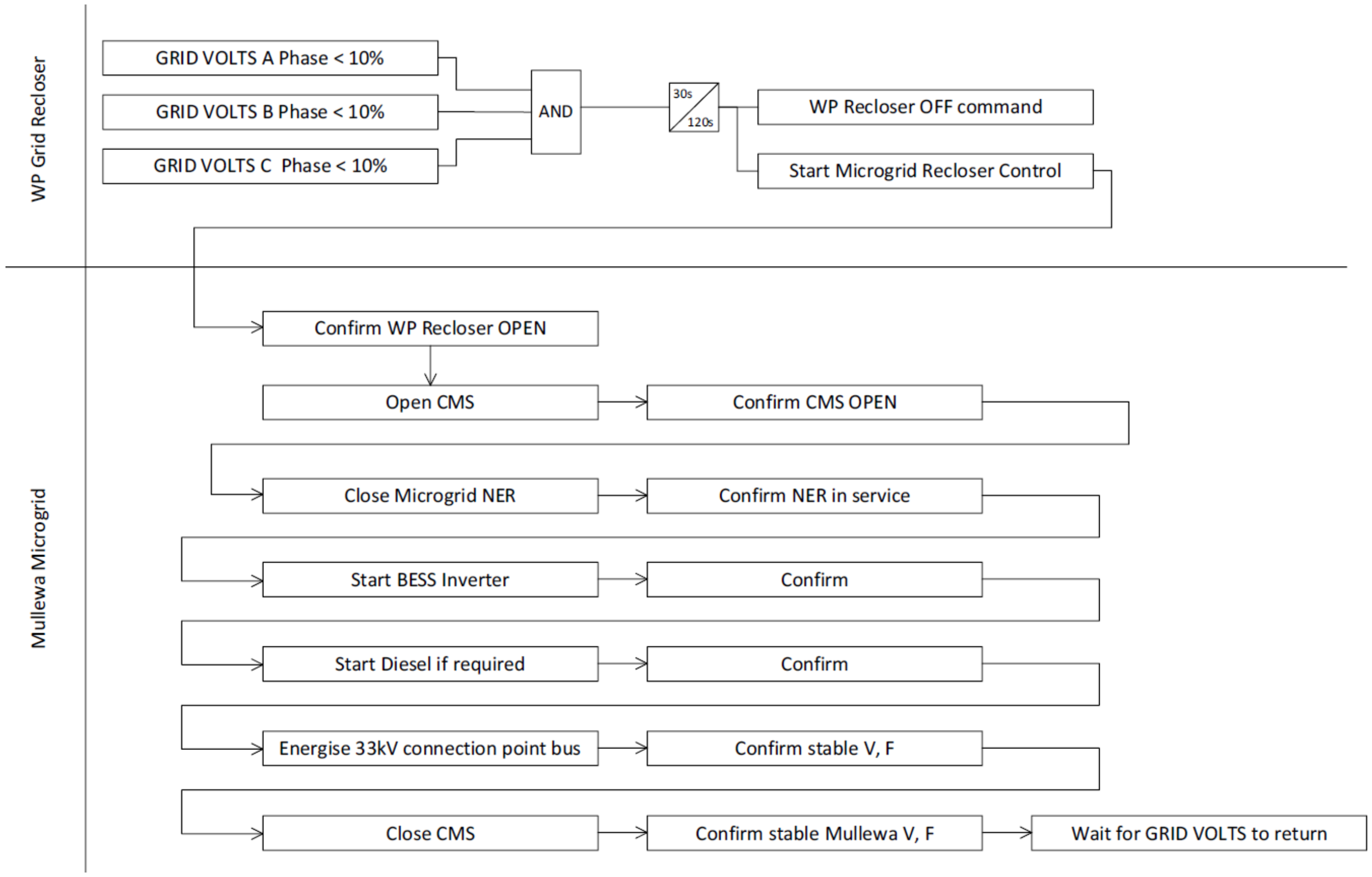


Figure 10-4: Mullewa Microgrid High Level Control Philosophy - Grid Down Mode

Microgrid Protection

Microgrid protection will be provided with connection point protections that meet ERA technical rules requirements. These protections will be located at the 33kV connection point and within the substation. When in grid-disconnected mode and the Microgrid is supplying power to Mullewa independently from Western Power, the protection system will adapt to a different mode of operation. The mode of operation (Grid Connected or Grid Disconnected) status will be provided automatically to the protection system. In Grid Disconnected mode, the fault levels will reduce, and fault detection and sensitivity requirements will become relevant and important. The protection systems will need to be designed for sensitive to short-circuit faults on the HV and LV networks. Detecting and selectively clearing for low level minimum fault currents will likely be the challenge to this project.

Directional overcurrent protections along with undervoltage backup protections will likely be required. The HV protection systems and input measurements (CTs and VTs) have been designed to allow for this flexibility. Protection studies have been allowed for in the FEED estimate, to be carried out during detailed design.

Lightning protection at the substation has not been allowed for as the overhead components (e.g. reclosers, air breaks, fuses, etc) are designed and commonly used for outdoor overhead operation. HV protection relays will be renowned international branded devices, and types SEL (USA origin) and Siemens (European origin) will be utilised.

Communications

Western Power Network Control Communications

Given the capacity of the new generation connected, it is expected that an interface will be required to communicate with the Western Power Network control centre. This will provide visibility to Western Power and also facilitate controls (ON, OFF and export limit setpoints). This type of communications is known as Remote Monitoring and Control (RMC). The most efficient means will be a combination of mobile radio (4G) and satellite communications. A serial interface will be provided through hardware installed within the Geraldton substation.

Grid Recloser Communications

A reliable communication link will be needed as the townships power system reliability will depend on its functioning at times of need.

The Western Power Grid Recloser location has been selected on high ground and to provide (close to) line-of-sight communications. A radio path analysis has been performed to check the expected reliability of this radio path (ref. Figure 10-5 and Figure 10-6).

The analysis was based on a recloser end antenna height of 7m (ie. mounted on the same pole as the grid recloser) and 5m at the connection point substation (ie. mounted on an antenna pole off the protection and automation container).

The results of the analysis concluded that Rayleigh Fade calculation yields a radio path availability of 99.98% which equates to 1hr 33m a year of unavailability in the radio link. This is considered an acceptable level of reliability for the purpose of managing Mullewa being supplied by the new Microgrid and interfacing successfully with the Western Power disconnection location (grid recloser).

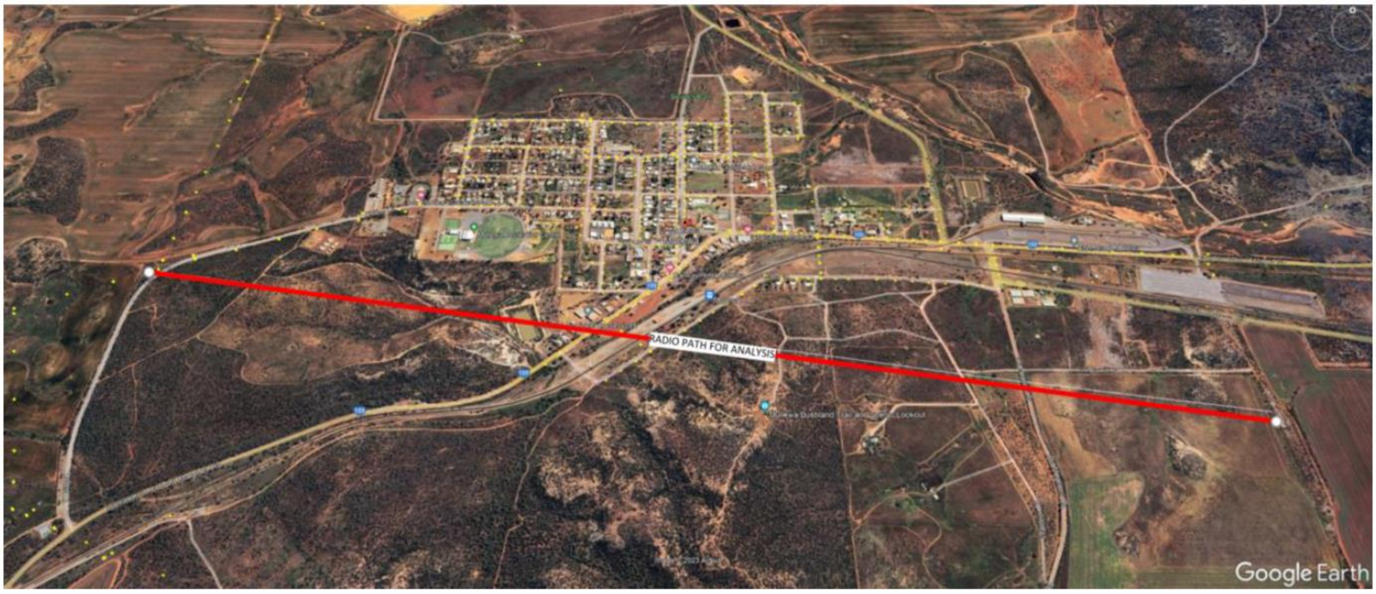


Figure 10-5: Radio path analysed for communications reliability (from Jarrah Solutions FEED Report, Appendix F)

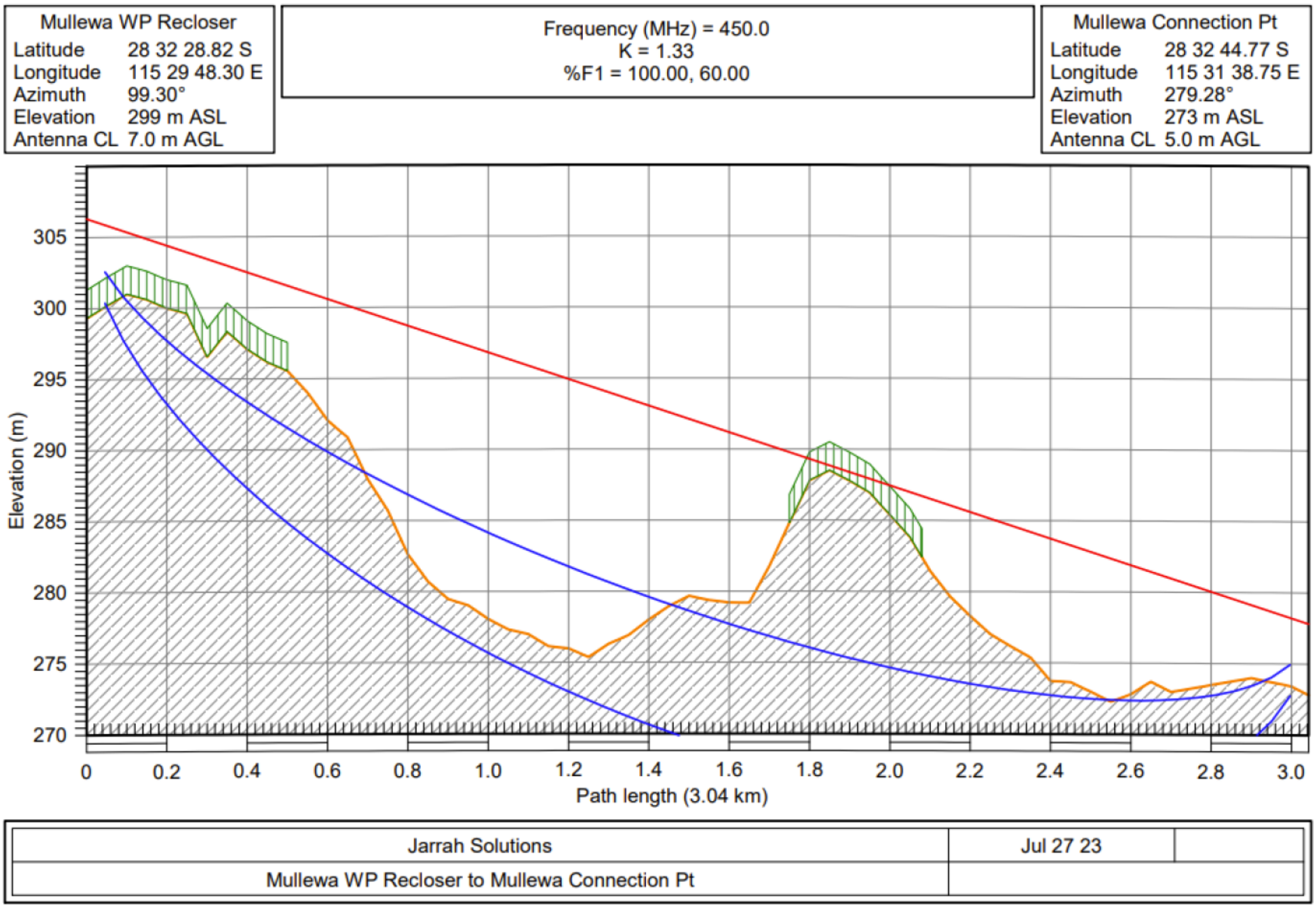


Figure 10-6: Radio path analysis (from Jarrah Solutions FEED Report, Appendix F)

10.2.5 Fully Costed Implementation

The FEED process includes a fully costed estimate based on actual equipment supplier quotations as well as quotations from design and construction sub-contractors and actual known geotechnical conditions. It also includes for a suitable margin that reflects the estimated risk associated with the “first-off” nature of the project. The estimate accounts for scope of the Microgrid up to the Western Power connection point as well as the Western Power Scope, as defined in Section 10.2.4, ie. extension of the existing Mullewa network powerline out to the connection point (ref. pink section of line in Figure 10-2) and installation of the automated recloser that enables the islanding of the microgrid (ref. Isolation Point in Figure 10-2). The project cost estimate is provided in Table 14.

Table 14: Project Cost Estimate

Cost Item	Cost Estimate
Solar Farm	$3.51m
BESS	$1.75m
Wind Turbines	$2.74m
Wind Turbines Powerline	$1.17m
Connection Point	$2.41m
Western Power Costs	$1.27m
TOTAL Project Cost	**$12.85m**

10.2.6 Project Execution Schedule

As part of the FEED work an overall project execution schedule was developed. The complete schedule can be found under Appendix E with the key milestones identified as follows (durations from project start):

- 1 month - Major Procurement orders placed
- 2 months - Geotech survey and foundation design for wind turbine commence
- 4 months - Civil works for wind turbines commence
- 6.5 months - Wind turbines received in Australia and refurbishment commences
  - Wind turbines electrical/comms work commences on site
- 8 months - Solar farm and battery long lead deliveries received on-site
  - Site works for solar farm commence
- 8.5 months - Wind turbines installation commences
- 9.5 months - Site works for connection site commence
- 11 months - Wind turbine installation complete
  - Connection site installation complete
- 12 months - Solar farm construction and battery installation complete
- 13 months - Commissioning complete

10.3 Commercial Development Activities

10.3.1 Retail Arrangements with Synergy

Sunrise provided Synergy with the estimated solar and wind generation data. Based on this Synergy provided an estimated purchase price for the Microgrid generation output on the understanding this could form the basis for negotiation of a bilateral take-off agreement should the project proceed. The pricing estimated was based on a 5 year term adjusted by 2.5% or CPI. For modelling over a 20 year period, the estimated pricing with 2.5% annual compounding was continued for the full 20 years.

In addition to a long-term agreement with Synergy or another retailer, an alternative based on using the services of a 3rd party to sell energy at the WEM balancing market price was also investigated. The costs associated with this include an initial start-up fee and then a continuing annual service charge. Based on the modelling performed according to current balancing market performance this approach shows a greater return for an investor, however has the associated increase in risk due to the greater uncertainty in pricing income.

10.3.2 Network arrangements with Western Power

As described in Section 10.2.1 Sunrise have submitted an Alternative Options Proposal (included in Appendix I) with Western Power for a reliability service that would be provided to Western Power by the Microgrid Operator. Should this proposal be accepted by Western Power then it would form the basis of the Network arrangement, which would be implemented under Western Powers standard Alternative Options Contract [8].

As per Section 9.3.2 the informal feedback from Western Power (prior to a formal access application) was that export capacity available at Mullewa was in the order of 1.5MW. A 2MW DSOC will be sought from Western Power, so that during the few occasions when called on by AEMO (as part of a capacity service agreement), generation from battery and diesel can also be exported to support a capacity shortfall in the SWIS.

10.3.3 Market arrangements with AEMO

A meeting was held with AEMO to understand what services the Microgrid would be eligible to supply to the market.

According to AEMO there is currently a conflict between terms that set the conditions for establishing whether a generation connection is defined as scheduled or non-scheduled. This conflict comes from one requirement stipulating that connections with multiple technologies (e.g. solar, battery and wind) would classify it as a scheduled service and another condition that generation connections with less than 10MW can be classified as non-scheduled. Accordingly it could be assumed that the Mullewa Microgrid would be non-scheduled and so not subject to a NAQ, and so export possible up to the assumed DSOC.

In terms of registering for the capacity market it was advised that if the Microgrid Operator registered for the capacity market but started operating prior to October 2026 it is likely the Microgrid would then be eligible for supplementary reserve capacity (SRC) credits, which supports the modelling of income from capacity credits from day 1 of Microgrid operation.

10.3.4 Policy alignment with Energy Policy WA

Given EPWA were the ones that proposed engaging with Wester Power via the Alternative Options Strategy it is clear that they are aligned with this approach as well as the project in general as confirmed in the feedback from the studies engagement with them (ref. Section 9.3.4).

As also indicated in their feedback was that they were supportive of investigating alternative models for a Microgrid (such as the EMN model) that could improve reliability in Mullewa and other fringe-of-grid towns, however conceded that it would be difficult to have alignment on a EMN type model based on the policy of making residential customers contestable, as it was expected this was not the policy of the current government, which was proven accurate during engagement with the Minister.

From Sunrise perspective this does not rule out alignment with EPWA for an EMN Microgrid type model in the future, if there is a change in government policy that is open to considering this.

10.3.5 Customer Arrangements

Given the selected Microgrid solution is based on an AOS model (ref. Section 9.6) the renewable generation will be sold to a retailer under a bilateral off-take agreement or to the market. This means there would be no change to any of the contestable or non-contestable customer arrangements.

Customer arrangements were however investigated for an EMN Microgrid model. The premise of the EMN model is that non-contestable customers would still be subject to the same Uniform Tariff Policy as the rest of the SWIS and so there would be no change from their perspective. The purpose of the Microgrid is not to offer cheaper energy but more reliable energy.

Contestable customers under an EMN model would still be offered a level of contestability. As per the legal review of the regulatory challenges (ref. Section 10.4) the Microgrid Operator would likely be required to offer open access on the basis of Western Power's standard Electricity Transfer Access Contract (ETAC), meaning non-contestable customers would have the right to choose a retailer other than the Microgrid Operator.

The premise for the EMN model, in terms of operating the Microgrid network, is that the Microgrid Operator would obtain a distribution license. Under this mode of operation customers would experience the same level of protections as they currently do as customers of the SWIS.

Under and EMN model it is in the commercial interest of the Microgrid Operator to match the load as closely as possible to the generation profiles and so this could result in customers being incentivised to alter their energy consumption habits in order to achieve this. Some of the possibilities for achieving this are mobile phone based applications that can provide information on best times for performing energy intensive activities, empowering customers with the knowledge to make decisions on energy usage that delivers the best results for them, and as a result, the best outcome for the Microgrid Operator.

10.4 Regulatory Activities

The selected AOS model for a Microgrid in Mullewa can be implemented today under the current regulations without any necessary amendments. In essence it is no different, from a regulatory point of view, than any other renewable generation currently connected to the SWIS in front of the meter.

The EMN model however, has not been implemented in a brownfields environment to date and so there are several regulatory challenges that would need to be navigated. As the EMN model is still considered a viable option for future brownfield Microgrids the study has investigated these regulatory challenges. Expert legal advise was sought on how to:

- best fit the EMN Microgrid model into existing regulations where possible, and where necessary;
- define in more detail the regulatory reforms that would be required to accommodate the "agreed in principle" features of the EMN Microgrid model.

Sunrise's summary of the resulting paper is given in the following sections.

10.4.1 Basis for the Review

The basis for the review is testing a model for the establishment of a “brownfield” EMN Microgrid, the characteristics of which are:

- The infrastructure of the network (Target Network) would be a discrete part of Western Power’s network (WPN) at “the fringe-of-grid”.
- The operator of the EMN Microgrid (EMNOP) would lease the Target Network from Western Power (WP).
- A master meter is installed at the single entrance point into the Target Network. This master meter then has all the loads in the Target Network as its load as well as any generation installed behind the master meter.
- The EMNOP acts a vertically integrated network operator, generator and retailer similar to other more typical embedded network operations.

10.4.2 A Covered Network and its Implications

The Western Power network became a “covered network” on commencement of the Access Code and all augmentations to the Western Power network are similarly part of that “covered network” under the terms of the Access Code.

Western Power is the sole “service provider” in respect of the Western Power network under the Access Code.

A “service provider” is defined to mean a person that owns or operates a network, and the access code makes provision for multiple service providers, including where a network is owned by one person and operated by another person. An EMNOP would become a “service provider” in relation to a Target Network on entering a lease agreement with WP for the Target Network.

Coverage under the Access Code gives rise to a very broad range of obligations on a “service provider”, which for an EMNOP as a “service provider”, would be too onerous to meet in the context of sustaining a commercially viable enterprise.

10.4.3 Addressing the Covered Network Challenges

The approach to addressing the challenges of an EMNOP becoming a “service provider” for a Target Network that will continue as part of a broader WPN under the Access Code and Western Power’s access arrangement (WPAA), ie. maintaining its coverage within the existing covered network, is based on Western Power seeking an amendment to its access arrangement (WPAA) to reflect an allocation of responsibilities between the EMNOP and Western Power in relation to the Target Network.

This allocation, if approved by the ERA, would enable a clear delineation of responsibilities between the parties and may also address the financial impact of the arrangement from a regulatory perspective, without the need for extensive contractual arrangements between the parties.

Some of the tasks associated with this approach (apart from the specific task of developing the operating lease and the WPAA amendments) would include:

- The EMNOP obtaining from the ERA an exemption from the ring-fencing requirements under the Access Code. Without such an exemption the ringfencing obligation would essentially undermine the core characteristics of the EMN model.
- Reaching a consensus with ERA that non-network operations (for example generation and retail operations) will not be “services” or “covered services” under the Access Code and therefore not subject to Access Code and/or WPAA regulation, ie. the price control / allowable revenue and related principles of economic regulation

that apply to WP would not apply to non-network operations – meaning development of the Operating Lease and amendments to the WPAA would need to incorporate this.

- Obtaining de-registration exemptions from the WEM Rules (in the first instance – and longer term possibly seeking applicable amendments to the WEM Rules in relation to developing a repeatable ENM model).
- Obtaining consent from users (ie. Synergy and existing contestable retailers, a total of five for Mullewa) to re-assign Western Power Electricity Transfer Access Contracts (ETAC's) from Western Power to the EMNOP.

10.4.4 Specific Issues

Will existing NMI meters become non-NMI meters after moving behind the meter?

Given the Target Network will remain a "covered network" the only way, under current regulations, that existing meters could become "non-NMI" (ie. excluded from WEM settlement calculations under the WEM Rules) is by AEMO granting exemption from registration requirements. This is a reasonable approach, particularly for a trial or pilot project, however may not provide the certainty for an EMNOP if the objective is to achieve a repeatable model – in that instance a longer term approach may be to seek amendment to the WEM Rules.

How is the requirement that a WPN connected load shall comply with AS/NZS3000 to be addressed?

The Western Australian Services and Installation Requirements (WASIR) 2022 requirement to comply with AS/NZS3000 is applicable to "consumer electrical installations", which start at the lot boundary. This is not the Target Network, which is a leased portion of the WPN and so still owned by WP and so not subject to complying with AS/NZS 3000 requirements and there are no grounds for why installation of a master meter upstream the Target Network should change this. Given the infrastructure connecting the WPN and Target Network would be owned by the EMNOP then that infrastructure would be required to comply and in addition any Target Network "consumer electrical installations". Regardless, for sake of clarity it would be appropriate for the WASIR to recognise the ENM model, and in doing so, exclude the Target Network as a separately owned and operated (from the SWIS) infrastructure.

When customers become "non-NMI" how are their rights and obligations associated with metering services maintained?

The obligation (in the absence of an exemption) of the EMNOP to hold a retail license will require compliance with the metering code. As mentioned in point a) an exemption from WEM rules would be required, meaning metering obligations applicable to a network under the WEM rules would not apply, but all other metering obligations would apply.
There are two possible ways of approaching metering in the ENM model, the first could be to appoint WP as the "metering data agent", in which case the meter would still remain a "NMI" just not a "WEM speaking NMI". This would be the least disruptive approach. Appointing an entity other than WP as the "metering data agent" is still a workable requirement that would not alleviate the requirement to meet all the obligations under the metering code (other than those under the WEM rules) but it would be more work and require some exemptions.

How can retailers other than Synergy supply electricity to "prescribed customers"?

Retailing of electricity by the EMNOP as the "service provider" in the Target Network and offering open access under the Customer Transfer Code would not offend against the prescribed customers or amount to WP contravening the Electricity Corporations Act. Care however needs to be taken in how the EMNOP and WP agreement is structured to ensure that WP can in no way be deemed to be providing a service, as this would then invoke the WP obligation to only distribute energy to non-contestable customers via Synergy.

Non-contestable customers would have the option to retain Synergy as their retailer and so implementation of an EMN model would not require consent of every customer in the Target Network.

How can Western Power's rights under the Energy Operators (Powers) Act 1979 (WA), EOPA, be used by the EMNOP?

The EOPA is out of date as it applies to electricity and so in the first instance the best route for dealing with this is for the EOPA to be updated to solve this for the entire industry not just this project – as has been done in relation to gas distributors and retailers under the Energy Coordination Act 1994 (WA).

As a fallback option in terms of how to ensure powers to access existing assets for operation (not for locating new assets) are afforded to the EMNOP in an EMN model, the EOPA already provides for a range of powers that may be delegated to third party contractors of WP, and so would be available to the EMNOP. The details around this would have to incorporated into the structure of the operating lease.

Is the Microgrid deemed to have an unfair advantage in terms of offering true contestability?

Given that the Target Network will remain a "covered network" under the Access Contract, it is highly likely even with an amended WPAA that the EMNOP will be required to offer access to the Target Network on the basis of Western Power's standard Electricity Transfer Access Contract. As such, there would not be an unfair advantage in connection with offering true contestability.

11 PHASE 6 – DOCUMENT AND SEEK INVESTORS

11.1 Financing Data to Support Due Diligence by Potential Financier

For producing the predicted financial performance of the final Renewable Microgrid Proposal, the GridCog model was updated with the following data coming out of the completed study work:

- Solar generation data output from PVSyst for the actual solar design (as opposed to less accurate GridCog internal estimate)
- Total wind generation output (generated by GridCog internal wind generation) adjusted based on the total annual energy yield estimated by BlairFox (ref. Section 5.6 and Appendix D)
- Battery storage size updated to supplier revised base size of 3MWh
- Update of estimated capacity credits income based on AEMO recent issue of the 2023 WEM ESOO [13]. In the 2023 ESOO the Cunderdin Solar Farm Project was assigned 48.7MW of capacity credits for 2024-25. Cunderdin is a 100MW solar farm with a 55MW/220MWh battery with 44.8MW assigned to the storage component and 3.8MW to the solar component. Taking this as an example of what would apply to the Mullewa Microgrid battery, it is expected the 1.5MW/3MWh battery could be assigned 0.6MW of credits (even with 50% reserved for the reliability service). The Cunderdin Solar has DC-DC connection to the battery and so output capacity from the battery and solar is limited to the battery inverter capacity which would explain why the credits assigned to solar are so small. For Mullewa, the solar and wind will be connected independent of the battery and so it is estimated that 15% of the installed 2.2MW capacity could be assigned capacity credits, meaning another 0.3MW. Assuming the 600kW of diesel generation would be in addition to this, the total capacity at Mullewa that could be assigned capacity credits is assumed to be 1.5MW. With the reserve price assigned for 2024-25 as $194,783/MW that equates to a capacity credits income of $290k per annum. A 2MW DSOC will be sought from Western Power so it is possible to export from the battery and diesel genset on the few occasions this service would be called on.
- Fully costed project capex as per Section 10.2.5
- Constraint on export between 4pm and 8pm assumed for first 3 years removed based on discussions with AEMO suggesting the project would not be subject to NAQ, ref. Section 10.3.3.
- Sale prices for renewable generation based on:

  Scenario a) Synergy estimate a per Section 10.3.1

  Scenario b) balancing market price as per Section 10.3.1
- Reliability service fee based on Alternative Options Proposal submitted to Western Power (Ref. Appendix I)
- Funding request to ARENA in order to de-risk the project, ref. Section 11.2

The output from the updated GridCog model is shown in Figure 11-1, giving the resulting IRR as 8.3% for Scenario a) and 9.6% for Scenario b)

Site Name:	Mullewa Township
Scenario:	Scenario a) - Synergy based pricing
Site Variation:	s6_Mullewa Township_var-1
Solar Specs:	1100+248.8kW, 0+0 , 0+10
Wind Specs:	1200kW
Battery Specs:	3000kWh, 2hrs, Co-optimised
Genset Specs:	0kW
Relative Cashflow:	$8,236,771
Relative Cashflow Min:	
Relative Cashflow Max:	
Simple Payback:	9.7
IRR:	8.3%
ROI:	103.6%
ROI Min:	
ROI Max:	
Emissions Reduction:	40,433
Emissions Units:	Grid MWh

Site Name:	Mullewa Township
Scenario:	Scenario b) - Balancing Market based pricing
Site Variation:	s7_Mullewa Township_var-1
Solar Specs:	248.8+1100kW, 0+0 , 10+0
Wind Specs:	1200kW
Battery Specs:	3000kWh, 2hrs, Co-optimised
Genset Specs:	0kW
Relative Cashflow:	$9,266,208
Relative Cashflow Min:	
Relative Cashflow Max:	
Simple Payback:	8.4
IRR:	9.6%
ROI:	116.2%
ROI Min:	
ROI Max:	
Emissions Reduction:	20,118
Emissions Units:	Tonnes CO2e

Figure 11-1: GridCog output from updated model, Scenario a) on the left and Scenario b) on the right

11.2 Investment Entities Who Have Expressed Interest in Microgrid Projects

11.2.1 ARENA

ARENA have a Regional Australia Microgrid Pilots Program [11] which is a $50million six year program that aims to improve the resilience and reliability of power supply for regional and remote communities, of which the funding is available to projects that have successfully completed a feasibility study.

Sunrise has already briefed ARENA on the Mullewa Renewable Microgrid Study. Comments from ARENA were that they are looking for projects that can demonstrate a repeatable model, and that a pilot project in Mullewa could be a suitable candidate. The main feedback however, was that key to obtaining serious consideration was to secure Western Powers participation. Accordingly, Sunrise have not proceeded with a formal grant application and are waiting on Western Powers response to the Alternative Options Proposal. Given the ARENA fund is for pilot programs with the emphasis on projects that have a repeatable a model, it is expected that the level of funding that could be expected would be tied to the estimated capital cost for the first-off pilot project (which would need to account for the associated unknowns and elevated risk level) compared to the estimate for future repeatable models after they have been de-risked from the pilot project and lessons learnt applied. Sunrise assessment of the cost for future brownfield microgrid projects in fringe-of-grid towns and the estimated cost reduction that could be achieved compared to a Mullewa pilot project is $3.7million. The main contributions to this figure are:

- A reduction in the Jarrah Solutions cost for the connection point scope. This scope carries the biggest risk because of the first-off nature of combining all the different generation sources and connecting and controlling it in a brownfield setting. This risk has been priced into the cost of this work and once it has been proven in practice it is expected a $0.3million in savings could be achieved.
- A reduction in powerline scope. Based on the lessons learnt (ref. Section 13), site selection will be done to ensure an agreement is put in place with a landowner for a site based on lowest capital cost, by minimising the distance between assets thereby minimising powerline costs. The estimated saving based on this is $1million.
- A reduction in cost for the Solar Farm. Fringe-of-grid towns are by definition remote and the cost of construction in these locations is increased and so the unit cost for installing solar increases substantially for smaller installations. Mullewa township is typically smaller than other towns that are likely to be targeted as candidates for future microgrids. This implies a larger solar installation that can be achieved at a lower unit rate with estimated savings being $0.4million.

- A reduction in cost for the wind turbines civilworks. The assumption is that locations for wind turbines can be found that have better existing access, such that cost allocated for access roads can be reduced, with estimated saving of $0.1million.
- A reduction in cost based on future cost of batteries. As can be seen from the plot of CSIRO data in Figure 11-2, the predicted cost of batteries is expected to nearly halve in the next 5 years based on the more conservative net zero emissions (NZE) post 2050 scenario, and even more than half in that time according to a NZE by 2050 scenario. The estimated saving based on this is $0.7million.

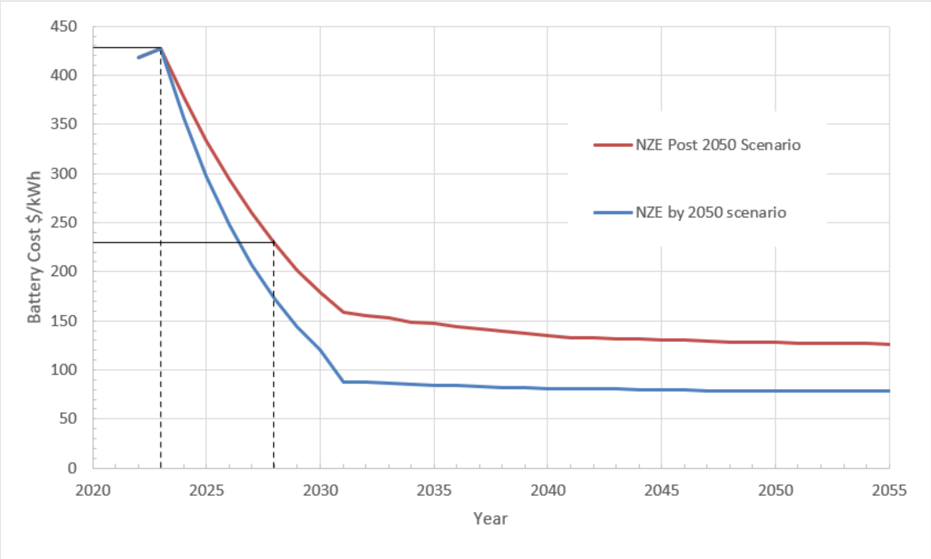


Figure 11-2: Plot of reduction in battery costs according to CSIRO GenCost Report [12]

- A reduction in the contingencies for most of the project areas to reflect the overall reduction in risk as a result of having proven the model via the Mullewa pilot. Estimated savings based on this is $0.5million.
- A reduction in Western Power design and administration costs after Mullewa proof of concept has been demonstrated in Mullewa. The decommissioning of the ERG's which is specific to Mullewa can also be excluded. Estimated saving based on this is $0.1million.
- A reduction in overall cost through synergies derived from executing future repeatable projects under a single portfolio. With this approach significant savings can be extracted from synergies in minor procurement and equipment hire as well as project management costs. Would also expect gains in design and construction efficiency via continuity of project personnel and sub-contractors would contribute to reduced costs. The estimated savings from this is based on a 10% reduction in non-major equipment costs, giving a saving of $0.6million

In addition to this $3.7million, a further $1.2million would help reduce the barrier to attracting investor interest. For a first-off pilot project such as Mullewa a reasonable IRR is required to attract an investor. To make the Mullewa Renewable Microgrid Pilot Project attractive to an investor and look beyond the inherently greater risk with a pilot project, it is likely to require a greater IRR than would be necessary to garner interest in a proven concept where investors could see the potential of a repeatable model that can be applied to a number of towns, executed as a portfolio of projects. Reducing the capital cost of a Mullewa pilot project by $1.2million in grant funding is expected to increase the IRR for the Mullewa pilot project somewhere in the order of 2%.

The Sunrise funding application to ARENA will therefore be looking for a grant for the Mullewa Renewable Microgrid Pilot Project, in the order of $4.9million.

11.2.2 Potential Investors

Sunrise have been in discussions with investors in relation to supporting a portfolio of Sunrise projects, which has included discussion of Mullewa as one of the projects for possible inclusion in this portfolio. Negotiations are still ongoing and subject to confidentiality agreements at this stage. This does not rule out possible engagement with investors looking specifically at the Mullewa Project, as given the current climate in the renewable energy sector, there is not a shortage of investors looking to put capital into renewable energy projects.

In order to approach investors specifically for the Mullewa Microgrid Pilot Project it is first considered necessary to have planning approval, acceptance from Western Power of the Alternative Options Proposal for the reliability service and confirmation of estimated capacity credit assignment. Ideally approval for ARENA funding would also be available, however the submission for ARENA funding suggest it may require evidence of co-funding commitments and financial capacity and so it is likely that these two parts of the project funding are progressed in parallel.

11.3 Commercial Offers for Select Investors and Preferred Investor

To date a commercial offer has not been received for investment in the Mullewa Renewable Microgrid. Discussions have been held with potential investors, however not solely or specifically around Mullewa. Sunrise do not expect to receive an offer from an investor until the confirmations noted in Section 11.2.2 above have been settled.

12 Risks & Opportunities

12.1 Risks

Identified risks for a Renewable Microgrid Project in Mullewa are presented in Table 15.

Table 15: Project Risks

Event	Risk	Mitigation Options	Residual Risk Level
Estimated Risks to Western Power (WP)			
Project Delays	Would delay timeframe in which reliability improvements would be seen and potentially impact on WP's ability to sufficiently demonstrate improvements sufficient to avoid penalties	Set realistic execution schedule with sufficient contingency to manage unforeseen events. Set commitment based on agreed FID date that allows time for pre-execution activities to be completed.	Low
Service Fails to Perform when called on	WP may incur penalties by not being able to demonstrate sufficient reliability improvements	Ensure designers have suitable qualification and experience to complete a robust design and conduct design review	Low
Service Provider Operates at a Loss	Risk of increase costs for the service in response to ultimatum from service provider that service costs must increase or risk losing the service altogether if the service provider goes out of business	Set WP as the operator of last resort so they can continue operation of the service in the event the Service Provider goes out of business	Low
Incident Occurs in Mullewa Network while operating is islanded mode	Arguments over responsible party when WP not in operational control leading to litigation	Ensure assignment of responsibilities under these scenarios are thought through and captured in the service agreement contract	Low
WP reject the Reliability Service Proposal	WP don't meet their obligations under AA5[4] to demonstrate improvement in reliability in pilot areas exposing WP to the possibility of commercial (and potentially reputational) penalties	Seek out alternative solutions for improving reliability for fringe-of-grid towns	Medium
WP seek out competitive reliability solutions via a tender process	Risk not receiving an offer with any improvement in price or performance over this proposal and have lost that time and money associated with a tender process	Proceed with the Mullewa Renewable Microgrid Proposal pilot and consider a second pilot to be sought via expressions of interest and tender process	Low
WP propose to do in house	With the current WP work load may lack the resources to execute in an acceptable timeframe	Proceed with the Mullewa Renewable Microgrid Proposal pilot and consider a second pilot executed in house	Low

Event	Risk	Mitigation Options	Residual Risk Level
Project Risks – Pre FID			
WP reject the reliability service proposal	Project no longer viable	Put the project on-hold until the environment is more open to an embedded network commercial model	High
WP insist on a radio communications link back to Geraldton substation	Project no longer viable due to excessive capital cost	Enter discussions with Western Power to understand what is driving this requirement and investigate viable alternative solutions that satisfy the same requirements	Medium
Can't get an off-take agreement with Synergy	Unable to sell the energy, such that the project is no longer viable	Seek offtake agreements with other retailers Look at selling to WEM at balancing market price via 3rd party service	Low
Not accepted by ARENA for funding	Unable to de-risk the project to a sufficient degree to attract a financier	Look at other funding options	High
Can't secure an investor	Project is no longer viable	Put the project on-hold until the environment is more open to an embedded network commercial model	Low
Can't secure a reasonable DSOC	Reduces commercial return expectation such that can't secure an investor	Look at other means of grant funding to compensate for this. If related to line capacity investigate with WP possibility of dynamic capacity rating	Medium
Aren't assigned capacity credits in line with expectations	Reduced commercial performance	Submit application to AEMO as soon as possible. Look for expressions of interest for Supplementary Reserve Capacity that could be applied for	Low
Project Risks - Execution			
Site access delays	Schedule delays, cost overruns, unable to meet the target date	Coordinate site access with land owners	Low

Event	Risk	Mitigation Options	Residual Risk Level
Western power delays for connection approvals and/or construction of the extension of the WP network to the connection point	Schedule delays, cost overruns, unable to meet the target date	Start approval process well in advance of required date. WP consider sub-contracting construction of the extension to the project, given the project will already have assets on-site to build the projects powerline scope	Low
Project Estimate for WP network extension exceeded	Greater than expected costs impacting commercial performance	Allow for additional contingency. Discuss possibility of project executing the work on behalf of WP in order to keep costs down	Low
Aboriginal Heritage	Evidence of Aboriginal heritage discovered during site works requiring works to stop	Organise Aboriginal heritage assessment of the sites (and possible survey if required) prior to project commitment	Low
Loss of key personnel	Schedule delays, cost overruns, unable to meet the target date, market conditions currently resource constrained	Maintain healthy working environment so personnel are happy to remain engaged with project, replace key personnel with alternative personnel as required	Low
Project Risks - Design			
Delays in detailed design of system	Schedule delays due to delays in placing procurement orders	Start detailed design well in advance of required date so procurement is not impacted	Low
2nd Hand Wind Turbines	Older 2nd hand turbines may pose challenges in meeting new technical rules and obtaining approval to connect them to the network	Select turbines that comply with the required rules and regulations and has a proven track record. Check the selected turbine with Western Power. With battery incorporated into the overall system this can assist in meeting necessary technical requirements	Low
Project Risks - Procurement			
Volatility of currency exchange rates	Australian Dollar continue to fall below \$0.60 to USD, cost escalation	Hedge USD or EUR	High
Volatility of panel pricing	Currently volatile due to world conditions	Place order when possible and manage closely	Medium
Volatility of cable pricing	Currently volatile due to world conditions	Place order when possible and manage closely	Medium

Event	Risk	Mitigation Options	Residual Risk Level
Logistics pricing and delays	Currently volatile due to world conditions and overseas items subject to delays. Procurement items with highest risks include: Panels, Tracking System, Inverter Stations, HV switchgear and. Transformers	Place order when possible and manage closely	High
2nd Hand Wind Turbines	Used turbines typically lack guarantees and manufacturer support. Purchasing used turbines from overseas involves responsibility for dismantling them which can lead to runaway costs.	Look for Turbines that have been operated under a manufacturers service agreement to ensure reliability and support. Conduct thorough due diligence by performing inspections on the turbines. Purchase operating turbines and identify worn components that may require refurbishment while they are on the ground. Visit the site in person to meet the owners and gain a comprehensive understanding of the turbine service history. Choose a trusted partner with a proven track record in selecting, purchasing and dismantling used turbines	Medium
Wind Turbine Transport	Significant logistical challenges as well risk of biosecurity issues as the turbines may be contaminated from agricultural properties and navigating through different countries permits and transport rules	Use partners with a proven track record who are familiar with the potential challenges that may arise. Initial early planning and ensure a proactive presence on the ground	Medium
Project Risks - Construction			
Rock Present	Piling and trenching delays	Piling will require pre-drilling, trenching will be trialled	Low
Contamination	Risk of dieback or fungal contamination when brining vehicles and imported fill into site	Establish appropriate measures for vehicle and material entry to site	Low
Manual Handling	Personal injury	Experienced installers and purpose built installation aids will be used to handle racking, panels and cable	Low
Electrical	Personnel injury & plant/equipment damage	Experienced electricians will be used to install electrical system	Low

Event	Risk	Mitigation Options	Residual Risk Level
Lifting	Crane overload/collapse, Personal Injury, & damage to plant, equipment, environment	Experienced crane operator and riggers will be used, minimal number of lifts	Low
Rubbish	Control of rubbish from site, in particular panel packing	Establish separate panel staging area to unpack panels in order to control and contain rubbish	Low
Dust	Airborne dust interferes with construction operations	Appropriate PPE, depends on time of year	Low
Labour Market	Labour difficult to find and retain given current market	Use known personnel and sub-contractors to maintain experienced personnel	Low
Vandalism/theft	Construction close to town will require additional security provisions for materials and equipment	Cameras, security guards	Low
Weather	Risk of Solar panel damage from extreme weather events (beyond design limits), e.g. hail, flooding etc. In particular during construction before tracking system has come on-line	Put in place appropriate insurance. During construction ensure panels are secured in "stowed" position.	Low
2nd Hand Wind Turbines	Degree of uncertainty during construction when 2nd hand turbines involved	Involve the team who dismantled the turbine.	Low
Project Risks - Operations			
Fail to meet service obligations when called on	Commercial risks due to penalties associated with not meeting obligations	Use experience and qualified design and construction personnel Ensure thorough commissioning process	Low
Wind Generation does not perform as expected	Commercial risks as income will be reduced		Medium
Vandalism	Damage to assets that prevent the service from meeting its obligations	Limit access through fencing and implement deterrents such as video surveillance Have insurance in place to cover this possibility	Low

Event	Risk	Mitigation Options	Residual Risk Level
Change in contract prices at end of initial contract terms	Commercial risk as may not be able to renew reliability service contracts and energy take-offs for the same prices as the initial terms.	Allow for reduced return in the commercial model for the period after the initial terms contracts	Low
Microgrid Instability	This is a complex network with integration of diesel, batteries and renewables in an islanded (off-grid) remotely located context. There is a risk of unplanned outages caused by Microgrid instability.	Use Experienced design, construction and commissioning personnel Electrical system protections will be in place to ensure that Mullewa customers are disconnected and isolated if the Microgrid does not meet the required power quality requirements Monitoring over time will be provided and compliance monitoring can be performed.	Low
Equipment Failures	Commercial risks due to possible penalties associated with not meeting service obligations and cost injections associated with breakdowns.	Procure equipment from reputable manufacturer's with proven service records. Put in place planned maintenance schedule in accordance with manufacturers recommendations. Monitor equipment performance to identify potential issues so they can be rectified prior to resulting in breakdowns	Low

12.2 Opportunities

Opportunities identified for a Renewable Microgrid Project in Mullewa are presented in Table 16.

Table 16: Project Opportunities

Opportunity	Description	How to Advance	Relative Benefit
Future change to operate under an EMN Microgrid Model	If the future government policy was more receptive to an EMN Microgrid model, it doesn't require a significant change to Microgrid infrastructure to go from AOS model to EMN model. The connection point protection and automation container needs to be relocated to where the grid isolation point is located. The container is designed as re-deployable. Under an EMN model there would be the opportunity to explore the benefits of this model such as the Microgrid Operator (MO) delivering some of the network operations services, via local Mullewa employees, the incentive for the MO to attract new business to the town in order to grow the load, enable the marriage of demand and supply to participate as DER in the market. Would provide an opportunity to demonstrate the model and given it is successful, incentivise investment in this Microgrid model in other fringe of grid towns.	Continue to lobby the government and its agencies about the potential benefits of the EMN Microgrid model. Continue to work with Western Power around the delivery model. Continue to develop the details around the regulation changes required	High for the Project, Mullewa and SWIS
Reduce the cost of the Western Power project scope	If Western Power can find a point in the existing network from which is closer to the Connection Point and so require a short powerline, cost of the powerline could be less.	Challenge Western Power to find the cheapest solution for extending the existing network to the Connection Point	Medium for the Project
Attract new business to the town	With local generation available and improved reliability of supply there is the opportunity to attract more energy intensive business to the town	Discuss with CGG the possibility of doing a marketing campaign	High for Mullewa
Develop agrivoltaics	The solar farm provides the opportunity to develop an agrivoltaics project.	Look into organisations currently investigating agrivoltaics and offer the Mullewa solar farm as possible testing ground for new agrivoltaics pilot projects Look for grants from funds that are looking to develop agrivoltaics projects	Medium for Mullewa

Opportunity	Description	How to Advance	Relative Benefit
Extend the extent of the islanded Microgrid towards Geraldton	If several automated reclosers could be positioned back along the Geraldton feeder line as you head away Mullewa, then for the AOS model, depending on where the fault occurred, this could enable the Microgrid to extend its support further West when grid supply is interrupted.	Advise Western Power and let them examine the cost-benefit value of this proposal	High for customers West of Mullewa, low for the project
Upgrade the Microgrid Network by adding equipment that can locate local faults	At present if the Mullewa network is islanded and operated by the Microgrid and a fault occurs within the Mullewa Network the Microgrid would have to shutdown causing an outage. If the local fault could be located so that it could potentially be isolated this would allow the remainder of the islanded network to come on line again.	Look at the cost-benefit value	Medium for Mullewa, Low for the project
Capacity Market at Peak	In addition to estimated income from assigned capacity credits could also sell excess generation during peak demand events. With solar and wind generation at peak capacity combined with battery and diesel have potentially up to 4.3MW of capacity (3.2MW with wind and solar at 50%) that could be dispatched when called on by AEMO during peak events.	Secure the necessary DSOC with Western Power	Low for the Project, Low for the SWIS
Extra Capacity in Mullewa	The local generation in Mullewa will increase Western Power capacity available in Mullewa and so will open up opportunities for the community, for example in pursuing an “electrification of everything” objective	Western Power to consider the value of this	Medium for Mullewa

13 LESSONS LEARNT

Lessons learnt throughout the completion of the Study include the following:

- It can take a considerable time to reach an agreement with a network provider and State retailer in order to obtain access to actual load data for modelling and so this should be accounted for when considering project timing. Also if significant loads come from contestable customers that have other retailers, the permissions and time required to obtain this data should also be accounted for.

- The impact on capital costs of the location for the microgrid can be significant, which highlight the criticality of securing suitable land early on in a project.

- There are large companies looking into acquiring rural land for large renewable energy based projects, which can potentially be in competition for land for small town microgrids. It can be difficult to compete with such companies on price, so have to be prepared to engage with land owners and discuss the upsides of committing land to a renewable microgrid project that can directly benefit the town.

- Need to get a heads-of-agreement signed before assuming offers for land have been secured.

- If considering investing in a digital twin, make sure there is already a working framework for it that can be reviewed prior to proceeding.

References

1. 2021/22 Price List for the Western Power Network, 14 April 2021
https://www.westernpower.com.au/media/5049/2021-22-price-list-20210624.pdf

2. 2020/21 Loss Factor Report, 29 May 2020
https://aemo.com.au/-/media/files/electricity/wem/data/loss-factors/2020/2020-21-loss-factor-report.pdf?la=en

3. Home EV Charging and the grid: impact to 2030 in Australia, Ross DeRango, August 2022
https://electricvehiclecouncil.com.au/wp-content/uploads/2022/08/Home-EV-charging-2030.pdf

4. 2022-2027 Access Arrangement for the Western Power Network (AA5), ERA, 31 March 2023
Access Arrangement 2022-2027 - Economic Regulation Authority Western Australia (erawa.com.au)

5. Alternative Options Strategy, Western Power, 1 October 2021
https://www.westernpower.com.au/media/5751/alternative-options-strategy-2021-20210930.pdf

6. Network Opportunity Map 2022 (NOM2022), Western Power, 1 October 2022
https://www.westernpower.com.au/media/6282/network-opportunity-map-2022.pdf

7. "Fourth world' power outages blamed for third batch of spoiled vaccines in regional WA", Cecile O'Connor – ABC News, 4 January 2019
https://www.abc.net.au/news/2019-01-04/vaccines-discarded-amid-mullewa-power-problems/10683258

8. Alternative Options Contract, Western Power
https://www.westernpower.com.au/media/5741/model-alternative-options-services-contract-20210922.pdf

9. Triennial review of the effectiveness of the Wholesale Electricity Market 2022, Discussion Paper, ERA, 29 July 2022
https://www.erawa.com.au/cproot/22805/2/D249712-WEM.Rep.2022---Triennial-review-of-the-effectiveness-of-the-Wholesale-Electricity-Market-2022.pdf

10. Position Statement: Renewable Energy Facilities, Department of Planning, Lands and Heritage, March 2020
https://www.wa.gov.au/system/files/2021-07/POS-Renewable-energy-facilities-position-statement.pdf

11. Regional Australia Microgrid Pilots Program, ARENA October 2020
https://arena.gov.au/funding/regional-australia-microgrid-pilots-ramp/

12. GenCost 2022-23, Final Report, Paul Graham, Jenny Hayward, James Foster and Lisa Havas for CSIRO, July 2023
https://www.csiro.au/en/research/technology-space/energy/energy-data-modelling/gencost

13. 2023 Wholesale Electricity Market Electricity Statement of Opportunities, AEMO, August 2023
https://aemo.com.au/en/energy-systems/electricity/wholesale-electricity-market-wem/wem-forecasting-and-planning/wem-electricity-statement-of-opportunities-wem-esoo