Final report

Hardwicks Microgrid Project

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Abstract

The Hardwicks Microgrid Project, as a demonstration of a renewable energy ‘microgrid’ in the Australian red meat industry, incorporates solar energy and battery storage to provide Hardwicks Meat Works processing facility with partial independence from the electricity grid. A microgrid is a small ‘subset’ of the electricity grid that provides energy generation and storage at a local level. They can incorporate renewable energy generation, in the case of Hardwicks being solar PV as well as battery energy storage.

The Hardwicks Microgrid comprises of:

Item	Description
Solar panels	2.5MW PV array (7600 panels in total)
Inverters	2.16MW PV inverters (80 inverters in total)
Battery storage	2MW/2MWh lithium-ion S&C (PureWave® SMS) battery
Diesel generator	200kW diesel generator
Connection point	High voltage transmission
Microgrid System Controller	EcoStruxure Microgrid Advisor

As well as offering economic and logistical benefits to the Hardwicks facility by becoming 65-70% self-generated renewable power supply, the project provides several opportunities for research that will benefit the industry, including pasture quality and animal behaviour from the grazing management studies that were conducted. The design, installation, operation and funding models will provide a blueprint for future renewable energy projects in the meat industry.

This report describes the Design, Installation, System Operation, 12-month Optimisation, Measurement and Verification, and summarises verification of the installed solar energy system against design including performance, verification of microgrid operation, and observation studies made throughout the five year project.

Figure 1: Ariel view of completed solar array.

Executive summary

Background

The purpose of this project is to combine renewable energy generation with sheep grazing as a demonstration of dual land use (Fig. 2). It is unique in that it utilises the renewable energy produced on agricultural land to process sheep grazed on that land, in a vertically integrated value chain.

As well as demonstrating microgrid technology in the red meat industry, the project offers the opportunity to study grazing and pasture management in conjunction with a 'greenfield' solar installation.

The results of this research aim to encourage other processors within the red meat industry to seek renewable energy options supported with various industry funding and/or financing options. The research findings are to be published on MLA's website in order to boost the productivity and sustainability along the supply chain.

Figure 2: Dual land use arrangement at Hardwicks, with sheep grazing within solar array.

Objectives

There are 6 project objectives:

1. Demonstrate an industrial microgrid as a means to enable off-grid red meat processing, including system integration with the mains electricity grid;
2. Design a microgrid that will enable grazing of sheep under the solar panels;
3. Establish an electricity tariff optimisation procedure to allow red meat processing facilities to request a demand reset from electricity suppliers.
4. Develop a grazing management plan for grazing of sheep under the solar array;
5. Consider future additions to the microgrid following the installation of the project; and
6. Present innovative project funding options to drive adoption of microgrids within the Australian red meat industry.

Methodology

The methodology of this project involved:

- Feasibility studies to understand what renewable options were the most suitable, what land size was available and what system size could be built;
- Stakeholder engagement: including local council, neighbours, and MLA;
- Design and Engineering: From concept to "for construction" drawings
- Construction of the solar array farm and battery storage area;

- Commissioning of the solar farm
- Commencement of pasture and grazing management studies over a 5 year period;
- Ongoing maintenance of the renewable energy assets; and
- Project conclusion and project review.

Results/key findings

The completion of the Hardwicks Microgrid has expected financial returns at $508,746 per annum as well as reducing carbon by approx. 1,300,000 kgs per annum.

There was a reduction in pasture growth in the areas where the solar panels had been constructed and the changes in quality measurements indicate that livestock production would be better under the solar panels as a result of pasture being higher in crude protein and containing higher levels of metabolisable energy.

The results suggest that you would need to run less animals under the solar panels compared to not having solar panels and they would continue to put weight on for longer and better weight gains later in the season.

From this trial alone it is hard to establish which would be a more profitable scenario as stocking rate is an important factor in farm profitability but the ability to extend the growing season as a trade-off for less production during the spring which was seen in this trial is probably quite favourable as the spring is typically a time of abundance of feed and underutilisation of feed.

Benefits to industry

As well as demonstrating microgrid technology in the red meat industry, the project offers the opportunity to others within the same industry to study grazing and pasture management in conjunction with a renewable energy project. This project aims to illustrate to others how project funding can be sourced and what research components can go into such a project to benefit the industry.

Hardwicks also held field days throughout the entirety of the project to provide industry stakeholders with the opportunity to inspect the installation of the Microgrid and to showcase the positive impacts Hardwicks is making within the red meat industry.

Future research and recommendations

The Heat Pump and Power Upgrade Projects should be completed by end of 2022. In 2023, the business needs to work out which projects can be executed to fully achieve Carbon Neutral status for the Kyneton site.

Current concept plans for future projects include additional solar PV, wood chip boiler and/or biogas generation.

Hardwicks and Kilcoy Global Food Group Australia would like to thank the MLA personnel involved with this project in bringing it to a successful conclusion.

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1. Background

The Hardwicks beef and lamb processing facility in Kyneton, Victoria, is currently supplied by a 22kV line with a 22kV/433V step-down transformer, and has a load of up to 1.3MW. The site experienced short grid outages 4-6 times per year, which can cause delays and loss of business for up to a day on each occasion. A microgrid system, including Photovoltaics (PV), energy storage system (battery storage), has been constructed for the site to resolve this situation by providing a level of autonomy from the grid and is one of Australia's largest privately owned Microgrids.

This final report describes the Design, Installation, System Operation, 12-month Optimisation, Measurement and Verification, and summarises verification of the installed solar energy system against design including performance, verification of microgrid operation, and observation studies made to date.

This project commenced in 2016 with the concept being developed by Hardwicks and Next Generation Electrical. The Microgrid project was 2 years of detailed planning and budgeting before any site works could commence. The construction of the solar farm and battery storage area was delivered in 2 stages due to the 2 different solar PV systems – total construction timeframe was a further 2 years. The research components of this project were able to commence once the solar farm was commissioned and the solar array farm was fenced in. The research components of this project, being the design, installation and operation of the Microgrid, pasture quality studies and grazing management studies were conducted from 2019 to 2022.

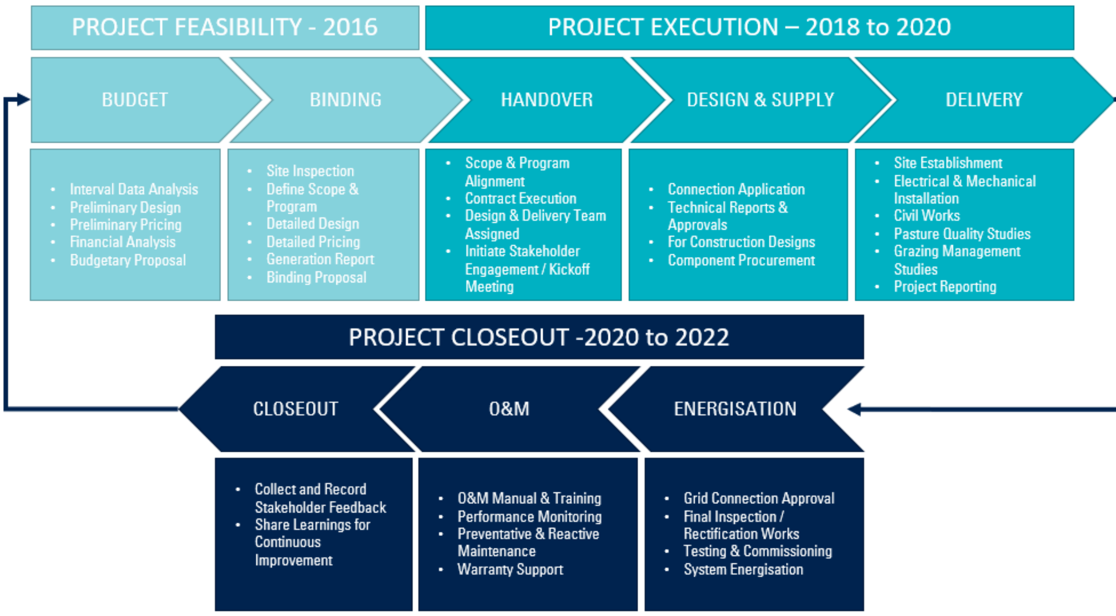

Figure 3: Project Development Lifecycle

This Final Report for the Hardwicks Microgrid Project comprises the verification of system design and performance. This includes:

- Year to date verification of PV system;
- Monitoring of PV system performance;
- System performance of battery storage technology;
- Microgrid operating methodology;
- System maintenance completed; and

- Observational studies on sheep completed over the last 12 months.

The research of this project is aimed at other producers within the red meat industry to illustrate the benefits of developing a Microgrid and how the interactions of solar energy generation and the grazing of sheep under the purpose-built system can benefit the producer both financially and logistically.

The key project outcomes are discussed in this report, including the cost/benefit analysis, recommendations for future R&D and the field visits during the 5 year evaluation period.

This report details the successful prolonged demonstration of an industrial microgrid as a means of enabling red meat processing facilities to operate independently of mains electricity.

2. Objectives

2.1 Objective 1 - successfully met

Objective: Demonstrate an industrial microgrid as a means to enable off-grid red meat processing, including system integration with the mains electricity grid – objective

The successful commissioning of the 2.5MW solar PV system, 2MW/2MWh of battery energy storage (BESS) and the Azzo Microgrid Controller demonstrates that Hardwicks' Microgrid can enable off-grid red meat processing whilst also being integrated to the mains electricity grid. The screenshots shown in section 3.3 illustrate the live view of the Microgrid.

2.2 Objective 2 - successfully met

Objective: Design a microgrid that will enable grazing of sheep under the solar panels

The array has been specifically designed for sheep mobility, with a 1.2m under-panel clearance (Figure 1) that distinguishes it as a unique shading situation. Figure 1 below also shows the design created prior to construction which enables sheep to graze under the panels. The solar array farm has strategically been designed so that the major electrical infrastructure (BESS, switchboards, ring main units (RMU) and generators) are located at the front of the Hardwicks facility and not within the fenced off area of the solar farm to allow more area for sheep to graze, but also for the safety of the livestock.

Figure 4: Panel-to-ground clearance (right of image above) and demonstrating dual land use.

2.3 Objective 3 - successfully met

Objective: By using the Microgrid Controller, establishing an electricity tariff optimisation procedure to allow red meat processing facilities to request a demand reset from electricity suppliers to lower energy costs. A demand reset is a request to have your demand reset back to zero, which reduces the cost of energy bills.

The Azzo EcoStruxure Microgrid Advisor optimises energy costs with the use of an economic dispatch model. This economic dispatch model is based on an energy pricing model which represents the tariff of the customer site. The pricing implemented is a time-of-use (price of the energy depends on the time only).

2.4 Objective 4 - successfully met

Objective: Develop a grazing management plan for grazing of sheep under the solar array.

The project has demonstrated the development and deployment of a grazing management plan for grazing of sheep under the solar array. The solar PV array provided high levels of shading in distinct patterns throughout the array field and as a result this project provided a valuable opportunity to investigate the preferences of sheep for shaded and unshaded areas in different environmental conditions.

2.5 Objective 5 - successfully met

Objective: Consider future additions to the microgrid following the installation of the project

In addition to original project with MLA, Hardwicks added an additional 1 MW of PV in 2019 resulting in the totalling 2.5MW PV & 2MW Hour Battery. Furthermore, Hardwicks are currently converting from Low Voltage (LV) to High Voltage (HV) customer and doubling power supply into the plant. Reconfiguring the Battery and PV so that it feeds into the new HV incoming board. The power upgrade will allow for further plant expansion. Also being HV customer, it will make additional renewable projects more cost effective in future as working with HV cables internally is significantly cheaper to LV cables. The cost of energy being HV customer compared to an LV customer is also lower.

Hardwicks is currently installing a 1000kW Ammonia Heat Pump to replace natural gas hot water boilers. This is anticipated to save 75% natural gas usage at the site and net CO2 e-reduction of 1000 tons per year. This project is scheduled to be completed by the end of 2022.

2.6 Objective 6 - successfully met

Objective: Present innovative project funding options to drive adoption of microgrids within the Australian red meat industry.

This project investigated the difference between an Environmental Upgrade Agreement (now referred to as Environmental Upgrade Finance (EUF)) against traditional debt financing underpinned by discounted Clean Energy Finance Corporation rates.

Rather than an agreement between a lender and property owner, as per traditional financing arrangements, the EUF is an agreement between a lender, a property owner, and the local council

(Figure 2). The financier provides the funding to the owner, but it is the council that collects repayments, via the rates system. As a result, the owed money is prioritised over other debts, increasing lender security and allowing the bank or other financier to offer long-term loans at competitive interest rates (State Government of Victoria, 2022). This service, facilitated by the Sustainable Melbourne Fund, permits Victorian councils to incentivise renewable energy projects without the direct use of taxpayer monies, and streamlines the project process for developers and customers alike.

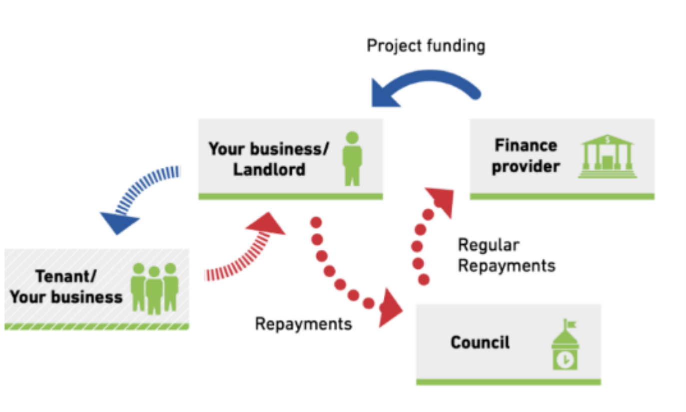

Figure 5: The EUF model (Sustainability Victoria, 2022)

As an additional source of funding to the Microgrid, Hardwicks applied to the Australian Renewable Energy Agency (ARENA) for funding for the current thermal heat pump and electrical supply project and was successful in receiving $838,000 in funding.
(see: https://arena.gov.au/news/decarbonising-the-meat-industry-using-geothermal-technology/, https://arena.gov.au/projects/hardwick-meatworks-heat-pump-installation-and-power-upgrade-demonstration/).

3. Methodology

3.1 Project methodology

This project is segmented into the below 3 key stages to illustrate how the Microgrid went from feasibility to construction, then into operation and maintenance stage.

3.1.1 Scope required to assess the feasibility of the project

The below table outlines the key tasks that were completed to scope the feasibility of this Microgrid project.

Scope Item	Scope Item
1	Feature level survey report
2	Underground services scan and report
3	Hydrology study for drainage and erosion.
4	Geotech survey and soil testing for pile and foundation designs
5	Detailed concept design and engineering package: Site General Arrangement drawing, AC Single Line Diagram, DC Single Line Diagram, PVsyst Generation report, tracker CAD layout, draft pile design and revised layout using items 1-4. NG/E to re-run preliminary report commercial analysis, system performance analysis post site investigation and concept design. Revised detailed budgetary cost estimate including key assumptions and exclusions.
6	Preliminary electricity network provider application submission including application fee
7	Planning & Council: Heritage and Ecology screen, Planning report, Traffic and Noise and Visual Impact. Soil testing and hydrology information to be utilised in reports. Excluding Submission Fee (costs unknown)

Table 1: Project feasibility stage

3.1.2 Construction stage

The below table outlines the key tasks that were completed to scope the feasibility of this Microgrid project.

Scope Item	Scope Item
8	Civil Works – solar farm preparation, concrete slab for the battery
9	Fencing Works – for solar array farm and battery location
10	Mechanical Build – piling and panelling works
11	Electrical Works
12	SCADA and Microgrid Integration Works
13	Commissioning works

Table 2: Project construction stage

3.1.3 Operation & Maintenance and Research & Development Stage

The below table outlines the key tasks that were completed to scope the feasibility of this Microgrid project.

Scope Item	Suggested Scope Item
14	Pasture quality studies
15	Grazing Management Studies – including animal behaviour studies
16	Operation and Maintenance of the Microgrid

Table 3: Project closeout stage

Annual system maintenance at Hardwicks is broken down into 3 key segments and involves 2 Electricians and 4 weeks in total to complete the following maintenance:

Item	Key components	Date of completed maintenance	Personnel Required	Timeframe
Solar Farm	**Fixed solar PV farm** 2755 x Jinko 325w panels 1805 x Jinko 330w panels 48 x Fronius 27kW inverters Schletter fixed tilt system **PEG solar PV farm** 3040 x Trina 330w panels 32 x Fronius 27kW inverters PEG racking system	28th November – 7th December 2022	2 fully qualified electricians	2 weeks
Battery Energy Storage System (BESS)	Purewave S&C 2MW/2MWh BESS	21st November 2022	2 specialist contractors from battery supplier	2 days
High Voltage Electrical Works	Transformer 1 & BESS substation Solar kiosk Transformers 1 & 2 substations	22nd November 2022	1 HV contractor	1 week

Table 4 – Completed maintenance schedule

4 Results

4.1 Verification of system performance against design

4.1.1 Actual vs estimated system performance – 2022 results

Combining the generation of both systems on site the total generation recorded in 2022 is 2,553 MWh. This is over 98% of the theoretical estimated generation by PV system and demonstrates a healthy functioning system with performance in line with generation estimates, whilst also factoring in the expected degradation of the solar PV system given that it was commissioned in February 2018.

Figure 6 and 7 below, illustrate the outputs generated by the solar monitoring system.

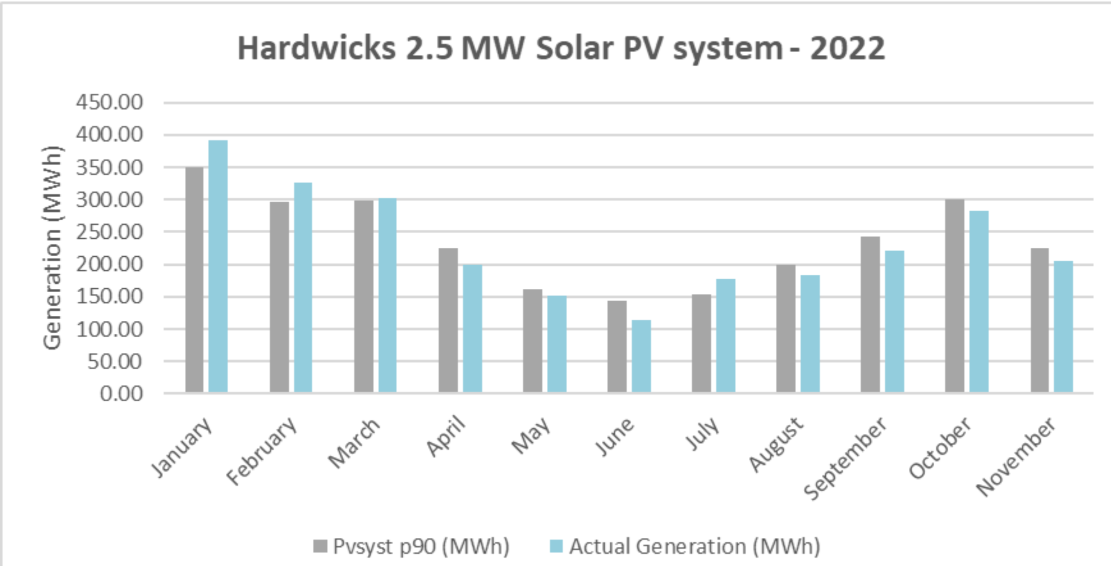

Figure 6: Actual vs estimated system performance

Total 2.5MW System	Pvsyst p90 (MWh)	Actual Generation (MWh)
January	349.26	391.38
February	296.99	326.27
March	298.53	301.62
April	223.99	199.78
May	162.13	152.45
June	143.74	114.15
July	153.34	176.83
August	198.18	182.59
September	243.28	220.85
October	299.98	281.90
November	224.00	205.62
December	TBC	TBC
Year	**2708.39**	**2717.58**

Table 5: Table summary of monthly generation results

The below graph and table compare the actual system performance from 2021 report period, compared to the 2022 period. Generation for 2022 (totalling 2553 MWh) is down 6% compared to 2021 (totalling 2717 MWh).

The La Nina weather system that has broken rainfall records across much of Victoria and NSW is forecast to ease in December. This weather system has had a major impact on the electricity generation of the Hardwicks solar PV system.

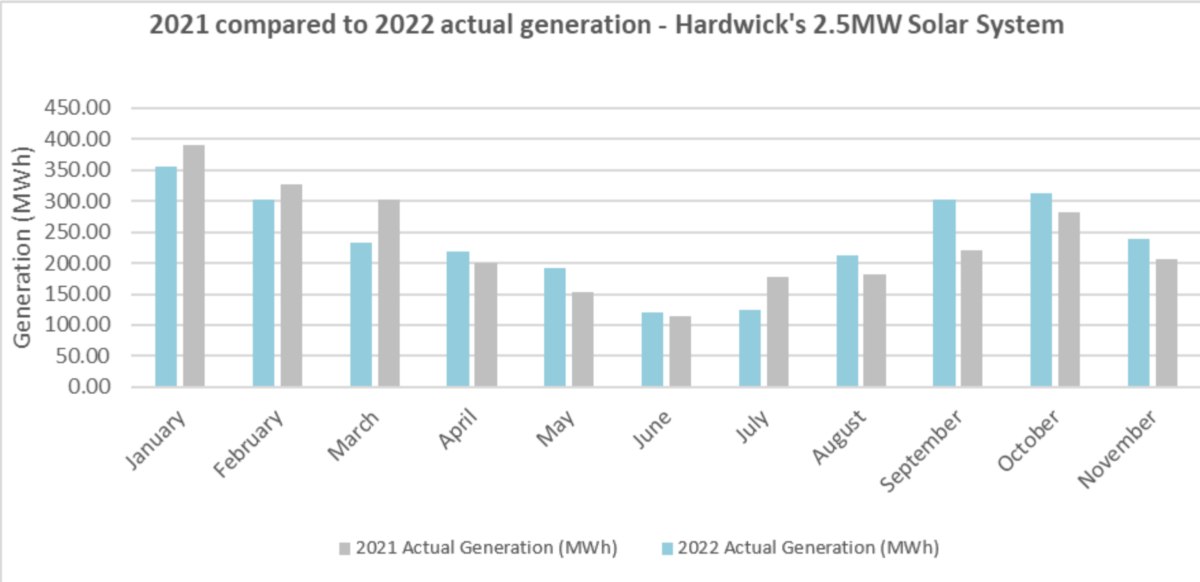

Figure 7: Actual system performance – 2021 compared to 2022

Total 2.5MW System	2021 Actual Generation (MWh)	2022 Actual Generation (MWh)	Improved Generation (MWh)
January	354.96	391.38	36.42
February	302.64	326.27	23.63
March	233.60	301.62	68.03
April	219.24	199.78	-19.47
May	191.54	152.45	-39.09
June	120.99	114.15	-6.85
July	124.80	176.83	52.04
August	212.28	182.59	-29.70
September	302.31	220.85	-81.46
October	313.49	281.90	-31.59
November	239.22	205.62	-33.60
December	354.96	TBC	
Year	**2717.58**	**2553.43**	**-61.63**

Table 6: Table summary of monthly generation results 2021 compared to 2022

5 Conclusion

This Microgrid Project commenced in 2016 and has required detailed planning, stakeholder engagement and specialist contractors, such as Next Generation Electrical and Livestock Logic to execute the program of works. The Project demonstrated the benefits of building a Microgrid and utilising to grazing management and pasture monitoring in a dual land use scenario incorporating sheep under the designed solar array.

5.1 Key findings

5.1.1 Microgrid cost/benefit analysis

As utility costs, both electrical and natural gas, continue to climb, the renewable initiatives taken by the business are confirmed to be a good investment. Hardwicks has been largely shielded by the current price shocks due to the large percentage of self-generation on the site. This has allowed the business to continue as a low-cost operator compared to some competitors and taking steps to reduce its carbon footprint.

The Solar PV project was first initiated as a cost savings / price protection project. Now with the refined focus of Carbon Natural from the parent business (Kilcoy Global Food Group Australia) and the increased realised necessity for the world to accelerate to Carbon Natural the business is being rewarded both economically and socially.

Hardwick's current expected financial returns at $508,746 per annum. This is based on two-year average system monitoring generation and consumption data, an expected energy savings rate of 11.1c/kWh from Hardwick's most recent October 2022 electricity bill, and today's current LGCs price of $66.25/MWh.

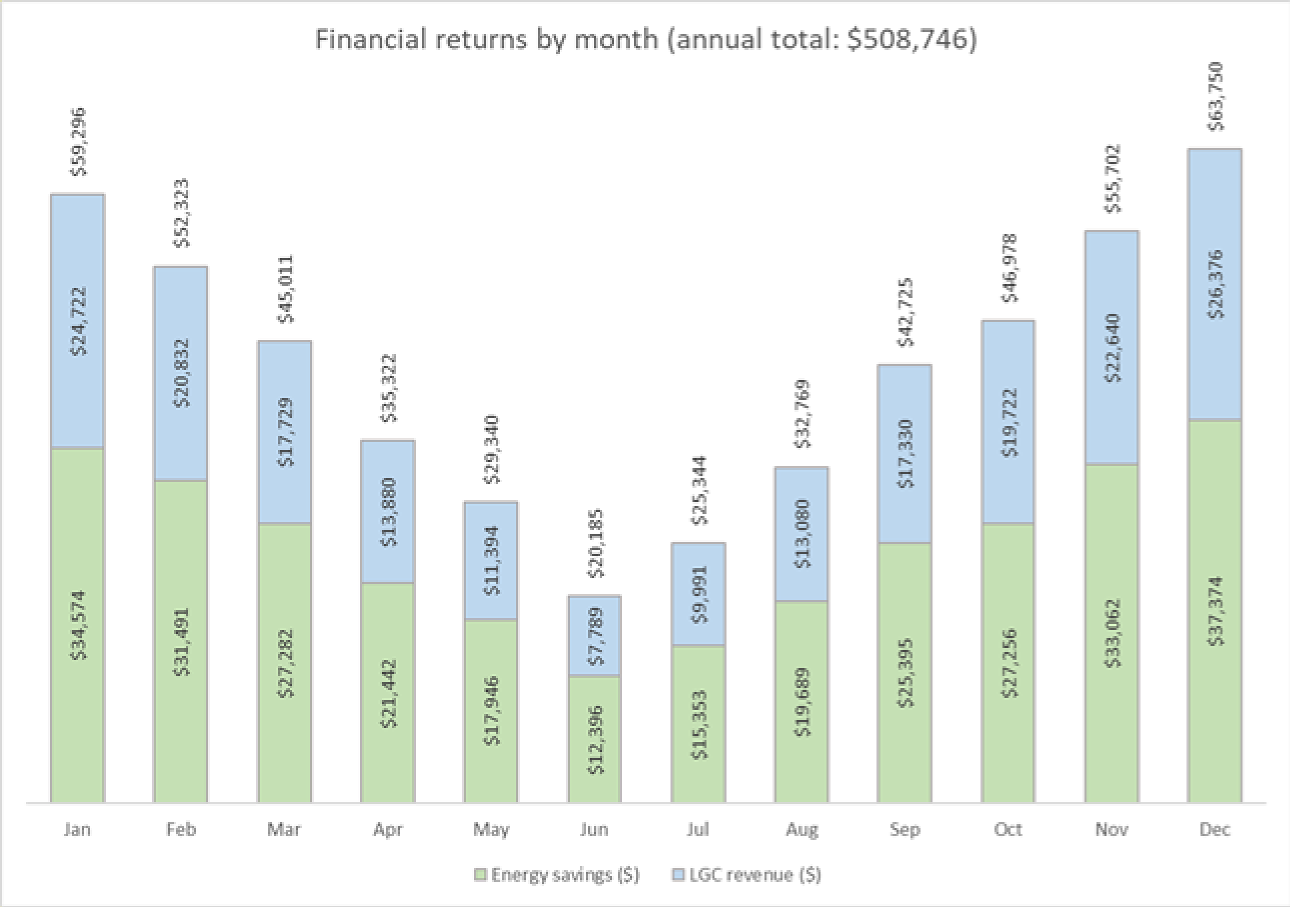

Figure 8: Hardwicks energy savings

5.1.2 Pasture quality

The below photos show a significant difference in pasture quality in the pasture under the solar panels. These are significantly different ($P<0.05$) and the changes in quality measurements indicate that livestock production would be better under the solar panels as a result of pasture being higher in crude protein and containing higher levels of metabolisable energy.

The results suggest that you would need to run less animals under the solar panels compared to not having solar panels but they would continue to put weight on for longer and better weight gains later in the season. From this trial alone it is hard to establish which would be a more profitable scenario as stocking rate is an important factor in farm profitability but the ability to extend the growing season as a trade-off for less production during the spring which was seen in this trial is probably quite favourable as the spring is typically a time of abundance of feed and under utilisation of feed.

Figure 9: Pasture quality Winter 2020

Figure 10: Pasture quality Winter 2021

Figure 11: Pasture quality late Spring 2021

5.1.3 Animal behaviour

Throughout this project, a study has been conducted to look at the difference in animal behaviour as a result of being run under the solar panels compared to being run in a normal pasture situation. The results from the pasture quality studies are consistent with the animal behaviour exhibited at Hardwicks - that the feed within the solar farm area is higher in crude proteins and containing higher levels of metabolisable energy, which attracted the livestock to graze within specific areas of the solar farm.

At the peak of the animal behaviour studies, there were 60 sheep grazing within the solar farm. The total area of the solar array is 33,068 square meters. An exact stocking rate is an important factor in farm profitability, but a recommended rate was not able to be decided due to stock availability throughout the project and the impacts of COVID-19 to the accessibility to monitor and record information associated to the livestock.

A larger study over numerous years would give more confidence in the changes that can be expected from the establishment of solar panels.

Figure 12: Sheep grazing under panels

5.2 Benefits to industry

Hardwicks held field days throughout the entirety of the project to provide industry stakeholders with the opportunity to inspect the installation of the Microgrid and to showcase the positive impacts Hardwicks is making within the red meat industry. The intended field days have been restricted in the later stages of the project due to COVID-19 impacting movement of people throughout the plant during 2020 and 2021. Although restrictions have continued to ease during 2022, processing plants have been slow to welcome back visitors due to the virus risk and limited workforce.

Below is a list of some of the field days conducted:

- 2nd March 2018 – Hosted MINTRAC / AMPC Environment Network Field Day to showcase solar project. Representatives from 7 local Meat Processing plants attended, including GBP Australia.

- 29th October 2018 – Hosted local state politicians Mary-Anne Thomas and Ben Carroll to promote solar project. Received local and state news coverage.

- 28th May 2019 – Hosted National Electrical and Communications Association (NECA) to promote the solar and battery project as part of the national awards, for which it won best medium scale industrial project of 2019. (https://www.neca.asn.au/vic/2019awards)

- 15th November 2019 – Showcased project to Victorian Premier Daniel Andrews. Received local and state news coverage.

- 12th April 2021 - Showcased project on national television ABC Four Corners – Fired Up: What's driving the Federal Government's push for a gas fired future. (https://iview.abc.net.au/video/NC2103H010S00)

When the heat pump is commissioned (target December 2022), Hardwicks are looking to host a field day in 2023 showcasing all the renewable projects at the Kyneton site including the Heat Pumps, Solar and Battery project. Hardwicks would look to work with MLA, AMPC, MINTRAC, ARENA, NG Electrical, Powercor and the state government to promote the field day. Hardwicks are happy to further discuss the event and take recommendations from MLA.

Some industry conferences where the Microgrid have been presented and discussed include:

- 22nd & 23rd May 2018 - Solar-Diesel Hybrid & Battery Systems Conference in Brisbane. Networking and sharing project outcomes with industry.

- 7th October 2022 Loddon Mallee Solar Showcase. Peter Elliot presented Hardwick's PV and Battery project at the event. The purpose of the event was to showcase various innovative solar and storage technologies that can be deployed to drive the Loddon Mallee region's commitment to reach net zero emissions. Attendees/presenters included State Environmental Minister Lily D'Ambrosio and other Meat Operators including Don Smallgoods.

- 19th October 2022 - Presented Hardwick's renewable initiatives at 'Energy Innovation X-Change 2022' at University of Technology Sydney. (https://www.a2ep.org.au/xchange2022)

Media Releases of the Microgrid include:

- 27th February 2019 Powercor Media Release 'Next phase for Powercor's large scale battery.' Publication to the electricity industry nationally. (https://www.powercor.com.au/media-and-resources/media-centre/powercors-large-scale-battery)

- Spring 2019 Smart Energy Industry Publication Volume 39 Issue 155 article by Schneider Electrical promoting microgrid project. National coverage. (https://smartenergy.org.au/wp-content/uploads/2021/01/Spring-2019.pdf)

6 Future research and recommendations

The Heat Pump and Power Upgrade Projects should be completed by end of 2022. In 2023, the business needs to work out which projects can be executed to fully achieve Carbon Neutral status for the Kyneton site.

Current concept plans for future projects include additional solar PV, wood chip boiler and/or biogas generation.

Hardwicks and Kilcoy Global Food Group Australia would like to thank the MLA personnel involved with this project in bringing it to a successful conclusion.

7 References

(A2EP's Energy Innovation X-Change | Australian Alliance For Energy Productivity), URL: https://www.a2ep.org.au/xchange2022

(Decarbonising the meat industry using heat pump technology |Australian Renewable Energy Agency), URL: https://arena.gov.au/news/decarbonising-the-meat-industry-using-geothermal-technology/

(Environmental Upgrade Finance for business | Sustainability Victoria), URL: https://www.sustainability.vic.gov.au/energy-efficiency-and-reducing-emissions/in-a-business/finance-energy-upgrades-in-you-business/environmental-upgrade-finance-for-business

(Fired up | Australian Broadcasting Corporation), URL: https://iview.abc.net.au/video/NC2103H010S00

(Hardwick Meatworks Heat Pump Installation and Power Upgrade Demonstration |Australian Renewable Energy Agency), URL: https://arena.gov.au/projects/hardwick-meatworks-heat-pump-installation-and-power-upgrade-demonstration/

(Media Release: Next phase for Powercor's large-scale battery | Powercor), URL: https://www.powercor.com.au/media-and-resources/media-centre/powercors-large-scale-battery

(Smart Energy |Smart Energy Council), URL: https://smartenergy.org.au/wp-content/uploads/2021/01/Spring-2019.pdf

(2019 NECA Apprentice and Excellence Awards |National Electrical and Communications Association), URL: https://www.neca.asn.au/vic/2019awards

8 Appendix A – Operation and Maintenance

8.1 System maintenance

8.1.3 Maintenance schedule

Annual system maintenance at Hardwicks is broken down into 3 key segments:

Item	Key components	Date of completed maintenance
Solar Farm	**Fixed solar PV farm** 2755 x Jinko 325w panels 1805 x Jinko 330w panels 48 x Fronius 27kW inverters Schletter fixed tilt system **PEG solar PV farm** 3040 x Trina 330w panels 32 x Fronius 27kW inverters PEG racking system	28th November – 7th December 2022
Battery Energy Storage System (BESS)	Purewave S&C 2MW/2MWh BESS	21st November 2022
High Voltage Electrical Works	Transformer 1 & BESS substation Solar kiosk Transformers 1 & 2 substations	22nd November 2022

Table 7 – Completed maintenance schedule

8.1.4 Solar Farm Maintenance

Annual maintenance activities were completed on 28th November – 7th December 2022. Key activities completed include:

- Cleaning of all solar panels – this takes 2 maintenance staff, 2.5 weeks in total to complete and does require specialist cleaning brushes, particularly for the PEG system as access is limited due to the long array.
- Inspection of all associated electrical infrastructure, such as inverters, switchboards, combiner boxes and cabling
- Thermal imaging of all switchboards and combiner boxes
- Checking for feed available to livestock – this is to be completed as much as possible, but at minimum at the start of each season
- Visual inspection of fence

8.1.5 Battery Energy Storage System (BESS) Maintenance

Monthly maintenance activities are completed on the BESS to ensure its operates in accordance to specifications. Key activities completed include:

- General Inspection of HVAC Units
- General Site and Building Inspection
- General Inspection of System State via HMIs in both Inverter and Battery Container
- Discharge Equipment to 0% Capacity and Charge Back to 100% Capacity if the Battery has not been charged or discharged in the Previous Month
- Conform that the battery has been cycled in the last month
- Fire Detection System Inspection as per AS 1851-6 Standards

Figure 22: Purewave S&C 2MW/2MWh BESS

8.1.6 High Voltage Maintenance

The scope of works for high voltage maintenance to be completed annually includes:

High Voltage Ring Main Units (RMUs) / Switchgear

- Visual inspections and operation checks including, contacts, operating mechanisms, auxiliary attachments, coils, gas pressure gauges, etc
- Inspect and clean terminations (re-lubricate where required)
- Insulation resistance testing of circuit breakers, isolators, and bus bar (5kV DC)
- Contact resistance testing of circuit breakers, isolators, and bus bar

Protection Relays

- Visual inspection including internals components are accessible (electromechanical relays or printed circuit boards)
- Verify protection settings via primary or secondary injection testing
- Functional trip checks to ensure protection relay trips the corresponding circuit breaker

Transformers

- Visual inspections including oil leaks, rust, damage paint condition, bushings etc
- Clean minor oil leaks and bushings
- Inspect and clean terminations (re-lubricate where required)
- Insulation resistance testing of HV windings (5kV DC)
- Replace silca gel crystals in breathers (where fitted)
- Functional testing of transformer auxiliary protection devices (where fitted)

Figure 23: HV Ring Main Unit (RMU)

High Voltage Cables

- Inspect and clean terminations (re-lubricate where required)
- Insulation resistance testing (5kV DC)

Figure 24: HV cables connection point

Low Voltage Air Circuit Breakers

- Visual inspections and operation checks including, contacts, operating mechanisms, auxiliary attachments, coils, etc
- Insulation resistance testing (1kV DC)
- Contact resistance testing
- Test protection relay either using propriety or secondary injection test sets (as applicable)

Earth System

- Visual inspection of earth bar
- Earth system resistance testing (using portable earth tester)

Figure 25: Main switchboard - LV Switchboard with transformer (kiosk)

8.1.7 High Voltage Upgrade Works

Hardwicks is currently undergoing a major electrical infrastructure upgrade whereby the facilities will be upgraded from a Low Voltage (LV) connection to a High Voltage (HV) connection from the Powercor Network. Powercor is a leading network distributor in the National Electricity Market, supplying power to approximately 1.2 million Victorian customers located Northern and Western Victoria. The purpose of this project is to simplify the electrical connection from the grid. Rather than the current 22kV incomer requiring a 433V step-down transformer to convert to a LV connection point, the works will result in the 22kV incomer feeding directly into a 22kV switchboard, resulting in the 433V step-down transformer being redundant, therefore saving on maintenance costs.

This will also mean that Hardwicks can move to a HV tariff with their energy retailer, which is typically a lower cost of energy compared LV tariff customers. Hardwicks also has plans to further expand the facility and by being a HV connected customer, add more electrical equipment to the site load is safer and more reliable.

Figure 26: New 22kV switchboard (High Voltage) due to be commissioned in December 2022