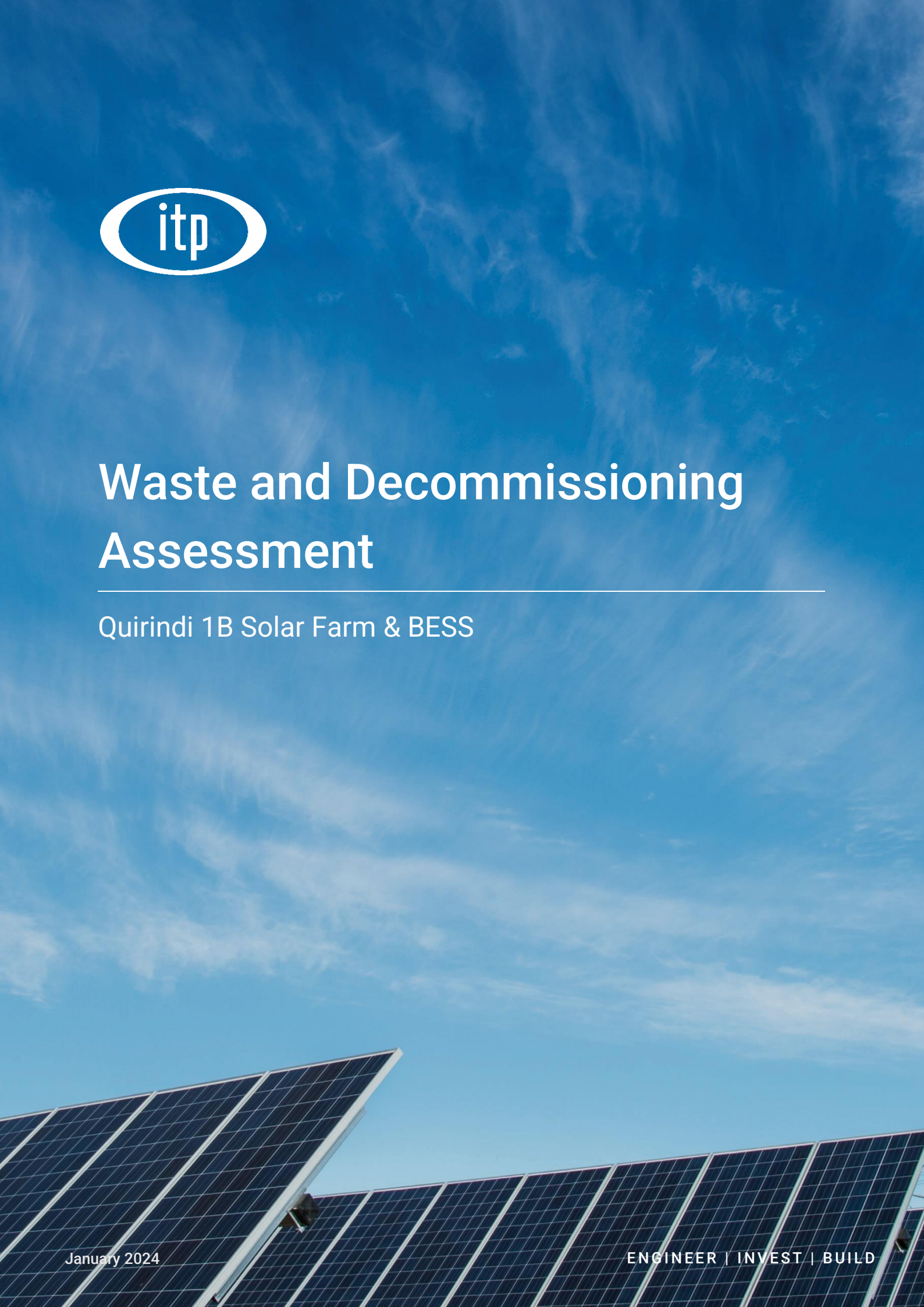
Waste and Decommissioning Assessment

Quirindi 1B Solar Farm & BESS



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ABOUT ITP DEVELOPMENT

ITP Development Pty Ltd (ITPD) is a developer of town-scale solar farms in regional Australia designed to match current and future electricity demand. We undertake solar farm landholder engagement, system design, planning approvals, financing, electrical connection approvals and commissioning. ITPD maintains relationships with multiple stakeholders to ensure projects are successfully delivered in accordance with their expectations.

We are part of the international ITPEnergised Group, one of the world's largest, most experienced and respected specialist engineering consultancies focussing on renewable energy, energy efficiency, and carbon markets. The Group has undertaken over 2,000 contracts in energy projects encompassing over 150 countries since it was formed in 1981.

ABBREVIATIONS

AC	Alternating current
EPA	Environmental Protection Agency
Ha	Hectare
ITPD	ITP Development
LCA	Life Cycle Analysis
MW	Megawatt, unit of power (1 million Watts)
MWp	Megawatt-peak, unit of power at standard test conditions used to indicate PV system capacity
NSW	New South Wales
POEO	Protection of the Environment Operations (Act)
PV	Photovoltaic
WMP	Waste Management Plan

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1 INTRODUCTION

The proposed Quirindi 5MW Solar Farm and BESS (referred to as the Project) is located on Borah Creek Road about 5 km to the north-east of the Quirindi township, within the Liverpool Plains Shire Council area, NSW (Figure 1). ITP Development (ITPD) is proposing to construct a 5.0 MW AC solar facility within the 141.75 ha site.

Table 1 – Site information

Parameter	Description
Solar farm name	Quirindi 5MW Solar Farm
Site reference	Quirindi 1B
Lot/DP(s)	Lot 130 & Lot 134 / DP751009
Street address	Borah Creek Road, Quirindi NSW 2343
Council	Liverpool Plains Shire Council
AC capacity	5.0 MW
Land area (total parcel)	141.75 ha
Project area	11.09 ha
Current land use	Cropping

This report provides a waste assessment to support the Development Application for the project. It provides a:

- Desktop review of resource use, waste generation type and quantity expected and Life Cycle Analysis (LCA) during construction and operation.
- Desktop review of waste generation against the Protection of the Environment Operations (POEO) Act 1997, POEO (Waste) Regulation 2014 and Waste Avoidance and Resource Recovery Act 2001.
- Desktop review of waste disposal options (local approved waste disposal facility), during construction and operation.
- Desktop impact assessment against NSW policies and referenced industry standards for solar photovoltaic systems.
- Desktop management assessment with mitigation measure recommendations for construction and operation

Figure 1 – Proposed project site, surrounding farm area and location of Quirindi Waste Management Facility. The solar farm development will comprise 11.09 ha within the 141.75 ha project site.

2 PROJECT DESCRIPTION

ITPD is proposing to construct a solar farm in Quirindi, NSW with an AC output of 5.0 MW on an approximately 141.75 ha site that is currently used minimally for cropping.

There are to be approximately 10,750 solar modules installed in rows (each row being approximately 92 m long) running east to west. There is approximately 6.0 m spacing between each row. The height of each module is approximately 2.0 to 2.75 m, and the mounting system is constructed on piles that are driven into the ground, typically within the depths of 1.5 m to 3 m. Each row of solar photovoltaic (PV) modules will rotate to track the sun across the sky from east to west each day.

The solar farm will also consist of an inverter station and a containerised battery energy storage system (BESS). The inverter station incorporates the high/medium voltage switchgear and transformers and two x 3.4 MW inverters. The inverter station is ground mounted and incorporated on a 12.19 m skid. Allowance is made for a 2.9 m high BESS, on a 12.1m skid, alongside the inverter stations.

The proposed battery is a prefabricated, off the shelf lithium-ion battery stored within two shipping containers installed adjacent to the inverter station.

During construction, there is expected to be up to 50 workers with only approximately 30 on site at any one time working from 7 am – 4 pm Monday to Friday; and up to 40 light vehicles with only approximately 24 accessing site at any one time. The construction is expected to take approximately 3 months. Once operational the site will be unmanned. Maintenance is expected to be carried out quarterly by a crew of 2 – 3 people.

Solar panels and related infrastructure will be decommissioned and removed upon cessation of operations. This is likely to occur within two years of the end of the project. The site will be returned to the pre-development land use of agriculture.

3 LEGISLATIVE CONTEXT

Waste management is an integral part of the construction, operation and decommissioning phases of a project. There are several acts and guidelines that relate to the assessment of waste and ongoing management during project operation.

3.1 Protection of the Environment Operations (POEO) Act 1997

The POEO Act aims to protect and restore and enhance the quality of the environment in NSW, while still having regard to ecologically sustainable development.

With relevance to waste management, the Act aims to reduce risks to human health and to prevent degradation of the environment by promoting pollution prevention and the reduction in the use of materials and the re-use, recovery or recycling of materials. The Act contains the requirements for the management of waste and also the offences that relate to pollution. Section 148 requires that any pollution incidents or those that threaten material harm to the environment must be notified to the relevant authority (e.g. NSW Environment Protection Authority (EPA)).

Section 143 of the POEO Act requires waste to be transported to a place that can lawfully accept it. Under section 115 of the ACT, it is an offence to negligently dispose of waste that may cause harm to the environment, unlawfully transport and deposit waste (e.g., if waste is transported to a place that cannot be used as a waste facility for the waste).

The waste classification definitions are also provided in the Act, and more information is provided under section 3.4 of the EPA Waste Classification Guidelines 2014.

Wastes that may be generated as part of construction and demolition activities, including 'building and demolition waste' as defined in the Act, includes unsegregated material that results from the demolition, erection, construction, refurbishment or alteration of buildings. Materials such as bricks, concrete, paper, plastics, glass and metal, and timber are included in this category.

3.2 Protection of the Environment Operations (Waste) Regulation 2014

The POEO Waste Regulation aims to protect human health and the environment and provides the framework for the waste industry in NSW, including the details of the licencing, reforms and the waste levy system.

The POEO Waste Regulation prescribes the wastes (hazardous waste, restricted solid waste etc) which are automatically deemed to be land pollution and posits that a person is guilty of an offence if such waste is illegally dumped.

3.3 Waste Avoidance and Resource Recovery Act 2001

The Waste Avoidance and Resource Recovery Act 2001 aims to encourage the efficient use of resources and to reduce environmental harm. Waste management for the project must be conducted in accordance with the Act. The projects' waste management program needs to consider the hierarchy outlined in the Act:

i. Avoidance of unnecessary resource consumption;
ii. Resource recovery (including reuse, reprocessing, recycling and energy recovery); and
iii. Disposal.

ITPD has an obligation to minimise material harm to the environment as a result of the construction, operation and decommissioning of the project. Details of the project waste management and minimisation can be found in Section 4 of this document.

3.4 EPA Waste Classification Guidelines

The EPA Waste Classification Guidelines 2014 comprise four parts:

1. Part 1: Classifying waste;
2. Part 2: Immobilisation of waste;
3. Part 3: Waste containing radioactive material; and
4. Part 4: Acid sulphate soils.

Part 1 of the Guidelines provide details on each of the classes of waste that are defined under clause 49 of Schedule 1 of the POEO Act 1997:

- Special waste;
- Liquid waste;
- Hazardous waste;
- Restricted solid waste;
- General solid waste (putrescible); and
- General solid waste (non-putrescible).

Classification of the projects' waste is discussed in more detail in Section 4 of this document.

3.5 Liverpool Plains Local Environmental Plan 2011

The Liverpool Plains Local Environmental Plan 2011 aims to make local environmental planning provisions for land in Liverpool Plains Shire Council in accordance with the relevant standard environmental planning instrument. The Plan does not provide specific management requirements for waste as it relates mostly to urban planning and conflicting land use management. The Plan provides the prohibited and permitted types of development

within the local area. Some types of development are also regulated by specific state environmental planning policies.

3.6 State Environmental Planning Policy (Transport and Infrastructure) 2021

Division 4 of the State Environmental Planning Policy (Transport and Infrastructure) 2021 relates to 'Electricity generating works or solar energy systems'. This section of the Policy relates to the approval process for solar energy systems, and there are no specific details required for waste management. The Policy generally states that for infrastructure projects waste materials must be sorted and must be disposed of at a waste or resource management facility.

4 WASTE MANAGEMENT AND MINIMISATION

Waste management and minimisation for the project should be in accordance with the POEO Act.

The waste management hierarchy is an internationally and nationally accepted guide for waste management practices with the objective of achieving optimal waste management outcomes. This hierarchy promotes waste avoidance and reduction and encourages resource recovery and efficiency and specifies the preferred order of practices, ranked from most to least preferred. This hierarchy is shown in **Error! Reference source not found.** and described below:

- AVOID or REDUCE unnecessary resource consumption and waste generation.
- RE-USE waste resources without further manufacturing.
- RECYCLE waste resources to make the same or different products.
- RECOVER waste resources, including the recovery of energy.
- TREAT waste before disposal, including reducing the hazardous nature of waste.
- DISPOSE of waste only if no viable alternative.

Most preferable

Avoid or reduce

Re-use

Recycle

Recover energy

Treat

Dispose

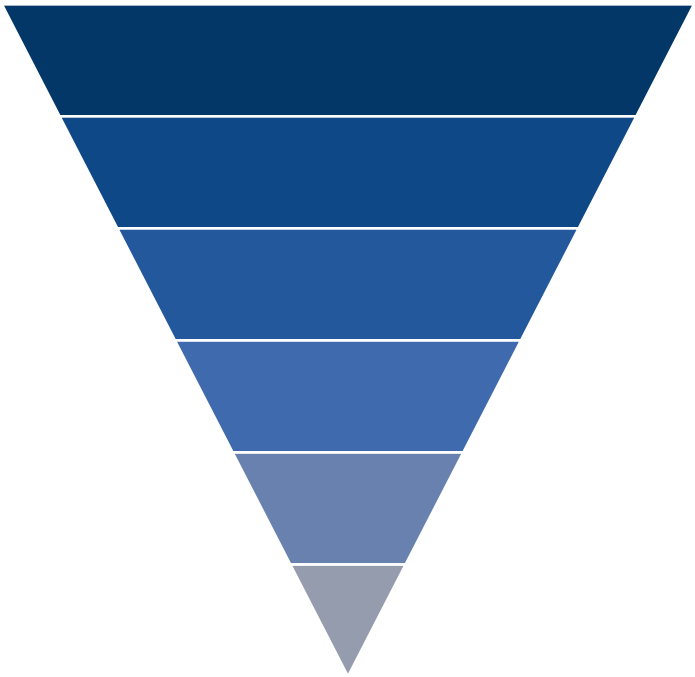

Figure 2 – Waste management hierarchy

4.1 Reduce

The project should aim to reduce waste where possible when purchasing goods for construction and during the operation phases. Inductions and staff education should include waste management and recycling procedures, particularly for the construction phase.

4.2 Resource Recovery (Reuse, Recycle, Recover)

If vegetation clearance is required during construction activities, the cleared vegetation should be re-used for mulch and soil erosion control where possible.

The site will be decommissioned at the end of the 35-year life of the solar products. Decommissioning should consider recycling, where possible. Recycling of solar PV modules is becoming more common in Australia (Energy Matters, 2012 and RenewEconomy, 2016).

There are companies who specialise in providing a drop off location or collection of modules. The decommissioned PV panels are then reclaimed and recycled into other products (Reclaim PV Recycling, 2018). The general steps in the recycling process done by specialist companies are:

- Remove aluminium frames, junction boxes and cables;
- Remove glue, recover glass, aluminium, solar cells and contacts;
- Separate out glass (crushed into small pieces) and other products for re-use in other new products; and
- Remove other materials for use in new models or other products.

4.3 Dispose

If no viable alternative exists, the waste product is required to be disposed of at a suitable waste facility. The waste should be separated during construction into different bins or skips for different waste streams (separate reusable and recyclable from non-reusable and non-recyclable waste).

The waste should be classified on site according to the EPA Waste Classification Guidelines and stored and handled on site in accordance with its classification. All waste should be removed as soon as practicable and sent to an appropriately licenced facility for disposal.

Waste should be classified and logged in a register and then tracked to ensure it reaches its destination offsite. The tracking process should include classification, a description of the waste, volume of the waste, date the waste is transported from site and the destination. An example of a waste tracking register is shown in Table 2.

If transported by a third party, the details of the company transporting the waste should also be recorded. The EPA provides an online waste tracking system for hazardous waste. This should be used if disposal of hazardous waste is required (EPA, 2018).

Table 2 – Waste Register Example

Date	Description of Waste	Classification	Volume	Tracking	Transport Details	Destination
1 Dec 2018	Cardboard	General solid waste (non-putrescible)	1 tonne		Example transport company	Recycled at waste disposal location

4.4 Waste Management Plan

Prior to operation of the development, a Waste Management Plan (WMP) should be produced. This will build on what is proposed in this report and provide detailed procedures regarding management, minimisation, recycling, record keeping and tracking and disposal of waste.

The WMP should contain:

- Strategies to reduce waste during all project phases;
- Recycling, re-use and recovery strategies and opportunities;
- Classification of all waste streams;
- Tracking register and details;
- Recycling management onsite;
- Responsibilities for recycling, re-use and disposal; and
- Reporting and notification procedures if a waste incident occurs where there is a threat to the material harm of the environment.

5 PROJECT WASTE

Waste will primarily be generated during the construction phase of the project and at the decommissioning phase (after cessation of operation). Construction waste is likely to predominantly consist of waste from packaging (such as wood pallets, cardboard) and from green waste. The project is not expected to generate putrescible waste. The waste types associated with the project are likely to be classified as general solid waste (non-putrescible) class under the POEO Act.

The operating phase will generate minimal waste streams predominantly associated with landscape maintenance and repair or replacement of equipment, if required.

Table 3 provides the details of the waste generation types and quantities expected during construction, operation and decommissioning. It also provides the options for disposal and management. Section 6 provides further details on the disposal and management options for the waste material. These quantities are estimates based on other solar projects and the actual waste from the project may vary depending on the packaging options from the PV supplier.

Table 3 – Waste Materials and Disposal and Management Options

Waste	Source	Estimated Quantity – TBD by Contractor	Bin/Container	Disposal and Management
Commissioning				
Cardboard	• Solar panel cardboard packaging	30 m^3	Cardboard only recycling skip bin (3)	Laydown area to set up skip bins for transfer to waste contractor's off-site facilities and/or the waste management facilities identified in **section 6** below
Wooden pallets	• Solar panel shipment • Solar tracker mounting shipment	97 m^3	Landfill skip bin (15)	Transfer to waste contractor's facilities and/or the waste management facilities identified in **section 6** below
Plastics	• Plastic pipe offcuts/scrap • Solar panel plastic wrapping • Drums used to temporarily store diesel fuel and water • Electric cable reels	Minimal		Transfer to waste contractor's facilities and/or the waste management facilities identified in **section 6** below
Scrap metal	• Electric cable waste	Minimal		Transfer to waste contractor's facilities or engaging a scrap metal merchant
Concrete	• Excess concrete waste from inverter and battery foundations and piling works	Minimal		**Specialised concrete recycling for repurposing into recycled products**

Waste	Source	Estimated Quantity – TBD by Contractor	Bin/Container	Disposal and Management
Chemicals	• Used lubricating oils and filters • Unused or spent chemicals	Minimal	-	**Fluids recycled where possible, or transfer to waste contractor's facilities**
Operation				
	• Waste as a result of maintenance or replacement of equipment	Minimal	-	**Taken offsite to appropriate recycling/disposal**
Decommissioning				
PV panels	• Glass for panels • Silicon for wafers • Supporting poles and mounts	10,750 panels 270 tonnes glass 40 tonnes silicon for wafers	-	Laydown area to set up skip bins for transfer to waste contractor's off-site facilities or to appropriate recycling facility
Scrap metal	• Electrical cable waste	860 tonnes scrap metal	Landfill skip bins	Transfer to waste contractor's facilities
Equipment	• Inverters and batteries	240 m^3	Landfill skip bins	Transfer to waste contractor's facilities
Concrete	• Foundations of the inverter, transformer and battery	19 m^3	Concrete recycling bin	**Specialised concrete recycling for repurposing into recycled products**
Other	• Fencing and storage containers	40-ft container (2)	-	Removed from site and reused where possible

6 WASTE DISPOSAL FACILITIES

The Head contractor is responsible for engaging a commercial waste contractor for waste management during construction and decommissioning. The commercial waste contractor will sort the waste generated into skip bins categorised by general waste, recyclables, and scrap material. The commercial operator will also transport these skip bins to their own depots for distribution and transfer within their own private networks. This is the preferred method of waste management to avoid straining local facilities.

The Head contractor may also choose to utilise the local council's waste disposal facility where suitable in compliance with the facility's restrictions and terms of use. The closest waste depot, Merinda Recycling, is located on Merinda Road, off Werris Creek Road, an approximately 10-minute drive (8 km) from the project site (see Figure 1).

The facility opening hours is the same for each day of the week. Outside of opening hours, sorted recyclable materials (glass, aluminium, plastic, cardboard) can be disposed of in the recycling wall located at the entryway to the facility. Special after-hours access to the main facility can also be granted for a fee.

Table 4 – Merinda Recycling (Quirindi Waste Management Facility), hours of operation

Day	Hours of Operation
Monday	9:00 am – 4:00 pm
Tuesday	9:00 am – 4:00 pm
Wednesday	9:00 am – 4:00 pm
Thursday	9:00 am – 4:00 pm
Friday	9:00 am – 4:00 pm
Saturday	9:00 am – 4:00 pm
Sunday	9:00 am – 4:00 pm

Disposal of green waste, scrap metal, garbage and building/construction materials is permitted at the facility. White goods and asbestos are also accepted with prior notice. Sorted recyclable materials can be disposed of 24/7.

The above-mentioned facility provides an option for waste disposal in the vicinity of the project site. Subject to the facility's services available at the time waste disposal is required

(primarily at the construction and decommissioning stages), alternative services/facilities will be sought and considered.

Regardless of whether specialised waste and recycling contractors are engaged to assist in waste disposal or independently undertaken, the waste produced by the project will be categorised on site and recycled or disposed of in accordance with the POEO Act and as outlined in this assessment report.

7 DECOMMISSIONING

The Quirindi solar farm is intended to be operational for approximately 35 years, at which point the solar farm will be decommissioned and the site returned to the original state. At the end of operational life, or in the unlikely event that the Quirindi solar farm is required to be decommissioned prior to the completion of the 35-year lifespan, the decommissioning process will be as outlined in Section 7.1 below.

7.1 Decommissioning Plan

The decommissioning process for the Quirindi solar farm will be undertaken all at once and will involve the following stages of decommissioning:

1. Notification of stakeholders of proposed de-energisation
2. De-energisation of the solar farm and disconnection of assets
3. Removal of PV modules and associated infrastructure
4. Removal of electrical wiring
5. Rehabilitation of land

Relevant equipment will be brought to site to facilitate decommissioning, including amenities for site crew for the duration of the works. This equipment may include mobile cranes, excavators, skid steers, loaders, rollers/compactors, pile drivers, telehandlers, skip bins, water carts, temporary shipping containers for storage, site office and site ablution blocks.

7.1.1 Notification of stakeholders of proposed de-energisation

ITPD will contact Essential Energy, the state-owned enterprise responsible for operating the distribution network, 12 months prior to the commencement of decommissioning.

Liverpool Plains Shire Council will be notified, and any necessary permits or approvals required for decommissioning will be sought from the Council or issuing authority. Any measures stipulated in these approvals will be implemented prior to works commencing on site.

ITPD does not foresee any issues arising from stakeholder notification of decommissioning.

7.1.2 De-energisation of the solar farm and disconnection of assets

Essential Energy crew or subcontractors will be brought to site to disconnect the service mains from the point of connection and ensure full isolation of the site from the grid.

All aspects of the solar system will be turned off for safety prior to commencement of work on the site in accordance with the shutdown procedure stipulated in the system operation manuals. All generation assets will be disconnected and isolated.

The inverter, transformer and battery skids will be removed from the site via a crane onto a semi-trailer or e-waste dismantling, recycling, scrapping and safe disposal at the waste disposal facility identified in Section 5. If possible, the transformer can be reconditioned and refurbished for additional service life at another site.

The concrete foundations of the inverter, transformer and battery will be excavated and the concrete recycled.

7.1.3 Removal of PV modules and associated infrastructure

At the end of life, the PV modules will be removed from site and transported on semi-trailers to a dedicated solar panel recycling facility. Lotus Energy have opened Australia's first PV recycling facility operating in South Australia, with the ability to recycle 100% of end-of-life solar modules, batteries and associated materials, including the inverter, cables and mounting structures (RenewEconomy, 2021). A number of other PV recycling plants are under development or have since been completed in Australia. The panel recycling technology will be monitored over the lifespan of the project and the specific plant used for recycling the panels for this project will be determined prior to decommissioning works commencing.

In the unlikely case there are no dedicated solar panel recycling facilities operating in 35 years, the panels can be broken down by removing the aluminium frame for recycling and the glass casing can be broken down to granular form for reuse.

The PV module tracker structure will be disassembled. The steel piles will be excavated from the ground and recycled at a scrap metal facility. Other site infrastructure, including the security fence surrounding the solar farm and concrete on site will be removed and re-used or taken to a waste facility to be recycled, where possible.

7.1.4 Removal of electrical wiring

Underground cabling and earthing networks will be excavated and recycled. Other cable materials, including cable covers, will be put into skip bins and taken to landfill. Any trenches excavated during this process will be refilled and levelled.

7.1.5 Rehabilitation of land

Any disruptions to the site created during the decommissioning process will be filled and/or levelled as required, such as the locations where piles were removed.

Gravel surfaces and accessways that were established as part of the development will be removed and the ground remediated unless a request is made by the landholder for them to remain for future use.

The site will be revegetated for cropping and grazing as per the original use of the site in consultation with the landholder. It is intended that established landscaping, including trees

planted during the construction, will remain on-site. After 35 years, the trees planted during construction will likely be large, hence if the removal of trees is requested by the landholder, a permit may be required.

The construction and decommissioning works do not result in significant damage to the land or grading. The measure of success for rehabilitation work will be whether the land is returned to the pre-works state to be used for cropping and grazing and rehabilitation is to the landholder's satisfaction.

7.2 Site Management

7.2.1 Decommissioning personnel

The decommissioning process is expected to take 6 – 12 months. During this period, there is expected to be 15 personnel on site working from 7 am – 4pm Monday to Friday.

The NSW Government's VisitNSW website lists potential accommodation for incoming personnel to Quirindi and the immediate surrounding areas. The website identifies 12 places of accommodation, comprising of 5 motels, 1 hotel, 1 tourist park and 4 lodges. In addition to these establishments, there is also unregulated accommodation available on Airbnb and Stayz.

7.2.2 Noise and dust impacts

Decommissioning does not involve significant excavation or earthworks. Therefore, the level of noise and dust impacts during the decommissioning stage are expected to be less significant than the construction phase. However, the operation of decommissioning equipment such as mobile cranes, loads, and rollers will generate some noise, which may impact surrounding areas. Appropriate noise mitigation strategies will need to be implemented such as limiting activities outside of scheduled work hours to those generating low noise emissions or installing noise barriers. The removal of PV modules and breakdown of concrete foundations of the inverter and battery platforms would also generate noise as well as demolition dust. Control measures such as water or dust suppressants can be considered to minimise the spread of dust during demolition activities.

8 LIFE CYCLE ANALYSIS

A Life Cycle Analysis (LCA), also called a Life Cycle Assessment, is an approach that considers all aspects of a projects resource use. It is an environmental accounting and management approach that considers all the aspects of resource use and environmental releases associated with a system throughout its entire life cycle, from material acquisition to decommissioning/waste disposal. The LCA assessment considers raw materials, material processing, manufacturing, operational/use phase, decommissioning and provides an estimate of energy and emissions based on the total life of the project (Wu et al, 2017).

Construction materials and energy used for solar panels includes purification of silicon, production of PV frames and cabling. The construction of each of these uses energy and creates waste products. Energy consumption and use of resources is greatest in the production of the PV panels and silicon (Alsema et al, 2006). The Department of Industry, Resources and Energy NSW (2016) states that during plant operation, PV modules emit no pollution, produce no greenhouse gases and use no finite fossil-fuel resources.

Müller, et al (2005) reviewed the environmental impacts of recycling processes for crystalline silicon modules. The findings indicated that energy consumption during the recycling process of PV panels can be substantial. However, the recycling of solar components is overall worthwhile. This is mostly due to the potential reuse of recovered components in future projects.

For solar projects, the LCA considers the total energy input and annual energy output of the project. This is termed the 'Energy Payback Time'. The energy payback time varies depending on the project's design and geographic location. For solar projects the general timeframe for energy payback is achieved in less than four years for projects with a 25 to 30-year operating period (Bhandari et al, 2015, Department of Industry, Resources and Energy NSW, 2016). Alsema et al (2006) found that PV panels had an energy payback of 1.5 – 2 years in southern Europe and 2.7 – 3.5 years for middle Europe. Due to the greater solar resource in Australia, the energy payback for this project is expected to be at the lower end of these ranges.

The Fraunhofer Institute for Solar Energy Systems (2015) considered the ratio of energy produced by a solar PV compared to the energy used to create the module. It was determined that the PV panels would provide more than 10 times the amount of energy used to make the system.

9 SUMMARY

The project will predominantly generate waste during the construction and decommissioning phases, rather than during operation. To comply with the NSW legislation and policies, waste will be recycled or re-used where possible and only disposed of if no alternative is available.

Cardboard, scrap metal and wood from the construction phase can be recycled. Plastics and general waste will require disposal at either the local waste facilities and/or alternative facilities. Technology for recycling of PV panels is advancing rapidly worldwide and, while recycling options currently exist, they are likely to be more advanced and readily available at the time of decommissioning. Options for recycling of PV panels should be reviewed as the project progresses.

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