



Waste and Decommissioning Assessment

Gilgandra 1A Solar Farm

October 2021

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Waste and Decommissioning Assessment of the Gilgandra 1A Solar Farm October 2021



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 ITP Energised 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 Gilgandra 1A Solar Farm (referred to as the Project) is located on Oxley Highway to the west of the Gilgandra township, within the Gilgandra Shire Council area, NSW (Figure 1). ITP Development (ITPD) is proposing to construct a 5.0 MW AC solar facility within the 133.2 ha site.

Table 1 - Site information

Parameter	Description
Solar farm name	Gilgandra 5 MW Solar Farm
Site reference	Gilgandra 1A
Lot/DP(s)	1 & 2/1070081
Street address	361 Oxley Highway, Gilgandra NSW 2827
Council	Gilgandra Shire Council
AC capacity	5.0 MW
DC capacity	6.4 MW
Site area	133.2 ha
Project area	11.3 ha
Current land use	Agriculture

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 11.3 ha solar farm site and surrounding farm area (note the project will comprise 133.2 ha within this area)

2 PROJECT DESCRIPTION

ITPD is proposing to construct a solar farm with a DC capacity of 6.4 MWp and AC output of 5.0 MW on an approximately 11.3 ha site that is currently used for agriculture.

There are to be approximately 12,000 solar modules installed in 138 rows (each row being approximately 105 m long and 2.2 m wide) running east to west. Each row of solar photovoltaic (PV) modules will rotate to track the sun across the sky from east to west each day. There is approximately 6.25 m spacing between each row. The maximum height of each module is 2.75 m.

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

The mounting system is constructed on piles that are driven into the ground. During construction there is expected to be 50 personnel on site working from 7 am – 4 pm Monday to Friday. 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).

Section 143 of the POEO Act requires waste to be transported to a place that can lawfully accept it. It is an offence under Section 115 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 in the EPA Waste Classification Guidelines (EPA, 2014) (Section 3.4).

Wastes that may be generated as part of construction and demolition activities, including 'building and demolition waste' as defined in the Act and 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 the person is guilty of an offence if the 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 6.

3.4 EPA Waste Classification Guidelines

The EPA Waste Classification Guidelines (EPA, 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 sulfate soils.

Part 1 of the guidelines provide details on each of the classes of waste that are defined in clause 49 of Schedule 1 of the (POEO Act):

- 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.

3.5 Gilgandra Local Environmental Plan 2011

The Gilgandra Local Environmental Plan 2011 aims to make local environmental planning provisions for land in Gilgandra 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 (Infrastructure) 2007

Division 4 of the State Environmental Planning Policy (Infrastructure) 2007 relates to 'Electricity generating works or solar energy systems'. 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 Figure 2 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.

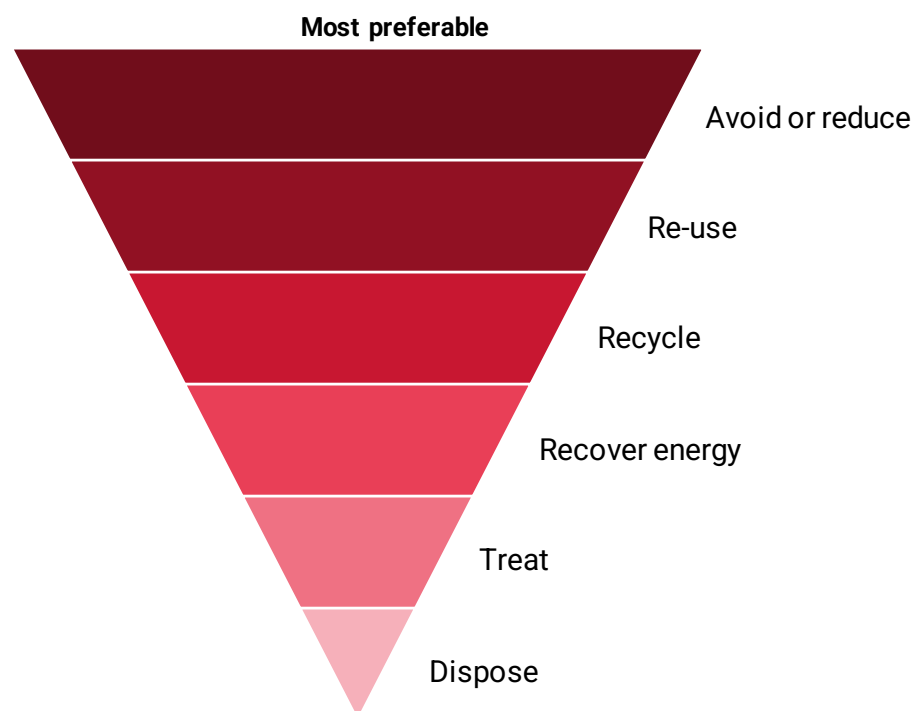


Figure 2 - Waste Management Hierarchy

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.

At the end of the 35-year life of the solar products the site will be decommissioned. 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 for the waste product it will require disposal to 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 then stored and handled on site in accordance with its classification. All waste should be removed as soon as practicable and then 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 in Table 2.

If transported by a third party, the details of the company transporting the waste should also be recorded. The EPA have 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 project, a Waste Management Plan (WMP) should be developed. 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 mostly be generated during the construction phase of the project, and at the decommissioning phase (after cessation of operation). Construction waste is likely to predominantly include packaging (e.g., wood pallets, cardboard), and green waste. There will be no putrescible waste as a result of the project. 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

Activity	Waste Material	Disposal and Management
Construction	<ul style="list-style-type: none"> Packaging waste such as cardboard, wood pallets, plastic wrap, scrap metal, general waste including approximately 860 wooden pallets and cardboard packing boxes. 	Laydown area to contain a skip bin to allow segregation of solid wastes into the following categories, for appropriate recycling/disposal as indicated: <ul style="list-style-type: none"> Steel and scrap metal (recycled) Timber/cardboard (recycled) General wastes and plastic (landfill).
	<ul style="list-style-type: none"> Excess concrete waste from inverter and battery foundations and piling works (minimal quantities) 	
	<ul style="list-style-type: none"> Electric cable waste and cable reels Plastic pipe offcuts/scrap 	
	<ul style="list-style-type: none"> Empty plastic and/or wooden cable reels and containers (minimal quantities) 	Collected and disposed at offsite waste facilities.

	<ul style="list-style-type: none"> • Drums used to temporarily store diesel fuel and water (minimal quantities) 	
	<ul style="list-style-type: none"> • Minimal used lubricating oil and filters • Unused or spent chemicals 	Fluids recycled where possible. Where not possible, disposed of at offsite waste facilities.
	<ul style="list-style-type: none"> • Minimal volumes of domestic waste such as office consumables, paper, plastics, glass from on-site demountable site office/lunchroom • Waste from maintenance of ablution blocks 	Taken offsite to appropriate recycling/disposal.
Operation	Waste as a result of maintenance or replacement of equipment.	Taken offsite to appropriate recycling/disposal.
Decommissioning	<ul style="list-style-type: none"> • PV panels (12,000 panels) and supporting poles and mounts • Glass for panels (270 tonnes) • Silicon for wafers (40 tonnes) • Inverters / transformers / batteries • PV boxes, skids, scrap metal (860 tonnes) • Electrical cables • Concrete • Fencing 	Taken offsite to appropriate recycling/disposal location.
	<ul style="list-style-type: none"> • Fencing • Storage containers (three 40-foot containers) 	Removed from site and reused where possible.

6 WASTE DISPOSAL FACILITIES

Gilgandra Waste Management Facility is located on Pines Drive, approximately a 6-minute drive (5 km) from the project site (see Figure 1). The facility hours of operation vary according to the day, as shown in Table 4 below.

Table 4 - Gilgandra Waste Management Facility hours of operation

Day	Hours of Operation
Monday	9.00 am to 5.00 pm
Tuesday	9.00 am to 5.00 pm
Wednesday	9.00 am to 5.00 pm
Thursday	9.00 am to 5.00 pm
Friday	9.00 am to 5.00 pm
Saturday	10.00 am to 4.00 pm
Sunday	10.00 am to 4.00 pm

Paper and cardboard recycling is available at the Waste Management Facility. Green waste and scrap metal can also be disposed, subject to council fees and charges (Gilgandra Shire Council, 2021). The Gilgandra Shire Council also has a Community Recycling Centre at the facility which supports recycling of batteries, motor oils, domestic paint and fluorescent lights.

7 DECOMMISSIONING

The Gilgandra 1A Solar Farm is intended to be operational for 35 years, at which point the solar farm will be decommissioned and the site returned to the original state. In the unlikely event that the Gilgandra 1A Solar Farm is required to be decommissioned prior to the completion of the 35-year lifespan, the decommissioning process will be the same as that outlined in Section 7.1 below.

7.1 Decommissioning Plan

The decommissioning process for the Gilgandra 1A 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.

Gilgandra 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 shut down 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 their 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 in Australia and are expected to be operational by the time of commissioning. 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' time, 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 agriculture, 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 agriculture and rehabilitation is to the landholder's satisfaction.

8 LIFE CYCLE ANALYSIS

A Life Cycle Analysis (LCA), also called a Life Cycle Assessment, is an approach that considers all aspects of a project's 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 from cradle to grave. 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, overall the recycling solar components is worthwhile. This is mostly due to the potential reuse of recovered component 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 25-30 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 10x 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 the local waste 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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