ITP Renewables
Consulting | Engineering | Implementation

WASTE ASSESSMENT

Daisy Hill Solar Farm

November 2019

About ITP Renewables

ITP Renewables (ITP) is part of the ITP Energised Group which, established in 1981, specialises in renewable energy, energy efficiency and carbon markets consulting. The Group has offices and projects throughout the world.

ITP was established in Australia in 2003 and has undertaken a wide range of projects, including designing grid-connected renewable power systems; providing advice for government policy; feasibility studies for large, off-grid power systems; developing micro-finance models for community-owned power systems in developing countries; and modelling large-scale power systems.

The staff at ITP have backgrounds in renewable energy and energy efficiency, research, development and implementation, managing and reviewing government incentive programs, high-level policy analysis and research, engineering design and project management.

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1. INTRODUCTION

ITP development is proposing to develop a solar farm as described in table 1. It will be located along the Kidman Highway, approximately 2.8 km south of the town of Hillston (see figure 1).

Table 1. Site information

Parameter	Description
Solar farm name	Daisy Hill Solar Farm
Site reference	Hillston 1A
Lot/DP(s)	103/755189
Street address	Hillston, NSW 2675
Council	Carrathool Shire Council
AC capacity	10.0 MW
DC capacity	Approximately 12.2 MW
Project area	Approximately 30 ha
Current land use	Wheat

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.

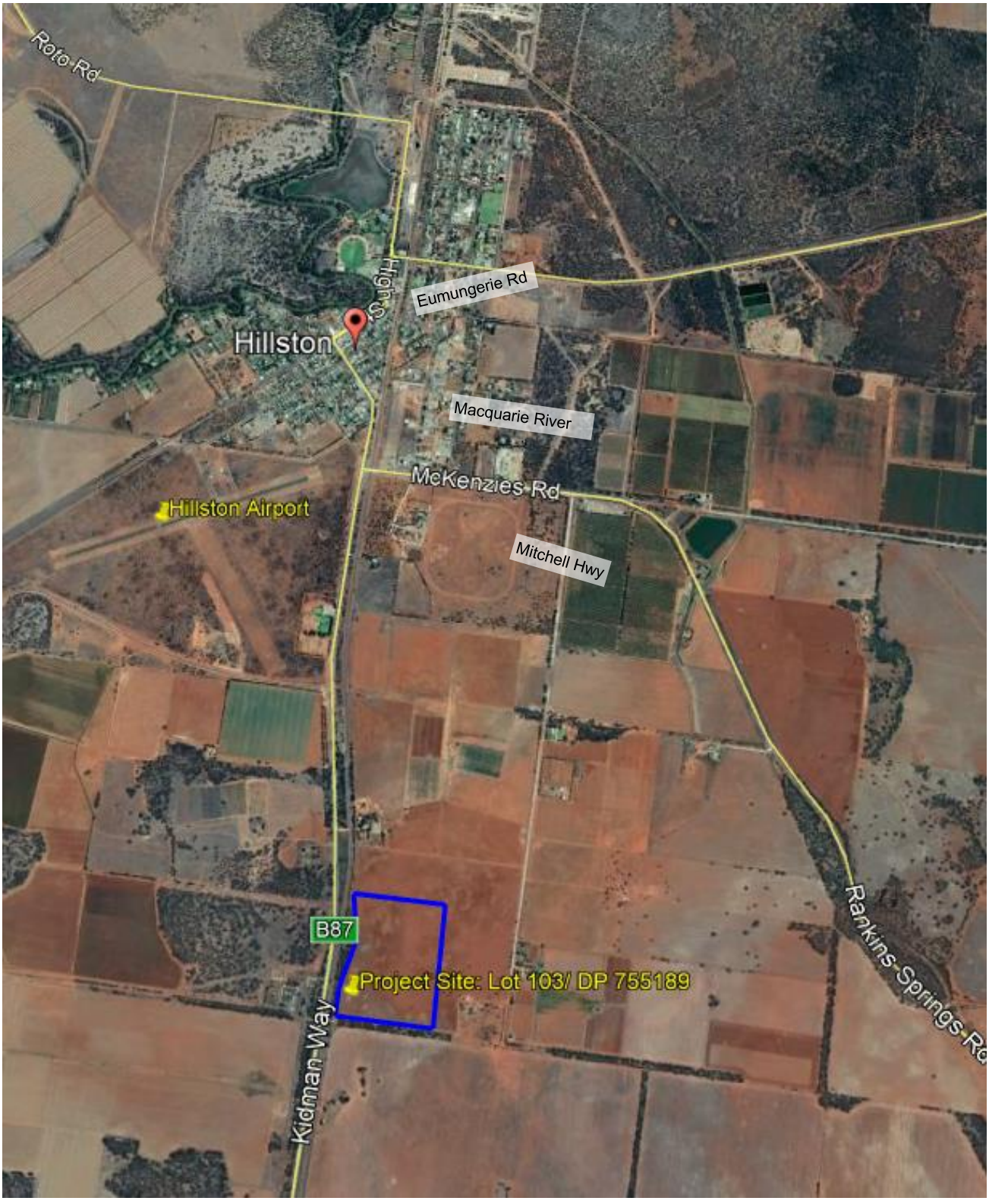

Figure 1. Proposed solar farm site and surrounding area

2. PROJECT DESCRIPTION

ITP is proposing to construct a solar farm with a DC capacity of 12.2 MW and AC output of 10 MW on an approximately 70 ha site that is currently used for wheat.

There are to be approximately 32,000 solar modules installed on around 400 mounting structures running north to south. 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 m spacing between each row. The hub height of each tracker is 2 m with the peak of the modules reaching a height of 2.5 m when the array is fully tilted to 60 degrees from horizontal.

The solar farm will also comprise two 5 MW inverter stations with two 2.5 MW inverters in each station. Each inverter station is to be located within the array on a 40-foot skid. It will incorporate the high voltage switchgear and transformer. The arrangement of the inverter station skid is shown in drawing HIL1A-E-430.

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 1.5 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 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) that 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.

ITP 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 sulphate 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. Carrathool Local Environmental Plan 2012

The Carrathool Local Environmental Plan 2012 aims to make local environmental planning provisions for land in Hillston 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 additional provisions for earthworks to ensure that earthworks for which development consent is required will not have a detrimental impact on environmental functions and processes, neighbouring uses, cultural or heritage items or features of the surrounding land.

The Plan provides the prohibited and permitted types of development within the local area. Some types of development are also regulated by 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. PROJECT WASTE

Waste will mostly be generated during the construction phase of the project and at decommissioning (after 20–-25 years of operation). Waste will not be produced during operation unless equipment maintenance, repair or replacement is undertaken.

The wastes are likely to include construction materials waste (e.g. wood pallets, cardboard), green waste and domestic waste. There will be no putrescible waste. The waste types generated from the project are likely to be classified under the general solid waste (non-putrescible) class in the POEO Act.

Table 2 provides an overview of the types and approximate quantities of waste generated during construction, operation and decommissioning, along with disposal and management options. These quantities were estimated from other solar farm projects, thus the actual waste from the project may vary depending on the packaging provided from equipment suppliers. Section 6 provides further details on the disposal and management options for the waste materials.

Table 2. Waste Materials and Disposal and Management Options

Activity	Waste Material	Disposal and Management
Construction	• Packaging waste such as cardboard, wood pallets, plastic wrap, scrap metal, general waste including approximately 1640 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: • Steel and scrap metal (recycled) • Timber/cardboard (recycled) • General wastes and plastic (landfill).
	• Concrete waste (minimal quantities)	
	• Electric cable waste and cable reels • Plastic pipe offcuts/scrap	
	• Empty drums and containers (minimal quantities)	Collected and disposed at offsite waste facilities.
	• Minimal used lubricating oil and filters • Unused or spent chemicals	Fluids recycled where possible. Where not possible, disposed of at offsite waste facilities.
Operation	Minimal volumes of domestic wastes such as office consumables, paper, plastics, glass.	Taken offsite to appropriate recycling/disposal.
	Waste as a result of maintenance or replacement of equipment.	

Activity	Waste Material	Disposal and Management
Decommissioning	• PV panels (32,000 panels) and supporting poles and mounts • Glass for panels (500 tonnes) • Silicon for wafers (80 tonnes) • Inverters / transformers / batteries • PV boxes, skids, scrap metal (1640 tonnes) • Electrical cables	Taken offsite to appropriate recycling/disposal for PV panels.
	• Fencing • Storage containers (four 40-foot containers)	Removed from site and reused.

5. WASTE DISPOSAL FACILITIES

The closest waste management facility to the project site is on Molesworth St in Hillston, approximately 3 minutes' drive north (see

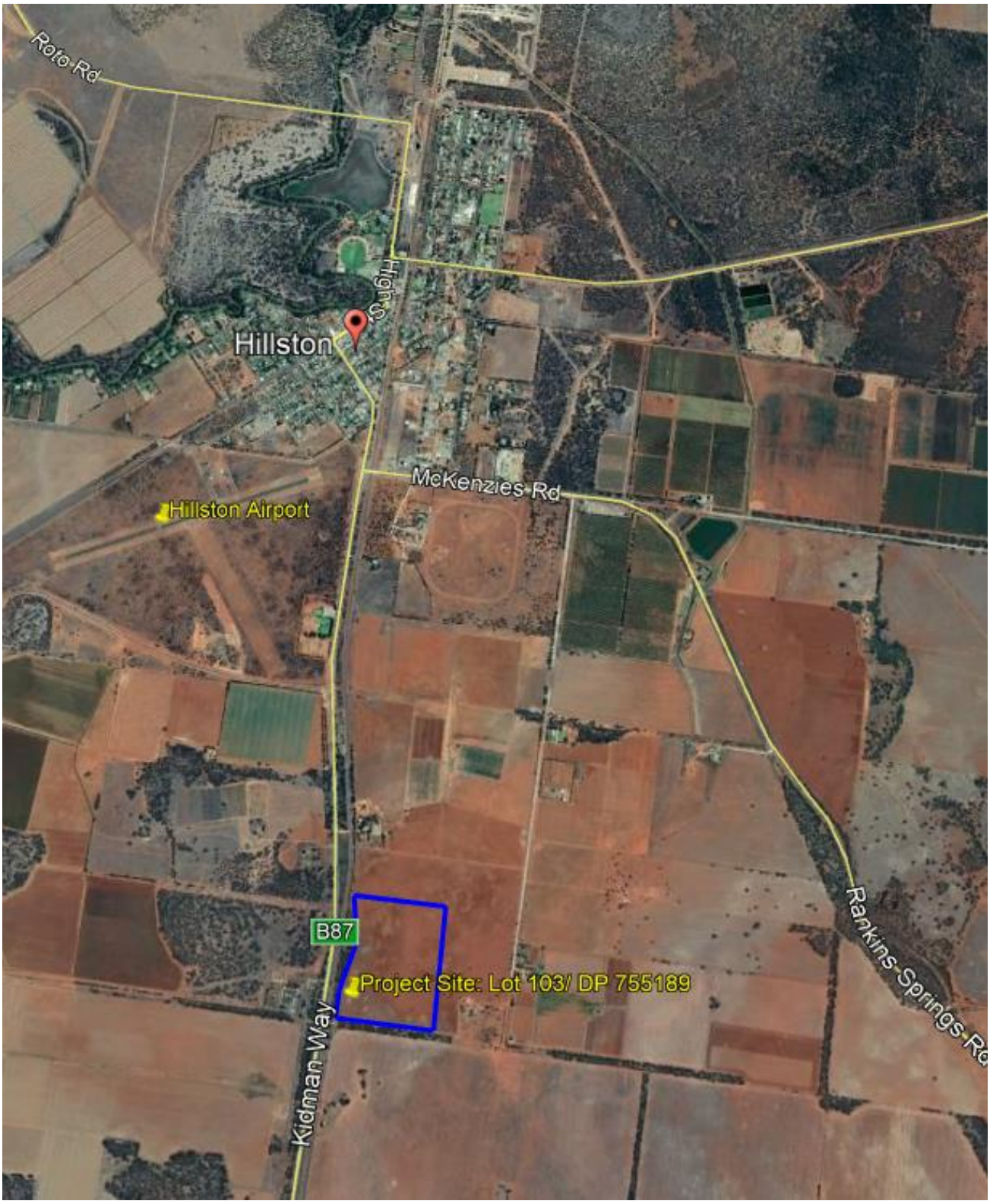

Figure 1). Opening hours for the Hillston Landfill Site are in Figure 2. There is also another facility in Carrathool, approximately 2 hours' drive south of the site and a waste transfer station in Goolgowi, approximately 40 minutes' drive south.

None of the waste facilities accept liquid waste (e.g. paint, chemicals, grease tank waste), hazardous waste (e.g. contaminated soil) or sharps (needles/syringes). In addition to these, the Goolgowi waste transfer station does not accept tyres or asbestos.

The waste facilities offer recycling for paper, cardboard, glass, plastic, steel, aluminium, used motor oil, car batteries, farm chemical drums that are properly cleaned, scrap metal and clean fill (by prior arrangement). The nearest scrap metal merchants are in Griffith, approximately 1 hour and 15 minutes' drive south-west of the site.

There are various fees and charges associated with using the waste facilities. For example, mixed waste incurs a minimum cost of $40 (more for larger volumes) and $25 for a trailer-load of green waste, while recycling is free. Commercial quantities are charged higher fees and usually by the tonne.

Hillston Landfill Site:

Monday:	CLOSED
Tuesday:	Open 7.30am to 10.00am & 1.00pm to 5.00pm
Wednesday:	Open 7.30am to 10.00am
Thursday:	Open 7.30am to 10.00am
Friday:	Open 7.30am to 10.00am & 1.00pm to 5.00pm
Saturday:	CLOSED
Sunday:	Open 10.00am to 4.00pm

Figure 2. Hillston Landfill site open hours

6. 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 (DEHP, 2014). This hierarchy is shown in Figure 3 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

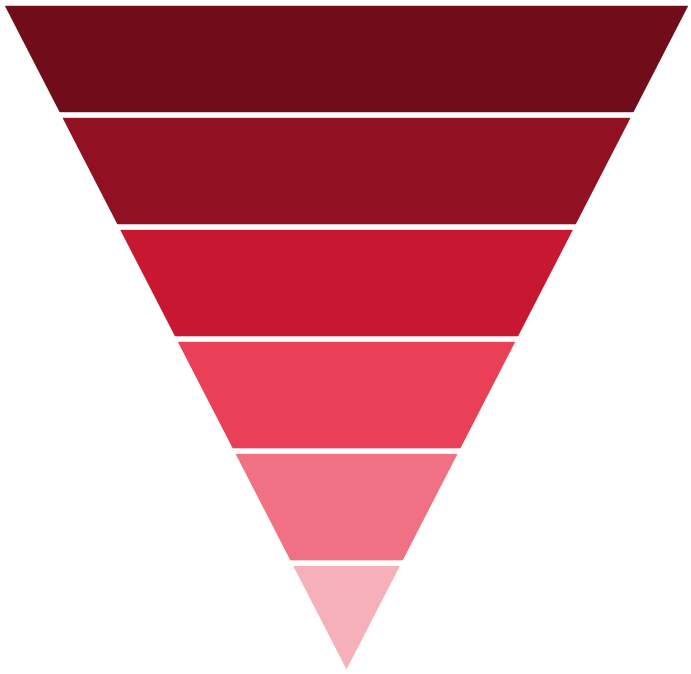

Figure 3. Waste Management Hierarchy

6.1 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.

6.2 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 20 to 25-year life of the solar products the site will decommissioned. Decommissioning should consider recycling where possible. Recycling of solar PV modules is becoming more common in Australia (Energy Matters, 2012 and Renew Economy, 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.

6.3 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).

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

Table 2. Waste Register Example

6.4 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.

7. 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 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 10 x the amount of energy used to make the system.

8. SUMMARY

The project will generate the most waste during the construction and decommissioning phases. To comply with the NSW legislation and policies, the waste should 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. Decommissioning of the project is likely to occur in 25-30 years' time. Technology for recycling of PV panels is likely to be more advanced and readily available. Options for recycling of PV panels should be reviewed as the project progresses.

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