ITP Renewables
Consulting | Engineering | Implementation

WASTE ASSESSMENT

Petersons Solar Farm

September 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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LIST OF ABBREVIATIONS

AC	Alternating current
EPA	Environmental Protection Agency
Ha	hectare
ITP	ITP Renewables
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

1. INTRODUCTION

ITP Development is proposing to develop a solar farm as described in Table 1. It will be located approximately 4 km southeast of the town of Armidale, NSW (see Figure 1).

Table 1. Site information

Parameter	Description
Solar farm name	Petersons Solar Farm
Site reference	Armidale 1B
Lot/DP(s)	Lot 494 DP66672, Lot 2 DP569410
Street address	347 Dangarsleigh Rd, Armidale, NSW 2350
Council	Armidale District Council
AC capacity	5 MW
DC capacity	6.05 MW
Project area	12.6 ha
Current land use	Grazing

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 facilities) for use 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.

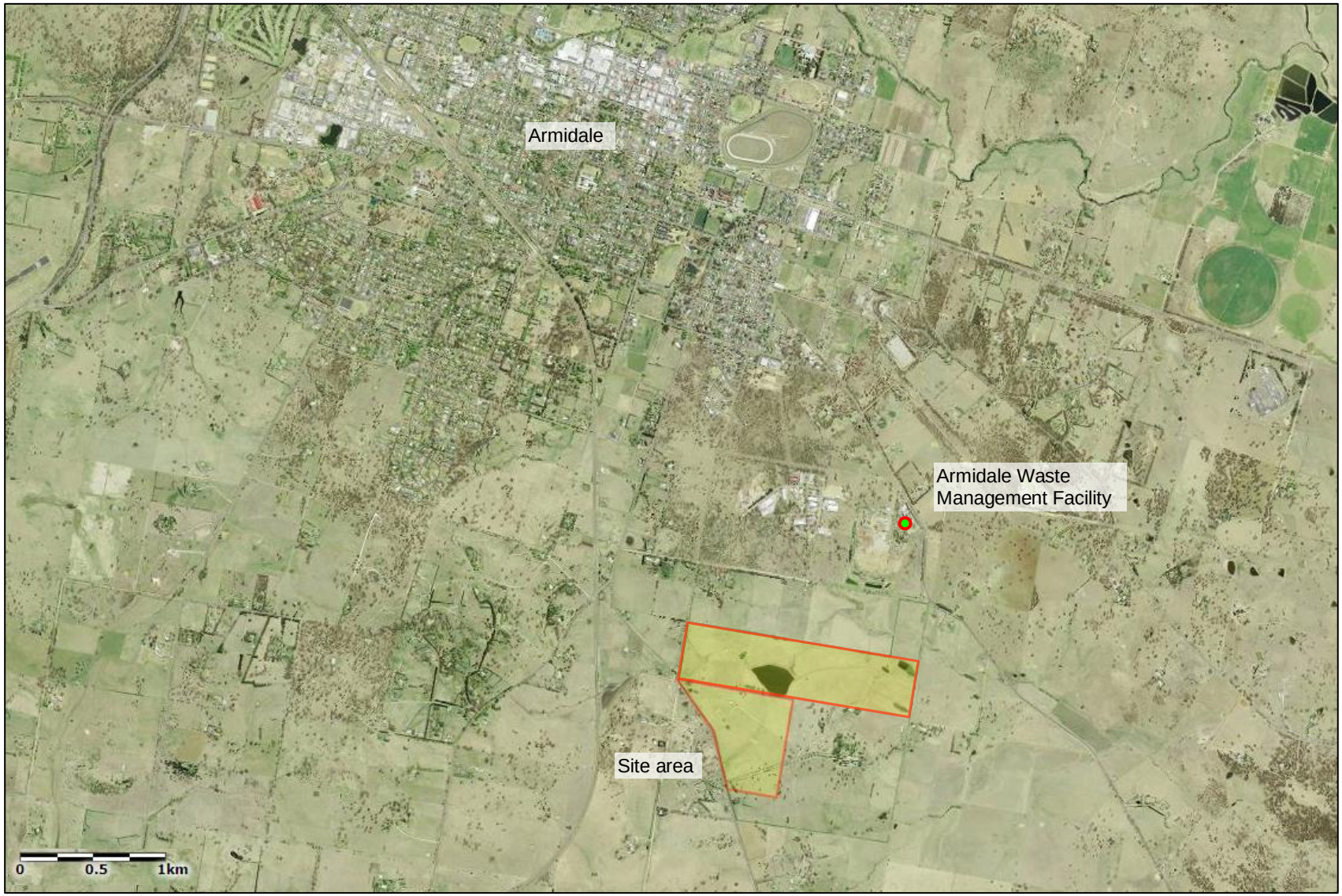

Figure 1. Proposed solar farm site and surrounding area

2. PROJECT DESCRIPTION

ITP Development is proposing to construct a solar farm with a DC capacity of 6.05 MWp and AC output of 5 MW, on an approximately 100.5 ha site that is currently used for grazing.

There are to be approximately 16,000 solar modules installed on around 200 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. The hub height of each tracker will be around 2 m with the peak of the modules reaching a height of approximately 2.5 m when the array is fully tilted to 60 degrees from horizontal. The general arrangement of the solar farm is shown on drawing ARM1B-G-210, and the array tracker details on drawing ARM1B-E-341.

The solar farm will also comprise two 2.5 MW inverter stations. These inverters are to be located within the array and are each mounted on a 20-foot skid. Each of these inverter stations incorporate the high/medium voltage switchgear and transformers. The arrangement of the inverter station skid is shown in drawing ARM1B-E-430.

The mounting system is constructed on piles that are driven in to 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.

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.

The Act aims to reduce risks to human health and prevent degradation of the environment through pollution prevention, reduction in the use of materials, and the re-use, recovery or recycling of materials. The Act contains requirements for the management of waste as well as offences that relate to pollution. Section 148 requires that any pollution incidents or those that threaten material harm to the environment must be brought to the attention of 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. It is an offence under Section 115 to negligently dispose of waste that may cause harm to the environment, and unlawfully transport and deposit waste (e.g. if waste is transported to a place that cannot be used as a disposal facility for the particular waste).

Waste classification definitions are also provided in the Act, and more information can be found in the EPA Waste Classification Guidelines (EPA, 2014) in Section 3.4. “Building and demolition waste” is defined in the Act as wastes that may be generated as part of construction and demolition activities, including unsegregated material that results from demolition, erection, construction, refurbishment or alteration of buildings; and materials such as bricks, concrete, paper, plastics, glass and metal, and timber.

3.2. *Protection of the Environment Operations (Waste) Regulation 2014*

The POEO Waste Regulation accompanies the POEO Act in providing a framework for the waste industry in NSW, including the details of the licencing, reforms and the waste levy system. It 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 reduce environmental harm. Waste management for the project must be conducted in accordance with the Act. The project's 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 Development has an obligation to minimise material harm to the environment during 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 following 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. *Armidale Dumaresq Local Environmental Plan 2012*

The *Armidale Dumaresq Local Environmental Plan 2012* aims to make local environmental planning provisions for land in Armidale Dumaresq 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 specifies the types of development that are prohibited and permitted within the local area. Some types of development are also regulated by particular State environmental planning policies.

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.

3.6. *State Environmental Planning Policy (Infrastructure) 2007*

Division 4 of the *State Environmental Planning Policy (Infrastructure) 2007* is dedicated to "Electricity generating works or solar energy systems". This relates to the approval process for solar energy systems, but does not provide specific requirements for waste management. The Policy generally states that for infrastructure projects, waste materials must be sorted and 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. Expected waste materials from the project 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 820 wooden pallets and carboard 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 off-site waste facilities.
	• Minimal used lubricating oil and filters • Unused or spent chemicals	Fluids recycled where possible. Where not possible, disposed of at off-site waste facilities.
Operation	Minimal volumes of domestic wastes such as office consumables, paper, plastics and glass.	Taken off-site for appropriate recycling/disposal.
	Waste as a result of maintenance or replacement of equipment.	

Activity	Waste Material	Disposal and Management
Decommissioning	• PV modules (16,000 panels) and supporting poles and mounts • Glass for modules (250 tonnes) • Silicon for wafers (40 tonnes) • Inverters / transformers / batteries • PV boxes, skids, scrap metal (820 tonnes) • Electrical cables	Taken off-site for appropriate recycling/disposal of PV panels.
	• Fencing • Storage containers (two 40-foot containers)	Removed from site and reused.

5. WASTE DISPOSAL FACILITIES

The Armidale Waste Management Facility is located approximately 3.5 km southeast of Armidale (Figure 1). It is operated by the Armidale Regional Council and is 7:30am to 5:00pm Monday to Friday and 12:00pm to 5:00pm on weekends and most public holidays.

Recycling is encouraged at the Armidale Waste Management Facility, and mixed or contaminated loads that can only be disposed of as landfill attract a higher fee. The following types of waste can be recycled at the Armidale Recycling Centre located within the Waste Management Facility:

- Paper and cardboard
- Plastic bottles and container
- Aluminium and steel cans
- Aerosols
- Plastic shopping bags.

It is expected that the following types of waste can be disposed of at the Armidale Waste Management Facility (this would need to be confirmed prior to construction):

- Green waste that can be turned into compost and mulch
- Electronic e-waste such as old electrical and computer equipment
- Scrap steel such as car bodies, corrugated iron and fencing wire
- Batteries, including car batteries
- Oils including cooking oil, motor oil and heating oil
- Gas cylinders
- Paint.

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. This hierarchy is shown in Figure 2 and described below:

- Avoid or reduce unnecessary resource consumption and waste generation
- Reuse 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 there is no viable alternative.

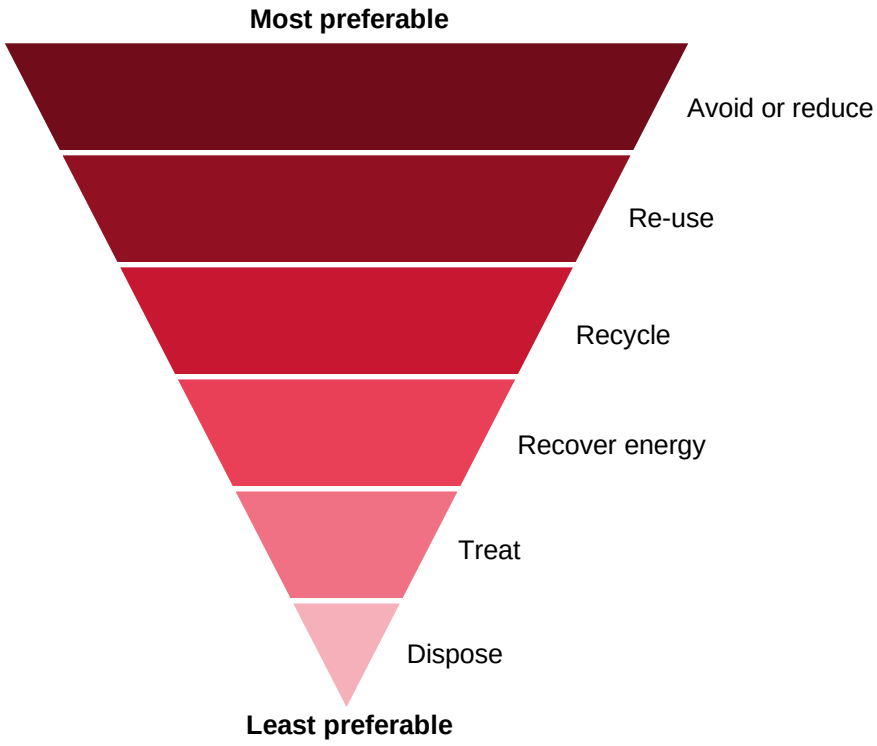

Figure 2. Waste management hierarchy

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 drop-off locations or collection of modules for decommissioned PV modules. The materials can be reclaimed and recycled into other products (Reclaim PV Recycling, 2019). 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 and other products for reuse 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 at a suitable waste facility. The waste should be separated during construction into different bins or skips for different waste streams (i.e. reusable and recyclable wastes should be separated from non-reusable and non-recyclable wastes).

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 off-site destination. The tracking process should include classification, a description of the waste, volume of the waste, date the waste is transported from site and destination. An example of a waste tracking register is in Table 3.

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 3. 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

6.4 Waste Management Plan

Prior to construction 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, reuse and recovery strategies and opportunities;
- Classification of all waste streams;
- Tracking register and details;
- Recycling management onsite;
- Responsibilities for recycling, reuse 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 project's resource consumption. It is an environmental accounting and management approach that considers all 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 and 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 modules 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 modules 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 modules 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, and varies depending upon 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 modules have an energy payback of 1.5-2 years in southern Europe and 2.7–3.5 years for central 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 modules would provide more than 10 times 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 NSW legislation and policies the waste should be recycled or reused 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 modules is likely to be more advanced and readily available. Options for recycling of PV modules should be reviewed as the project progresses.

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