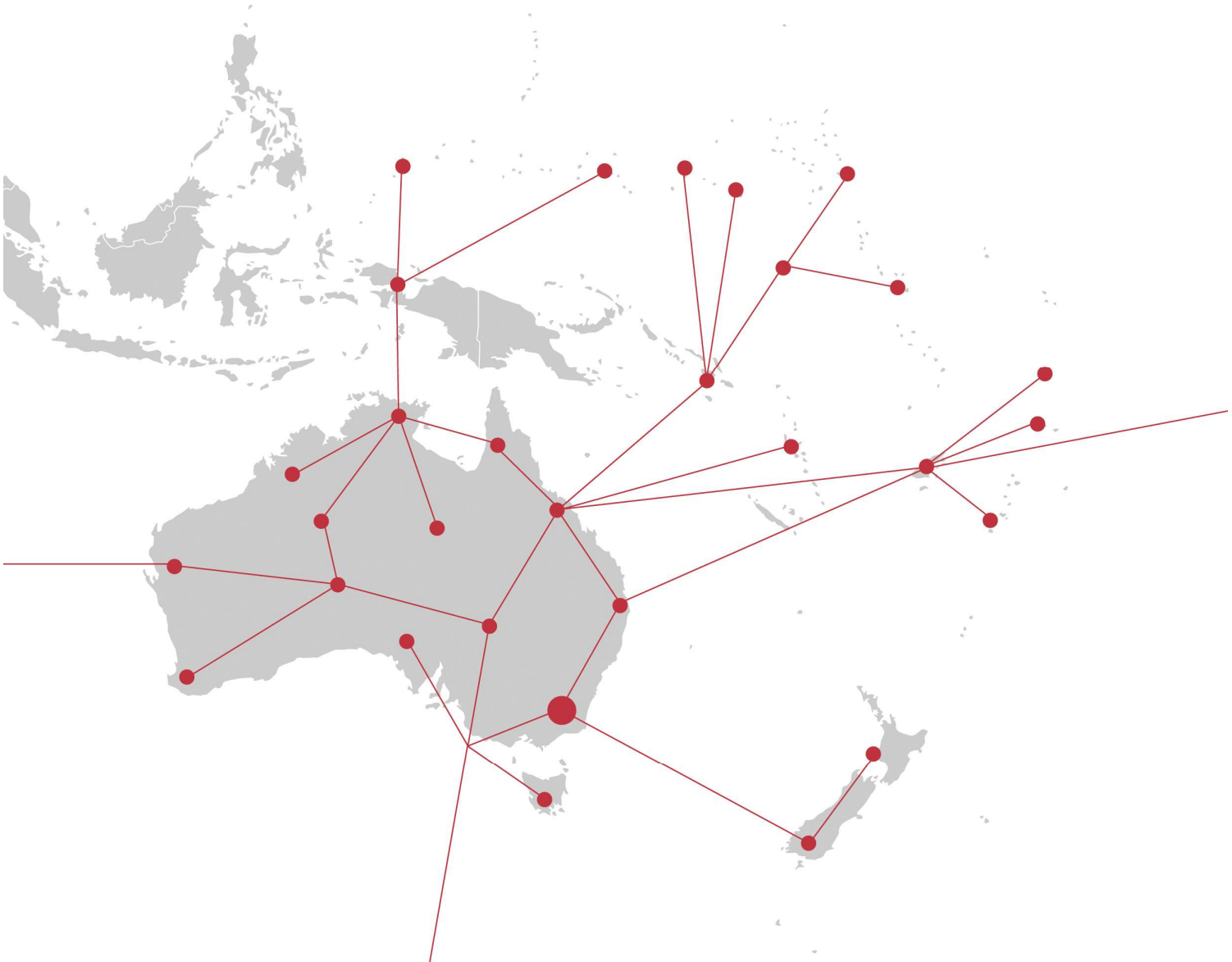
ITP Renewables
Consulting | Engineering | Implementation

DECOMISSIONING PLAN

Temora Solar Farm

February 2021



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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Document prepared by:

ITP Renewables
Suite 1, Level 1,
19-23 Moore Street, Turner, ACT, 2612, Australia
PO Box 6127, O'Connor, ACT, 2602, Australia

Tel. +61 2 6257 3511
Fax. +61 2 6257 3611
E-mail: info@itpau.com.au
Website: http://www.itpau.com.au

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1. INTRODUCTION

Parameter	Description
Solar farm name	Temora Solar Farm
Site reference	Temora 1C
Lot/DP(s)	Lot 1 DP 1110693
Street address	197 Moroneys Lane, Temora, NSW 2666
Council	Temora Shire Council
AC capacity	5 MW
DC capacity	6.46 MW
Site area	48.56 ha
Project area	11.0 ha
Current land use	Grazing

Table 1. Site information

This report provides a decommissioning plan and associated 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.
- Systematic plan of decommissioning the system and removal of components from site.
- Plan of restoring the site to its pre-existing development condition.

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 6.46 MWp and AC output of 5 MW, on an approximately 48.56 ha site that is currently used for grazing. The project will take up a 11.0 ha area within the site.

There are to be approximately 12,100 solar modules installed on around 140 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 1.5 m with the peak of the modules reaching a height of approximately 2.75 m when the array is fully tilted to 60 degrees from horizontal. The general arrangement of the solar farm is shown on drawing TEM1C-G-2100, and the array tracker details on drawing TEM1C-E-3400.

The solar farm will also comprise two 3 MW inverter stations. These inverters are to be located within the array and are each mounted on a 12.19 m skid. Each of these inverter stations incorporate the high voltage switchgear and transformers. The arrangement of the inverter station skid is shown in drawing TEM1C-E-4300.

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 commence within 3 months 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.

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 **Error! Reference source not found.**.

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 5.

3.5. Temora Local Environmental Plan 2011

The *Temora Local Environmental Plan 2011* aims to make local environmental planning provisions for land in Temora 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 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 DECOMMISSIONING

The anticipated generation expected life of the Temora Solar Farm is projected to be 35 years, whilst the plant and equipment on site could possibly have a longer design life than this and generation can continue past this time duration, it is the plan to return the entire site back to its original state after 35 years of electricity production.

4.1 Decommissioning During Construction

In the unlikely event that the Temora Solar Farm requires to be decommissioned during the actual construction, the tasks involved will be contingent on the progress of works at that particular point in time but in essence will be the same as the decommissioning of the site as a whole after 35 years as per 4.2 below.

4.2 Decommissioning Process After 35 years of Generation

After the anticipated generation life of the Temora Solar Farm Park of 35 years, the site will be returned back to its original state for the land owner. This process involves;

- Notification of the DNSP of proposed de-energisation.
- Notification of the Council/LGA of the proposed decommissioning and removal of assets from site.
- Deployment of plant and equipment required for decommissioning, site amenities for crews
- De-energisation of the solar plant and isolation of all electrical and data circuits.
- Disconnection of the HV transformers from the grid.
- Disconnection of the inverters/battery from site assets.
- Removal of PV modules and de-construction of mounting mechanicals/piles
- Removal of electrical wiring
- Remediation of land
- Ancillary items
- Demobilisation of plant and equipment
- Improvements in technology/process

4.2.1 Notification of the DNSP of proposed de-energisation

Essential Energy is the state owned enterprise that wholly owns and operates the electricity distribution network in Temora on behalf of the NSW Government. Notification of the DNSP prior to commencement of decommissioning will occur 12 months beforehand if any specific requirements need to be undertaken.

ITP does not anticipate any issues arising from this procedure. As part of the grid connection procedures undertaken and agreed with Essential Energy, network augmentation and any external assets required to connect the solar system to the grid in the first place become gifted assets to Essential Energy.

It is expected that Essential Energy crews will make an appearance on site to remove the service mains from the point of attachment. It is not expected AEMO notification is required.

4.2.2 Notification of Council/LGA on proposed demolition

Consent will be lodged and any necessary permits, approvals and certificates will obtained from the Council or issuing authority. Any control measures stipulated will be in place prior to the works commencing on site.

ITP does not anticipate any issues arising from this procedure as no new developments are occurring on site and the land is being returned to its original state.

4.2.3 Deployment of plant/equipment to site

Upon successfully receiving all necessary approvals from regulatory authorities on site, relevant plant and equipment will be brought to site as well as setting up the site for crew amenities for the duration of the decommissioning process. Plant and equipment likely deployed will consist of;

- Mobile cranes
- Excavators
- Loaders
- Skid steers
- Rollers/compactors
- Pile drivers
- Telehandlers
- Skip bins
- Water carts
- Temporary shipping containers for storage
- Site office/lunch rooms
- Site ablution block

4.2.4 Disconnection of the site from the grid

Essential Energy crews or their associated contractors will be brought to site to disconnect the service mains cables from the street, and ensuring full isolation through the switching station, to permanently and physically isolating the grid connection to the site.

4.2.5 De-energisation of the solar plant

In order to work safely on the solar system itself, all aspects the system will be switched off permanently accordance with the shut down instructions stipulated in the system operation manuals. The AC HV side will be de-energised first, isolating all the generation assets from the grid before systematically working down each of the protection circuits until all AC circuits are isolated.

The first order of works will be disconnecting the breakers in the RMU to isolate both the inverter side and the battery sides. Upon the AC side made safe, the DC side can be safely isolated down to the string level by turning off the DC isolators and then removing the fuses from the cartridges located in each of the combiners & the inverters. Each solar panel can be then individually disconnected. All associated monitoring and data circuits can also be removed at this point.

4.2.6 Disconnection of the inverter and battery

Upon the RMU being safely isolated and made safe, the electrical cabling terminations made between the inverter, battery and DC combiners in the field can be unterminated and removed which will allow the removal of the inverter/transformer and battery skids via crane onto a flatbed

semi-trailer for e-waste dismantling, recycling, scrapping and safe disposal. It essential that after the de-energisation and before touching any cables, to discharge any static residual current on the cables, before proceeding with the decommissioning.

Contingent on the condition of the transformer and economics at this point of time this could also be possibly reconditioned and refurbished for additional service life on another site for another purpose.

The concrete pad foundations of the battery and inverter/transformer skid can then be excavated up and transported to concrete recyclers.

4.2.7 PV module removal and mount dismantling/piles

The PV modules once safely isolated are removed in reverse order in which they were installed. The PV modules are fixed in place via clamps that are undone via Huck tooling, after which these can be stacked on pallets and then forked onto flat bed semi-trailers for transport to PV module recyclers located around Australia.

The Nextracker torque tubes, operating motors and support structures are then disassembled in reverse order of its installation via the use of Huck tools. The steel piles can be removed from the ground using hydraulic pile pull out machines or can be excavated out. The existing mount structure which is primarily comprised of steel is then sent for scrap metal recycling.

4.2.8 Removal of electrical cabling

Using as-built diagrams, the location of the existing trenches can be excavated up and the existing direct buried cables including any earthing network can be collected up in coils as is any overhead wiring and sent for recycling. Should any existing cable covers be found, these will be put into the skip bins for landfill as non-recyclables.

The existing trenches will then be backfilled with the existing soil and the ground levelled via earth moving equipment and compacted, returning the ground level to its pre-existing state.

4.2.9 Remediation of the existing ground conditions

The design and installation of the solar system did not involve land levelling or grading and hence there should be little change to the elevations of the natural ground post-decommissioning. The removal of piles from the ground will have disturbed the ground that can be remediated and levelled via earth moving equipment and compacted.

There are no existing utility services on site to reconnect other than the existing home’s services which was not affected by this development.

4.2.10 Ancillary Items

The solar project also involved the construction of a steel fence surrounding the array as well as a compacted earth road between the arrays. Consultation with the land owner will be made as to whether they would consider the re-use of these, otherwise the fence can also be dismantled and taken for scrap metal recycling.

4.2.11 Demobilisation of plant/equipment

The return of temporary plant, equipment and crews from site after decommissioning is completed handing the site back to its original form to the landowner, concluding the project.

4.2.12 Improvement in technology/process

This decommissioning plan is written from a standpoint of the methodology, procedures and technology as of the date of this report. It is expected that when decommissioning takes place circa 2056, many other solar farms across the world would have reached their ends of service lives and improvements in, plant, machinery, methodology would have occurred in decommissioning and dismantling farms.

It is expected these advances in processes would be applied to this decommissioning plan which would likely improve the rates of work and processes compared to conventional methods of work detailed in this report.

5. PROJECT WASTE

Waste will mostly be generated during the construction phase of the project and at decommissioning (after ~35 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
Decommissioning	• PV panels (~12,180 panels) and supporting poles and mounts • Glass for panels (~270 tonnes) • Silicon for wafers (~40 tonnes) • Inverters / transformers / batteries • PV boxes, skids, scrap metal (~1,640 tonnes) • Electrical cables	Taken offsite to appropriate recycling/disposal for PV panels. Metal scrapping where recycling is not possible. Landfill as a last resort.
	• Fencing • Storage containers (four 40-foot containers)	Removed from site and/or reused/recycled.

6. 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.

7. 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 ~35 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.

Decommissioning of the project involves a systematic process of isolating the system and individually de-constructing the project into its core components which is transported away for recycling.

8. REFERENCES

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Level 1, 19-23 Moore St, Turner, ACT 2612
PO Box 6127 O'Connor, ACT 2602
info@itpau.com.au
www.itpau.com.au

abn 42 107 351 673
p +61 (0) 2 6257 3511
f +61 (0) 2 6257 3611