Appendix N Concept Design Statement

Fast-Track Approvals Act 2024 Substantive Application

Hinuera Solar Farm

Harmony Energy NZ #6 Limited

SLR Project No.: 880.016894.00001

19 August 2026

Hinuera Solar Farm

Technical Report: Concept Design Statement

Harmony Energy NZ #6 Limited

Date: October 2025

Version	Date	Comment
0.1	3/10/2025	Consent Commencement
1	23/06/2026	Consent Lodgement

Contents

1 Introduction

Harmony Energy NZ #6 Limited (HENZ) are developing an approximately 70MW AC/100MW DC solar/BESS project at the corner of State Highway 29 and State Highway 27, Hinuera. The project will export generated electricity via the Powerco substation at the corner of Lake Road and State Highway 27, Hinuera.

The purpose of this report is to provide an overview of the project concept design, including the following key topics:

- Project site
- Overall design approach
- Concept design overview
- Engineering detail
- Civil design
- Grid connection
- Construction detail
- Operational detail

This report is intended to be used to inform consultants assisting with site investigations, the development of associated plans and effects assessments. Reference should be made to design process outlined in Section 4 of this report and the relevant design phase.

2 Harmony Energy

Harmony Energy NZ #6 Limited (**HENZ**) is a wholly owned subsidiary of Harmony Energy NZ Holdings (Harmony)

Harmony is the leading independent renewable energy developer in New Zealand, with an experienced team of 9 staff.

Harmony is well advanced on construction of their first solar farm in the New Zealand pipeline (150 MW AC Tauhei Solar Farm) via a joint venture. Construction is expected to be complete in Q4 of 2026. Harmony has a further nine projects in their pipeline, including three consented solar farms with BESS.

3 Project Site

3.1 Project Site

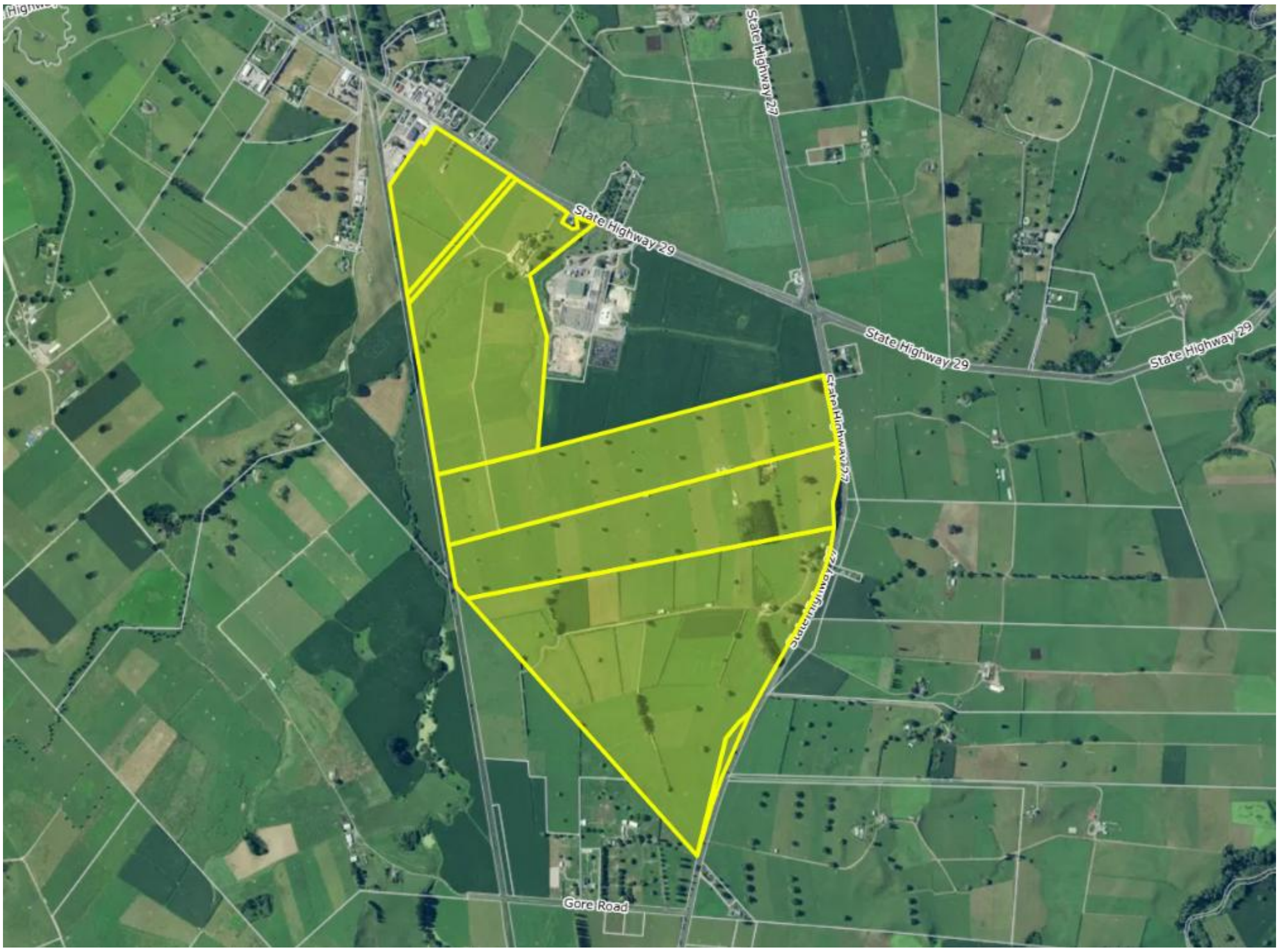
The Hinuera Solar Farm is to be located over six Records of Title at the corner of State Highway 29 and State Highway 27, Hinuera.

Details of the Records of Title are set out in Table 1 and a site location plan is included in Figure 1, over the page.

Table 1: Site Details

Title Reference	Address	Legal Description	Size (ha)
SA69A/179	4775 State Highway 29, Matamata	Section 1 Block X Tapapa Survey District and Lot 1-2 Deposited Plan South Auckland 83767	38.3939
SA50B/243	State Highway 29, Matamata	Section 9 Block X Tapapa SD	0.0060
SA292/111	State Highway 27, Matamata	Lot 1 Deposited Plan 11891	25.7507
SA308/1	8270 State Highway 27, Okoroire, Tirau	Lot 2 Deposited Plan 11891	25.7507
647047	8302 State Highway 27, Okoroire, Tirau	Part Lot 3 Deposited Plan 11891 and Lot 2 Deposited Plan 473263	63.4790
SA13B/333	State Highway 27, Okoroire, Tirau	Section 3 Block X Tapapa SD	1.1442
		Total	**153.3743**

Figure 1: Site Location Plan



3.2 Current Use and Features

The site comprises of two separately operating dairy farms.

The northern farm (comprising of titles SA69A179, SA292/111 and SA308/1) contains three dwellings, two adjacent to State Highway 27 and one adjacent to State Highway 29. There is a dairy shed located adjacent to State Highway 27 and a number of implement/farm sheds, generally located in the southern portion of the farm. Of note is a woodlot comprising of exotic trees over an area of approximately 1.2 ha adjacent to the southern boundary of the property.

The southern farm is comprised in 647047 and contains one dwelling and a dairy shed, both accessed via State Highway 27. Exotic trees line the first portion of the driveway/access and there are two implement sheds located adjacent the main race.

Both properties have dispersed exotic trees throughout the site.

3.3 Existing Entranceways

There are currently 5 entrances to the site, these are located as follows:

1. 4775 State Highway 29 – dwelling access only
2. 4739 State Highway 29 – farm access (dairy shed) and dwelling access
3. 8270 State Highway 27 – farm and dwelling access
4. 8302 State Highway 27 – dwelling access
5. 8302 State Highway 27 – farm access and secondary dwelling access

The location of vehicle entrances is illustrated in Figure 2, below.

Figure 2: Existing Vehicle Entrances

3.4 Easement Option

HENZ has Easement Agreements over the land, granting HENZ the option to take a 34 year registered easement over the land for development, construction and operation of a solar farm. It is free to exercise that option and will do so when consents and Overseas Investment Office consents are in place. The terms of the easement contain all the land rights needed to construct and operate the solar farm for 34 years.

Under the terms of Easement Agreements, the landowners retain the right to farm the land underneath the panels.

3.4.1 Existing Buildings

As a general rule, dwellings/dwelling curtilage areas and existing farm buildings on site are excluded from the development area. Interactions with these areas, including placement of structures and/or vegetation will be discussed with landowners throughout the design process.

3.5 Overseas Investment Office

HENZ has already obtained an exemption from Overseas Investment Office (OIO) from the "farmland advertising" requirements of the Overseas Investment Act (OIA) in respect of the interests held by HENZ under its Easement Agreements with the relevant landowner(s).

If resource consent is obtained, HENZ will promptly submit applications for OIO consent for the interests in "sensitive" land that will be held by HENZ and any key equity investors in the project who are "overseas persons" for the purposes of the OIA.

HENZ will prepare the applications for OIO consent in parallel with preparation for the expert consenting panel process and submit applications promptly to the OIO if resource consent is obtained. A staged approach is necessary because the benefits of the project (such as generation output) cannot be accurately described to, or assessed by, the OIO until the scale and design of the project is refined through the resource consent process.

The OIO's guidelines for maximum processing periods for applications for OIO consent to interests in sensitive land are 100 days, but the OIO has indicated that applications relating to renewable energy projects are prioritised and processing times have materially reduced below the maximum.

HENZ is confident that it's standing as an experienced and reputable developer, and the significant public benefits of the investment mean that it is highly likely that OIO consent will be given. As such, it is very unlikely that the OIO process would cause delays in the construction of the project.

4 Overall Design Approach

The project will progress through a defined sequence of design phases, with each stage delivering increased refinement and optimisation across all engineering, environmental, and constructability aspects. As the project advances through its lifecycle, design assumptions are progressively validated, reducing uncertainty and enabling more precise specifications.

Figure 3 illustrates the typical design lifecycle from concept design (resource consent stage) to final design (construction). The pyramid depicts the relationship between project phase and uncertainty: during early stages, the degree of uncertainty is highest, necessitating greater design tolerances to accommodate potential changes. As the design develops and approaches the construction phase, uncertainties are systematically reduced. The design process consists of 5 stages being, *concept*, *30% design, 80% design, 100% design,* and, *final or issued for construction designs.*

This document broadly outlines the approximate project scope as detailed in Phase 1 and will be refined throughout the development of the consent process. Figure 3, details the design process.

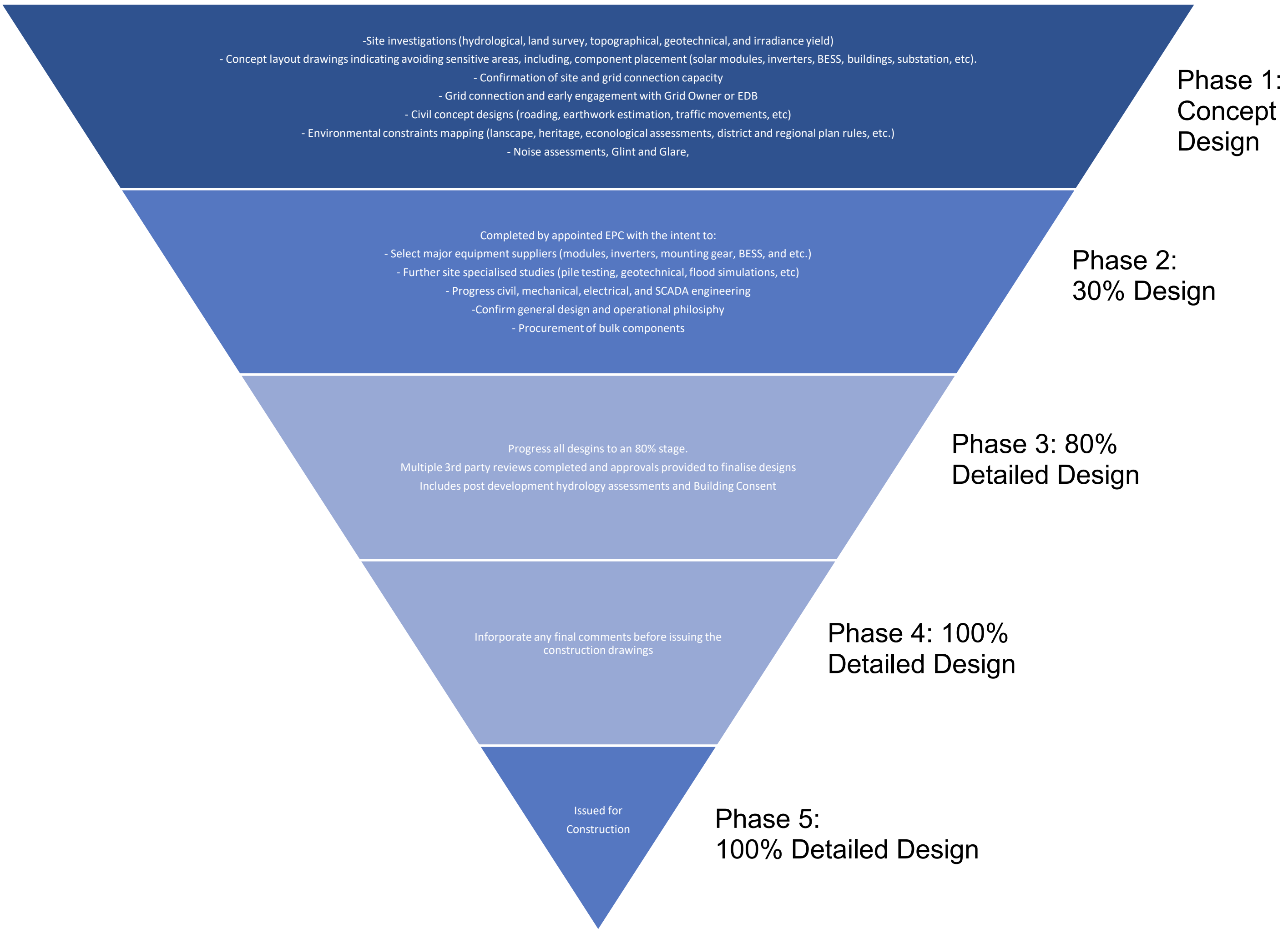


Figure 3: Overall Design Process

4.1 Concept Design

4.1.1 Approach to Development

At the consenting stage, the purpose of the concept design is to present a well-justified, and realistic project specification scope that demonstrates to the consenting authority, EPC contractor and project investors what will likely be built, where it will be located, how it will be constructed and operated. This typically includes any potential constraints or limitations that might have an adverse effect on either the project or environment, how they will be avoided, remedied, or mitigated. The approach focuses on defining an outer design envelope, setting the maximum extents for dimensions, footprints, and environmental effects, so that detailed design can proceed within consent conditions and scope without the need for constant variations resulting in overall project delays and uncertainty.

The first step is to establish site constraints and opportunities. This involves collecting baseline data on topography, cadastral boundaries, hydrology, soil classification, flood hazards, and geotechnical conditions. The planning context is also reviewed, including zoning, heritage areas, highly productive lands, floodplain designations, and any other relevant district and regional plan rules. Environmental sensitivities, including wetlands, waterways, protected vegetation, and significant habitats, are also mapped and understood. Engagement with mana whenua is undertaken to understand cultural values, aspirations and any areas of sensitivity. Access and grid connection opportunities are assessed by identifying the proximity to transmission or distribution infrastructure and road access points.

Once the site envelope is defined, a preliminary layout is developed. Photovoltaic (PV) blocks are located to avoid sensitive areas, respect setbacks, and align with site topography. Solar module configuration or range of, whether fixed-tilt or tracking, is defined along with tilt angle, row pitch, height, and orientation. Ancillary infrastructure such as inverters, batteries, transformers, substations, the operations and maintenance (O&M) building, warehouse and storage buildings, water tanks, access and internal roads, and temporary laydown and contractors camp areas as defined. At this stage, the construction footprint is established, distinguishing between temporary areas needed during construction and permanent operational infrastructure.

Engineering feasibility is assessed at a concept level. A preliminary energy yield model is developed based on site irradiation, tilt, orientation, and shading analysis. The electrical concept is illustrated through an indicative cable trenching and cable runs, single-line diagram showing generation block arrangement, cable routing, and the proposed grid connection point. Civil works and concepts are prepared, including access and internal road layouts.

Environmental and planning assessments identify potential effects and propose mitigation. This may include but is not necessarily limited to: landscape and visual effects; ecological effects; effects on hydrology; management of any soil contamination; archaeology; traffic management; earthworks and construction effects; glint and/or glare; and acoustic effects.

Ongoing engagement with mana whenua will continue throughout the development of the concept design to ensure cultural values are appropriately reflected. Where required, a cultural impact assessment is prepared.

The outputs of the concept design stage are compiled into the consent documentation package. This typically includes general arrangement drawings showing the site layout, arrays, access, and infrastructure, supported by a conceptual design report summarising the technical basis, assumptions, and key parameters. An Assessment of Environmental Effects (AEE) will be prepared in accordance with the Resource Management Act and accompanied by relevant specialist reports.

The approach for concept design is broadly set out in Figure 4, below:

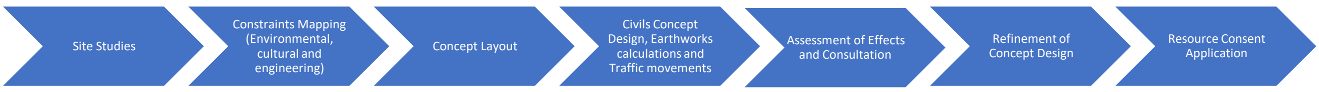


Figure 4: Concept Design Process

It is noted that while this is shown as a linear process, in most instances and for most components, it is more iterative.

Constraints mapping, in respect of ecology, contaminated land and landscape was completed by SLR in November 2023.

4.1.2 Envelope Approach

Due to the level of refinement expected during the design process, an ‘envelope’ approach to concept design has been taken, meaning that the maximum design envelope and number of components have been utilised. This ensures that effects assessments are based on a ‘worst case scenario’, with real world implementation resulting in the same or lesser effects.

5 Equipment Detail

This section provides details of key infrastructure to be included within the solar farm.

5.1 General Equipment Overview

A utility-scale solar farm is an integrated power generation facility that converts solar radiation into grid-quality electricity through a sequence of coordinated components.

At the core are the photovoltaic (PV) modules (known colloquially as ‘panels’), which absorb sunlight and convert it into direct current (DC) electricity via the photovoltaic effect. These modules are mounted on fixed-tilt structures or single-axis trackers, which are designed to optimise solar capture throughout the day. Support structures are anchored to the ground, typically with driven steel piles or other engineered foundations to ensure stability under wind and environmental loads.

The modules are connected to one another via DC cables (otherwise known as ‘string cables’) to create a ‘string’. From this point, two different power conversion approaches can be used, namely, Central and String:

In a central inverter configuration, the DC electricity produced flows through the DC string cables to string combiner boxes which consolidate the output from multiple module strings to form an array. Larger DC main cables then carry the combined output to high-capacity Power Conversion Units (PCU) (also known as a central inverter station) located across the site.

Each inverter station converts DC to alternating current (AC) and steps the voltage up (typically from 400–800 V to 33 kV) via a medium-voltage transformer.

In a string inverter configuration, rather than strings consolidating in combiner boxes they can consolidate in string inverters. String inverters both consolidate the output from multiple strings to form an array and convert the electricity from DC to AC. From the string inverter AC cables carry the combined output to step-up transformers located across the site. The transformers step up the voltage (typically from 600-800 V to 33kV).

In parallel, Battery Energy Storage Systems (BESS) are connected directly to the PCU via DC-to-DC converters. Up to three BESS units, each typically housed in a 20 ft container but not larger than a 40ft container, may be connected to a single PCU. The BESS provides energy storage capacity to store surplus energy for later dispatch, improving grid stability and operational flexibility.

From the PCU’s (or alternatively transformers in the event string inverters are used), the stepped-up AC electricity is transmitted via 33 kV medium-voltage (MV) cables in buried trenches to the on-site switchroom before being exported to the utility grid. The substation also houses protection and control systems, including circuit breakers, disconnect switches, and protection relays for safe operation and fault isolation.

Supporting infrastructure includes an Operations & Maintenance (O&M) building with workspace, offices, meeting rooms, and storage facilities which can consist of secure containerised storage for spare parts and tools.

Supervisory Control and Data Acquisition (SCADA) systems connect to sensors and meters throughout the site, enabling real-time performance monitoring, fault detection, energy yield tracking, and remote control. The monitoring system is supported by meteorological stations measuring irradiance, wind speed, ambient and module temperature, rainfall, and other environmental parameters for performance analysis and forecasting.

Although solar farms are spread across large areas and composed of relatively small, modular components, they are high-capacity generation assets critical to meeting renewable energy targets. As long-term investment infrastructure, they require robust security, typically a perimeter security fence with integrated CCTV coverage around and within the site. These provide protection for both outside public access and on-site equipment.

Figure 5 and Figure 6 below illustrate the typical connection and interaction of the components described above.

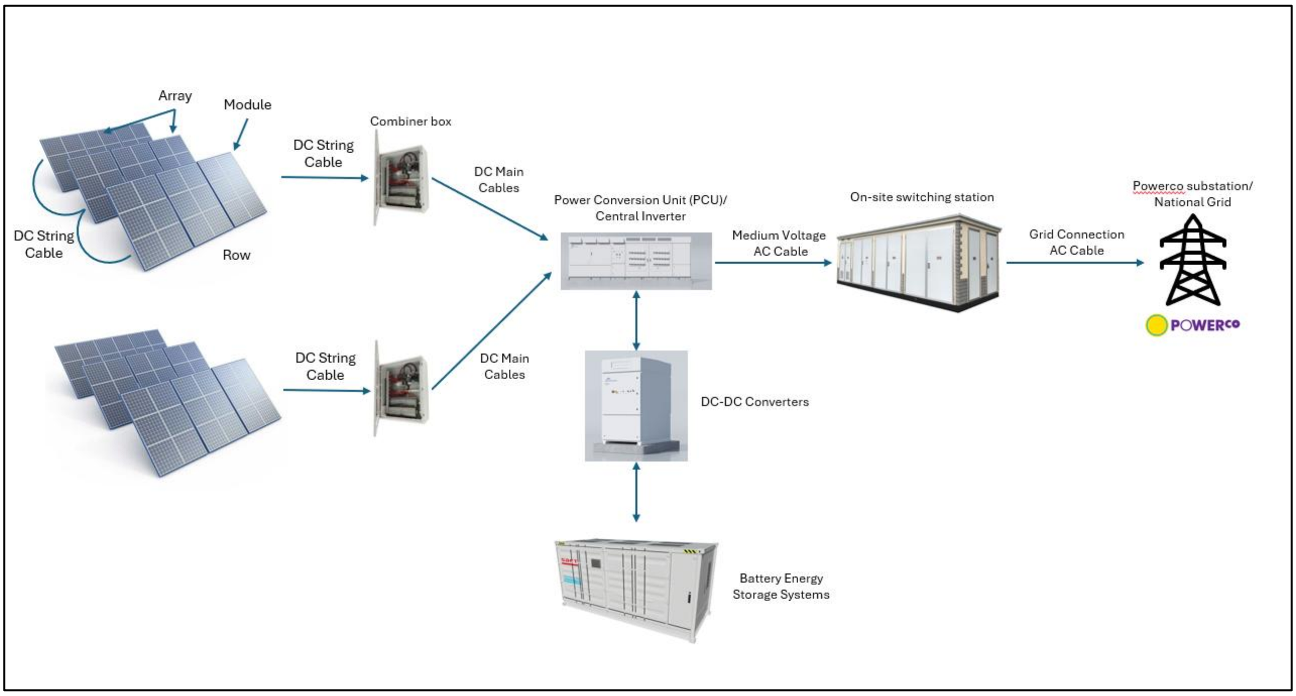


Figure 5: Central Inverter Schematic.

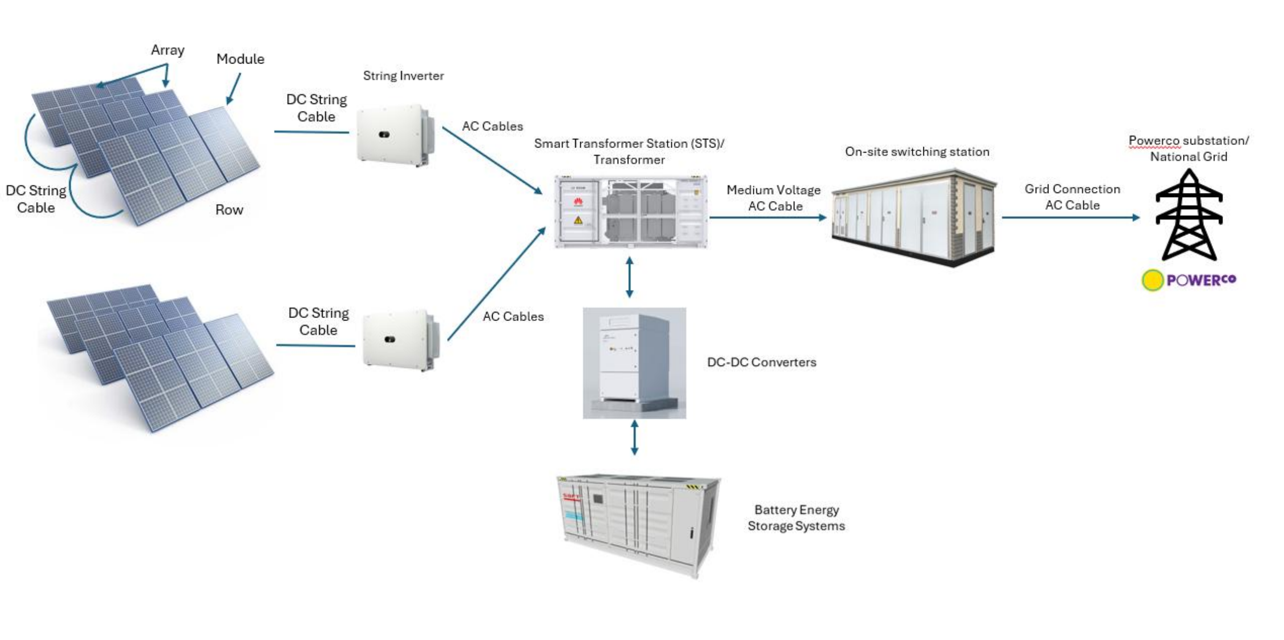


Figure 6: String Inverter Schematic

Table 2 below provides a summary of the key infrastructure that will be included on the Hinuera Site. Full details and descriptions of this infrastructure are included in the following sections.

Table 2: Summary of Key Infrastructure

Item	Number	Size (approximate)
PV Module (Panel)	170,000 (maximum)	2.8m^2
String Combiner Boxes*	350 (approx.)	650mm(h) x 900mm(l) x 300mm (w)
String Inverters*	350 (approx.)	900mm (h) x 1200mm (l) x 350mm (w)
Power Conversion Units /Central Inverter Station (PCU/ITS)**	30 (maximum)	20ft Container - /6.2m(l) x 2.5m(w) x 2.6m (h) Or two combined into a 40ft container/12.4m (l) x 1.4m (w) x 2.6m (h)
String Transformer Station (STS)**	30 (maximum)	20ft Container – approximately 6.2m(l) x 2.5m(w) x 2.6m (h) Or two combined into a 40ft container – approximately 12.4m (l) x 1.4m (w) x 2.6m (h)
DC-DC Converters	120 (maximum)	1.5m (l) x 2m (w)
Battery Energy Storage System (BESS)	90 (maximum)	20ft container – approximately 6.2m(l) x 2.5m(w) x 2.6m (h) Or two combined into a 40ft container – approximately

		12.4m (l) x 1.4m (w) x 2.6m (h)
Switching Station/Switchroom	1 (maximum)	$80m^2$ (maximum)
Operations and Maintenance ***	1 (maximum)	$180m^2$
Storage Building***	1 (maximum)	$180m^2$
Storage containers ***	5 (maximum)	$28m^2$

*String Combiner Boxes are only used in a Central Inverter Configuration and String Power Conversion Units are only used in a string inverter configuration. Accordingly, one or the other will be used within the site – not both.
** PCU's are only used in a Central Inverter Configuration and STS's are only used in a string inverter configuration. Accordingly, one or the other will be used within the site – not both.
*** provided the total combined area of these buildings will not exceed $500m^2$.

5.2 Detailed and Project specific Overview

5.2.1 Solar Modules

5.2.1.1 Background

Photovoltaic (PV) modules are the primary energy-generating component of the solar farm. Each module consists of multiple small photovoltaic cells electrically connected in series and encapsulated between layers of tempered glass which protect against moisture ingress, UV degradation, and mechanical impact. For utility solar farms, bifacial modules are used to improve the generation conversion. A bifacial module means that the module can generate power from both the front and rear of the module. As light naturally reflects from the earth's surface, ie. water, snow, grass, earth, and rocks, the back-side of the module can generated power from the reflected energy. Although the reflected irradiance has a much lower strength compared to direct sunlight, it could add up to 5% additional generation, improving the overall efficiency of the plant.

- Electrical output – Modules are rated by their nominal power (W), open-circuit voltage (Voc), and short-circuit current (Isc) measured under Standard Testing Conditions (STC). The actual output varies with irradiance, temperature, and angle of incidence. Modules used in utility solar farms are often more than 620W per module.
- Mechanical configuration – Modules are typically framed in anodised aluminium for rigidity, with junction boxes housing bypass diodes to prevent hot spots in shaded conditions.
- Temperature effects – Output decreases with cell temperature; this is quantified by the temperature coefficient (e.g., −0.35%/°C). Module design and layout aim to maximise airflow for cooling.
- Durability – Modules are tested to IEC 61215 (design qualification) and IEC 61730 (safety) standards for resistance to mechanical loading, hail, thermal cycling, humidity, and potential induced degradation (PID).

Modules are connected in series to form a string, with each string's voltage kept within the inverter's maximum input voltage rating (often 1,500 V DC for utility-scale plants). The number of modules per string is determined by the module Voc, local temperature extremes, and inverter specifications.

Mounting configuration is project-specific, but may include:

- 1-portrait – Taller, narrower table arrangement, often used with trackers.
- 2-portrait or 4- landscape – Wider table arrangement, often used with fixed-tilt systems to optimise land use and reduce moving parts

While panels vary in size, they are approximately 2.8m^2.

5.2.1.2 Hinuera Solar Farm

Subject to final design, including selection of make/model and voltage of panels, it is anticipated that the Hinuera Solar farm will have a maximum of 170,000 modules. To allow for maximum flexibility, the intention was to allow for either a fixed tilt or Single Axis Tracking System mounting system during the consenting phase.

However, due to incidences of model glare from a fixed tilt system, consenting will proceed on the basis of a Single Axis Tracking System only.

5.2.2 Panel Tables

5.2.2.1 Background

Solar farms may adopt single-axis tracking, fixed-tilt, or a hybrid arrangement. These are described below.

- Single-axis trackers mount PV modules in north–south rows and rotate them east–west using actuator systems, maintaining a near-perpendicular angle to the sun to maximise generation. Modules are typically installed in a 1-portrait configuration.
- Fixed-tilt systems place modules at a fixed tilt and azimuth for the plant's lifetime, often in 2-portrait configuration. These are simpler to design and install, with higher tolerance for irregular terrain.

Trackers generally offer higher yields but involve more complex installation due to moving parts and tighter mechanical tolerances (often up to 120 modules per row). Fixed-tilt tables are shorter in design and better suited to irregular parcels or undulating ground, minimising earthworks. A hybrid layout can balance yield optimisation with site adaptability.

In both single-axis tracking and fixed tilt arrangements a group of panels, mounted on one mechanical structure, is called a 'table' Tables come in a variety of lengths from 28 to 120 modules - and each 'row' of modules within a solar farm may consist of a number of tables. Where there is more than one table in a 'row' the tables are separated between 250 and 500mm.

Mounting structure components typically include:

1. Piles or posts.

   Steel piles, often hot-dip galvanised for corrosion protection, anchor the mounting system. They must resist both downward loading from the module assembly and uplift forces from wind.

   - Typically driven 2.4–4.5 m into the soil, depending on geotechnical conditions.
   - Alternative foundation methods (e.g., micropiles, concrete collars, screw piles) are used if ground conditions are unsuitable for direct driving.
   - Approximately 600 piles are installed per MWp of solar modules

2. Top structure consists of rails or beams are mounted to piles support the PV modules. Made from galvanised steel or aluminium alloys, these form the table structure.

3. Tracker-specific components – Motors, gears, bearings, dampers, and sensors enable rotation. Motors turn the trackers from east to west. The power to the motor can be provided from a centralised auxiliary supply, often provided from the PCU station, or alternatively via a self-power solution with a small solar module and battery connected to actuator. Mechanical dampers are installed between the post and top structures to help limiting wind-induced oscillations. Every tracker table has a dedicated motor and control module. Depending on the tracker system, multiple communication and meteorological towers might be installed throughout the site to communicate with all the individual tracker motors. These towers are often installed at a maximum height of 10m and located towards the middle of the farm.

For illustration of the components described above, please refer to the Figure 7 - Figure 10

Figure 7: Fixed Tilt System. Source: https://www.schletter-group.com/mounting-systems/fixed-tilt-systems/

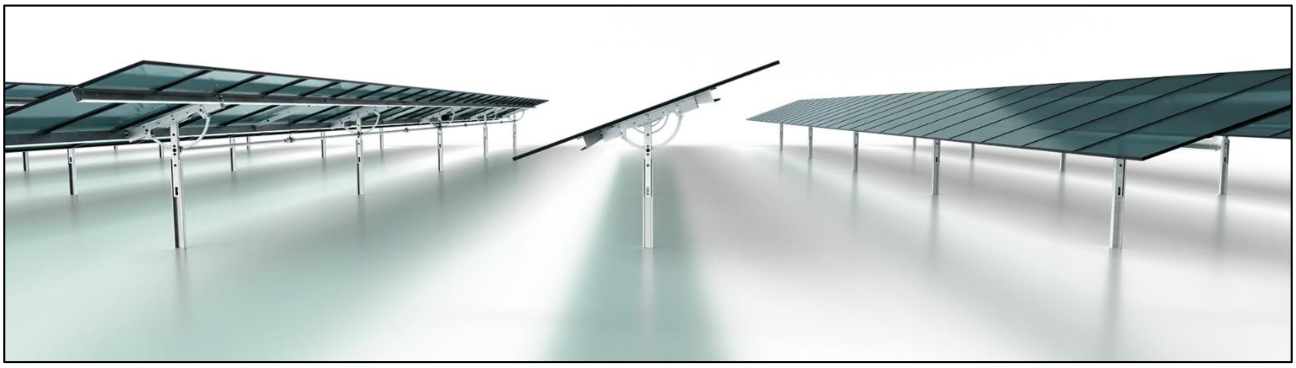


Figure 8: Single Axis Tracking System. Source: https://www.schletter-group.com/mounting-systems/tracking-systems/

Figure 9: Tracker Self-Powered motor, solar module, battery and controller unit.. Source: https://www.pv-tech.org/nextracker-finalises-split-from-flex-and-becomes-independent-company/

Figure 10: Example of a Meteorological Communication Unit

5.2.2.2 Hinuera Solar Farm

The project will utilse a single-axis tracking system so as to avoid glint and glare effects.

The following *minimum* row separation and *maximum* height is proposed:

- Single axis tracking system tables typically measure between 32m and 130m in length. Row separation in an east-west direction is typically between 4.5 to 7.0m when from point-to-point (centres).
- The maximum height of panels in a single axis tracking system is 3.25m.

For consenting purposes, the minimum separation distances, measured from point-to-point, will be consented, i.e. 4.5m. This is because minimum separation distances will result in the greatest extent of ‘bulk’ within the site and are considered to represent the ‘worst case’ scenario.

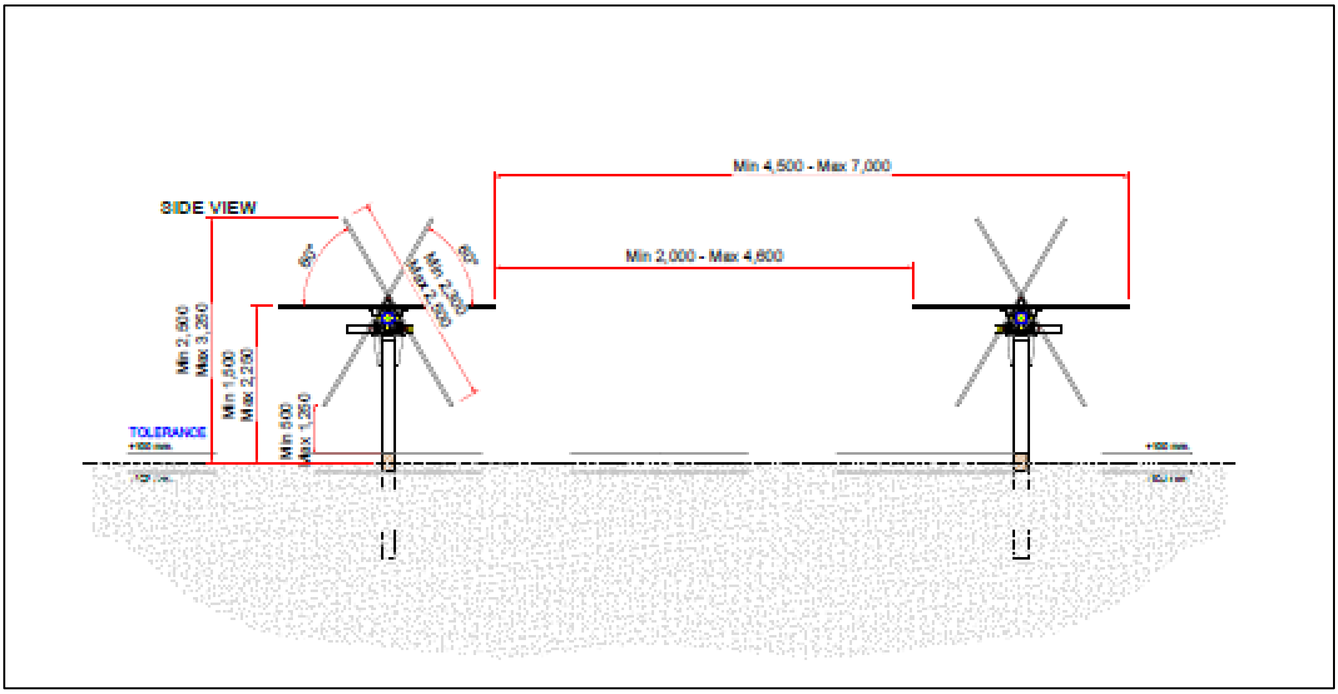


Figure 11: Single Axis Tracking Elevation

5.2.3 <u>DC String Cables</u>

Each module string is interconnected by PV-rated DC cables, designed for:

- UV and ozone resistance for outdoor exposure
- Double insulation for electrical safety
- High temperature tolerance (−40°C to +90°C continuous operation)
- Low smoke zero halogen (LSZH) sheathing in compliance with site safety requirements

Cables are routed along the mounting structure using UV-resistant cable clips or ties, avoiding mechanical stress points and sharp bends to minimise wear.

Figure 12, below is an example of connected DC string cables

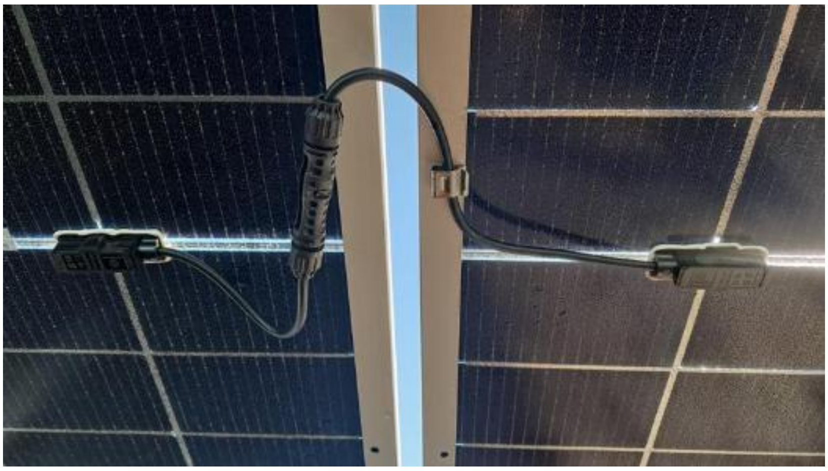


Figure 12: DC String cables (Source: HENZ – Tauhei Solar Farm)

5.2.4 String Combiner Boxes

5.2.4.1 Background

String combiner boxes aggregate the outputs of multiple module strings into a single DC main cable for delivery to the inverter station. They perform both electrical consolidation and protection functions, as discussed below. String combiner boxes are only utilised with Central PCUs, as string inverters have a build-in combiner box.

Key Functions

- Typical SCBs combine 12–32 strings, depending on the system voltage, layout, and inverter configuration.
- Each string input is protected by a DC fuse (positive, negative, or both poles, depending on system earthing). This isolates faulty strings and protects the electrical system.
- Surge protection devices (SPDs) are included to protect against over-voltage transients from lightning or switching events.
- DC disconnect switches allow safe isolation of the SCB for maintenance or fault repair.
- Some SCBs integrate monitoring electronics to measure current, voltage, and temperature for each string, enabling early fault detection through the SCADA system.

Construction

- SCBs are outdoor rated to IP65 or higher, with UV-resistant polymer, plastic, or resin type housing. Ventilation may be passive or fan-assisted depending on internal heat dissipation.
- DC cable entries are via weather-sealed glands at the bottom of the enclosure or MC4-type connectors, with proper strain relief to prevent cable damage.
- Installed on galvanised steel posts or directly onto mounting structures, positioned for minimal DC cable length while maintaining safe working access.
- SCB sizing will vary depending on the selected make and model, typical dimensions are approximately 650mm in height and 900mm length and 300mm in width.

An example string combiner box is included in Figure 13, below.

Figure 13: Example String Combiner Box (Tauhei Solar Farm)

5.2.4.2 Hinuera Solar Farm

If a central inverter configuration is utilised, an estimated 350 string combiner boxes will be installed at the Hinuera Solar Farm.

5.2.5 String Inverter

5.2.5.1 Background

String inverters (otherwise known as String Power Conversion Units Inverters) are smaller types of inverters, often 350 kVA in capacity and below 1kV connection voltage. The inverter converts the DC power generated by the solar modules directly into AC power for connection to the low-voltage AC collection system. Unlike central inverters, string inverters incorporate built-in string-level aggregation and protection, thereby eliminating the need for external string combiner boxes. They are distributed across the solar array and mounted close to the PV modules, reducing DC cable length. String inverters have the benefit of higher granular monitoring and controlling capability but require more detailed communication networks. String inverters also require a separate transformer station which then steps-up the voltage from LV to MV, typically, from 0.8kV to 33 kV.

Key Functions

- Convert DC electricity from connected module strings into grid-compliant AC power.
- Each inverter accepts multiple string inputs (typically 2–20 inputs, depending on inverter size and rating).
- Higher quantity of independent MPPT channels optimize power output from different strings or array orientations, improving overall system yield.
- Integrated fuses or electronic protection isolate faulty strings, preventing back-feeding and ensuring system safety.
- Built-in surge protective devices (SPDs) safeguard against over-voltage events caused by lightning or grid disturbances.
- Each inverter typically includes a DC disconnect switch and AC isolator for safe maintenance and fault isolation.
- Provide real-time monitoring of voltage, current, energy yield, and faults, with data transmitted to the SCADA system via RS485, Ethernet, or wireless protocols.

Construction

- Designed for outdoor use, typically IP65–IP67 rated with aluminium, powder-coated steel, or polymer housings. Units are fan-cooled or convection-cooled, depending on manufacturing type.
- DC inputs via MC4 or similar connectors.
- AC outputs via weather-sealed cable glands or terminal blocks.
- Communication ports are protected with weatherproof covers.
- Installed on module mounting structures, dedicated inverter racks, or ground-mounted pedestals. Positioned to minimise DC cable length, reduced directed sun and rain exposure, and allow safe working access.
- String inverter sizing will vary depending on the selected make and model, typical dimensions are approximately 900mm in height, 1200m in long and 350mm in width.

String Inverters are similar in appearance and capacity to string combiner boxes – refer to Figure 14.

5.2.5.2 Hinuera Solar Farm

If a string inverter configuration is utilised, an estimated 350 string inverters will be installed at the Hinuera Solar Farm.

5.2.6 String Transformer Stations

5.2.6.1 Background

With String inverters, a separate Transformer station is required to collect all the low voltage AC connections from the string inverters and step-up the voltage from generally 0.6kV to 33 kV. This is done via a String Transformer Station (STS) and looks very similar to a regular central inverter with similar breaker control points, protection equipment, transformer, and switchgear. The main difference being that an STS has multiple LV AC inputs with no active power conversion units, where-as a central inverter has multiple DC inputs with a power conversion unit.

Each STS station is typically sized between a 20ft and 40ft container.

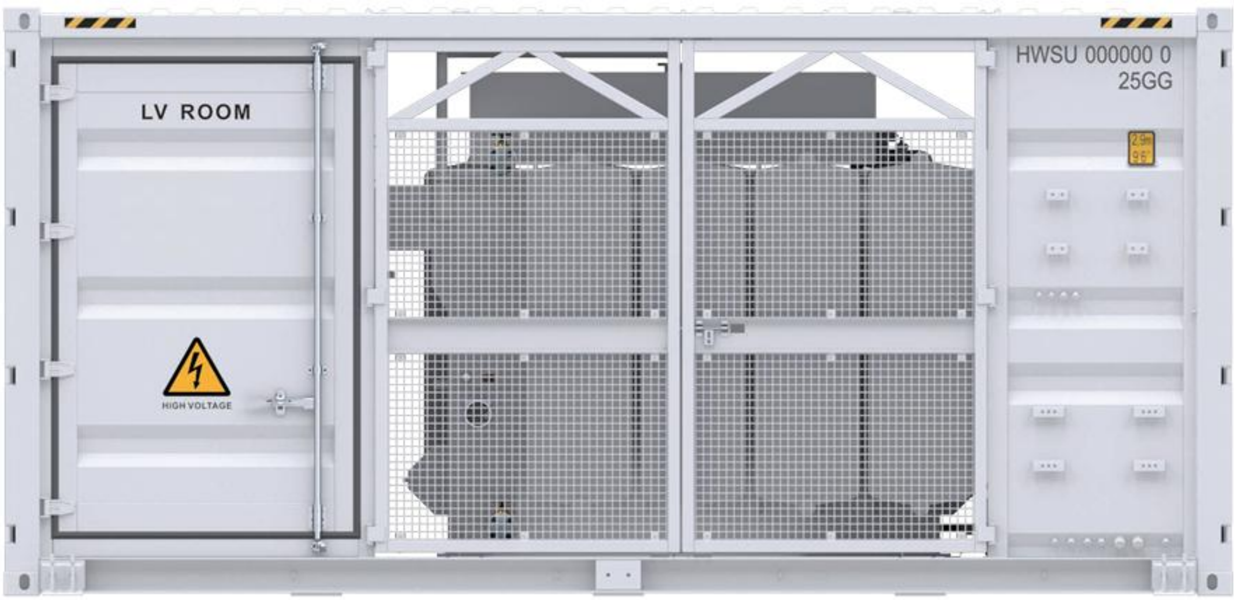


Figure 14: String Transformer Station (Example) Source: https://solar.huawei.com/admin/asset/v1/pro/view/1f9c3a1cc965483b8ed662f0f5db198e.pdf

5.2.6.2 Hinuera Solar Farm

If a string inverter configuration is utilised a maximum of 30 STS transformer stations will be installed at the Hinuera Solar Farm.

5.2.7 Central Power Conversion Units (Central Inverter Station)

5.2.7.1 Background

The Central Inverter Station (ITS) also referred to as a Power Conversion Unit (PCU) is a key conversion point in the solar farm's electrical system, transforming a large amount of DC electricity from the PV arrays into grid-compatible AC power and stepping the voltage up to the medium-voltage (MV) collection system.

Key Functions

- Convert large, aggregated DC input (multi-MW range) into grid-compliant AC power.

- Provide system-level MPPT (fewer MPPT trackers compared to string inverters), optimising for large PV blocks.
- Integrated protection on DC inputs and AC outputs, preventing equipment damage and isolating faults.
- Built-in surge protective devices (SPDs) on both DC and AC sides to mitigate lightning- or grid-induced transients.
- Equipped with DC isolators, AC circuit breakers, and often motorised disconnect switches for safe operation and maintenance.
- Provide comprehensive monitoring of voltage, current, power factor, temperature, and alarms. Data is communicated to the SCADA system via fibre, Ethernet, or industrial communication protocols.
- Modern central inverters support grid codes (e.g., reactive power control, low-voltage ride-through, frequency regulation).

Construction

- Typically housed in outdoor-rated (IP54–IP65) containerised enclosures. Designed with forced-air or liquid cooling systems to manage heat generated.
- Includes power electronics (IGBT modules), transformer (sometimes integrated in the same enclosure), auxiliary systems (cooling, control, and monitoring), and switchgear.
- DC inputs are fed via cabling from string combiner.
- AC outputs connect to the LV/MV transformer which then step the voltage up to typically 33 kv.
- Installed on reinforced concrete pads or skids, located near the PV block.
- ITSs requires clear access for operation, maintenance, and crane handling during installation and maintenance.
- Typically, containerised units of 20–40 ft length, weighing several tonnes depending on rating. ITS can be made up with smaller modular components for ease of delivery and installation.

Figure 15: Central Inverter Station/Power Conversion Unit (Example)
Source: https://en.sungrowpower.com/productDetail/3112/1-x-modular-inverter-sg3300-4400ud-mv-20

5.2.7.2 Hinuera Solar Farm

If a central inverter configuration is utilised, a maximum of 30 ITS will be installed at the Hinuera Solar Farm.

5.2.8 Switching station/ Switchroom

5.2.8.1 Background

The 33 kV switchroom provides the interface between the solar farm's medium-voltage (MV) collection network and the transmission/distribution grid. It consolidates the output from one or more power blocks, and provides protection, metering, monitoring and control, and isolation functionality to ensure safe and reliable operation.

Figure 16: Switching Station (Example) Source: www.wibs.com.au/switch-rooms

Key Functions

- Connects all LV/MV transformers (from PCU or STS) to a central consolidated busbar
- Includes circuit breakers, disconnect switches, and earthing switches to safely energise/de-energise circuits for operation and maintenance.
- Houses protective relays and current/voltage transformers (CTs/VTs) for fault detection, overcurrent, differential, and earth fault protection.
- Supervisory control and data acquisition (SCADA) integration for real-time status, alarms, and event logging.
- Revenue-grade metering and power quality monitoring in compliance with grid operator requirements.
- Provides grid support functions, ensuring compliance with codes such as synchronisation, reactive power control, frequency regulation, and fault ride-through.
- Mechanical and electrical interlocks to prevent unsafe switching operations.
- Housing auxiliary equipment for all ancillary services as step-down transformers, back-up diesel generators, and automatic transfer switch (ATS). These might be located either inside or outside of the switching building.

Construction

- The switchroom equipment is typically housed in a prefabricated, factory-built modular building (E-House) designed for outdoor installation. The structure is typically steel-framed with insulated sandwich panels, rated to IP54–IP65, and engineered for fire resistance, seismic loading, and environmental protection.
- MV switchgear (air-insulated or gas-insulated) is installed within the prefabricated building. Internal busbar arrangements can be configured for single bus, double bus, or ring bus schemes depending on utility requirements.

- Incoming feeders from inverter transformers, outgoing feeders to the grid/export cable, busbars, circuit breakers, disconnectors, earthing switches, CTs/VTs, and surge protection.
- Control and protection panels, auxiliary power supplies, and HVAC systems are integrated within the same building.
- The E-House is installed on a reinforced concrete pad with embedded cable trenches or duct banks for underground MV cabling. Lifting points are provided for transport and installation by crane.
- Control, protection, and SCADA equipment are housed within segregated compartments of the prefabricated building, ensuring separation of high-voltage and low-voltage/control systems.
- The prefabricated building incorporates HVAC for thermal management, fire detection/suppression systems, lighting, and auxiliary AC/DC supplies.
- Dimensions vary depending on equipment rating and configuration (typical E-Houses range from 6–15 m in length, 2.5–5 m in width, and 3–4 m in height). Depending on the cable design and flooding model, the building can be raised above the ground level by up to 2m.
- Additional auxiliary transformer and diesel generators are often required to provide electricity to ancillary services. The auxiliary transformer steps the voltage from 33kV down to 400/230V and between 50 to 100 kW depending on the load requirements. The generator is sized slightly bigger than the auxiliary transformer, but not larger than 150 kVA in size.
- Depending on the PV plant size and grid stability, harmonic filters might be required. If harmonic filters would be required, they would be placed within the switching yard with a maximum area required of 10 x 10m.
- Auxiliary transformer to feed the switchroom, auxiliary loads, and other services. Alongside the auxiliary transformer, additional UPS power suppliers and diesel back-up generators can be installed to ensure continuous control of the plant.

5.2.8.2 Hinuera Solar Farm

For Hinuera, a prefabricated switchroom will be constructed to electrically connect the solar farm to the grid at Hinuera Substation.

The switchroom will have a maximum size of 80m^2. An additional 10m x10m yard may also be required for harmonic filters following the commissioning and testing of the site.

5.2.9 Operations, Maintenance and Storage Buildings

The Operations & Maintenance (O&M) building and associated storage facilities form the central hub for managing, maintaining, and supporting the solar farm’s long-term operation. Together, these facilities provide secure, functional spaces for operational staff, equipment storage, and spare parts inventory management.

5.2.9.1 Operations and Maintenance Building

The Operation and Maintenance (O&M) Building serves as the primary operational base for site staff and contractors, housing all necessary facilities for day-to-day plant monitoring, administration, and maintenance activities.

Typical Facilities Include:

- Reception area for site inductions, administration staff and general facility introduction.
- Security office with large CCTV monitors displacing the site’s CCTV feeds, alarms, fire panels, etc.
- A dedicated space for the Supervisory Control and Data Acquisition system, control servers, communication racks, and monitoring screens. Often a possible air-controlled unit.

- Workspace for plant operators, engineers, and management staff, as well as meeting rooms for operational briefings and stakeholder visits.
- Work areas equipped with workbenches, tools, and diagnostic equipment for minor repairs, testing, and assembly tasks.
- Staff facilities such as a kitchen/tearoom, lockers, showers, and restrooms to support daily operations and visiting maintenance teams.
- Document control rooms and storage cabinets Fire-resistant storage for plant manuals, drawings, permits, and compliance records.

Construction and Services:

- Either constructed on site or build off-site as perforated and transported to site.
- HVAC for office, control room, and workshop spaces to maintain optimal equipment and staff working conditions.
- Controlled access via swipe cards or coded locks, integrated with site-wide CCTV.
- Smoke detection, fire alarms, and portable extinguishers, with specific suppression systems where electronics are concentrated.

5.2.9.2 Storage Building

A dedicated enclosed storage facility is provided for critical spare parts, which must be stored in secure, environmentally controlled conditions to ensure readiness for use.
Critical Spares Typically Include:

- Spare PCU components, breakers, fuses, relays, SPDs, etc.
- SCADA and PPC components and protection relays.
- CCTV components.
- MV/HV switchgear components.
- Transformer bushings, gaskets, and auxiliary equipment.
- Weather station spare sensors.
- PV modules of the same type.
- Combiner boxes or string inverters.
- Cabling, termination and jointing kits.
- Tracker spare electrical components.
- Specialist tools required for high-voltage or mechanical repairs.

5.2.9.3 Containerised Non-Critical Spares Area

Adjacent to the storage building, the project may position a small number of 40-foot shipping containers to store non-sensitive spares. These are items that do not require climate control or immediate availability but are still valuable for minimising replacement lead times.
Typical Non-Critical Spares Include:

- PV modules (new or recovered but serviceable).
- Mounting structure members, rails, and brackets.
- Cabling reels and connectors.
- Spare LV/ MV transformers.
- Hazardous substances.
- Any other materials not required to be stored indoors.

Container Design and Placement

- Standard ISO 40-foot containers with secure locking mechanisms.
- Placed on compacted gravel or concrete pads for stability and drainage.
- Weather-sealed and internally fitted with shelving or pallets for organisation.
- Positioned to allow forklift or vehicle access for loading/unloading.

- A spare transformer container could be open top with a heavy duty sail covering the opening. This is to simplify the removal of the transformer by lifting it out of container instead of pushing and pulling it sideways.

5.2.9.4 Integration and Site Layout

- The combined O&M building and storage (including containerised area) will not exceed 500 m² footprint.
- Centrally located or near the main site entrance for easy access by operations staff and delivery vehicles, while maintaining proximity to key electrical infrastructure to share facilities were possible and efficient response times.
- Dedicated parking and loading areas, with clear separation between pedestrian and vehicle movements. External lighting for safe after-hours operation.
- Connected to the site's LV network for power supply, with backup from the auxiliary generator. Telecommunications link integrated with site SCADA and security systems.

5.2.9.5 Hinuera Solar Farm

The Hinuera Solar Farm will include the following:

- 1x O&M Building of approximately 180m$^{2.}$
- 1x Storage Building of approximately 180m$^{2.}$
- Up to five containers of approximately 28m^2 each.

In order to retain flexibility in final design, and consistent with the 'envelope' approach to consenting, it is proposed that rather than specifying the floor area of each of the components above, consent will be sought of up to 500m^2 of storage and operational buildings, including no more than five (5) containers.

5.2.10 Security, Lighting, and CCTV

The security system for the solar farm is designed to protect critical infrastructure, ensure the safety of personnel and the public, and minimise the risk of theft, vandalism, or unauthorised access. The system combines physical barriers with electronic surveillance for a layered security approach in compliance with relevant safety, planning and insurance requirements. By maintaining a robust but non-intrusive security presence, the system supports safe, reliable, and uninterrupted operation of the solar farm over its full design life.

5.2.10.1 Security Fencing

The perimeter fence defines the site boundary, restricts unauthorised entry, and provides a first line of defence for the solar farm's infrastructure.

Design Requirements

- Not to exceed 2.4 metres, in accordance with planning restrictions and safety guidelines.
- Constructed from galvanised steel posts and rails, heavy-duty chain-link mesh or welded mesh panels with anti-climb design, tensioned top, intermediate, and bottom wires to prevent deformation or breaching as needed.
- Lockable swinging or sliding gates and pedestrian gates with key-controlled or electronic access systems.
- Posts set in concrete footings sized for the appropriate wind loading and soil conditions.
- Appropriate anti-burrowing features below the fence to prevent the entering of rodents, rabbits, and other small animals that might cause damage to infrastructure.

Integration

The fence alignment follows the full site perimeter, enclosing all operational areas including PV arrays, inverter stations, BESS units, and the substation. Internal fencing may also be installed around high-voltage equipment and BESS unit compounds for an additional layer of protection.

5.2.10.2 CCTV Surveillance System

Purpose

A full perimeter and key equipment CCTV system provides continuous monitoring of the site, acting both as a deterrent and as a real-time security tool for detecting and responding to unauthorised activity.

System Features

- Cameras positioned at strategic intervals along the fence line to provide continuous overlapping fields of view.
- Fixed or PTZ (pan-tilt-zoom) cameras installed around high-value areas such as:
    - Substation and main power transformer
    - Central inverter stations and BESS units
    - O&M building and storage facilities
- Typical camera types:
    - High-resolution day/night IP cameras with infrared illumination for low-light operation.
    - PTZ cameras for active monitoring and incident follow-up.
    - Weatherproof enclosures rated to IP66 or higher.
    - Communication and power cabling
    - Lightning and surge protection
- Video Management:
    - Digital video recorders (NVRs) with local storage and redundancy.
    - Remote viewing capability via secure connection to the site's SCADA or dedicated security network.
    - Automated alerts for motion detection, fence breaches, or camera tampering.
- Power Supply:
    - Connected to the site's auxiliary power system with UPS backup.
    - Critical cameras (e.g., substation, main gate) connected to backup generator feed for operation during extended outages.

5.2.10.3 Lighting & Security Integration

- LED security lighting installed at gates, main buildings, and high-value equipment areas to enhance operational visibility and increase security presence.
- Security gates are often equipped with key card or keypad entry to record all entry/exit events.
- CCTV and access control systems linked into the site SCADA for centralised monitoring and alarm handling. The SCADA system can also be monitored remotely.
- Lighting, for the purposes of both security and health and safety will be required during construction.

5.2.10.4 Hinuera Solar Farm

Security Fence

A security fence, to a maximum height of 2.4m will be constructed around the perimeter of the site. This will be located internal to any landscape/ecological planting where applicable.

CCTV/Surveillance

CCTV cameras to a maximum height of 10m will be erected around the site, in a manner that provides coverage of the entire perimeter. Where planting is proposed, CCTV cameras will be located internal planting. All CCTV cameras will be erected to comply with permitted standards for height in relation to boundary.

Construction Lighting

Lighting, for the purposes of both security and health and safety will be required during construction. Such lighting is likely to include:

- Lighting in carpark area(s) and contractors compound to allow for security and safe navigation around the site.
- Security lighting in laydown areas and at access points.
- Access control points and security gates.

Temporary/movable lighting towers will be required to provide the required lighting. Such lights will be set at no more than 3.5m above ground level and will be directed downwards and into the site to minimise any light spill beyond the immediate area.

Permanent Lighting

Permanent lighting is expected to be restricted to that required for Health and Safety and/or security purposes. Specifically, LED security lighting may installed at gates, main buildings, and high-value equipment areas to enhance operational visibility and increase security presence. To minimise any light spill beyond the immediate area, any permanent lighting will:

- be directed downward and into the site.
- placed at the lowest practicable height.
- utilise motion sensers where practicable.

In all cases lighting will comply with District Plan provisions.

5.3 Battery Energy Storage System

5.3.1 <u>Background</u>

Battery Energy Storage Systems (BESS) are deployed to store excess solar energy and discharge it when required, improving plant flexibility, reliability, and grid compliance. BESS units can be integrated either at the DC side (DC-coupled with PV inverters) or at the AC side (AC-coupled with the plant's MV/LV network). The configuration is selected based on project objectives, grid requirements, and commercial optimization. In this instance, a DC-coupled BESS system is proposed. Figure 18 below shows the setup and interconnection between the PV modules, central inverter station, DC-to-DC converter and BESS. *Figure 18*shows the DC-to-DC converter used to link the BESS with the central inverter. Every BESS unit will require its own set of converters.

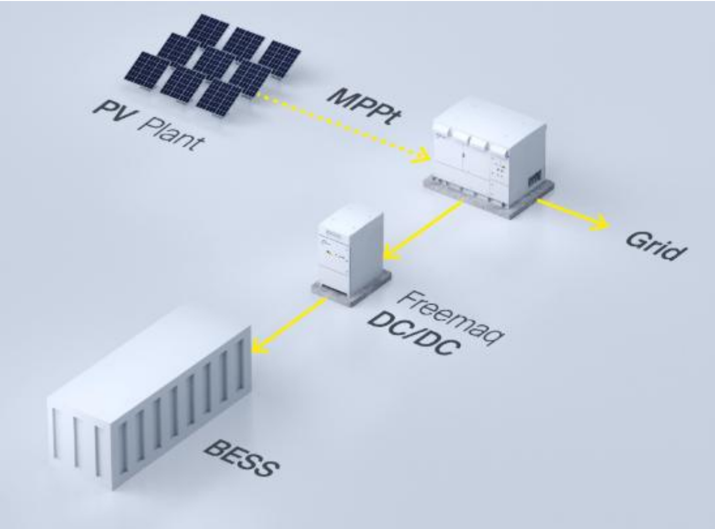


Figure 18: Schematic – BESS


Figure 17: DC/DC Converter Source: https://power-electronics.com/en/solar/dc-dc

Overall Key Functions

- Capture surplus solar energy and release it during high demand or low irradiance periods.
- Support ancillary services such as frequency regulation, reactive power support, black start, and spinning reserve.
- Shift energy generation to match demand or tariff structures.
- Smooth solar generation variability and reduce ramp rates.
- Integrated electrical and thermal protection systems including fuses, circuit breakers, surge protection, fire detection, and suppression.
- Continuous monitoring of voltage, current, temperature, State of Charge (SOC), State of Health (SOH), and alarms, with integration into SCADA/EMS.

BESS Construction

- BESS systems are typically housed in prefabricated containerised enclosures (20 ft or 40 ft ISO containers) or modular components up to 15m, outdoor-rated (IP54–IP65), thermally insulated, and equipped with HVAC and fire detection and suppression systems.
- Lithium-ion batteries are the most common, arranged into racks and modules. Other technologies (LFP, NMC, flow batteries) may be considered depending on application.
- DC coupled BESS shares a central inverter’s DC bus. Additional DC/DC converters are added to manage charging/discharging between the inverter and BESS, while the central inverter handles DC/AC conversion. The DC/DC converters sit in between the BESS and Central Inverter.
- Auxiliary power, HVAC, fire detection and suppression, emergency lighting, battery management system (BMS), and energy management system (EMS) is key to the safe operation of any BESS system.
- Containerised enclosures are installed on reinforced concrete pads with underground cable ducting.
- BESS is a quick evolving environment and constantly being improved in terms of size, capacity, and safety features. Typically, a 20-ft container could provide between 3 and 7 MWh of storage.
- Every BESS unit typically connects with the central inverter via a DC-to-DC converter. The converter helps maintain the voltage and current flow between the 2 devices. Depending on

the converter's size, multiple units can be connected together to achieve the required capacity.

5.3.2 Hinuera Solar Farm

The Hinuera Solar Farm will incorporate DC coupled BESS. The capacity of this system will be based on available technology, grid code requirements, and commercial agreements.

To allow for a worst-case scenario, the consent should allow for:

- 4h-hour battery at maximum grid capacity (i.e. 400MWh)
- Three BESS units per inverter (being a total of 90)
- One Power Conversion Unit for every 3 BESS units (being a total of 30)

Four DC-to-DC converters per central inverter station, each unit approximately 1.5m wide by 2m long (being a total of 120)

5.4 Hazardous Substances

5.4.1 Background

During both construction and operation of a solar farm, a range of hazardous substances may be present on-site. These are required for construction activities, equipment operation, maintenance, and vegetation management. Hazardous substances must be stored, handled, and disposed of in compliance with relevant legislation and local standards, as well as site-specific Health, Safety, and Environmental (HSE) requirements.

Typical Hazardous Substances

- Diesel and petrol for construction plant, vehicles, and backup generators
- Lubricants, oils, and grease for moving parts, machinery, and rotating equipment.
- Transformer oils (often mineral or ester-based) for cooling and dielectric insulation.
- Cleaning solutions for PV modules and equipment.
- Herbicides or pesticides for site management to maintain clear solar array zones.
- Small quantities of paints, adhesives, welding gases, or similar consumables may also be present during construction.

Storage and Control

- Non-dangerous substances (e.g., mild cleaning agents, lubricants in sealed cartridges, low-risk consumables) are stored in a ventilated warehouse building.
- Flammable or more hazardous substances (e.g., fuels, solvents, pesticides, transformer oils) are stored in a ventilated, controlled facility and in approved containers appropriate to the material being stored (e.g., double-walled fuel tanks, bunded chemical cabinets, flameproof pesticide lockers).
- All storage areas are clearly marked, fitted with spill containment systems, and subject to routine inspection.
- Spill kits, fire extinguishers, and MSDS sheets are positioned in accessible locations.

5.4.2 Hinuera Solar Farm

For Hinuera solar farm, non or low hazardous substances would be stored within the O&M Building or warehouse. Any higher risk or flammable hazardous substances would be stored in an appropriate ventilated container and comply with the HSE requirements and storage recommendation of the product.

5.5 Meteorological Stations

5.5.1 Background

Meteorological stations or weather stations provide real-time monitoring of environmental and meteorological conditions across the solar farm. The data is used for performance monitoring, energy forecasting, asset protection, and tracker control. Typical stations measure solar irradiance, temperature, wind speed/direction, precipitation, and other site-specific variables. For plants with solar trackers, dedicated wind monitoring stations provide critical data to enable automatic stowing of trackers under high wind conditions.

Construction features

- Each weather station consists of an enclosure housing data loggers, communication equipment, sensor connections, UPS supply, and other auxiliary components.
- The enclosure and sensors are typically mounted onto a tower with arms extending to mount sensors onto.
- Most sensors are mounted at a typical height of 2–4 m above ground level (irradiance sensors) and 10 m above ground (anemometers for wind monitoring), per IEC/ISO standards. Enclosures are outdoor-rated (IP65–IP67).
- Often the higher towers (10m) are also used to mount tracker communication devices for to communicate with the tracker motor controller.
- The towers are often installed on top of concrete foundations to provide stability.

The Figure 19 a below illustrates typical meteorological weather station and tracker stations.

Figure 19: Examples of Meteorological Communication Stations

5.5.2 Hinuera Solar Farm

Consent should include allowance for a maximum of:

- three full meteorological stations with a maximum height of 4m.
- An additional three wind meteorological stations, with a maximum height of 10m.

6 Civil Design

This section provides an overview of the key components of civil design. Reference should also be had to Table 3 below, which provides a summary of the key design considerations.

Table 3: Civils - Key Design Specifications

Project infrastructure	Design rainfall event / flood return period	Required freeboard above design flood level	Maximum required freeboard above ground level
Permanent access roads, pavements and hardstand surfaces	5% AEP	N/A	250mm
Temporary construction access roads, pavements and hardstand surfaces	10% AEP	N/A	250mm
Any public road drainage infrastructure replacements	Sized like for like	N/A	N/A
Drainage or stormwater ways	2% AEP	N/A	N/A
Transformers, Inverter Stations and other electrical equipment including Contractor Goods	1% AEP	300mm	500mm
Floor levels of all buildings, kiosks and enclosures	1% AEP	300mm	250mm
Switchroom bench	1% AEP	500mm	500mm
Solar PV modules (at all possible orientations)	1% AEP	300mm	500mm (minimum)

6.1 Earthworks

6.1.1 Background

Earthworks establish the engineered ground conditions required for a utility-scale solar farm, creating level platforms for PV arrays, BESS, inverters, transformers, control buildings, switchroom stations, cable management, auxiliary infrastructure, and roading. Good earthworks practice minimises long-term settlement and instability, reduces erosion and sediment mobilisation during construction, and preserves material (topsoil) for post-construction rehabilitation. Earthworks must incorporate site geotechnical conditions, groundwater, cultural and ecological constraints, and consenting requirements.

Overall key functions

- Create stable, level platforms, foundations and formation levels.
- Manage cut/fill to balance site volumes and minimise imported fill and haulage.
- Protect and salvage topsoil for later reinstatement and landscaping.
- Control erosion, sediment and dust during construction.
- Provide temporary and permanent slope stability (batters, benches, retaining) where required.
- Interface with drainage, utilities, foundations and cable routing.
- Minimise disturbance to ecological, cultural heritage and groundwater resources.

Earthworks construction

- Pre-works surveys and setting out (topographic survey, mark cultural/ ecological exclusion zones, locate services).

- Vegetation clearance and grubbing confined to authorised areas; progressive clearing to minimise exposed areas.
- Erosion and sediment control measures: silt fences, swales, settling ponds, stabilized entry/exit points, wheel washes and dust suppression programs.
- Topsoil stripping and stockpiling (kept separate, seeded/covered, located clear of construction traffic and sediment pathways).
- Bulk cut and fill operations: sequencing to balance earthworks, re-use of suitable material, import of engineered fill only where required.
- Formation preparation: proof-rolling, over-excavation and replacement where unsuitable material is encountered, compaction to specification.
- Construction of reinforced foundation pads.
- Cabling will be installed in trenches – see section 7.2 for further information.
- Dewatering and groundwater control where excavations intercept groundwater – see section 8.5.3 for further information.
- Progressive reinstatement and landscaping using salvaged topsoil once permanent surfaces are established.
- Quality control: in-situ density testing, survey checks and sign-off before placement of foundations, PV mounting, or BESS pads.

Design considerations

- Earthworks will be informed by a detailed geotechnical survey; where possible cuts and fills will be balanced on site to reduce haulage and community impacts.
- Geotechnical input to define cut/fill limits, allowable bearing, compaction criteria, and where ground improvement or over-excavation is required.
- Stockpiling and reuse of topsoil to the extent possible - for later reinstatement to support revegetation and ecological mitigation areas.
- Heavy equipment will be located on reinforced concrete pads requiring higher bearing capacity including (switchroom, buildings, inverters, BESS, transformers, etc).
- Selecting equipment with the appropriate tolerance and design flexibility to minimise earthworks were possible.
- Settlement tolerances for PV arrays and BESS pads, as differential settlement could compromise container alignment, cable connections and fire protection clearances.
- Slope stability analysis for permanent and temporary batters; design of retaining structures where required.
- Integration with stormwater management to avoid creating erosion points or concentrating flows toward sensitive receptors.
- Use of permeable track surfaces where possible to reduce runoff volumes.
- Formation levels for platforms will be achieved with minimum disturbance to any adjacent wetlands, watercourses and identified ecological patches with exclusion zones demarcated.
- Controls for dust, noise, vibration and traffic during bulk earthworks.
- Construction sequencing to limit exposure of bare soils and optimise access to subsequent works (roads, BESS foundations, PV structures).

6.1.2 Hinuera Solar Farm

- Access formation and internal roads will be constructed early in the program to provide controlled haul routes and reduce rutting and erosion.
- Temporary erosion and sediment controls will be installed and maintained according with an Erosion & Sediment Control Plan, with regular inspection and reporting.
- Any discovery of archaeological material will be managed under relevant legislation and the agreed cultural heritage protocol with tangata-whenua.

- Quality assurance will include documented compaction tests, proof-rolling records and as-built survey certificates prior to placing PV foundations or BESS pads.

Reference should be had to the draft concept plans prepared by Maven. It should be noted that these designs are intended to be both draft and concept in nature and prepared to demonstrate the extent of earthworks that may be required for consenting purposes. The appointed EPC contractor may choose an alternative layout, within the bounds of an approved consent.

6.2 Stormwater and Hydrology

6.2.1 Background

Stormwater management is a critical component of solar farm design, ensuring that rainfall is safely conveyed, infiltrated, or detained without creating erosion, flooding, or downstream impacts. At the Hinuera Solar Farm, PV arrays, internal roads and hardstands will alter natural hydrology, requiring a coordinated drainage and treatment approach. Stormwater systems must protect infrastructure, preserve downstream water quality, and comply with regional hydrological and environmental requirements.

Overall key functions

- Collect and manage stormwater runoff from impervious surfaces.
- Protect infrastructure foundations from erosion, scour, and localised flooding.
- Incorporate resilience for extreme rainfall events and climate change projections.
- Maintain pre-development hydrological conditions where practical (runoff volumes, peak flows).
- Provide stormwater quality management.
- Support erosion and sediment control measures during construction and integrate into permanent drainage.
- Avoid adverse effects on wetlands, watercourses, and downstream receptors.
- Enable firewater management and safe discharge from infrastructure fire suppression systems (if required and triggered).

Stormwater and hydrology construction

- Installation of temporary erosion and sediment controls during earthworks (silt fences, sediment basins, stabilised outlets).
- Formation of swales, culverts, and/or shallow drains alongside access roads and PV blocks to capture and safely convey runoff as required.
- Foundations and hardstands with controlled drainage to prevent ponding, manage firewater runoff, and direct flows toward oil/water separation devices where required.
- Installation of stormwater detention/retention basins, level spreaders, or infiltration trenches where necessary to attenuate flows and promote infiltration.
- Incorporation of scour protection at discharge points and culvert outlets.
- Integration with site grading plan to avoid concentrating flows onto sensitive areas or adjacent properties.
- As-built surveys and inspections to verify levels, gradients, and hydraulic function.

Design considerations

- Pre-construction hydrological modelling to assess baseline catchments, runoff volumes, and downstream capacity.
- Compliance with regional council stormwater management guidelines, including treatment train design.
- Hydrology design of swales and culverts to accommodate design storm events.

- Integration of stormwater treatment devices (sediment forebays, vegetated swales), as required to improve water quality prior to discharge.
- Integration with site grading and earthworks to create positive outfall away from infrastructure.
- Avoidance of adverse impacts on natural watercourses, wetlands, and culturally significant waterways.
- Inclusion of erosion protection at discharge points to prevent scour into receiving environments as required.
- Long-term stormwater management designed for low maintenance, with periodic inspection and sediment removal.

6.2.2 Hinuera Solar Farm

The concept design demonstrates that stormwater can be managed on site through a range of methods. Post development stormwater modelling will be required as part of final design, to demonstrate that there is no increase in flooding on adjoining properties as a result of the project.

6.3 Access and Internal Roads

6.3.1 Background

Access and internal roads form the backbone of construction and operational logistics at a utility-scale solar farm. They enable the delivery and construction of all equipment, as well as provide access for maintenance, fire protection, and emergency response. Road alignments and designs must accommodate the turning radii, axle loads, and clearance requirements of heavy delivery vehicles, including oversize transport equipment and electrical equipment. Roads also interface directly with stormwater systems, foundations, and site grading.

Overall key functions

- Provide reliable, all-weather access for construction traffic, deliveries, and ongoing operations.
- Accommodate heavy loads and oversize deliveries.
- Maintain safe access for firefighting and emergency services.
- Reduces site rutting soil disturbance/ erosion.

Access and road construction

- Construction of a stabilised site entrance.
- Establishment of temporary haul roads and laydown areas for bulk earthworks and heavy equipment deliveries as required.
- Formation of permanent access and internal roads with appropriate subgrade preparation, compaction, and basecourse layers.
- Pavement designs tailored to traffic type, including as follows:
  - Heavier pavements with reinforced base for major construction routes, oversized and heavy equipment.
  - Lighter pavements for routine maintenance tracks within PV fields.
  - Installation of culverts and roadside swales for drainage as required.
  - Geotextile reinforcement in soft ground areas to prevent rutting.
  - Surfacing will mainly consist of gravel or crushed rock pavement design with minor sealed finished to only the switchroom, O&M building and warehouse.
- Signage, speed limits, and road markings implemented for site safety.

- As-built verification of road geometry, gradients, and load capacity.

Design considerations

- Stabilised entrance(s) established on the connecting public road, designed for the anticipated delivery of infrastructure equipment.
- Road alignments designed to minimise cut and fill while achieving acceptable gradients and turning radii.
- Load design based on the heaviest anticipated delivery.
- Access roads will connect to distributed infrastructure locations and allow crane access for installation and potential replacement of equipment.
- Access roads to accommodate firefighting appliances – see section 6.7 for more details.
- Integration with stormwater design to ensure road runoff is safely managed and does not cause erosion.
- Surfacing will generally be gravel, with potential sealing of high-use areas such as site entrances and buildings or parking bays.
- Arterial roads to be between 100 and 250mm above 1:100 year flood.
- Connection to stormwater network
- Avoidance of ecological and cultural heritage areas.
- Support long-term durability with low maintenance requirements.
- Long-term maintenance strategy for grading, resurfacing, and drainage upkeep.

6.3.1.1 Hinuera Solar Farm

The concept plan demonstrates the location of entrances to the site and provides an indicative layout of roading within the site. Final design may alter the location of internal roading, however entrance locations will remain unchanged. Access for fire appliances is also to be retained in the final design.

Typical roading cross sections are included with the Concept Civil Designs, however these may be refined or altered during detailed design.

Quality assurance will include compaction testing, load testing of reinforced pavements, and survey checks of gradients and clearances.

6.4 Foundations and Structural Platforms

6.4.1 Background

Foundations and structural platforms provide engineered support systems for all major infrastructure at a solar farm. These include PV module mounting structures, inverters, transformers, control buildings, switchroom, site auxiliaries, and BESS. Each asset type imposes different loading and durability requirements, influenced by geotechnical conditions, equipment size, and long-term operational stresses. BESS and transformer pads in particular require robust reinforced concrete pads with tight tolerances for alignment, vibration control, and fire separation, given their weight and sensitivity. The design and installation of foundations must ensure structural integrity, minimise settlement risks, and interface seamlessly with drainage, cable routing, and site access.

Overall Key Functions

- Provide stable and durable support for PV mounting structures, inverters, transformers, BESS enclosures, switchroom, and buildings.

- Distribute static and dynamic loads to the ground without excessive settlement or misalignment.
- Withstand environmental stresses including wind uplift, seismic activity, and thermal expansion.
- Ensure long service life with minimal maintenance over the 35+ year project horizon.
- Integrate with earthing, cable entries, and stormwater management systems.
- Facilitate efficient installation and replacement of prefabricated or containerised equipment such as BESS.

Foundation and Platform Construction

- PV arrays typically supported by driven steel piles or screw piles, allowing rapid installation with minimal concrete use.
- Heavier equipment, including BESS enclosures, transformers, and control buildings, supported on reinforced concrete pads or rafts.

Design considerations

- Detailed geotechnical investigations to determine soil bearing capacity, groundwater levels, seismic classification, and ground improvement requirements.
- Corrosion protection for steel piles (e.g., galvanising or protective coatings).
- Seismic design in accordance with New Zealand standards to ensure resilience under regional hazard scenarios.
- Heavy equipment pads designed with:
    - Increased reinforcement for high point loads.
    - Integrated under-slab conduit entries for power and communication cabling.
    - Earthing connections and fire-resistance considerations.
    - Edge protection and drainage channels to manage stormwater and firewater runoff.
    - Use of cast-in anchors, plinths, and embedded rails to suit equipment requirements.
- Concrete foundations will incorporate under-slab ducting, earthing bars, and provisions for HVAC equipment as required.
- Concrete mix design tailored for geotechnical conditions.
- Ground improvement methods (e.g., compaction, geogrid reinforcement, over-excavation and engineered backfill) applied where soil conditions are poor.
- Settlement tolerances critical for heavy equipment.
- Clearances around pads for fire access, thermal expansion, and maintenance as required.
- Coordination with drainage systems to prevent ponding around pads, especially BESS.
- Foundations located to avoid ecological, cultural heritage, or archaeological exclusion zones.
- Refer to Table 3 for the required freeboard and size requirements for all infrastructure.

6.4.2 Hinuera Solar Farm

- PV structures will primarily utilise driven steel piles for speed and cost-effectiveness, with pile lengths informed by geotechnical testing. Where this method is not suitable due to either too soft or hard ground conditions, alternative solutions will be utilised.
- Sequencing will be coordinated so that foundations are completed in time for just-in-time delivery, minimising laydown requirements.
- Quality control will include pile load tests, pad bearing capacity verification, reinforcement inspections, and dimensional surveys prior to installation.
- Freeboard levels as outlined in Table 3.
- Certification of works by qualified geotechnical and structural engineers prior to equipment installation.

Typical foundation details are attached to the concept civil design. These foundations designs will be refined with engineering input during final design.

6.5 Temporary Works and Construction Facilities

6.5.1 Background

Temporary works and construction facilities provide the infrastructure needed to support safe and efficient delivery of the solar farm. These facilities include site compounds, laydown areas, temporary access, worker amenities, and utility services. Proper planning ensures that equipment such as modules, mounting structures, inverters, cabling, imported aggregate or engineered back-fill, BESS containers, transformers, and prefabricated buildings can be received, stored, and installed with minimal double-handling. Temporary works must be integrated into the overall construction sequence, while also complying with environmental and health and safety requirements.

Overall key functions

- Provide secure and functional compounds for offices, workshops, and worker amenities.
- Provide laydown areas for storage of equipment in a manner that avoid soil erosion and sediment mobilisation.
- Provide temporary utilities including power, water, lighting, and communications.
- Provide site security, emergency locations, and comply with construction Health and Safety requirements,
- Facilitate safe access and storage of construction equipment and vehicles.
- Support efficient logistics and sequencing of deliveries.

Temporary works and facility construction

- Site compound established early with portable buildings for site offices, meeting rooms, first aid, and amenities.
- Temporary fencing and security systems installed around compounds and storage areas.
- Laydown yards formed with compacted gravel or hardstand.
- Crane pads and heavy-lift staging areas constructed with reinforced bases to support delivery and installation of oversized equipment.
- Temporary access tracks established for construction traffic.
- Temporary drainage measures installed around compounds and laydown areas to control stormwater runoff.

Temporary utilities

- Construction power supply (e.g., diesel gensets or temporary grid connection).
- Potable and non-potable water supply for workforce and dust suppression.
- Portable toilet and contractor-serviced holding tanks.
- Lighting towers for extended working hours and/or health and safety.
- Communications (wired and wireless) for safety and coordination.
- Waste management systems established for general waste, recycling, and hazardous materials.
- Demobilisation and reinstatement of temporary facilities following completion, including removal of gravel laydowns and restoration of topsoil.

Design considerations

- Minimise environmental disturbance

- Compounds located for efficient access to main construction zones while minimising impact on sensitive areas.
- Sizing of laydown areas based on equipment volumes, with space for storage and an anticipated 200+ personnel during peak construction.
- Requirements for reinforced hardstands for heavy equipment delivery and storage.
- Temporary crane pads will be constructed to facilitate heavy lifts as needed.
- Temporary power supply will be provided via quiet containerised diesel generators until permanent electrical infrastructure is commissioned.
- Potable water will be brought to site via tanker, with non-potable water drawn from approved local sources.
- Waste management facility requirements will be installed in line with project environmental management plans.

6.5.2 Hinuera Solar Farm

- Indicative locations of the contractors camp, car parking areas and laydown areas are illustrated on the concept civil plans.
- The contractors camp and site parking area will comprise an area of approximately 12,500m².
- The laydown areas will comprise an area of approximately 25,000m².
- Following commissioning, compounds and laydown areas will be deconstructed, with hardstands removed and reinstated with salvaged topsoil, or topsoil spread across the hardstands while ensuring sufficient topsoil to ensure growth of vegetation and water drainage seepage.

6.6 Boundary and Security Fencing

6.6.1 Background

Boundary and security fencing is required to protect the solar farm from unauthorised access, theft, and vandalism while ensuring the safety of the public. Fencing also defines property boundaries and helps manage livestock or wildlife interactions. Within the site, security fencing may be required around critical infrastructure such as BESS pads, transformers, switchroom, and/ or buildings. Design must consider security requirements, fire access provisions, integration with farming activities and integration with ecological and cultural values.

Overall key functions

- Define the perimeter of the solar farm and prevent unauthorised entry.
- Protect critical infrastructure.
- Maintain compliance with electrical safety regulations regarding restricted access zones.
- Allow for safe access by emergency services, including firefighting vehicles.
- Integrate with farming activities, landscape planting and/or ecological mitigation measures.

Fencing construction

- Temporary fencing may be installed during construction to define exclusion zones, protect ecological features, and separate work areas.
- Security fencing typically constructed of chain-link or mesh fencing at heights of 2–2.4 m, topped with barbed wire or security extensions.
- Gates installed at all vehicle and pedestrian access points, with locking mechanisms and provision for emergency access.

- Internal security fencing installed around BESS pads and other high-voltage equipment where required.
- Fence posts embedded in concrete footings at specified depths to ensure stability and resistance to uplift.
- Stock fencing to manage livestock throughout the site post commissioning.
- Quality control includes alignment checks, tensioning inspections, and certification of clearances from electrical equipment.

Design considerations

- Compliance with New Zealand electrical and safety standards for restricted access areas.
- Security design tailored to asset risk profile.
- Security fencing to be located internally to any landscape planting and/or placed with consideration of aesthetics and community values, particularly where the site is visible from public roads.
- Durability of materials (e.g., galvanised or powder-coated steel mesh) to achieve a minimum 35+ year service life.
- Integration with CCTV, lighting, or intrusion detection systems if required.
- Fire access gates provided with clear signage and emergency override features.
- Avoidance of any cultural heritage sites and minimisation of ecological impact.
- Anti-burrowing features to prevent pests accessing and damaging high power infrastructure equipment.

6.6.2 Hinuera Solar Farm

- Temporary fencing will be used during construction to protect exclusion zones and maintain site safety.
- Security fencing will enclose the entire project area at a height of 2 -2.4m, with access gates at designated entry points.
- Fence alignment will follow property boundaries where practicable, while avoiding wetlands and sensitive ecological features where possible.
- Where perimeter planting is provided, security fencing will be located internal to planting.
- BESS pads, transformers and switchroom may be enclosed with dedicated security fencing for additional access control.
- Access gates will be located to ensure compliance with firefighting access requirements, with clear signage provided.
- All fencing materials will be treated to withstand local environmental conditions.

6.7 Fire Access and Firefighting Infrastructure

6.7.1 Background

Fire access and firefighting infrastructure are essential for ensuring site safety and compliance with regulatory requirements. The presence of electrical equipment, transformers, and BESS introduces a fire risks that require some design considerations. Infrastructure must allow emergency services to access all critical areas quickly, provide water supply or suppression systems where required, and ensure that equipment is installed with appropriate fire safety provisions.

Overall key functions

- Provide safe and reliable access for firefighting vehicles to all areas of the site, including BESS, transformers, and control buildings.
- Ensure fire suppression water supply and hydrants are available at required capacities.

- Minimise the risk of fire spread between PV arrays, BESS units, and other infrastructure.
- Support compliance with national fire and electrical safety standards.
- Provide a robust fire management system with a 35+ year operational design life.
- Ensure sufficient water storage and pumping stations.
- Integrate firefighting infrastructure into the overall site layout and emergency response plan.

Fire access and firefighting construction

- Access tracks designed to accommodate firefighting vehicles, with all-weather surfaces and turning radii in line with Fire and Emergency New Zealand (FENZ) requirements.
- Firebreaks created by maintaining clear zones with low vegetation (i.e. short grass) around PV arrays, BESS pads, and transformers as appropriate.
- Fire hydrants or water storage tanks installed at designated intervals, sized to meet FENZ requirements.
- Underground water mains constructed with isolation valves and hydrant connections for redundancy as relevant.

Design considerations

- Compliance with New Zealand Building Code fire safety requirements and FENZ design guidelines.
- Road widths, gradients, and turning circles designed to meet FENZ heavy appliance requirements.
- Fire separation distances applied in accordance with international best practice for BESS installations.
- Integration of early warning systems including smoke and gas detection within BESS units.
- Flammable equipment installed with integrated fire detection. Depending on the equipment, fire suppression systems might also be included.
- Fire-rated separation distances maintained between BESS containers, transformers, and other equipment to limit fire propagation.
- Maintenance and inspection protocols developed to ensure firefighting infrastructure remains operational over the 35+ year service life.
- Site fire management plan prepared and agreed with FENZ prior to commissioning.
- Emergency access gates installed along boundary fencing, with clear signage.
- Lighting provided at firefighting access points for night operations.
- Where reasonably practicable planting, whether for the purposes of landscape mitigation or ecological enhancement, should be selected on the basis of flammability, with reference to relevant FENZ guidelines.

6.7.2 Hinuera Solar Farm

- Access roads provide access to key infrastructure.
- BESS containers will be fitted with integrated fire detection and suppression systems, and monitored via SCADA.
- Emergency access gates will be installed around the boundary and clearly marked for FENZ entry.
- Fire safety infrastructure will be integrated into the commissioning plan, with training provided to local FENZ crews on site-specific systems.

6.8 Water and Wastewater Supply

6.8.1 Background

A reliable water supply is necessary for both construction and operational phases of the solar farm. Construction utilities are discussed in section 6.5. This section therefore focuses on operational water and wastewater requirements.

During operations, water supply is required to support firefighting infrastructure, vegetation management, and ongoing site maintenance. Firefighting requirements are discussed in section 6.7 and should be read in conjunction with this section.

Wastewater infrastructure is required to manage sanitary needs of site personnel and safe disposal of human waste.

Overall key functions

- Provide adequate potable and non-potable water supplies for operational needs.
- Ensure sufficient water storage for firefighting, vegetation management and maintenance.
- Provide sanitary wastewater management for construction and operational phases.
- Ensure compliance with environmental standards and local authority requirements.
- Prevent contamination of soil, groundwater, and surface water.
- Support worker welfare with appropriate amenities.
- Deliver a low-maintenance, durable system with a 35+ year design life for permanent facilities.

Water and Wastewater supply construction

- Water storage tanks and facilities installed
- Potable water supply provided to the site compound and control building via connection to local supply or tanker delivery with on-site storage tanks.
- Permanent wastewater systems installed at the control building and operational compound.
- Non-potable water drawn from approved local sources or via tanker delivery with on-site storage tanks, for long-term vegetation management and dust control.

Design considerations

- Water reticulation systems installed with isolation valves, backflow prevention, and redundancy in line with best practice.
- Separation of potable and non-potable systems to avoid contamination.
- Frost protection considered for above-ground pipework and tanks.
- Pipework and fittings designed for durability and minimal maintenance over a 35+ year life.
- Access provided for water tanker delivery, with reinforced hardstand adjacent to tanks.
- Compliance with New Zealand Building Code and Waikato Regional Council regulations.
- Septic and holding tanks will be constructed of durable, corrosion-resistant materials to achieve a 35+ year design life.
- Wastewater disposal fields located outside sensitive areas such as wetlands or cultural heritage zones.
- The operations and maintenance building will accommodate, on average, approximately 10 FTE, five days a week or as needed over weekends for corrective maintenance.
- Adequate setbacks from property boundaries and watercourses in line with regulatory standards.
- Provision for regular servicing and pump-out without disruption to site operations.

- Integration of wastewater systems with site layout to avoid conflicts with utilities, drainage, or foundations.

6.8.2 Hinuera Solar Farm

Water tanks will be provided for operational and firefighting water. The location, number and capacity of tanks will be determined through a site specific design. Water tanks will likely be filled with a combination of roof supply and trucked in supply.

Wastewater from the O&M building will be disposed of via septic tank, designed in compliance with the relevant wastewater provision of the Waikato Regional Plan.

6.9 Earthworks Volumes

Earthworks volumes, including requirements for aggregate import are based on concept civil design and are set out in the concept civil design and infrastructure report prepared by Maven.

7 Electrical and Grid Connection

7.1 Grid Connection

7.1.1 Background

The 33 kV grid connection forms the critical interface between the solar farm and the regional electricity network, enabling the export of generated power to electrical grid. This infrastructure must be designed and constructed to ensure long-term reliability, safety, and compliance with New Zealand's electrical standards and the connection requirements. The solar farm consist of multiple key electrical equipment to enable the successful and safe evacuation of electricity, including the switchroom, ancillary services, SCADA and cabling. The switchroom has been explained in section 5.2.8.

7.1.2 Hinuera Solar Farm

Electricity will be collected from various internal 33kV power cables at the Hinuera switchroom. From the switchroom, 33kV main cables connect the solar farm with the electrical grid owned and operated by Powerco. The Powerco substation, also referred to as *Hinuera Substation*, or *Lake Road Substation*, is located at the corner of State Highway 27 and Lake Road.

To electrically connect the solar farm with the Powerco substation, 33kV cabling would be installed between the two points via public road reserves or private land easements. To enable this work HENZ will apply for Electricity Operator Status, under section 4A and 24 of the Electricity Act in respect of this project – following the grant of all relevant resource consents. Electricity Operator Status has been granted to HENZ in respect of its other projects, accordingly, there are no concerns with the likely success of such an application. Electricity Operator Status affords rights for the construction, placement and maintenance of electrical infrastructure within the road reserve. The usual authorities (i.e. CAR approval, TTMP) are still required for all work within the road reserve.

The exact location/route of the cable will be determined following detailed design, which will include a survey of all existing services within the road reserve.

7.1.3 Works within the Powerco Substation

The Hinuera solar farm will connect directly to the Powerco 33 kV network with a maximum grid capacity of 80 MW. Although the design is still be finalised, it is expected that the minimum of one additional 33kV breaker would be required at the Powerco substation to connect the solar farm. This might require the extension of the building to accommodate the additional breaker and protection/ metering panels.

Any requirements for resource consent to enable works within the Powerco substation falls outside of this application and will be managed separately.

7.2 Cable and Trenching details

7.2.1 Background

Utilities and cable routing form the critical connections between the various elements of a solar farm, enabling the safe and efficient transfer of power, communications, and control signals. Careful planning of routing minimises voltage drop, avoids clashes with existing services, drainage and roads, and ensures safe, maintainable systems for the life of the project.

Overall key functions

- Provide safe and efficient electrical and communication pathways between PV arrays, BESS, inverters, transformers, and grid connection.
- Minimise voltage drop and electrical losses through optimised routing and conductor sizing.
- Protect cables from mechanical damage, water ingress, and thermal stress.
- Provide reliable earthing and bonding systems for equipment safety.
- Allow for future maintenance, inspection, and potential expansion.

Utilities and cable routing construction

- Trenching works coordinated with earthworks and drainage to maintain clearances and avoid rework utilising the smallest machinery practicable.
- Multiple ducts or cable trays used for segregating DC, AC, communication, and control cables as needed.
- Trenching completed in sections to minimise open trenches.
- Trenching backfilled as soon as practicable.

Design considerations

- Compliance with applicable New Zealand electrical standards and codes.
- Routing designed to minimise cable length and voltage drop, while accommodating site constraints.
- Conduits sized for thermal capacity and future pulling of replacement cables.
- Adequate separation between DC and AC circuits to reduce interference and heating.
- Fire-safe routing around BESS, including sealed duct entries and flame-retardant cable insulation.
- Use of concrete encasement or protective covers where cables cross under roads or areas with heavy traffic.
- Cable bends designed to respect minimum radii for high-voltage and fibre optic cables.
- Installation of reinforced underground conduits and cable pits at BESS, transformer and switchroom pads to accommodate high-capacity connections.
- Earthing systems installed in accordance with electrical standards to ensure equipotential bonding between all metallic or electrical infrastructures.
- Fibre optic and SCADA communication cables installed in dedicated conduits or sleeves.
- Drainage integrated with trenches to avoid water ingress; subsoil drainage where required.

- Expansion capacity considered for future BESS augmentation or PV expansion.
- Above cable route marking, warning tape and mechanical cable protection laid above buried services for future identification and protection
- As-built surveys and cable test records (insulation resistance, sheath integrity, commissioning tests).
- System designed for a minimum 35+ year operational life, with consideration of derating factors (temperature, soil resistivity).

7.2.2 Hinuera Solar Farm

- DC string cabling will be routed on mounting structures until the end of each row followed by underground trenches from PV blocks to central inverters.
- High-strength conduits will be installed beneath key infrastructure, with additional conduits for communication and fire monitoring systems.
- Earthing grids will be integrated with electrical and mechanical equipment, designed to handle the fault currents and meet touch/step voltage requirements.
- Internal cable routing, we possible, will be aligned with access roads to simplify construction and minimise land disturbance.
- Road crossings will use conduits or concrete-encased ducts at appropriate depths to provide protection from heavy vehicle loads.
- All buried services will be clearly marked on as-built drawings, with GPS coordinates logged for long-term asset management.

Cable Types

The main cable types within the site will be:

- DC string cables – connecting the modules or Arrays to the string combiner boxes or string inverter.
- DC main cables – connecting the string combiner boxes to the PCU's.
- LV main cables – connecting the string inverter to the STS station.
- 33kV cabling (medium voltage cabling) – connecting the PCUs or transformers to the on site switchroom and then with Powerco substation.
- Earthing, Fibre and Communications Cables – Earthing cables connect every mechanical structure to each other for the purpose of establishing equipotential bonding. Fibre and communications cables providing connections between and for the inverters, BESS, O&M building, weather stations, CCTV and SCADA.

All of the above cables require different trenching specifications and specifications will vary depending on the number of cables within each trench. Additionally, where possible earthing, fibre and communications cabled will be co-located with other cables to reduce the requirement for trenching.

Typical cable cross sections have been provided with the substantive application and will be refined during the final design.

Approximate trenching lengths are included in Table 4, over the page

Table 4: Approximate Cable Lengths

Cable Type	Approximate Total Length (m)
Earthing Cable	2450
DC String Cables	3901
DC Main Cables	7573
MV Cables	8166

7.2.3 Above Ground Cabling

It is anticipated that underground cabling will be utilised both within the site and between the onsite switchyard and the Powerco substation. However, in the event underground cabling is found to be unsuitable in any locations, above ground cabling may be required. If that occurs, any associated structures (poles/pylons) will comply with the relevant permitted standards.

8 Construction Detail

8.1 Construction Timing and Sequencing

Construction is likely to take approximately 18-24 months to complete from start to finish.

Construction sequencing is determined by the contractor, but will generally follow the below sequence:

1. Site establishment
   a. Establishment of main on-site access roads and establishment of contractor compound
   b. Establishment of laydown areas and commencement of on-site roading
   c. Perimeter/security fencing
   d. Installation of health and safety signage
   e. Mitigation screen planting as required
   f. Implementation of management plans, in particular noise and soil erosion
2. Civil works
   a. Roadworks
   b. Flood model and drainage system
   c. Foundation
   d. Building and warehouse constructions
3. Mechanical works
   a. Piling
   b. Mechanical construction (installation of tabletop structures/frames)
   c. Fixing of panels to tables
   d. Installation of all ancillary electrical infrastructure (PCU's, string combiner boxes, etc)
4. Electrical works
   a. Installation of the switchroom
   b. Cabling and trenching
   c. Cable terminations and interconnections
   d. Weather station, SCADA, CCTV, and other ancillary services
5. Grid connection

    a. Cabling works between the solar farm and the grid connection
    b. Any upgrade or interconnection works required at the point of connection
    c. Testing and handover to the grid owner
6. Testing and commissioning
    a. Cold commissioning, including testing of all components
    b. Hot commissioning
    c. Energisation of the grid
    d. System compliance and performance testing
7. Demobilisation, including removal of all construction machinery and removal of contractors camp.
8. Transition to operational activities
9. Commencement of maintenance period

It is noted that while the above activities are listed sequentially, in practice they will have some overlap. For example, the beginning of mechanical works will likely overlap with the completion of civil works and high voltage works and electrical commissioning will commence prior to the completion of all mechanical installation. An indicative and simplified program is included in Figure 20.

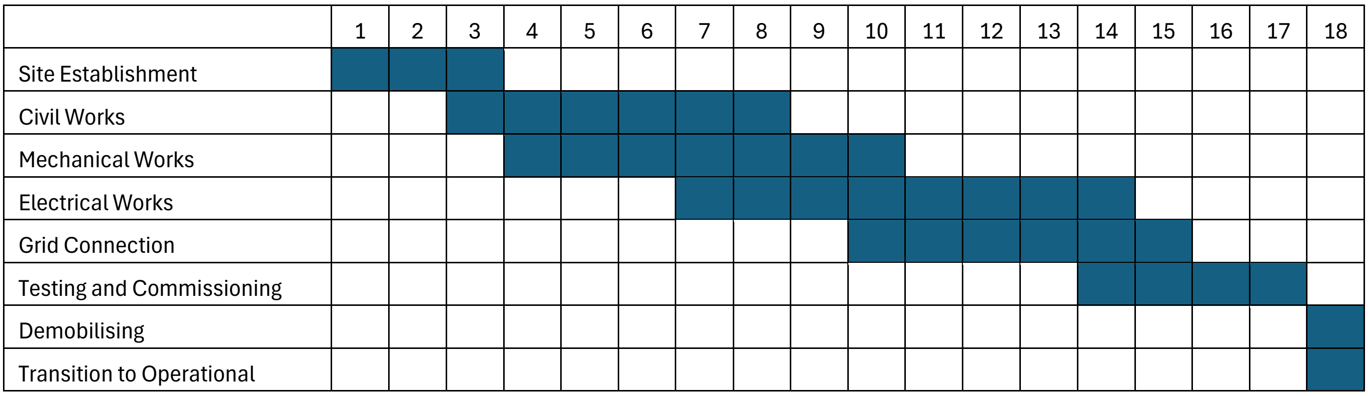


Figure 20: Indicative Construction Program

Note, an 18-month construction program has been provided for the purposes of construction as this will condense traffic movements, however, construction may take up to 24 months.

8.2 Construction Hours

Construction activities will generally occur over a six-day week (i.e. Monday – Saturday), between 7am and 6pm. However, quiet work, staff arrivals and departures and deliveries may occur outside of these hours. There will also be a security and CCTV monitoring presence on site 24 hours a day, seven days a week, during the construction phase of the project.

8.3 Staff Numbers

Staff numbers will fluctuate throughout the construction phase, with the structural construction phase requiring the greatest staff numbers. Estimated staff numbers for each stage of construction are included in Table 5, over the page.

Table 5: Anticipated Staff Numbers

Phase	Estimated Staff Numbers
General site administration/management staff	10-30
Site establishment	15-30
Civil works	10-25
Mechanical construction	30-70
Electrical works	20-70
Grid Connection	10-30
Electrical Commissioning	10-20
Transition to Operational	10

Given the overlap between tasks, at peak construction there will be approximately 180 staff on site.

Environmental assessments and designs should allow for the upper end of the ranges provided above.

8.4 Construction Access

The primary Construction access will be via the existing tanker track serving 8302 SH 27. This access will be upgraded in accordance with the Transport Assessment Report.

A second access will be provided via SH 29 either at the existing access servicing the dwelling and dairy shed at 4739 State Highway 29, or a newly created entrance located in accordance with the Concept Civil designs and Transport Assessment Report. The second access will primarily be used to service the portion of the solar farm located to the north of the Mangawhero Stream, in order to minimise heavy vehicle movements across the stream.

8.5 General Methodology

8.5.1 Equipment/Machinery

Civil and construction works will be carried out with a range of plant. Typical plant is including in Table 6, however additional plant may be utilised.

Table 6: Plant List

Plant	Noise level at 10m from plant (dB L_{Aeq})
Driven piling (ramming machine)	97
Woodchipper	86
Hydraulic breaking (concrete)	84
Drill rig	79
Directional drill	77
Plate compactor	77
14t bulldozer	77
7t bulldozer	73
6t padfoot roller	73
Concrete pump and truck discharging	72

Front end loader	72
Excavator mounted 600kg drop hammer	72
Excavation and loading trucks with 30t excavator	72
100t mobile crane under load	71
Excavation and loading trucks with 20t excavator	69
Generator	66
5t vibratory compaction roller	66
20t grader	65
Use of power tools	65
10t grader	62
Watercart (10,000l)	62
Idling dump truck	62
5t static compaction roller	62

Note: The above noise levels should be verified by the acoustic engineer. Additionally, any modelling should allow for the simultaneous operation of plant across the site – including approximately 10 piling rigs operating at any one time across the site.

8.5.2 Delivery Traffic Sizing

The majority of deliveries will occur via standard truck and trailers units. Oversized deliveries may be required for pre-fabricated buildings (contractor's camp, O&M, switching building, warehouse), large cable drums if required, and water tanks.

8.5.3 Dewatering

To allow for efficient construction, it may be necessary to dewater both trenches and foundations in the event of either rainwater or ground water intrusion.

Dewatering extraction techniques are likely to include:

- Direct extraction using a sump pump (trenching and shallow foundations).
- Well pointing (substation foundations).

Retention/Discharge methods are likely to comprise of a mix of the following:

- Temporary storage and reuse for non-potable purposes such as within a water cart for dust control.
- Controlled discharge to land, utilising the likes of: a decanting earth bund; turkeys nest; sediment retention ponds; sediment dewatering bags.
- Chemical treatment may also be utilised for the purposes of removing sediment.

8.5.4 Traffic

Heavy traffic numbers will fluctuate during the construction period, with peak deliveries occurring in relation to civil works (being the delivery of aggregate) and during the mechanical construction phase (being delivery of steel piles and panels).

The estimated heavy vehicle movements are set out in Transport Assessment Report and are anticipated to peak at 30 per day during months 5 and 6 of construction.

On the assumption that all construction staff will travel individually to site, staff movements are anticipated to peak at 320 per day, during month 14 of construction in the period during which mechanical installation and electrical works overlap. In practice, it is likely that some staff will carpool to site, reducing the peak number.

9 Operational Details

9.1 On-Site Resourcing

To ensure reliable operations, the solar farm requires dedicated staffing for daily supervision, preventative maintenance, corrective maintenance, and emergency response. Resourcing levels should be sufficient to cover electrical, mechanical, and vegetation management tasks, as well as monitoring and reporting functions.

The operational team would generally consist of:

- Operations staffing: 1 site manager, 1 site receptionist and administrator, 2-3 operators, and 2–3 full-time technicians, 1-2 security guards on site during business hours (Mon–Fri, 40 hours/week each).
- Corrective maintenance personnel as required to remediate the specific issue.
- Seasonal contractors as required for vegetation, module cleaning, civil works as drain cleaning, or specialist testing.
- Security monitoring: monitored on-site by the security guard and 24/7 via remote SCADA/CCTV platforms.

9.2 Corrective Maintenance and Response Times

Corrective maintenance addresses faults or failures that occur during operations. Response times vary depending on the criticality of the issue and its impact on safety, production, or compliance. Generally, corrective maintenance would occur within the below time frames:

- Critical faults (grid connection loss, major inverter/BESS failure, fire safety systems offline): response within 2–4 hours, resolution target within 24 hours.
- High priority (reduced plant output, partial inverter failure, major road blockage, significant storm damage): response within 24 hours, resolution target within 72 hours.
- Medium priority (non-critical equipment failure, fencing damage, routine panel replacement): response within 3–5 days, resolution target within 2 weeks.
- Low priority (cosmetic issues, non-urgent vegetation trimming, signage repair): scheduled during next routine maintenance window, typically monthly to quarterly.

9.3 Preventative Maintenance

Preventative maintenance is essential to keep the plant operational and in good, safe working conditions.

9.3.1.1 PV Modules and Arrays

Solar panels form the core generation asset. To maintain efficiency and extend lifespan, they require routine inspections and cleaning. Regular thermal and electrical testing assists in identifying underperforming strings or hot spots before they escalate into failures. PV modules would be cleaned at least once per year with certain high traffic areas (next to gravel roads) requiring more frequent cleaning. The PV modules are cleaned with either clean water or environmentally friendly cleaning solutions.

9.3.1.2 Inverters, Transformers, and Switchgear

Inverters, transformers, and switchgear are critical for converting DC output to grid-compatible AC power. Their continuous operation is vital for plant performance, and preventative maintenance reduces the risk of overheating, failure, accidental environmental accidents, and downtime resulting in a loss of generation.

9.3.1.3 Battery Energy Storage System (BESS)

The Battery Energy Storage System (BESS) supports grid stability and energy storage but carries heightened safety risks, including fire. Regular monitoring and specialist inspections are essential to ensure safe and reliable operation.

9.3.1.4 Monitoring, Control, and SCADA Systems

SCADA and control systems provide real-time monitoring, data analysis, and alarms across PV, BESS, and electrical systems. Their integrity is crucial for performance optimisation, control of the facility, fault detection, site safety, and general maintenance.

9.3.1.5 Electrical Protection, Cabling, and Earthing

Cabling, protection systems, and earthing safeguard equipment and personnel. Periodic testing ensures resilience against faults, surges, and lightning strikes.

9.3.1.6 Access Roads and Internal Tracks

Access roads and tracks must be maintained in all weather conditions to support site operations and emergency access. Preventative works minimise erosion and maintain safe travel routes.

9.3.1.7 Stormwater and Drainage Systems

Effective drainage prevents flooding, erosion, and foundation damage. Regular inspections ensure swales, culverts, and basins operate as designed. Additional inspections and cleans would be undertaken after heavy storms or rains to ensure drains are free-flowing.

9.3.1.8 Vegetation Management and Groundskeeping

Vegetation must be controlled to prevent shading, maintain fire safety, invasive weed infestation and ensure operational access. Sheep grazing is the primary method, supported by mowing and weed control as required. Healthy vegetation helps prevent erosion and ground scouring.

9.3.1.9 Perimeter Security and Fencing

Fencing and security systems maintain asset protection and site safety. Regular inspection and prompt repair are required to maintain an effective security barrier.

9.3.1.10 Fire Safety and Emergency Preparedness

Fire prevention and response are critical, particularly for electrical systems and BESS. Fire systems, hydrants, and access must be maintained in readiness.

9.3.1.11 Waste and Recycling Management

Safe handling and disposal of defective panels, oils, and batteries prevent environmental harm. Recycling obligations must be maintained through secure storage and contractor collection.

9.3.1.12 Sheep Grazing and Vegetation Control

Sheep grazing supports dual land use, reduces mowing needs, and helps maintain grass levels for fire safety. Animal welfare depends on well-maintained fencing and water troughs. The design will need to consider the welfare of livestock among the site equipment and how best to protect both the facility and animals.

9.3.1.13 O&M Building and Warehouse

The on-site O&M building will securely house tools, spares, and PPE needed for daily and specialist maintenance activities, these may include but will not necessarily be limited to:

- General electrical testing equipment: multimeters, clamp meters, insulation resistance testers, earth resistance testers
- Thermal imaging camera (handheld) and drone-mounted thermal camera
- IV curve tracer and string-level testing equipment
- Partial discharge tester and HV test equipment
- SCADA backup hardware and software
- Cybersecurity toolkit and secure storage media
- Personal protective equipment (PPE): arc flash suits, FR clothing, helmets, harnesses, gloves
- Portable fire extinguishers, hydrant fittings, pressure test kit
- Cable tools: crimpers, cutters, locators, torque wrenches, connectors
- Earthing and grounding spares
- Vegetation tools: brush cutters, ride-on mower, chainsaws, spill kits
- Road/earthworks tools: shovels, compactor, grader (contractor arrangement)
- Water and trough equipment: portable pumps, hoses, troughs, repair kits
- Livestock equipment: fencing units, fence testers, posts, wire, veterinary kit
- Waste management containers: panel racks, oil drums, recycling storage
- Access and lifting gear: ladders, MEWPs, slings, shackles
- Workshop consumables: hand tools, fasteners, tapes, lubricants
- First aid kits (staff and livestock), emergency response kit
- Documentation: O&M manuals, datasheets, contact lists
- Spare parts: spare equipment to maintain the plant

10 Decommissioning/Re-Energising

At the completion of the useful life of panels, one of two options are available: decommissioning or re-energising. These are described in the following subsections.

10.1 Decommissioning

If the site is decommissioned, all infrastructure can be removed and the site returned to pasture. If this occurs all components will be recycled to the extent possible. Specifically:

- In respect to the modules, 100% of the metal is re-used, 95% of glass is re-used and 85% of silicon is reused. In modern solar panel recycling processes, even the heat used to separate the materials is captured and re-used. It is anticipated that by the time the solar farm would be decommissioned, the recycling process would be further developed with higher recycling efficiencies.
- The mounting structure is made of steel which can be 100% recycled.
- The more complex electrical infrastructure is designed to be recycled because it is comprised of valuable materials such as aluminum, copper and stainless steel.
- Components such as lithium, cobalt, nickel, copper and graphite incorporated in BESS are recyclable but specialised facilities are required to extract and recycle these components.

New Zealand does not yet have any large-scale recycling program for either panels or utility scale electrical components; however, it is anticipated that the establishment for such services will be driven by increasing demand over the life of the solar farm. Recycling, upgrading and disposal requirements will be guided by government requirements at the time of decommissioning; whether this be to a New Zealand based recycling facility, overseas based recycling facility, or to licensed landfill. Harmony will dispose of the panels in accordance with regulatory requirements at the time of decommissioning.

10.2 Repowering

Despite operating in harsh conditions, the PV modules would still be able to produce at the minimum 85% of its original power of day-one power in 35 years time. As an alternative to decommissioning, the site could be repowered by replacing key equipment as needed. Any consent(s) required under this approach would be obtained at the time.