



KZN Operating Unit

Network Engineering & Asset Design

Project overview and objective

- The project provides off-grid Solar Home Systems (SHSs) as an electrification solution for 59 households and Maqhashiya Primary School in Mashaqiya Village, located approximately 20 km south of Melmoth in KwaZulu-Natal.
- The objective is to provide a reliable, sustainable and cost-effective electrification solution, supported by a practical, safe and SANS 62305-compliant earthing and lightning protection system to ensure personnel safety, equipment protection and continuity of electricity supply.
- The project area is rural and includes dispersed homesteads across uneven, rocky and elevated terrain. Access is mainly via local gravel roads, with some households requiring river crossing and pedestrian bridge access.
- The proposed SHSs will be installed within individual household yards. The site includes residential dwellings, Maqhashiya Primary School, local access roads and a pedestrian bridge.

1. Solar Home System Description

Each Solar Home System (SHS) installation shall comprise, as applicable, a 5.4 kWp Solar PV array, 5 kW hybrid inverter, 5.3 kWh lithium battery system, telecommunications equipment, AC and DC protection systems, customer reticulation and metering interface equipment, and all associated civil, structural, electrical, earthing and lightning protection infrastructure required to provide a complete operational installation.

2. Contractor scope statement

The Contractor shall procure, supply, deliver, install, test, commission, document and hand over the complete Solar Home System works, including all associated civil, structural, earthing, lightning protection, equipment installation, quality control, health and safety, environmental management and rehabilitation requirements needed to provide a complete and compliant installation at each approved installation site.

The Contractor shall execute the works in accordance with the approved design drawings, project specifications, Eskom standards, applicable SANS requirements, manufacturer requirements, the Health and Safety Specification, and written instructions issued by the Engineer / Project Manager.

3. Procurement and supply requirements

- Procure and supply all equipment and materials required for the complete SHS installation, including PV support structure components, equipment enclosure support components, foundation-related materials, concrete, reinforcement, earthing materials, lightning protection components, bonding materials, labels, fasteners, inspection pits, testing equipment and consumables.
- Supply and install a Class III Lightning Protection System comprising four, 1 m high aluminium air termination rods mounted on the PV carport structure edges.
- Supply and install two 3 m long, 16 mm diameter copper-clad steel earth rods according to the design drawings, interconnected using 10 mm diameter round copper conductor.
- Supply and install 10 mm diameter round copper conductor for the equipotential bonding of the PV carport structure, equipment enclosure support structure and associated metallic components to the common earthing system.
- Supply 50 mm x 3.15 mm flat copper bar for bonding foundation bolts inside each foundation and for connection of the steel support structure to the earth mat through the holding down bolts.
- Provide earthing and equipotential bonding connections for AC and DC Surge Protection Devices (SPDs) to ensure integration with the common earthing and lightning protection system.
- Ensure materials delivered to site are received by a competent person, kept in a complete inventory, stored in accordance with manufacturer and Eskom specifications, secured against vandalism and theft, kept dry where required, and protected from water, mud and damage.
- Replace or repair equipment damaged in transit or during construction at the Contractor's cost if required by the Design Engineer / Clerk of Works.
- Procure and supply Solar photovoltaic modules and associated mounting systems required for each complete SHS installation.
- Procure and supply 5 kW hybrid inverter systems and 5.3 kWh lithium battery systems.
- Procure and supply AC and DC protection equipment, associated accessories, customer reticulation and metering interface equipment.
- Procure and supply equipment enclosure ventilation and cooling systems required for the safe and reliable operation of inverter, battery and associated electrical equipment.
- Procure and supply telecommunications and remote monitoring equipment, including GPRS communication equipment and any required communication accessories for integration with the inverter monitoring platform.
- All equipment supplied shall be new, fit for purpose, and compliant with approved design drawings, Eskom standards, manufacturer requirements and relevant SANS requirements.

4. Civil and structural installation scope

- Clear and grub all vegetation and organic material within 1.5 m of the foundation footprint.
- Strip topsoil to a minimum depth of 150 mm in areas to be excavated. Stripped topsoil shall not be used as backfill unless approved for later use by the Environmental Control Officer where applicable.
- Prepare excavations for new foundations so that the bottom is flat, level and horizontal. Where solid rock is encountered at founding depth, clean and dry the surface and implement stepping or dowelling where required to prevent lateral movement.
- Place all backfill in 150 mm layers and compact to 93% Modified AASHTO density. Backfill within 500 mm of the foundation footprint shall not contain organic matter or stones larger than the lesser of 150 mm or two-thirds of the layer thickness.
- Install a 50 mm thick Grade 15 concrete blinding layer before placing reinforcement.

- Prepare suitable steel shuttering / formwork for foundation concrete pouring in accordance with the applicable foundation drawing.
- Accommodate structure earthing within the foundations, in line with the electrical specification and applicable foundation drawings.
- Protect newly placed concrete from rapid drying and extreme temperature changes and cure for at least seven days using accepted curing methods such as water spray, plastic sheeting or approved curing compounds.
- Ensure all structural foundations match the dimensions, positions and engineering details shown on the foundation design drawings.
- Erect all structural load bearing elements in strict accordance with the engineering documentation and structural design drawings.
- Install all structural members and connection systems in accordance with the structural connection design drawings.
- Mount and place Solar PV panels in accordance with the engineer's provided design and drawing specifications.

5. Site survey, positioning and orientation

- Undertake a high-level site survey to determine the most suitable installation site for each Solar Home System in conjunction with the design engineer's studies and approved design information.
- Identify, set out and confirm the final location of each Solar PV support structure and associated pole-top equipment in accordance with the approved design drawings and site-specific constraints.
- Orientate each Solar PV array to face True North to optimise solar energy yield, unless site-specific conditions or written instruction by the Engineer require otherwise.
- Use an approved surveying method, GPS device or suitable compass corrected for magnetic declination to establish True North.
- Verify the final position and orientation before foundation construction and panel installation.
- Report obstructions, shading concerns or site conditions that may affect the required orientation to the Engineer for review and approval before installation proceeds.
- Position the associated pole-top box to fulfil its operational requirements, integrate with relevant system infrastructure, facilitate maintenance access and maintain compliance with the required Solar PV array orientation and electrical design requirements.

6. Electrical, earthing and lightning protection scope

- Install and connect all equipment detailed in the design in accordance with the relevant Eskom and/or manufacturer specifications, applicable detailed design drawings, project specifications and sound engineering practice.
- Install the Type A earth termination arrangement consisting of two 3 m long, 16 mm diameter copper-clad steel earth rods interconnected using 10 mm diameter round copper conductor.
- Install the round copper conductor at a depth of 0.6 m below finished ground level and concurrently with the earthworks to minimise disturbance of final formed and compacted surfaces.
- Install and bond the conductor within foundations to the steel support structure to provide equipotential bonding and connection to the common earthing system.
- Complete all joints, crossings and interconnections of the earthing system using Silbralloy brazing to achieve permanent, low-resistance and mechanically robust electrical connections. Sample joints shall be approved by the Clerk of Works before brazing proceeds on site.
- Complete joints between round copper and copper-clad steel earth rods using exothermic welding.

- Bond all four corners of the PV carport structure and the equipment enclosure support structure to the main earthing system.
- Install the enclosure earth busbar within the equipment enclosure and connect it to the main earthing system. The busbar shall provide termination points for the inverter, battery system, AC and DC SPDs, equipment enclosures, support structure and associated bonding conductors.
- No earthing or bonding is required for the pole-top box structure where it is non-metallic and does not introduce exposed conductive parts.
- Earth LV cable armouring at both ends through the cable gland where the gland plate is conductive, or by adding an earth ring where the gland plate is non-conductive. Bond earth rings and gland plates to the earth bar/stud where necessary.
- Earth all spare cable cores at the panel end by lugging and bolting the cores together per cable, connected to the earth bar/stud using a single green earth core with ferrules numbered to the cable number.
- Use only brass or stainless-steel bolts, nuts and washers for electrical connections. Galvanised or electroplated bolts are not acceptable for these electrical connections.
- Fit all applicable operational labels to equipment, junction boxes and control boxes, and install OHS Act safety and warning notices where appropriate.
- Install and commission hybrid inverter systems in accordance with the approved design, manufacturer specifications and Eskom standards.
- Install and commission lithium battery energy storage systems in accordance with manufacturer requirements and approved design documentation.
- Install AC and DC protection equipment, including all required isolation, protection and coordination devices.
- Install customer reticulation and metering interface equipment as detailed in the approved design documentation.
- Install ventilation and cooling systems required for the safe operation of inverter, battery and control equipment housed within the equipment enclosure.
- Install and configure all telecommunications and monitoring equipment necessary for remote system performance monitoring.

7. Telecommunications and Remote Monitoring

The Contractor shall supply, install, configure, test and commission the telecommunications and remote monitoring systems associated with the Solar Home System installations.

- Supply and installation of GPRS communication equipment with eSim capabilities.
- The Contractor shall supply, activate and use an eSim for the installation.
- Integration with the inverter monitoring platform.
- Configuration of remote monitoring functionality.
- Configuration of alarming and notification functionality.
- Provision of system reporting capabilities.
- Verification of communication functionality during commissioning.
- Demonstration of successful communication between each installed SHS and the designated monitoring platform prior to submission for completion.

8. Testing, commissioning and acceptance

- Install and commission one complete Solar Home System as a pilot installation before commencing the remaining installations.

- Perform all specified inspections, tests and measurements on the pilot installation, including earth resistance testing. Where required earth resistance or other performance criteria are not achieved, install additional earth electrodes or implement other corrective measures and retest until compliance is demonstrated.
- Perform testing and commissioning of the earthing and lightning protection system, including earth continuity testing, bonding verification, earth resistance measurements and verification of overall system functionality.
- Undertake preliminary testing of cables to prove correct installation.
- Ensure final testing and commissioning of installed electrical equipment is performed by the manufacturer, Eskom, or an Eskom appointed contractor where specified.
- Verify successful operation of all GPRS communication equipment.
- Verify connectivity between field equipment and the inverter monitoring platform.
- Verify functionality of alarms, status reporting and communication interfaces.
- Verify reliable transmission of operational data from each SHS to the monitoring platform.
- Complete concrete cube testing in compliance with SANS 5860, SANS 5861 and SANS 5863 where applicable to the concrete works.
- Submit all relevant test results for materials, workmanship and commissioning to the Engineer / Project Manager for review and acceptance.
- The earthing system may only be buried after acceptance of the earthmat jointing and testing by the Design Engineer and/or Clerk of Works.

9. Quality assurance and hold points

- The Contractor shall be solely responsible for producing work that complies with the specifications to the satisfaction of the Engineer and shall implement an appropriate quality assurance system on site.
- The Contractor shall provide regular feedback on quality control as a prerequisite to final handover / takeover.
- All hold points shall be observed. No further work shall continue beyond a hold point until inspection and approval is obtained from the Design Engineer and/or Clerk of Works.
- The Contractor shall give suitable notice to the Design Engineer and Clerk of Works for inspection.
- Upon completion and submission of each portion of the Works for examination, the Contractor shall provide the Engineer with relevant tests, measurements and levels to confirm compliance.
- The latest revision of Eskom document 240-87605434, Quality Checklist for Distribution Substation Primary Plant Prior to Handing Over for Commercial Operation, shall be completed for the applicable civil and electrical portions and returned with the as-built documentation.

10. Engineer's Health, Safety and Site Control Specifications

- Comply with the Occupational Health and Safety Act and Regulations, No. 85 of 1993, and applicable Construction Regulations.
- Submit an Occupational Health and Safety Plan for approval, addressing the mitigation of anticipated project-specific onerous site conditions.
- Appoint a full-time competent construction supervisor in writing and appoint additional competent employees in writing where required.
- Ensure all relevant PPE is worn at all times and Eskom Life Saving Rules are adhered to at all times.
- Prepare method statements for the project and each individual activity.
- Perform risk assessments before and during construction, by a competent person appointed in writing, and include the Project Risk Assessment in the Health and Safety Plan.

- Ensure work at elevated levels is supervised, fall arrest systems are issued and training completed where required, and no work is undertaken directly beneath personnel working at height.
- Ensure excavations are supervised, shored and barricaded as required. Orange plastic netting supported on rigid poles/posts is identified as the acceptable barricading method for excavations.
- Restrict construction equipment and mobile plant to trained and authorised operators, maintain and inspect plant daily, and ensure lifting equipment certificates are current.
- Appoint a Responsible Person in writing for electrical work, testing and commissioning, and appoint an authorised person in writing to issue the Certificate of Compliance for the LV installation where required.
- Maintain good housekeeping, correct storage of materials and equipment, regular removal of scrap/waste/debris, and establish secure storage areas.
- Maintain fire precautions, prohibit open fires, make fire extinguishing equipment available, train sufficient site employees, and complete emergency appointments in writing.
- Control site access, prevent unauthorised access, and do not remove Eskom property without written authorisation from the Project Manager.

11. Environmental, access and community constraints

- Keep to existing access roads and approved access routes at all times.
- No cut-and-fill operations, road construction, road widening, vegetation clearing or establishment of temporary access roads may be undertaken without prior written Eskom approval.
- Submit any proposed deviation from existing access arrangements to the Engineering, Environmental and Execution Departments responsible for review and approval before implementation.
- Confine operations to as small an area as practical and do not disturb natural vegetation except where essential for execution of the work or directed by the Engineer.
- Do not cut or remove indigenous vegetation without required tree cutting permits from DFFE.
- Apply weed killer to finished floor level before commissioning only with direct authorisation from the project environmental specialist.
- Protect watercourses. Construction vehicles crossing the river must have no oil leakage or other contaminating substances and may cross only at the designated area agreed by the Environmentalist and Engineer.
- No abstraction of water from the river is permitted for construction purposes. Provide potable drinking water for workers.
- No washing of vehicles or construction equipment is allowed in the river. Conduct all concrete mixing on an impermeable surface and prevent cement-containing water from entering the river.
- Dispose of surplus and unsuitable material at legal spoil areas arranged by the Contractor.
- Rehabilitate the site in accordance with the Environmental Management Plan.

12. Proposed construction sequence

1. Site access issued by the Project Manager; all permits, safety documentation and risk assessments completed.
2. Site survey, final position confirmation and True North orientation verification for each installation.
3. Site clearing, vegetation control and topsoil removal.
4. Civil bulk earthworks, intermediate excavation, removal of boulders where applicable, and backfilling with approved material.
5. Setting out of PV carport positions and earthing system locations.
6. Excavation and installation of 50 mm x 3.15 mm flat copper conductor within foundations for equipotential bonding and connection to the common earthing system.
7. Establishment and casting of carport foundations and equipment enclosure support foundations.

8. Installation of earth rods, inspection pits and 10 mm diameter round copper conductor for earth rod interconnection and connection to the common earthing network.
9. Erection of galvanised steel PV carport structure.
10. Installation of equipment enclosure support structure.
11. Installation of air termination rods on PV carport structure.
12. Bonding of all four corners of the PV carport structure and the equipment enclosure support structure to the main earthing system.
13. Provision of AC and DC SPD earthing and bonding connections.
14. Installation and placing of Solar PV panels, equipment and associated connections.
15. Installation, configuration and communication verification of telecommunications and remote monitoring equipment.
16. Pilot SHS testing and commissioning, including earth resistance testing and corrective works if required.
17. Testing and commissioning of all installed equipment and systems.
18. Site rehabilitation and handover documentation submission.

13. Contractor deliverables and handover documentation

- Approved Health and Safety Plan and risk assessments.
- Written appointments and authorisations, including construction supervisor, Responsible Person and authorised testing / commissioning personnel.
- Method statements for project activities and critical tasks.
- Material delivery records, receiving inspections, inventory records and storage records.
- Quality assurance records, hold point sign-offs and Clerk of Works / Design Engineer inspection records.
- Concrete test results, compaction records, survey/setting-out records and foundation alignment verification records.
- Earthmat sample joint approval, earthmat inspection records, earth continuity results, bonding verification records and earth resistance measurements.
- Pilot installation commissioning results and records of any corrective measures implemented.
- Commissioning test records for primary and control plant equipment and all relevant SHS equipment.
- Marked-up drawings and as-built package, including all relevant primary and control plant marked-up drawings. All documents and drawings shall be submitted in their editable format as well as PDF file format's.
- Certificates of Compliance for LV installation where applicable.
- Operation and Maintenance manuals for Solar PV modules, inverter systems, battery systems, telecommunications equipment and ancillary equipment.
- Telecommunications commissioning reports, including GPRS communication verification records.
- Monitoring platform configuration records and communication interface test records.
- Remote monitoring, alarming and reporting system acceptance records.
- Confirmation that each completed SHS installation is functional and ready for handover to Eskom.
- Completed applicable sections of the Eskom quality / handover checklist and final handover package.

14. Operation and Maintenance Requirements

The Contractor shall include operation and maintenance support during the defects liability period for the Solar Home System installations. These requirements are intended to support safe operation, sustained performance, early defect identification and orderly handover to Eskom.

14.1 Defects liability obligations

As part of the defect's liability period, the Contractor shall correct defects attributable to any of the following:

- Poor workmanship.
- Incorrect installation.
- Defective materials.
- Failure to achieve the specified performance requirements.

14.2 Maintenance services during the defect's liability period

The Contractor shall create a preventative maintenance schedule, a corrective maintenance plan and provide maintenance services during the defect's liability period, including the following as applicable in conjunction with 240-171000351:

- Quarterly Scheduled inspections.
- Quarterly cleaning of relevant Solar PV and enclosure components.
- Preventive maintenance activities (this can also be initiated by poor system performance).
- Monitoring of system performance and alarms.
- Firmware and software updates were required by the equipment manufacturer or Eskom.
- Download and backup monthly to be handed over to Eskom Engineering.
- Battery health checks.
- Quarterly corrosion inspections of the support structure, enclosure, fixings, fasteners, electrical terminations and associated components.

Hybrid inverter system operation

The installed Solar PV system shall operate as a fully off-grid hybrid system capable of supplying the connected household independently, if customer energy demand is maintained within the approved operating limits. The system shall use solar energy during daylight hours and store surplus energy in the battery bank for periods of low or no solar generation.

System components

- A 5.4 kWp PV array mounted on the carport structure with a 20 degree tilt and north orientation.
- A 5 kW single-phase hybrid inverter to convert DC power from the PV array and battery into AC power for the household or facility.
- A 5.3 kWh battery bank to store energy for night-time operation and periods of low solar irradiation.
- A monitoring and control system providing real-time data on PV production, battery state of charge (SOC), total load consumption and system operating status.

Integration and operating requirements

- During daytime operation, solar power generated by the PV array shall first be used to supply the household or facility loads.
- Excess PV energy shall be stored in the battery bank for later use.
- The inverter shall continuously manage power flow between the PV array, battery and loads to optimise energy use and maintain battery health.
- The hybrid inverter shall charge the battery where PV production exceeds current load demand and automatically draw power from the battery when PV production is insufficient to meet the load.
- Battery discharge shall be managed to avoid depletion below 10% state of charge, preserving battery life.

- During night-time and low irradiance operation, the inverter shall supply the household or facility from the battery where PV generation is not sufficient.
- The inverter shall include over-current protection and battery management functions to prevent over-discharge and overcharge.
- The system shall support efficient energy use during extended periods of low solar availability.

Fault Response During Defects Liability Period.

The Contractor is to respond all faults during the first year within a time period defined by Eskom.

Spare Holdings

The Contractor shall provide a recommended spare parts schedule for all major equipment supplied under the Works. The schedule shall identify the spare parts required to support routine maintenance and fault response during the operational life of the installation. Allowance for spare parts should typically be in the range of 2% to 5% of the value of major components such as PV modules, inverters, and battery storage systems.

15 For details refer to the approved Final Detail Design:

- 15.1 Mashaqiya Solar Project Nkandla Electrification FDP
- 15.2 ER00000-00-P0#0.1-00 Mashaqiya Solar Project Nkandla
- 15.3 ER00000-00-P0#1.1-00 Mashaqiya Solar Project Nkandla
- 15.4 ER00000-00-P0#1.2-00 Mashaqiya Solar Project Nkandla
- 15.5 ER00xxx-00-P01#2.1-00 Mashaqiya Solar Project Nkandla
- 15.6 ER00xxx-00-P01#2.1-00 Mashaqiya Solar Project Nkandla
- 15.7 ER00xxx-00-P01#2.2-00 Mashaqiya Solar Project Nkandla
- 15.8 ER00xxx-00-P01#2.6-00 Mashaqiya Solar Project Nkandla
- 15.9 KZN-EBC-2403-1190868-S1 of 4
- 15.10 KZN-EBC-2403-1190868-S2 of 4
- 15.11 KZN-EBC-2403-1190868-S3 of 4
- 15.12 KZN-EBC-2403-1190868-S4 of 4
- 15.13 Mashaqiya Solar Home System BOM (Electrical)
- 15.14 Mashaqiya Solar Home System BOQ (Electrical)
- 15.15 Mashaqiya Solar Home System BOQ (Earthing and Lightning)
- 15.16 Mashaqiya Solar Home System BOQ (Civil/Structural)