

Terms of Reference (ToR) for the procurement of goods and services
Procurement and Installation of Solar PV Systems for KNMP Biak, Papua

A. Background

The GIZ-implemented Energy Programme Indonesia/ASEAN is supporting the Indonesian Government in achieving its targets for a sustainable energy transition through a partner-based approach. These targets include reaching 23% renewable energy in the power mix by 2025 and 34% by 2030, achieving Net Zero Emissions by 2060, and integrating low-carbon technologies into the overall economic transformation.

As part of the Energy Programme, the "Solar Cold Chains for a Green Economy in Indonesia" (SOCOOL) Project, which is funded by the German Federal Ministry for Economic Cooperation and Development (BMZ), has the objective to establish suitable technological and market framework conditions for long-term CO2 emissions reduction in Indonesia's cooling sector. This shall contribute to Indonesia's Vision 2045 and broader economic transformation towards a green economy. The project will make clear contributions to Indonesia's Nationally Determined Contributions and renewable energy targets while achieving socio-economic improvements in related sectors, such as fisheries and agriculture, which have high demands for cold chain expansion and preservation of valuable goods.

In collaboration with the Ministry of Marine Affairs and Fisheries (KKP) and the Ministry of Energy and Mineral Resources (ESDM), SOCOOL will deploy a solar PV system in the Fisheries Village Project located in Biak, Papua. The objective of this project is to integrate solar PV and battery energy storage systems (BESS) into the fisheries supply chain, serving as a demonstration model for potential replication in other fisheries villages across Indonesia under the government program Kampung Nelayan Merah Putih. The electricity generated by the solar PV and BESS system will be used to power cold chain infrastructure, including cold storage, air blast freezing (ABF), ice production, and other facilities operated by the cooperative. As the existing fisheries hub in Biak already has reliable grid electricity, the solar PV and BESS system will be synchronized with PLN. This integration is expected to reduce electricity costs and overall operational expenses.

This TOR covers the procurement of an integrated PV-BESS system through an EPC-style contract, including detailed engineering, supply, installation, testing, and commissioning.

B. List of Terms and Nomenclature

For this TOR and all associated tender, contract, design, testing, commissioning, handover, and warranty documents, the following terms shall have the meanings stated below.

Term	Definition
Owner / Contracting Authority	GIZ or contracting entity issuing this TOR and administering the tender and contract. Unless otherwise specified, these terms shall be considered synonymous with this document.
Contractor / EPC / EPC Contractor	Any company, consortium, or legal entity submitting an offer in response to this tender prior to contract award. The Contractor to whom the contract is awarded and who is fully responsible for engineering,

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	procurement, construction, installation, testing, commissioning, training, documentation, handover, warranty support, and all other obligations under the Contract.
Facility Owner/ KNMP (<i>Kampung Nelayan Merah Putih</i>)	Fisheries Village facility supported by the Ministry of Marine Affairs and Fisheries (KKP).
TOR	Terms of Reference forming part of the tender and contract documents and defining the minimum scope, technical requirements, commercial requirements, deliverables, and obligations.
BoM	Bill of Materials forming part of the tender and contract documents and listing the principal equipment, materials, and components required for the Works.
Works / Project	The complete EPC delivery of the rooftop PV, PV canopy, BESS, electrical integration, monitoring, civil, structural, testing, and handover scope described in this TOR.
PV System	The complete photovoltaic generation system includes modules, mounting structures, DC cabling, PV inverters, protection devices, monitoring interfaces, and all accessories required for complete operation.
Battery system / BESS	Battery Energy Storage System including batteries, battery racks or cabinets, BMS, protection devices, communications, thermal management, and auxiliary systems.
Battery Inverter	Power conversion equipment used to convert DC battery power to AC power and vice versa, and to provide the required grid-forming or grid-support functions where applicable.
BMS	Battery Management System is responsible for battery monitoring, protection, balancing, alarms, communications, and safety.
PLN	Perusahaan Listrik Negara, being the Indonesian electricity utility and the existing grid supply source for this Project.
Control and monitoring System	The supervisory, monitoring, control, data acquisition, HMI, logging, reporting, and communication system used for operation and supervision of the PV-Battery system and its interfaces.
Cold Commissioning	Pre-energization checks and functional verification activities carried out before the system is electrically energized, including inspection, wiring

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	verification, continuity, insulation, configuration, and logic checks.
Hot Commissioning	Post-energization testing and functional verification activities carried out under live operating conditions, including performance verification, operating mode verification, interlocks, alarms, and system stability.
IFC	Issued for Construction documents approved for execution at site.
As Built	Final drawings and documents updated to reflect the actual installed configuration, dimensions, settings, routing, and equipment delivered at site.
MAR	Material Approval Request submitted by the EPC Contractor for review and approval of equipment, materials, accessories, and related technical documents prior to procurement or installation.
O&M	Operation and Maintenance documentation, procedures, manuals, instructions, schedules, and records for safe and effective operation of the Project during its service life.

C. Project Location

The project site is located in Desa Samber Binyeri, Biak, Papua, Indonesia, under the KNMP (Kampung Nelayan Merah Putih) government program, supported by the Ministry of Marine Affairs and Fisheries (KKP). The site consists of several operational buildings including the Ice Maker facility, Office building, and ABF (Air Blast Freezer) area. The site is located in a coastal environment and may be exposed to high humidity, salt laden air, and tropical weather conditions. Approximate site reference:

- Google Maps: <https://maps.app.goo.gl/DryL2Hdvwm7GqnBi8>
- Coordinates: -1.1713285981148724, 135.9062419095743

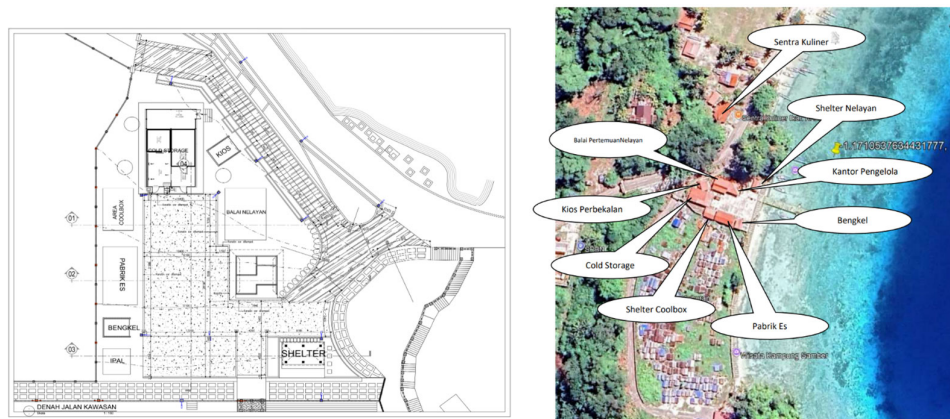


Figure 1. Site Layout

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Figure 2. Drone Photo

The Kalamo Biak Cold Chain Facility serves as a key reinforcement of the local fisheries value chain, providing reliable freezing, storage, and ice production to maintain product quality from sea to market. The integrated system, consisting of Air Blast Freezer (ABF), Cold Storage, and Ice Maker & Ice Storage, ensures continuous cold chain operations.

Block Diagram: Existing and Proposed Electrical Integration & Metering Concept

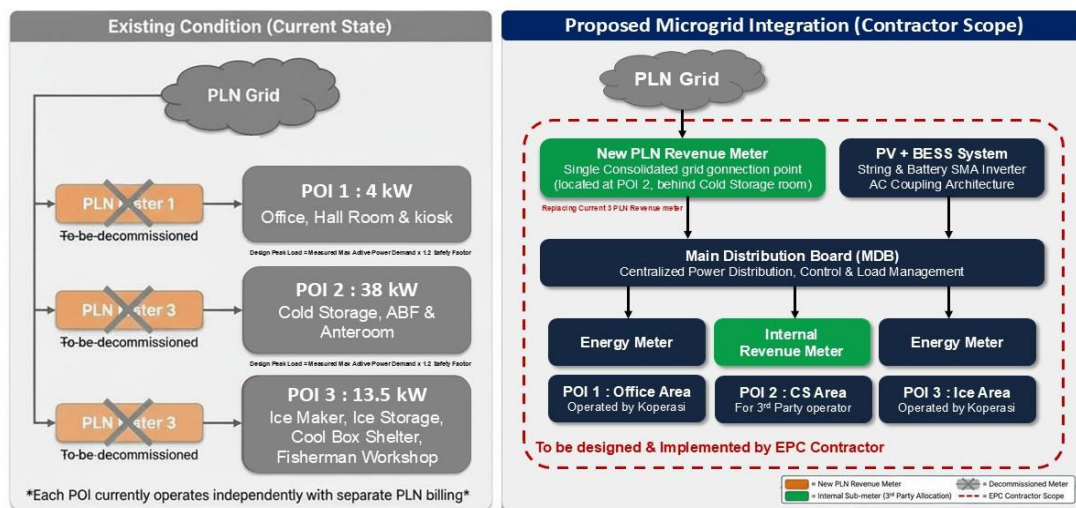


Figure 3. Conceptual Block Diagram

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The diagram above illustrates the transition from the current condition where three independent PLN revenue meters separately supply POI 1 (office), POI 2 (cold storage), and POI 3 (ice processing) to a proposed integrated microgrid architecture. In the proposed system, all existing PLN meters are decommissioned and replaced by a single new PLN revenue meter located at POI 2, which serves as the main utility interface (subject to PLN approval).

A centralized Main Distribution Board (MDB) then distributes power to all POIs, while a PV + Battery system is connected to the MDB to support energy supply and load management. Internal metering is implemented only at POI 2 to enable energy allocation for the 3rd party operated cold storage, whereas POI 1 and POI 3 remain under *koperasi* operation without separate sub metering. The overall design consolidates the system into a single controlled distribution point, improving operational efficiency and enabling future energy optimization.

D. Objectives

The objective of this service is to design, supply, install, integrate, test, and commission a technically robust, safe, and reliable Solar Photovoltaic (PV) and Battery System at the Kalamo Biak site under a full EPC delivery approach, in compliance with applicable Indonesian regulations and GIZ procurement standards.

The system shall be delivered as a complete and operational installation, suitable for remote island conditions and long-term sustainable operation.

Specific objectives include:

- Provision of a PV-Battery system (BESS) capable of maximizing on-site solar energy utilization.
- Reliable operation of cold chain and auxiliary loads with minimal reliance on the PLN grid.
- Compliance with applicable Indonesian standards, utility interconnection requirements, and international best practices.

E. Scope of work for the EPC contractor

- The EPC Contractor shall execute the Project on a full EPC (Engineering, Procurement, Construction, Installation and Commissioning) basis and shall be fully responsible for the complete delivery of the Solar Photovoltaic (PV) and Battery System at the Kalamo Biak. The Solar PV system includes 85 kWp (DC) rooftop PV system and 150 kWh battery energy storage system. As defined in Annex B (BoM).
- The EPC Contractor shall ensure that the system is delivered as a complete, fully operational, safe, and compliant installation in accordance with this Terms of Reference (TOR), the applicable Technical Specifications, the Bill of Materials (BoM), and good industry practices.
- The EPC Contractor scope shall include all balance of plant equipment, protection systems, control systems, interconnection works, and auxiliary components necessary to achieve full functional operation, whether individually itemized in the BoM. The EPC Contractor shall

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remain solely responsible for overall system performance, integration, and compliance.

- Single-point responsibility: The EPC Contractor shall have full single-point responsibility for the design, code compliance, procurement, logistics, construction, installation, testing, commissioning, training, documentation, warranty support, and overall performance of the complete PV-Battery system. No split responsibility between OEMs, subcontractors, civil contractors, electrical contractors, system integrators, or monitoring vendors shall relieve the EPC Contractor of its obligations.
- Completeness of scope and price: The EPC Contractor's lump-sum EPC price shall be deemed to include all items, materials, services, accessories, consumables, software, licenses, settings, labels, supports, cable containment, earthing/bonding accessories, auxiliary supplies, interlocks, communication devices, spares for commissioning and 5 years of operation, safety provisions, and ancillary works required for a complete, safe, reliable, maintainable, and compliant system, whether or not each item is expressly listed in the BoM.
- No variation order shall be admissible for foreseeable roof strengthening, replacement of deteriorated roof sheets or fixings within PV work areas, sealing and waterproofing reinstatement, additional mounting accessories, cable supports, panel modifications, labels, earthing accessories, trench reinstatement, temporary access/scaffolding, commissioning consumables, or other items reasonably inferable from the tender documents, applicable codes, manufacturer instructions, or prudent site inspection. Only truly unforeseeable latent conditions that could not reasonably have been detected during tender stage site verification may be considered under the Contract variation mechanism
- Each Contractor shall submit: (i) a compliance matrix against this TOR, (ii) a deviation list, (iii) a schedule of exclusions, assumptions, and clarifications, and (iv) a signed site-verification statement confirming that the Contractor has inspected the site and included all reasonably foreseeable costs and constraints in its offer. Any deviation or exclusion not expressly identified in the offer shall be deemed included in the Contract Price.
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The scope includes, but is not limited to, the following Items and Services (further defined in the Technical Specifications and BoM):

Item 1: Solar Photovoltaic System

- Rooftop-mounted photovoltaic modules installed on the **eligible buildings (Cold storage and Ice factory) and additional canopy structure identified with minimum capacity of 85 kWp.**
- PV mounting structures suitable for the existing roof types and coastal environmental conditions
- Reinforcement of existing building roof for PV rooftop installation, subject to the structural analysis results
- PV canopy structure along the pedestrian walkway suitable for near shore conditions with minimum of C5 corrosion protection
- DC string configuration, DC cabling, and protection devices. If required, combiner box shall

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be provided.

- Grid-connected solar inverters interfaced with low-voltage distribution systems.
- DC and AC surge protection devices, disconnector switches, and safety equipment.
- Auxiliary items required for a complete and turnkey PV installation



Figure 4. Indicative PV layout (subject to the layout optimization by Bidder)

Item 2: Battery System

- Battery nominal capacity shall be fixed at 150 kWh, forming the binding basis for all offers. The Contractor shall clearly declare nominal energy, usable energy, usable SOC window, minimum retained capacity under warranty, auxiliary consumption assumptions, and the corresponding operating temperature basis
- Battery power conversion system or battery inverter suitable for grid-forming operation in islanded mode and Hybrid system with the PLN grid serving as backup for self-consumption optimization
- Battery management system (BMS) and associated protection, monitoring, and communication components
- Battery enclosures, mounting arrangements, and environmental protection measures
- DC cabling, protection devices, and on-load isolation equipment for battery integration

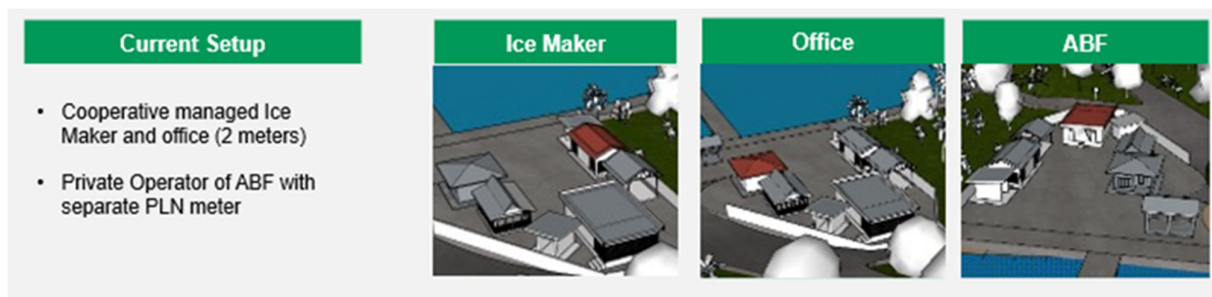
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- Auxiliary items required for a complete and turnkey battery system installation

Item 3: Electrical Integration and Control

- Integration of PV inverters and battery inverters at the low-voltage panel distribution
- Change-over / bypass / backup arrangement to allow supply from the PLN grid during shortage, maintenance or fault conditions
- Electrical panels, switchgear, protection devices, and auxiliary power supplies as required
- Energy metering and monitoring equipment for PV generation, battery charge/discharge, and load consumption
- System control, monitoring, and data logging interfaces
- Industrial grade PC with minimum 40-inch monitoring display to show the system performance and operational status, including the installation accessories such as cabinet, desk, and brackets.
- Weather monitoring stations include at minimum Class-C pyranometer, ambient temperature, and relative humidity.
- Complete cable installation, wiring, configuration, and commissioning of all electrical and control systems
- Lightning protection system and grounding system
- Fire alarm system and fire fighting

Item 4: PLN Connection Consolidation and Load Integration



The site currently has three separate PLN meters serving different facilities: the Ice Maker building, the Office building (approximately 2 meters from the Ice Maker), and the ABF facility rented and operated by a private operator.

The EPC Contractor shall integrate the existing Ice Maker meter, Office meter, and ABF meter into one consolidated PLN meter. All loads shall be combined into a single main distribution panel, with the new meter located behind the ABF building. The EPC Contractor shall carry out the necessary electrical works and coordinate with PLN to implement the meter consolidation and connection arrangement.

The scope shall include, but not be limited to, the following:

1. Load Consolidation

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- Survey and assess the existing three (3) phase PLN connections and associated load distribution.
 - Disconnect and reroute the existing loads from the three service points.
 - Integrate all loads into a single new main distribution panel (MDP).
2. New Distribution Panel Installation
- Design, supply, and install a new main distribution panel or modify the existing panel to accommodate all loads.
 - Provide necessary protection devices, busbars, breakers, and internal wiring suitable for the combined load capacity.
3. Cable and Electrical Works
- Supply and install required power cables, conduits, trays, and cable management systems to connect all loads to the consolidated distribution panel.

Item 5: Services

The Contractor shall provide all engineering, technical, and project services necessary for complete EPC delivery of the PV-Battery system, including but not limited to:

- Site survey and studies
- Detailed engineering design, calculations, IFC and as-built drawings, and documentation (civil, structural, electrical, protection, control, and integration).
- Project management, scheduling, reporting, and coordination.
- The Contractor shall perform and submit a structural assessment of the eligible rooftop buildings (ice plant and cold storage building) and PV canopy (Figure 4) using a software simulation such as STAAD.Pro, or similar software, demonstrating adequacy for additional PV loads during the detailed engineering stage.
- Procurement management, factory coordination, and inspection
- Supply, installation, integration, testing, and commissioning of all PV Battery equipment and balance of plant components.
- Preparation of commissioning procedures, test records, and as-built documentation.
- Conduct functional testing to ensure all loads are safely and properly connected to the new distribution system. Ensure compliance with applicable electrical standards and PLN requirements.
- Coordination with site stakeholders and other contractors or sub-contractors, including providers of refrigeration and electrical loads.
- **Coordinate with PLN regarding the service consolidation and capacity upgrade requirements.** Obtain technical requirements and cost information from PLN for upgrading the connection capacity. Support documentation, application process, and communication with PLN as required by the project. Cost incurred for the connection upgrade shall be

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covered by Bidder/contractor.

- **Coordinate with PLN for the PV rooftop application on behalf of the facility owner and obtain the other required permits such as SLO (Sertifikat Laik Operasi), parallel connection approval, etc.**
- Provide updated single line diagrams (SLD) of existing facility, load schedules, and as-built drawings reflecting the new consolidated connection.
- Training of designated site personnel on safe operation, basic troubleshooting, and routine maintenance
- Coordination with local authority for logistics and any other issues

Item 6: Civil and Structural Works

As an initial concept, the solar PV system is planned to be installed on the rooftops of two main buildings (cold storage and ice factory) as well as on a baywalk canopy. Accordingly, civil and structural works are mandatory and form an integral part of the EPC scope.

The complete assessment results, including preliminary structural analysis and conceptual design documents provided by GIZ Indonesia, are issued for reference purposes only and shall not relieve the Contractor of its obligation to independently verify, validate the calculation prior to the bidding, and finalize the structural and civil design.

The Contractor shall be fully responsible for the design and execution of all required civil and structural works, including but not limited to:

- Conduct detailed structural verification and load calculations based on the final PV layout and equipment configuration.
- Design and implement structural reinforcement of existing buildings, including strengthening of roof trusses, rafters, purlins, beams, anchoring systems, and replacement of corroded or structurally deficient elements
- Design and implement bay walk canopy as additional space for solar PV installation
- Upgrade and rehabilitate rooftops as required, including replacement of damaged roofing sheets, improvement of fastening systems, and restoration of waterproofing. Waterproofing shall be ensured and tested after completion.
- Apply corrosion protection suitable for tropical coastal environments (Minimum C5 or equivalent classification).
- **Ensure compliance with applicable SNI standards, Indonesian building codes, and relevant IEC standards.**
- Ensure a minimum structural safety factor of 1.5 under combined dead load, live load, wind load, and seismic load conditions.
- Design structural works to achieve a minimum service life aligned with the PV system design life (25 years).

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- Provide structural calculations signed and stamped by a certified structural engineer.

All civil and structural works shall be included in the Contractor's lump-sum EPC price. The Contractor shall bear full responsibility for the structural integrity and long-term safety of the installation. No variation order related to foreseeable reinforcement requirements shall be accepted after contract award.

Item 7: Additional notes

- The solar PV and Battery system is to be installed as a behind-the-meter system connected to the existing internal low-voltage distribution network.
- The PV Battery system shall operate in parallel with the PLN grid under a behind PLN revenue meter configuration. The system is designed exclusively for self-consumption, with active export limitation controls and protection settings to prevent reverse power flow to the PLN grid. The switch-over / bypass arrangement shown in the conceptual SLD in Annex C is indicative. The binding technical requirement is defined by TR-03 and TR-06, which require full electrical interlocking and prohibition of parallel operation, irrespective of schematic representation.
- Before detailed design approval, the Contractor shall submit a binding operating philosophy covering normal grid-connected mode, non-export control, island mode, black-start logic, load prioritization, return-to-grid sequence, and all electrical/mechanical interlocks. This philosophy shall be coordinated with vendor equipment architecture and shall form part of the approved design basis
- The refrigeration equipment and cold rooms are not part of this scope; however, the Contractor shall ensure correct electrical and operational integration of the PV-BESS system with these loads.
- Conceptual designs and reference calculation are provided in the Appendix. These documents define the system envelope and constraints, but do not constitute the final design.
- In case of system overload, the PV-BESS system shall implement automatic protective load disconnection or power limitation, ensuring equipment protection and system stability. Manual-only intervention is not acceptable.
- The Contractor shall review all reference documents and notify the Contracting Authority of any discrepancies prior to final design approval.
- The Contractor shall also be responsible for obtaining and maintaining all permits, approvals, submissions, notifications, inspection bookings, and utility coordination necessary for lawful execution and energization, except for documents that can legally be issued only by the Contracting Authority or Facility Owner. The Contractor shall prepare all technical submittals and support the Contracting Authority or Facility Owner in obtaining such documents without additional cost.
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F. Responsibility of the contracting authority

The Contractor shall be responsible for the complete and safe execution of the works in line with this TOR and the BoM, including the following:

F.1 Planning and Preparation

- Review all drawings, specifications, and reference documents supplied with this tender and notify the Employer of any inconsistencies or omissions.
- Conduct a site visit prior to installation to verify conditions, access, and interfaces.
- Submit a final detailed technical design and implementation plan for Employer approval prior to procurement and installation.

F.2 Supply, Transport, and Installation

- Procure, transport, and deliver to site all equipment and materials required for the PV–BESS system, including any structural reinforcement works if required.
- Provide qualified personnel (engineers, technicians, and site supervisor) for all installation activities.
- Install the PV system, BESS, electrical panels, and all associated cabling and protection systems in accordance with approved designs.
- Install and integrate monitoring, control, and metering systems, including configuration and communication setup.
- Apply best practices to prevent damage to equipment, following manufacturer instructions and project-specific requirements.
- **Ensure the permit and regulation compliance as the solar PV system will be connected to the PLN electricity grid, including NIDI, PLN Application, IUPTLS, SLO. All required permits and approvals must be secured within 2026 to align with the project commissioning and operational target by November at the latest.**
- Ensure the use of appropriate personal protective equipment (PPE), tools, and measuring instruments during all work.
- Ensure compliance with applicable Environmental, Social, Health and Safety (ESHS) requirements during all work, including occupational health and safety, waste management, noise control, and protection of surrounding activities. The Contractor shall implement site-specific HSE measures consistent with Indonesian regulations and GIZ standards.

F. 3 Testing, Commissioning, and Handover

- Support inspections and acceptance checks conducted by the Contracting Authority or its appointed representative.
- Perform functional testing, protection checks, and system adjustments.
- Carry out commissioning tests to demonstrate correct operation in all defined operating modes, including islanded operation and PLN bypass mode. Commissioning tests shall be

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carried out in the presence of the Contracting Authority or its designated representative

- Provide training to designated site personnel on system operation, monitoring, and safety. Training shall have a minimum duration of one (3) full working day, combining theoretical instruction and on-site practical demonstration.

F. 4 Documentation and Deliverables

- Provide complete as-built drawings and system documentation. All documentation shall be provided in English. Operation and Maintenance manuals and safety-related documentation shall additionally be provided in Bahasa Indonesia. Documentation shall be delivered in digital format (PDF); editable source files shall be provided where applicable.
- Submit the following documentation as part of handover:
 - Certificates of Compliance
 - Manufacturer data sheets and manuals
 - Test and commissioning reports
 - Warranty certificates
 - Operation and Maintenance manuals
- Provide warranty coverage for all supplied equipment and systems installed in accordance with this TOR. Provide warranty coverage for all supplied equipment and installed systems for a minimum period of twenty-four (24) months from the date of Final Acceptance. Where manufacturer's standard warranties exceed this period, such warranties shall apply in full by handing over to Contracting Activities.

F.5 Compliance

- All works shall comply with:
 - This TOR and the Technical Specifications
 - The Bill of Materials (BoM)
 - Applicable include, but are not limited to:
 - IEC standards explicitly referenced in Section E
 - Relevant Indonesian standards (SNI)
 - ASTM standards, ISO, British Standard, AS/NZS, UL, IEEE, and other relevant international standards
 - Manufacturer installation and safety standards
- **Applicable Indonesian laws, regulations, and utility requirements, (for example PLN regulation as the system will be connected to the PLN Grid)**

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G. Technical Requirements (TR) – Solar Photovoltaic and BESS

1. System Level Requirements

Ref.	Requirement	Minimum Requirement
TR-01	System scope	Design, supply, installation, testing, and commissioning of a rooftop photovoltaic (PV) and battery system, including all balance-of-system components, protection, control, monitoring, and interfaces required for safe and reliable operation. Indicative capacities: PV 85 kWp (DC), BESS 150 kWh, AC system 400/230 V, 50 Hz, 3-phase. The system shall be delivered on a turnkey basis and shall include all equipment, software, civil works, interconnection works, monitoring, safety devices, and documentation necessary to achieve the required operating modes. The Contractor shall verify the final AC and DC capacities, stringing, inverter loading ratio, and usable battery capacity during detailed design and shall remain responsible for the overall performance of the integrated system.
TR-02	Connection point	The PV–BESS system shall be connected electrically behind the existing PLN supply, at the internal low-voltage (LV) distribution level of the facility. No upstream or utility-side connection is permitted. In case of any discrepancy between Annex C (conceptual SLD) and these TRs, the TRs shall prevail. The Contractor shall verify based on site visit the exact point of common coupling, existing panel ratings, feeder arrangement, breaker interrupting capacity, neutral arrangement, and available installation space. Any modification required to achieve a safe and compliant behind-the-meter connection shall be included in the Contract Price.
TR-03	Parallel operation	The PV BESS system shall operate in parallel with the PLN grid under a behind PLN Revenue meter configuration. Electrical coupling to the internal low voltage bus is permitted. The system shall function strictly as a non-export (zero feed in) installation, ensuring that no active power is injected into the PLN grid under any operating condition. Zero-export performance shall be guaranteed, and the Contractor shall demonstrate during and site commissioning that reverse active power flow to PLN is prevented at any time.

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TR-04	Export to grid	Export of electrical energy to the PLN grid is strictly prohibited. The system shall be configured to ensure zero exports under all operating conditions, including transient events and control failures. A change over arrangement shall be provided to ensure source exclusiveness between PV BESS & PLN supply and the onsite generator. At any time, only one of these two sources (PV BESS & PLN or Genset) shall energize the internal LV bus, unless otherwise specifically approved and designed for synchronized operation.
TR-05	Operating mode	The system shall be by default running on an island mode to increase self-consumption and connected to the PLN grid whenever the battery state of charge (SOC) below the specified level (i.e. 20%). The battery SOC shall be maintained at least 10% (i.e. minimum SOC 30%) during night-time for emergency cases (No PLN connection). In island mode, the PV BESS system shall operate in grid forming configuration to supply internal loads without reliance on the PLN grid. If a diesel generator is present, its integration during island operation shall follow the defined source interlocking and synchronization philosophy.
TR-06	Grid bypass mode	PLN only bypass mode shall be provided via a dedicated isolation or change over arrangement. In bypass mode, all PV and BESS inverters shall be electrically isolated from the internal LV bus, and internal loads shall be supplied exclusively by PLN. Function shall be tested during the commissioning. Bypass mode shall be manually selectable and interlocked to prevent unintended parallel energization of isolated sources. Bypass mode is intended for maintenance, commissioning, or emergency operation. This prevents future interpretation that bypass is the default configuration. All bypass and isolation devices shall be sized for the full load current and short-circuit duty at the point of installation. Clear mimic labels, operating instructions, lock-out-tag-out provisions, and status indication lamps shall be provided so that the maintenance mode can be used safely by plant operators.
TR-07	Grid-forming capability	The system shall include grid-forming capability provided by a hybrid inverter and/or dedicated battery power conversion system

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		(PCS). Grid-following-only inverter architectures are not acceptable.
TR-08	Backup autonomy	The system is not required to guarantee a fixed backup duration for full facility load. Backup performance shall depend on available battery state of charge and real time load conditions. If backup operation is required, critical loads and autonomy expectations shall be defined separately during detailed design.
TR-09	Design and compliance basis	The system shall be designed, installed, and commissioned in accordance with: (i) the technical requirements defined in this ToR and the BoM; (ii) manufacturer installation and operating instructions; and (iii) explicitly referenced international and Indonesian standards listed elsewhere in this ToR. General or unspecified “applicable standards” are not sufficient. All standards, codes, manufacturer instructions, and project-specific technical requirements used as the basis of design shall be explicitly listed in the design document.
TR10	Annexes	Conceptual designs and calculations provided in the Annexes are indicative. In case of any discrepancy, the technical requirements defined in this TOR shall prevail. Where the Annexes are conceptual only, the Contractor shall reconcile them during detailed engineering design and submit a deviation reconciliation note for approval. The approved IFC package shall become the binding reference for construction and commissioning.
TR-11	PV inverter bypass mode	A PV inverter output bypass shall be provided via a changeover arrangement. In case of battery inverter failure, the PV inverter could operate parallelly with the PLN grid with zero export capability. Bypass mode shall be manually selectable and interlocked to prevent unintended parallel energization of isolated sources. Bypass mode is intended for maintenance, commissioning, or emergency operation. All bypass and isolation devices shall be sized for the full load current and short-circuit duty at the point of installation. Clear mimic labels, operating instructions, lock-out-tag-out provisions, and status indication lamps shall be provided so that the maintenance mode can be used safely by plant operators.

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2. Electrical Basis

Ref.	Requirement	Minimum Requirement
TR-EL-01	AC system configuration	Three-phase AC system, 400/230 V, 50 Hz, compatible with Indonesian LV distribution practice and internal facility loads. Where applicable, inverter control functions shall be consistent with Indonesian LV interconnection and power quality requirements. The Contractor shall verify the existing voltage tolerance, load imbalance, harmonic sensitivity, and starting characteristics of the cold-chain equipment and shall ensure compatibility of inverter and battery controls with these loads. All offered equipment shall be suitable for continuous operation at the local ambient conditions.
TR-EL-02	AC bus topology	Single internal LV bus supplying all defined critical and non-critical loads. PV-BESS shall connect to this bus downstream of PLN incomer and upstream of load feeders. The system shall provide the ability to designate critical vs non-critical feeders, enabling priority supply and load shedding via control logic and/or panel arrangement.
TR-EL-03	Short-circuit design basis	All equipment (switchgear, panels, breakers, busbars) shall be rated for the prospective short-circuit current at the point of installation, calculated by the EPC and documented in design submissions. Protection design and calculations shall cover both AC and DC sides, including PV string/combiner DC fault currents and DC disconnection/selectivity
TR-EL-04	Selectivity and protection coordination	Full protection coordination shall be demonstrated between MCCBs, MCBs, RCDs, and inverter protections to ensure discrimination under fault conditions. The Contractor shall submit a documented protection coordination study showing time-current curves, breaker settings, relay settings, RCD selection, and discrimination philosophy. Selectivity shall be demonstrated for both grid-connected and islanded modes wherever technically achievable.
TR-EL-05	Earthing system	A common earthing system shall bond PV structures, inverter/PCS, BESS enclosures, AC panels, DC equipment, lightning protection, communications, and other metallic components. The bonding resistance between components shall be $\leq 5 \Omega$ while the target earth resistance is $\leq 5 \Omega$, unless stricter site conditions require lower values. Where inverter/PCS topology does not permit a direct

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		neutral-earth bond in island mode, the Contractor shall implement and document an equivalent equipotential bonding / voltage equalization approach consistent with safe touch voltage limits. The Contractor shall carry out an earthing resistivity investigation and provide details. If the target resistance cannot be achieved due to soil conditions the Contractor shall propose and justify a technically sound alternative design. Bonding conductors shall follow IEC standards for the minimum and prospective short circuit current at the equipment.
TR-EL-06	Neutral and grounding philosophy	TN-S earthing arrangement preferred. Neutral-earth bonding shall be clearly defined and shall not be duplicated across grid-forming and grid-bypass modes.
TR-EL-07	Environmental basis	Electrical design shall explicitly account for coastal/marine environments (< 50 m from shoreline), including salt mist, high humidity, condensation risk, and accelerated corrosion. All outdoor and semi-outdoor electrical equipment shall be selected for coastal service with appropriate IP rating (Minimum IP65), anti-condensation measures, corrosion-resistant hardware, and UV-resistant materials.

3. PV DC Components, DC Cable, and Accessories

Ref.	Requirement	Minimum Requirement
TR-DC-01	PV DC system voltage	Maximum system voltage 1,500 Vdc. All DC components (modules, cables, connectors, SPDs, isolators) shall be rated $\geq 1,500$ Vdc. Final maximum string voltage at the minimum site temperature, operating current at the maximum site irradiance, and inverter MPPT voltage window compliance shall be demonstrated by calculation. Voltage design margin of at minimum 5% should be included and documented.
TR-DC-02	PV DC cables	Copper, tinned, class 5 flexible PV cable, TUEV PV1-F or IEC 62930 equivalent, 1.5 kVdc, halogen-free, UV resistant, temperature rating -40°C to $+90^{\circ}\text{C}$ (120°C short-circuit). Minimum conductor size is $1 \times 6 \text{ mm}^2$ for string circuits. Cable sizing should additionally consider voltage drop, current-carrying capacity, grouping derating, roof temperature, installation method, mechanical protection, and fault withstand. Color coding and

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		polarity identification shall be consistent throughout the installation as per SNI standard. Where cables are not directly clipped on module, cable support and containment systems shall be provided using corrosion-resistant materials suitable for severe marine exposure. Outdoor cable cleats, clips, saddles, and supports shall be UV-resistant and corrosion-resistant, with stainless steel (SS) 316 hardware minimum in outdoor/coastal areas. Contractors shall only use epoxy coated cable ties for the outdoor installation.
TR-DC-03	PV DC connectors	MC4-type connectors or equivalent, certified for 1.5 kVdc, IP68 when mated, UV- and corrosion-resistant, touch-safe from a single connector family per string. Only original, manufacturer-approved mating connectors from the same connector family shall be used, field mixing of non-compatible connectors is prohibited.
TR-DC-04	PV DC isolation	DC isolators rated ≥ 1.5 kVdc, utilization category DC-21B minimum, lockable in OFF position, clearly labelled, accessible for emergency shutdown. Inverter-integrated DC switch-disconnector is acceptable provided it satisfies the required array/sub-array isolation function, is DC load-break rated for the maximum system voltage and current and complies with the applicable IEC standards and project requirements.

4. AC Panels, Switchgear, and AC Cables

Ref.	Requirement	Minimum Requirement
TR-AC-01	Main AC distribution panels	Main AC distribution panels shall be designed for three-phase, 400/230 V, 50 Hz operation and rated for the calculated short-circuit current at the point of installation. Panels shall include appropriately rated circuit breakers, busbars, and terminals, and shall be suitable for coastal/marine environments. The panel shall have a minimum plate thickness of 2.0 mm. The new main AC distribution panel shall combine the New PLN energy meter located at Cold storage room and the PV & BESS output from Inverter AC Combiner box. Automatic bypass switch for PLN grid connection direct connection to load shall be provided in the panel. The panel shall be designed to

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		accommodate the existing loads in the facility (Office area, cold storage area, Ice area) and additional spare of minimum 20% for future connection. Cable connection between the New main distribution panel to each area or sub distribution panel shall be provided by the Contractor. Energy meters shall be provided in the panel. Panels shall be factory-built or workshop-built using professional enclosure systems with engraved labels, internal wiring ferrules, wire numbers, and typed terminal markers. Busbar sizing, heat rise, enclosure IP54 at minimum if located inside a clean room, and corrosion resistance shall be demonstrated in the design submission. Routine test report shall be provided. All panels, boards, cubicles, and fabricated metallic enclosures supplied under this Contract shall be factory powder coated after proper surface preparation. For outdoor and severe coastal installations, the coating system shall be suitable for C5 service with documented thickness and shall be compatible with the specified anti-corrosion strategy. Protective cover shall be provided to avoid any direct contact with the live conductor when opening the panel for maintenance. Busbar shall be provided with insulation material compatible with the system voltage. Creepage and clearance distance should be maintained as per IEC and should have sufficient distance for maintenance activities. Internal cable tray shall be provided to route the cable properly and safely to avoid any direct touch with other conductors. Panel shop drawing shall be provided for approval.
TR-AC-02	Protection and selectivity	Protection devices (MCBs, MCCBs, RCBOs, inverter protections) shall be coordinated to ensure selectivity and discrimination under fault conditions. Protection settings and coordination studies shall be documented. All loads shall be protected with an RCBO. Interlocking shall be fail-safe and shall use mechanical interlock wherever practical. The Contractor shall provide detailed schematics, operating sequence diagrams, and panel mimic indications for all change-over arrangements. The switches to the feeder shall provide feedback status to the plant control and monitoring system with ON/OFF/TRIP.
TR-AC-03	Change-over switch and isolation	Change-over, bypass, and isolation devices shall ensure safe disconnection of PV and BESS inverters during PLN back-up operation and PV inverter parallel operation directly with PLN grid.

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		Devices should be lockable, clearly labelled, and accessible for operation and maintenance.
TR-AC-04	AC surge protection	Type I+II AC surge protection devices shall be installed at new main AC distribution panels and coordinated with DC SPDs and the lightning protection system. SPD selection and coordination shall be based on the site lightning exposure, cable lengths, earthing arrangement, and equipment withstand levels. The Contractor shall define nominal discharge current, maximum discharge current, and upstream protective devices for each SPD location.
TR-AC-05	PV inverter AC combiner box	PV inverter AC combiner box shall combine the AC output of multiple PV inverters. The box shall be suitable for 230/400 V AC, 3-phase, 4-wire, 50 Hz operation, with current rating as required by the final design. It shall be complete with busbar system, incoming and outgoing MCCBs, isolation devices, surge protection I+II, neutral and earth bars, bypass switch for PV inverters to PLN grid, and control/monitoring terminals where required. The enclosure shall be minimum IP54 if located indoors, corrosion resistant, and suitable for tropical environmental conditions including high humidity, dust, and high ambient temperature. The assembly shall comply with IEC 61439, IEC 60947, and IEC 60529. Panels shall be factory-built or workshop-built using professional enclosure systems with engraved labels, internal wiring ferrules, wire numbers, and typed terminal markers. Busbar sizing, heat rise, enclosure and corrosion resistance shall be demonstrated in the design submission. Routine test report shall be provided. All panels, boards, cubicles, and fabricated metallic enclosures supplied under this Contract shall be factory powder coated after proper surface preparation. For outdoor and severe coastal installations, the coating system shall be suitable for C5 service with documented thickness and shall be compatible with the specified anti-corrosion strategy. Protective cover shall be provided to avoid any direct contact with the live conductor when opening the panel for maintenance. Busbar shall be provided with insulation material compatible with the system voltage. Creepage and clearance distance should be maintained as per IEC and should have sufficient distance for maintenance activities. Internal cable tray shall be provided to route the cable properly and safely to avoid any direct touch with other conductors.

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		Panel shop drawing shall be provided for approval.
TR-AC-06	Inverter AC Combiner Box	The Inverter Combiner Box shall be factory-assembled, factory-tested, and manufacturer-approved for the proposed battery inverter system. It shall be suitable for combining multiple single-phase battery inverter units into a common 230/400 V, 50 Hz three-phase AC system, with a common three-phase AC busbar for connection of the battery inverters, PV inverters, load, and generator or grid source where applicable. The combiner box capacity shall be selected to suit the PV inverter capacity, battery inverter capacity, and minimum load requirement of 45 kW. It shall include suitable protection devices for the battery inverter, PV inverter, and load connections, and shall be compatible with TN-S, TN-C-S, or TT earthing arrangements. The enclosure protection shall be not less than IP54. The Contractor shall submit manufacturer confirmation that the combiner box is approved for the proposed battery inverter model and quantity, PV inverter connection, and load connection.
TR-AC-07	Automatic transfer switch system	The Contractor shall supply, install, test, and commission the Automatic transfer switch system (ATS) for interfacing the battery inverter / Inverter AC Combiner box with the utility grid. The equipment shall be compatible with the selected inverter system and shall provide the required connection, disconnect, and transfer function between the off-grid and the utility grid. The enclosure shall be minimum IP54, corrosion resistant, and suitable for tropical environmental conditions.
TR-AC-8	AC power cables and accessories	AC power cables shall be stranded copper conductor cables rated minimum 0.6/1 kV for 230/400 V LV distribution systems. For fixed power wiring, cables shall comply as applicable with IEC 60502-1, IEC 60228, IEC 60332-1-2, IEC 60754, IEC 61034, IEC 60364, and relevant SNI requirements. Conductors shall be Class 2 minimum for fixed installation, flexible Class 5 conductors may be used only where specifically required for equipment connection and vibration-prone terminations. Indoor cables within buildings, powerhouses, and enclosed panels shall be XLPE insulated, LSZH sheathed, flame-retardant type. Outdoor exposed cables, including roofs, canopy structures, and coastal locations, shall be XLPE insulated with UV-resistant, moisture-resistant, and weather-resistant outer sheath, black colour preferred for UV durability, suitable for wet and dry locations, conductor operating temperature 90°C, and short-circuit conductor temperature

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		250°C. For severe marine exposure areas near the shore, the cable outer sheath and accessories shall be suitable for salt-laden atmosphere and installed with corrosion-resistant supports, glands, and cleats. Minimum conductor sizes shall be 2.5 mm² for lighting/control power, 4 mm² for single-phase power circuits, and 6 mm² for three-phase feeder circuits unless calculations require larger sizes. Neutral conductors shall be full size up to and including 16 mm² phase conductors. Protective conductor sizing shall comply with IEC 60364 and relevant SNI. Cable sizing shall consider current-carrying capacity, ambient temperature correction, grouping derating, installation method, short-circuit withstand, and voltage drop. Maximum steady-state voltage drop shall not exceed 1% for inverter AC output circuits, 1% for battery inverter / microgrid output circuits, and 2% from main LV board to final power loads. Terminations shall use compression lugs matched to conductor material and size, with heat-shrink and ferrules as applicable. Cable glands shall be nickel-plated brass or stainless steel 316, double-compression type, minimum IP67. All AC cables shall be identified at both ends and at intermediate accessible points. The Contractor shall submit manufacturer datasheets, type test / routine test certificates where applicable, complete AC cable sizing calculations, voltage drop calculations, short-circuit checks, and cable schedule during detailed design.
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5. PV Modules

Ref.	Requirement	Minimum Requirement
TR-PV-01	Module technology	Module technology shall be state-of-the-art n-type HPBC or demonstrably equivalent n-type bifacial technology. Bifacial modules are mandatory. A single module make, model, wattage class, and cell technology shall be used across the entire project for uniformity of spares, operation, and replacement.
TR-PV-02	Module rating	Minimum module nameplate power shall be greater than 650 Wp per module. The Contractor shall not mix different module wattages or power class, dimensions, cell technologies, or BOM families within the project unless explicitly approved for documented supply-chain reasons without impact on performance, spare strategy, or

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		structural design.
TR-PV-03	System voltage compatibility	Modules and string configuration are compatible with maximum system voltage 1,500 Vdc. String design shall maintain compliance with module Voc limits at minimum temperature and inverter operating window at expected high-temperature conditions. String mismatch between roof areas shall be minimized by appropriate MPPT allocation.
TR-PV-04	Module efficiency	Module front-side efficiency shall be greater than 24% under STC. Bifacial modules shall have declared bifaciality and rear-side contribution assumptions in the design calculations and energy estimate. The Owner reserves the right to reject older-generation or lower-efficiency module products even if nominally compliant in other respects.
TR-PV-05	Junction box	Junction box rated IP68, UV-resistant, factory-installed, with bypass diodes.
TR-PV-06	Connectors	MC4-type connectors or equivalent, certified for 1,500 Vdc, touch-safe and IP68 when mated. Connector installation shall prevent water ingress, cable strain, and unsupported hanging loops. All exposed connectors shall be positioned away from sharp edges and ponding areas.
TR-PV-07	Certification	IEC 61215, IEC 61730, and anti-salt mist certification mandatory.
TR-PV-08	Traceability	Each module shall be uniquely identifiable via serial number. Packing list and serial number list shall be provided. The Contractor shall provide a module serial-number map linked to roof layout, string number, and inverter MPPT. Replacement modules during defects liability period shall be traceable to the installed array.
TR-PV-9	Warranty	Product warranty of 12 years shall be provided. 30 years performance warranty with maximum 1% degradation in the first year and 0.4% annual degradation.

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6. PV Mounting Structure System

Ref.	Requirement	Minimum Requirement
TR-MNT-01	Mounting for flush mount or rooftop	Mounting arrangement shall be matched to each roof type and roof condition and shall minimize roof penetrations, local overstress, galvanic corrosion, and maintenance obstruction. Layout shall preserve safe access routes, roof drainage paths, and future maintenance access to rooftop equipment.
TR-MNT-02	Structural design life	Minimum design life ≥ 25 years. Design life shall apply not only to primary mounting rails and supports but also to clamps, anchors, fasteners, weather seals, coatings, and secondary steel supports. Any component with a shorter replacement interval shall be identified in the O&M manual.
TR-MNT-03	Structural materials	Aluminum structural with documented mechanical properties with minimum type of AL6005-T5 or equivalent.
TR-MNT-04	Corrosion protection	Corrosion protection system suitable for C5 coastal environment, including material selection, coatings, and fasteners. For installations in severe marine exposure, all mounting accessories, support steel, and interfaces with cable containment and rooftop penetrations shall be detailed as a complete anti-corrosion system, including compatible fasteners, isolation washers, edge protection, and repair of all damaged galvanized / painted areas after installation.
TR-MNT-05	Fasteners	Minimum stainless steel SS316 (A4).
TR-MNT-06	Wind and seismic design	Structural design shall explicitly account for local wind and seismic loads applicable to the site. Comprehensive structural calculations with combined loads shall be submitted by the Contractor.
TR-MNT-07	Roof penetrations	All roof penetrations shall be watertight, sealed, and warranted by the Contractor. Waterproof shall be tested during test and inspection.
TR-MNT-08	Installation tolerances	Tilt, spacing, and fixing arrangement shall follow structural and energy-yield optimisation, documented in detailed design. The Contractor shall provide a roof layout drawing showing module clearances, maintenance paths, row spacing, edge distances, and

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		setbacks from roof ridges, gutters, and other equipment. Installation tolerances shall be practical and verifiable during QA/QC. The minimum distance to the roof edge shall not be less than 500 mm.
TR-MNT-09	Canopy Mounting application	• Canopy mounted PV system above the existing pedestrian area (baywalk), supported by a new standalone canopy structure independent from the existing pedestrian structure. The canopy shall have at least 4.5 meter to avoid the shading from the existing streetlight poles. The width of the canopy shall follow the length of the PV module. • The canopy structure shall be fabricated from hot-dip galvanized steel or other equivalent material suitable for marine environments. The structure shall be designed with corrosion protection for a minimum service life of 20 years. The galvanization thickness shall be not less than 85 microns, with an additional paint coating incorporating a Papuan pattern. • The columns shall be constructed from H-beams or wide flange sections, while the rafters and beams may use hollow steel profiles. An aesthetic architectural design shall be developed and submitted for Contracting Authority's approval. The Contracting Authority has the right to review and provide comments on the architectural drawings. • The canopy shall be designed to provide full shade coverage to the walkway and shall prevent water leakage during rainfall. A durable sealing system between PV modules shall be provided, suitable for at least 20 years of operation. The wind and seismic load for structural analysis shall follow the SNI and actual condition on site and at minimum 40 m/s for ultimate-level, whichever higher. • The PV mounting mechanism shall be compatible with the PV modules and approved by the PV OEM.

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7. PV and Battery Inverters

Ref.	Requirement	Minimum Requirement
TR-INV-01	PV String Inverter type	The PV inverter shall be a three (3)-phase string inverter suitable for microgrid operation, 230/400 V, 50 Hz AC system, and AC-coupled PV-battery application. The total inverter AC capacity shall be selected with a DC/AC ratio not exceeding 1.15, with a minimum of three inverter units for redundancy, preferably of equal capacity. The PV inverter shall be of the same manufacturer as the battery inverter to ensure that PV inverter is fully compatible with the proposed battery inverter. The manufacturer shall have experience in Indonesia within the last three years by submitting a project reference list including project name, location, commissioning year, system capacity, battery inverter model, and end-user name.
TR-INV-02	DC input	Compatible with PV string design up to 1,000 Vdc. PV/ inverter sizing calculations shall include voltage window, current limits per MPPT, DC/AC ratio, clipping assumptions, temperature correction, and cable losses. Any oversizing beyond manufacturer recommendations shall not be acceptable without written OEM confirmation.
TR-INV-03	MPPT	Minimum three (3) independent MPPTs per inverter to minimize the mismatch losses. MPPT allocation shall be coordinated with roof orientation, shading profile, and string-length uniformity to minimise mismatch losses. Roof zones with materially different irradiance or orientation shall not be paralleled on the same MPPT unless justified. Mismatch losses shall be justified through PVSyst simulation with no more than 2% in total.
TR-INV-04	Efficiency	European efficiency $\geq 98\%$.
TR-INV-05	AC output	Three-phase, 400 Vac, 50 Hz. Inverters shall be suitable for the site earthing system and local distribution voltage tolerances.
TR-INV-06	Grid functions	The inverter shall be able to run with island mode or grid mode. The Contractor shall provide a detailed control philosophy showing how inverter active/reactive power control, zero-export control, curtailment, and the operation philosophy with battery inverter.

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TR-INV-07	Protection	The inverter shall include integrated DC disconnection and DC arc-fault detection or equivalent arc protection, with outdoor enclosure protection of at least IP65 and an operating temperature range suitable for the site environmental conditions Inverter shall be equipped with overcurrent protection, over/under voltage, surge protection device Type I+II, over/under frequency, and thermal protection. Validation shall consider both single-phase and three-phase fault conditions.
TR-INV-08	Communication	It shall support open communication protocols for monitoring system integration and stable operation when the battery inverter forms the AC network. The Contractor shall provide the complete communications architecture, including protocol list, IP addressing, Modbus register mapping, and remote access philosophy. The Contracting Authority shall receive full Contracting Authority or Facility Owner-level access credentials to access the device
TR-INV-09	Battery Inverter	The battery inverter shall be a grid-forming inverter suitable for AC-coupled PV-battery operation in a 230/400 V, 50 Hz three-phase system. The battery inverter system shall consist of multiple single-phase inverter units arranged to form a three-phase network, with one or more units per phase for redundancy. The units shall be equally distributed across the three phases. The inverter shall be compatible with the proposed battery system, with nominal battery voltage of 48 V DC or as required by the selected battery. The total rated continuous AC output power shall be not less than 45 kW at the site ambient temperature of 35°C, with overload capability of at least 130% for 30 minutes and 180% for minimum 3 seconds to support high inrush current. The inverter shall have efficiency of not less than 95%, enclosure protection of at least IP54, and an operating temperature range suitable for the site environmental conditions. The battery inverter shall be located indoors with an air conditioner. The battery inverter shall be of the same manufacturer as the PV inverter to ensure that all inverters are fully compatible. The manufacturer shall have operational experience in Indonesia within the last three years by submitting a reference list including project name, location, commissioning year, system capacity, battery inverter model, and end-user name.
TR-INV-10	Communication	The Contractor shall provide all required communication and

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	and supervisory equipment	supervisory equipment for a complete system, including the communication to battery and proposed monitoring and control device required I/O or communication interface accessories, network switches, and complete parameterization for zero-export, monitoring, and alarm handling. Compatible communication cables and other required accessories should be provided to ensure smooth communication and operation. It shall be capable of controlling or limiting the PV inverter output and shall be compatible with the manufacturer-approved lithium-ion battery BMS.
TR-INV-11	Metering for export control and energy balance	The Contractor shall provide a compatible energy meters / power sensors as required for export limitation, load measurement, PV production verification, and battery energy accounting. Meter classes, CT ratios, and placement shall be selected to achieve accurate control and reporting.
TR-INV-12	Mounting bracket	The mounting bracket shall be suitable to hold the PV and battery inverters and container wall material. Brackets shall be made of galvanized steel or other corrosion proof material.
TR-INV-13	Warranty	A 5-year warranty period shall be provided for the PV and battery inverters.

8. Battery System

Ref.	Requirement	Minimum Requirement
TR-BESS-01	Battery chemistry	Lithium Iron Phosphate (LFP). Only LFP cells/modules from reputable manufacturers with proven stationary-storage references and compatibility with selected battery inverter, certified safety compliance, and traceable serial numbers shall be accepted. The Contractor shall identify the actual cell/module manufacturer and not only the pack assembler. Battery packs shall have IP rating of IP65 and anti-corrosion category of C5-M.
TR-BESS-02	Installed capacity	At minimum 150 kWh. The battery should be a stacking type with an equivalent number of batteries per string when connected in parallel (i.e. 3-3-3, 4-4-4, 5-5-5, etc.).
TR-BESS-03	Usable energy	Contractor shall declare nominal energy, usable energy, Depth of Discharge (DoD) limits, C-rate, and auxiliary consumption

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		assumptions. Minimum continuous charge and discharge capability shall be $\geq 0.5C$. The Contractor shall declare continuous and peak C-rates. DoD should be maintained at maximum 80% or minimum usable capacity of 120 kWh.
TR-BESS-04	Cycle life	$\geq 6,000$ cycles at 80% DoD (stated conditions). The cycle-life declaration shall state the exact reference conditions, including temperature, charge/discharge rate, SOC window, and end-of-life criterion. The Contractor shall additionally state the battery warranty term in years, and the minimum retained usable capacity at warranty end
TR-BESS-05	Electrical interface	DC-coupled connection to hybrid inverter or PCS via dedicated DC protection devices. The battery interface design shall include disconnecting means, polarity protection, voltage and current measurement, grounding/bonding arrangement, communication interfaces, and emergency shutdown integration. The battery-to-inverter compatibility statement shall be provided by the relevant OEM(s). Battery status, parameter, and data shall be readable by battery inverter and plant monitoring system. A dedicated battery monitoring platform shall be provided to monitor the number of cycles, state of health, pack voltage and current, cell temperature, etc.
TR-BESS-06	DC protection	Dedicated DC MCCB rated for continuous, peak, short circuit battery currents shall be provided. Load breaks switch accessible from outside shall be provided for emergency purposed.
TR-BESS-07	DC Battery combiner panel	- The DC Battery Combiner Panel shall be designed to combine the DC output and input of multiple battery strings and distribute power to the DC bus system. The panel shall be suitable for battery voltage operation, with current rating as required by the final design and battery configuration. It shall be complete with a properly sized busbar system, incoming and outgoing DC-rated circuit breakers (MCCBs), isolation devices, and dedicated positive, negative, and earth bars. A load break switch (LBS) or DC isolator shall be provided and shall be accessible from outside the panel enclosure to allow safe isolation during operation and maintenance. The panel shall have minimum plate thickness of 2.0 mm. - The enclosure shall be minimum IP54 for indoor installation, corrosion-resistant, and suitable for tropical environmental conditions, including high humidity, dust, and high ambient

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		temperature. The panel assembly shall comply with the applicable requirements including IEC 61439, IEC 60947, and IEC 60529. • Panels shall be factory-built or workshop-built using professional enclosure systems and shall include engraved nameplates, internal wiring with ferrules and wire numbering, and typed terminal markers for clear identification. The design shall demonstrate adequate busbar sizing, thermal performance, short-circuit withstand capability, and corrosion resistance of both enclosure and internal components. Routine test reports shall be provided. • All panels supplied under this Contract shall be factory powder coated after proper surface preparation. For outdoor and coastal installations, the coating system shall be suitable for C5 corrosion category, with documented coating thickness and compatibility with the overall anti-corrosion strategy. • The panel shall be designed with protective covers or barriers to prevent direct contact with live conductors during maintenance. Busbars shall be provided with insulation material suitable for 48 VDC systems, and creepage and clearance distances shall comply with IEC requirements while allowing sufficient space for safe maintenance activities. An internal cable management system shall be provided to ensure proper routing, segregation, and protection of cables. • Detailed panel shop drawings shall be submitted for approval, including general arrangement, single line diagram, wiring diagram, bill of materials, and design basis demonstrating compliance with the specified requirements.
TR-BESS-08	Fire safety	Integrated BMS protections; detection and mitigation philosophy documented. Smoke and fire detection system shall be provided in the battery room and connected to audible annunciator. If required, rapid shutdown device shall be provided outside the container with protected cover in case of emergency.
R-BESS-09	Certification	IEC 62619 and UN 38.3 Mandatory. Copies of valid IEC 62619, UN 38.3, and any additional mandatory safety certificates for the completely offered battery system shall be submitted. Certifications shall correspond to the actual configuration offered, not to a materially different model.
TR-BESS-10	Warranty and service	Minimum battery warranty shall be not less than ten (10) years or the manufacturer's standard commercial warranty, whichever is

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	conditions		longer, is subject to the stated operating conditions. The Contractor shall design the charging and discharging cycles as well as the operating conditions to meet the warranty terms and conditions.
TR-BESS-11	Battery cable	DC	Flexible copper battery DC cable for battery system, with XLPO/XLPE insulation, LSZH, suitable for nominal 51.2 Vdc operation and battery current up to the number of battery packs in parallel, complete with insulation, lugs, polarity identification, and accessories compatible with the battery and inverter terminals. Cable sizes shall be selected based on continuous current, voltage drop, installation method, and short-circuit withstand, and shall comply with the battery OEM and inverter OEM requirements. Cable to each battery bank/string shall have the same length. Max voltage drop is 0.5%.

9. Communication Cable

Ref.	Requirement	Minimum Requirement
TR-COM-01	Ethernet Communication Cable	Supply of CAT 5e or eqv, 4-pairs twisted pair, 24 AWG solid bare copper conductor, overall shielded (STP), UV-resistant PE outer sheath, suitable for outdoor and industrial installation, compliant with TIA/EIA-568-C.2 and ISO/IEC 11801, minimum bandwidth 100 MHz, rated for -20°C to +75°C operation, including manufacturer test certificate. The communication cable shall anti-rodent
TR-COM-02	RS485 Comm Cable	1 pair (2C) or 2 pair (4C) twisted pair communication cable or eqv, 22 AWG stranded tinned copper conductor, individually twisted pair with overall foil shield and drain wire (F/UTP or equivalent), characteristic impedance 120 Ω $\pm$ 10%, low capacitance, UV-resistant PE outer sheath for outdoor installation, compliant with EIA/TIA-485 standard, flame retardant IEC 60332-1, temperature rating -20°C to +75°C, complete with manufacturer test certificate.
TR-COM-03	CAN Comm Cable	1 pair (2C) twisted pair communication cable for CAN Bus application, 22-24 AWG stranded tinned copper conductor, characteristic impedance 120 Ω $\pm$ 10%, low capacitance (<50 pF/m), individually twisted pair with overall foil shield and drain wire, UV-resistant PE outer sheath (for outdoor) or LSZH (for indoor container), compliant with ISO 11898-2 (High-Speed CAN), flame retardant per IEC 60332-1, temperature rating -20°C to +75°C (minimum), complete with manufacturer test certificate.

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TR-COM-04	Communication cable installation	The communication cable shall not be installed in the same conduit or tray as the power cable. Galvanized steel tray shall be provided to reduce the EMI from the surrounding power cable. Provide at least 20 cm distance between communication cable tray and power cable trays.
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10. Control and monitoring system

Ref.	Requirement	Minimum Requirement
TR-MON-01	System monitoring	- Central local monitoring system covering PV production, BESS charge/discharge, inverter status, alarms, and events. The monitoring system shall include event/alarm logging, user management, historical trending, and dashboards sufficient for operation, troubleshooting, and warranty support. Monitoring shall cover PV, battery, inverter, key breakers/interlocks, meter data, trends, KPI, alarms, and environmental sensors provided under the scope. Remote access shall be provided to the operator workstation. - The contractor shall also provide an online monitoring system through Web-based platform. Contracting Authority or Facility Owner credential shall be provided and handed over after commissioning. - The platform or license shall be valid for at least 10 years of operation.
TR-MON-02	Data resolution	Minimum logging interval 1–5 minutes. The Contractor shall declare the actual logging interval for each measured point category and confirm local data retention duration and export capability. Critical alarms shall have time-stamped event records.
TR-MON-03	Communication	Modbus TCP and/or Modbus RTU; Ethernet-based local access.
TR-MON-04	Local access and monitoring	Web-based or local interface for on-site operation and troubleshooting shall be provided in the powerhouse. PC desktop shall be provided with minimum 27-inch, intel processor capable of handling the required software, 32 GB RAM, and storage of minimum 1 TB or sufficient to store the historian data for at least 1 year. Additional 40-inch smart TV for monitoring should be provided

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		for showing the performance of the PV outside the power house or office room.
TR-MON-05	Data ownership	All operational data shall remain accessible to the Contracting Authority without vendor lock-in.
TR-MON-06	Weather station and Pyranometer for GHI	- Weather station shall consist of ambient temperature, relative humidity, and pyranometer sensor. - The pyranometer shall have the following specification: ISO 9060 spectrally flat Class C pyranometer complete with Modbus TCP/RTU communication and 0–1 V or 4–20 mA analog output, active temperature correction (-40°C to +80°C), temperature response ≤5% (-10°C to +40°C), long-term stability with no change of desiccant for minimum 10 years, suitable for outdoor PV monitoring application, including mounting bracket, adjustable tilt arm, cabling interface, and all necessary accessories for complete installation and commissioning. - Ambient temperature sensors shall have the operating temperature range of at least 0 degC to 50 degC with accuracy of +- 0.1 degC. The Relative Humidity (RH) sensor shall be able to measure the RH of 0 to 100%. - The Contractor shall provide mounting location, orientation, cleaning access, and calibration/maintenance recommendations for the pyranometer. Sensor placement shall avoid shading and shall be representative of the PV field conditions.
TR-MON-07	Revenue Meter & Accessories	- Three-phase, four-wire revenue-grade energy meter, CT-operated type (5A secondary), accuracy Class of minimum 0.5S compliant with IEC 62052-11 and IEC 62053-22, capable of bidirectional energy measurement (kWh import/export, kVAh), load profile recording, event logging, and RS485 Modbus communication for EMS integration. Suitable for 400 V, 50 Hz LV system. Complete with compatible current transformers (as per calculated ratio), shorting terminal block, wiring, meter enclosure (IP54 minimum indoor), sealing provision, testing, calibration verification, and commissioning. - Meter class, CT ratio, CT burden, sealing provisions, and communication settings shall be documented in the metering package. If multiple meters are required for zero-export control, revenue verification, and load monitoring, all such meters shall be included in the scope.

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TR-MON-08	Energy metering and accessories	• AC metering shall be provided to measure PV generation, battery charge/discharge, facility load consumptions of each feeder, PLN incoming, Inverter AC Combiner box output. Meters shall be compatible with the monitoring system and installed at clearly defined measurement points. The energy meter shall be used for zero export and monitoring purposes with minimum class 0.5. • Measurement points, CT locations, meter burdens, communication wiring, and data mapping shall be shown on the SLD and monitoring architecture drawing. Metering arrangements shall support operational verification of zero-export control and plant performance including performance ratio, self-consumption rate, etc.
TR-MON-09	Control and monitoring system	Control and monitoring system shall include data logger/RTU compatible with the selected equipment, configured for local data acquisition, export limitation logic interface, event logging, remote diagnostics, and plant reporting. The system shall have local storage and shall also be accessible online for remote monitoring.
TR-MON-10	Internet connectivity	Industrial ethernet switches, mobile modem, and sim card shall be provided by Contractor. The contractor shall provide internet connection during the warranty period for operation and monitoring purposes.
TR-MON-11	CCTV	CCTV should be provided in the Power house and the surrounded area for security and safety surveillance. The CCTV shall cover all the area inside the power house and at the entrance of the power house.
TR-MON-12	Communication interface panel	The Communication, control and monitoring panel shall house the data logger/RTU, communication switches, power supplies, interface relays, terminal blocks, and other control and monitoring related components required for monitoring, communication, and control of the system. The panel shall be suitable for the required supply system, typically 230 VAC and/or 48 VDC, and shall include internal power distribution, protective devices, surge protection, and dedicated earth and signal grounding bars. The panel shall have minimum plate thickness of 2.0 mm. A UPS shall be provided to supply the Control and monitoring

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		system during loss of normal power. The UPS shall be sized to support all essential control and monitoring loads connected to the panel, including the data logger/RTU, and communication devices, for a minimum of 8 hours. The enclosure shall be minimum IP54 for indoor installation, corrosion-resistant, and suitable for the near shore condition. The panel shall be factory-built or workshop-built using professional enclosure systems and shall include engraved nameplates, ferrules, wire numbering, typed terminal markers, and proper cable management. Internal wiring shall be arranged with clear segregation between power and communication cables. Detailed shop drawings and technical documents shall be submitted for approval, including general arrangement, schematic diagram, wiring diagram, terminal plan, bill of materials, and UPS sizing calculation.
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11. Earthing, Lightning Protection & Miscellaneous

Ref.	Requirement	Minimum Requirement
TR-EAR-01	Earthing system	Single integrated earthing system bonding PV structures, inverters, BESS, panels, and metallic parts. All exposed conductive parts, cable trays, module frames, mounting rails, metallic roofs where applicable, inverter enclosures, BESS enclosures, and auxiliary steelwork shall be bonded into the integrated earthing system. Bonding continuity shall be tested and recorded.
TR-EAR-02	Earthing and bonding resistance	Target earth resistance $\leq 5 \Omega$, unless stricter site conditions apply. The bonding or continuity resistance shall not be higher than 0.3Ω . A grounding rod and box with a handhole shall be provided and connected to the existing grounding facility.
TR-EAR-03	Lightning protection	Lightning protection system designed for coastal environment; coordinated with PV and BESS installations. Lightning protection design shall consider the existing buildings' LPS status, lightning protection system level, roof geometry, proximity of PV modules to air terminals/down conductors, and the need for separation distance or isolated LPS concept. The Contractor shall submit a

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		coordinated LPS layout.
TR-EAR-04	SPD coordination	Coordinated DC and AC SPDs, aligned with lightning protection design. SPD coordination shall include DC, AC, communication, and control circuits as applicable. Replacement indication and maintenance provisions for SPDs shall be included.
TR-EAR-05	Verification	Earth resistance and continuity tests documented at commissioning. Verification shall include earth resistance, continuity of protective conductors, insulation resistance where applicable, polarity checks, and functional verification of surge protection status indicators. Results shall be tabulated in the handover dossier.
TR-EAR-06	Accessories	All necessary accessories including but not limited to appropriately sized tinned copper cable lugs and ferrules, double-compression cable glands (nickel-plated brass or stainless steel for outdoor use), UV-resistant cable ties (SS316 for outdoor/coastal areas), heat-shrink tubing with adhesive lining, identification ferrules, permanent UV-resistant engraved or printed labels, stainless steel mounting hardware, grounding and bonding conductors, earthing lugs, termination kits, protective conduits or trunking where required, IP-rated junction/termination boxes (minimum IP65 for outdoor), surge protection devices where applicable, and all fixing, sealing, testing, and commissioning materials necessary to ensure complete, safe, and compliant installation in accordance with IEC standards and project specifications.

12. Balance of System

Ref.	Requirement	Minimum Requirement
TR-BOS-01	Cable trays and supports	Indoor and exposed outdoor cable trays, ladders, covers, brackets, and supports shall be hot-dip galvanized steel after fabrication with minimum average zinc coating thickness of 85 µm in accordance with ISO 1461 / ASTM A123 plus an additional paint coating for marine coating system. Tray cover, anti-UV, and fireproof sealant shall be provided to avoid animal intrusion. Fasteners, bolts, nuts, and washers for outdoor tray/support installations shall be stainless steel 316 minimum. Minimum tray material thickness shall be 2.0 mm for trays up to

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		300 mm width and 2.5 mm for trays above 300 mm width, unless calculations require greater. The cable route connecting the PV canopy and PV rooftop to the PV inverter inside the Powerhouse shall be routed within a cable tray for mechanical protection. The cable tray installation shall be in elevation and neatly installed, properly supported, and arranged so as not to obstruct the access road or hinder safe operation and maintenance access in the facility.
TR-BOS-02	Conduits and fittings	Outdoor conduits shall be heavy-duty UV-resistant conduit or corrosion-resistant metallic conduit suitable for the environment and mechanical duty. Metallic conduits and fittings in coastal outdoor areas shall be hot-dip galvanized or stainless steel, with corrosion-protected threads and accessories. Flexible conduits used outdoors or in wet areas shall be liquid-tight UV-resistant type with corrosion-resistant glands and fittings. Anti-UV, and fire proof sealant shall be provided to avoid animal intrusion Conduits for outdoor exposed installation shall be minimum HDPE or hot dip galvanized rigid steel conduit as suited to the location.
TR-BOS-03	Cable containment fill ratio	Conduct fill shall not exceed 40% of the internal cross-sectional area for two or more than two conductors and 50% for a single conductor. Cable tray / ladder fill shall generally not exceed 40% of the usable cross-sectional area, and final cable sizing / derating shall consider grouping, ambient temperature, solar gain, and future maintainability. Cable tray calculation shall be provided to justify. Cable shall be installed neatly in flat configuration in tray with spacing for heat dissipation. Cable ties shall be provided to arrange the cables.
TR-BOS-04	Routing and accessibility	Cable trays, conduits, and cable routes shall be arranged to avoid obstruction of walkways, access doors, equipment maintenance zones, roof drainage paths, firefighting access, and routine facility operations. Routing shall be coordinated with existing services and building use so that the completed installation does not create trip hazards, headroom conflicts, restricted access, or difficulties for future maintenance.
TR-BOS-05	Minimum enclosure and	Unless a more stringent OEM or code requirement applies, minimum ingress protection ratings shall be: IP65 for outdoor

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	equipment IP rating	exposed electrical panels, junction boxes, isolators, monitoring boxes, and field-installed control enclosures; IP54 minimum for indoor electrical panels located in clean electrical rooms; and IP55 minimum for indoor equipment located in humid, dusty, or wash-down-prone industrial/service areas. Outdoor cable glands, boxes, and accessories shall maintain the enclosure's final installed IP rating.
TR-BOS-06	Anti-corrosion protection and material compatibility	All exposed metallic parts shall be protected against coastal corrosion by suitable material selection and coating system appropriate for C5-M / severe tropical marine conditions. Dissimilar metals shall be isolated to prevent galvanic corrosion. Field-drilled holes, cut edges, welds, and damaged coating areas shall be repaired using an approved touch-up / repair system fully compatible with the parent coating.
TR-BOS-07	Water cleaning system	Consisting of a water storage tank, electric booster pump, PVC/HDPE piping network, hose bib points, flexible hoses, and manual cleaning accessories (soft brush and telescopic pole). The system shall provide adequate flow and pressure suitable for safe cleaning of PV modules without causing glass or coating damage. All outdoor components shall be UV-resistant and corrosion-resistant, suitable for tropical environment
TR-BOS-08	Cable accessories	Cable accessories including indoor cable ties, outdoor SS cable ties with epoxy coating, tinned copper compression lugs, ferrules, glands, heat-shrink, stainless steel cable tag with embossed markers, and sealing accessories, suitable for indoor, outdoor, and coastal installation.

13. Civil Works

Ref.	Requirement	Minimum Requirement
TR-CW-01	Dismantling, Cut and Fill, and Reinstatement	All civil reinstatement shall restore the area to at least its pre-existing functional condition and appearance. The Contractor shall provide compaction records, trench warning tape where required, and drainage restoration to avoid future settlement or water ingress.
TR-CW-02	Structural Strengthening	Perform design verification and execute structural strengthening works for the PV mounting system and/or roof reinforcement to support PV canopy installation. Scope shall include supply and

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		installation of additional steel members, bracing, reinforcement plates, anchor bolts, fasteners, and corrosion protection treatment as required. All works shall comply with applicable structural load requirements (dead load, wind load, and relevant local codes) and utilize hot-dip galvanized or corrosion-resistant materials suitable for outdoor tropical environments. Scope includes installation, finishing, and submission of structural compliance documentation.
TR-CW -03	Power house	• The Power House shall be of prefabricated modular construction and specifically designed for installation in a severe coastal and near-shore environment. The enclosure shall be suitable for long-term outdoor service under salt-laden air, high humidity, condensation risk, high UV exposure, wind-driven rain, and elevated ambient temperature. • The power house size shall be finalized by the Contractor according to the actual equipment arrangement, available space, and required operational and maintenance clearances. The Contractor shall ensure sufficient space between equipment rows and sufficient front, side, and rear access where required for installation, cable termination, inspection, testing, operation, and replacement of components. The minimum clear maintenance distance in front of battery systems, inverters, and electrical panels shall be 1.5 m. Where manufacturer recommendations or applicable codes require greater clearance, the more stringent requirement shall apply. • The walls and roof of the power house shall be constructed from insulated prefabricated sandwich panels or equivalent purpose-built enclosure materials suitable for electrical equipment rooms in coastal service. The outer wall sheet shall be corrosion-resistant steel with adequate thickness for mechanical strength and durability, and the inner wall sheet shall be of corrosion-resistant steel or equivalent non-hygroscopic durable material. The insulation material shall be fire-retardant and non-hygroscopic, such as rockwool, PIR, or PU, with thickness sufficient to meet the thermal and HVAC design requirements, and in any case not less than 50 mm unless justified otherwise by calculation. • The roof construction shall be weatherproof, insulated, and designed to prevent water ingress and ponding. The floor system shall be designed for the actual static and dynamic loads. • The floor finish shall be anti-slip, durable, and suitable for industrial electrical room application. The power house shall be

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		designed to maintain the internal environmental conditions required by the installed equipment, including temperature control, humidity control, and condensation prevention, through a properly sized HVAC system based on actual heat dissipation and site ambient conditions. • All external hardware, hinges, locks, supports, bolts, nuts, washers, and exposed accessories shall be SS316 minimum. Dissimilar metals shall be electrically isolated where required to prevent galvanic corrosion. All cut edges, drilled areas, welds, and damaged coatings shall be properly repaired using approved corrosion protection materials and procedures. • The minimum enclosure protection rating shall be IP54, with higher protection provided where required by equipment arrangement, ventilation openings, or coastal exposure conditions. All cable entry points, louvers, doors, and service penetrations shall be designed so that the required ingress protection is maintained. • The Contractor shall submit detailed layout drawings, material specifications, structural calculations, corrosion protection specifications, and construction details demonstrating that the proposed power house is suitable for the actual installed equipment and the severe near-shore environmental conditions of the project site. • Certified Fire alarm systems such as heat and smoke detectors shall be provided in the Power house. Fire extinguishers suitable for electrical appliances shall be provided inside and outside.
TR-CW-04	Canopy reinforced concrete foundation	The 4.5 m high PV canopy along the walkway shall be supported on reinforced concrete foundations designed in accordance with SNI 2847 and relevant geotechnical assumptions. Unless final calculations justify otherwise, minimum concrete grade shall be K-300 (approximately f'c 25 MPa), reinforcement shall be minimum deformed bar grade fy 420 MPa for main bars and fy 280 MPa for ties/stirrups, nominal clear cover shall be 75 mm for concrete cast against soil and 50 mm for pedestal/above-ground exposed members, and minimum founding depth shall be 1.5 m below finished grade. Final dimensions shall be based on structural calculation and geotechnical assumptions.
TR-CW-05	Minimum civil and structural design &	The Contractor shall submit detailed documents covering rooftop structure reinforcement simulation, canopy structure simulation, foundation stability, anchor bolt design, base plate design,

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	calculations	deflection, serviceability, wind uplift, seismic actions, concrete bearing pressure, overturning, sliding, uplift, punching, crack control, and waterproofing interface details. Calculations shall identify the design codes, load combinations, assumed soil parameters, and utilization ratios.
TR-CW-06	Power house general arrangement and foundation	The Contractor shall provide power house general arrangement drawing, foundation general arrangement drawing, foundation design calculations.
TR-CW-07	HVAC system	HVAC capacity in Power house shall be based on actual inverter, battery, charger, and auxiliary heat dissipation with a minimum indoor design temperature at 25 degC and demonstrated in calculation. Final heat-load calculations shall be submitted to justify HVAC sizing and internal temperature limits. The HVAC shall be redundant with 2x100% as per heat load calculation.

14. Documentation Training, Warranty, spare parts

Ref.	Requirement	Minimum Requirement
TR-DOC-01	As-built documentation	As-built documentation shall be provided as per engineering document list. Editable source files (CAD) and raw project file shall be submitted in addition to PDF.
TR-DOC-02	Manuals	Operation and maintenance manuals for all major equipment. Manuals shall include OEM manuals plus project-specific O&M procedures, switching instructions, emergency response, battery safety instructions, cleaning procedures, inspection checklists, and recommended spare-parts lists. Manuals shall be fully consistent with the installed system.
TR-DOC-03	Training	On-site training for designated staff covering operation, safety, and routine maintenance. Training shall cover normal operation, alarms, safe shutdown/start-up, bypass operation, battery safety, roof access precautions, cleaning, basic troubleshooting, and routine inspection tasks. On-the job practical training shall be performed apart from in-class training. Attendance records and training materials shall be handed over.
TR-DOC-04	Warranty	Warranty schedule shall be tabulated by equipment type and shall state warranty term, responsible party, response time, and

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		claim procedure. Where extended OEM warranties are offered, these shall be clearly identified in the bid.
TR-DOC-05	Spare part	The Contractor shall submit spare part list including commissioning spares and minimum first five (5) year spare parts covering PV modules, inverters, battery system, BMS, Control and monitoring system, Inverter AC combiner box, energy meters, switchgear, communications devices, SPDs, fuses, MCBs, MCCBs, cables, fans / filters, and other critical control accessories. The matrix shall identify quantity included in the Contract Price, storage conditions, and replacement responsibility. EPC Contractor shall provide at least 0.5% of spare modules or Six (6) units at minimum for spare parts and 1-3% at least for other consumables.
TR-DOC-06	Key project management documents	As a minimum, the Contractor shall submit Project Execution Plan, detailed project schedule, Project Quality Plan including Inspection and Test Plan, Project HSE Plan, organisation chart, material approval request (MAR) register, document register, reporting format, and procurement / expediting plan.
TR-DOC-07	Performance test and reliability records	The handover dossier shall include approved performance test procedures, signed performance test records, availability calculation sheets, reliability run records, punch-list closeout records, and final settings backups for all controllable devices.

15. Energy Yield Assessment

Ref.	Requirement	Minimum Requirement
TR-EYA-01	PV energy yield study	The Contractor shall prepare a detailed PV simulation using PVsyst based on the actual proposed PV module model, inverter model, string configuration, tilt, azimuth, shading conditions, site meteorological inputs, temperature assumptions, system losses, degradation assumptions, and export limitation / operational constraints. The PVsyst report shall include, at minimum, monthly and annual energy yield, specific yield, performance ratio, array losses, inverter losses, thermal losses, mismatch losses, soiling assumptions, and shading losses

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TR-EYA-02	Hybrid / battery operation study	The Contractor shall prepare a HOMER or equivalent time-series simulation using the actual proposed PV, battery, inverter / PCS, control logic, and facility load profile. The study shall demonstrate the expected operating behavior of the system under PLN-connected mode, zero-export mode, island mode, and battery charge / discharge cycles.
TR-EYA-03	Simulation inputs	The Contractor shall clearly state all key assumptions, including meteorological data source, load profile, operating hours of cold storage / ABF / ice-making loads, battery usable energy, depth of discharge, round-trip efficiency, auxiliary consumption, inverter clipping, system availability, and dispatch strategy.
TR-EYA-04	Deliverables	Editable PVsyst and HOMER model files shall be included in the handover package together with the final reports. Any future change in the offered component model shall require a corresponding update of the simulation results.

16. Quality Assurance, Type Test, FAT, and SAT

Ref.	Requirement	Minimum Requirement
TR-QCA-01	General QA	The Contractor shall implement a documented quality assurance and quality control system covering engineering, procurement, manufacturing, installation, testing, and handover. The quality system shall be project-specific and aligned with the approved Inspection and Test Plan.
TR-QCA-02	Type test and routine test reports	• PV modules: IEC 61215, IEC 61730, and relevant bifacial / PID / salt mist / ammonia / mechanical load / hail / fire class certificates where applicable. • Battery cells / modules / racks: IEC 62619, UN 38.3, manufacturer routine test reports, and documented safety and performance test evidence. • PV inverter, battery inverter, inverter AC Combiner box equipment should be provided with relevant IEC compliance certificates, routine factory test records, and manufacturer test certificates for protection, dielectric withstand, and functionality as applicable to the equipment type. • DC battery combiner panel, AC combiner panel, main distribution panels should be provided with routine test certificates in accordance with applicable IEC standards,

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		including at minimum visual inspection, wiring check, insulation resistance test, and functional verification.
TR-QCA-03	Hold points	The Contracting Authority shall have the right to witness key inspections, selected critical cold or hot commissioning steps. Release for shipment or energization shall not proceed before closure of material non-conformities.

17. Commissioning and Performance Test

Ref.	Requirement	Minimum Requirement
TR-CMS-01	Cold commissioning (minimum)	• Verification that all approved drawings, test sheets, settings sheets, and method statements are available and current. • Mechanical completion check of PV mounting, canopy steelwork, foundation works, panels, battery installation, cable trays, conduits, supports, earthing, labels, nameplates, and housekeeping. • Inspection of torque tightening records for structural bolts, anchor bolts, electrical terminals, DC connectors, and busbar / breaker terminations where applicable. • Visual and dimensional inspection of cable routing, bend radius, tray / conduit fill ratio, segregation between power and communication cables, gland sealing, ingress protection measures, and corrosion protection touch-up. • Continuity testing, insulation resistance testing, polarity verification, earthing continuity checks, earth resistance testing, control wiring checks, and communication loop checks. • Verification of breaker ratings, fuse ratings, panel labels, circuit schedules, CT orientation, meter wiring, protection settings upload, interlock logic, alarm mapping, and software / parameter backup. • Verification of battery installation condition, BMS communication, auxiliary supply availability, ventilation / cooling availability, fire detection readiness, and emergency shutdown / isolation devices. • Pre-energization verification that the system cannot unintentionally export to grid and cannot unintentionally

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		parallel incompatible sources.
TR-CMS-02	Hot commissioning (minimum)	• Sequential energization and functional verification of AC and DC systems in accordance with the approved commissioning procedure. • Verification of PV inverter startup, battery inverter / PCS startup, BMS alarms, meter readings, communication interfaces, monitoring dashboard, and time synchronization. • Functional test of zero-export control under varying load and irradiance conditions, including confirmation that active export to PLN does not occur. Demonstration of island operation, transfer logic, load supply continuity for designated feeders, and correct behavior upon loss and restoration of PLN supply. • Charge and discharge functional testing of the battery system, including verification of SOC measurement, charge / discharge limits, alarms, and protective actions. • Testing of bypass / changeover / isolation logic and all electrical and mechanical interlocks, including verification that prohibited parallel operation cannot occur. • Protection function tests, alarm tests, emergency stop / shutdown tests, and restoration tests. • Thermographic inspection under load after stabilization period, trending of major measurements, and rectification of abnormal temperature rise or nuisance alarms. • Completion of a reliability / observation run and submission of signed hot commissioning records, punch list, and closure plan.
TR-CMS-03	Performance test	• After completion of hot commissioning and defect rectification, the Contractor shall perform a formal performance test over a continuous minimum seventy-two (72) hour demonstration period under representative operating conditions. The test shall verify correct PV production measurement, battery charge/discharge operation, zero-export control, islanding transfer logic, monitoring functionality, and feeder supply continuity for the intended loads. • The performance test pass criteria shall include, as a

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		minimum: (i) no uncontrolled trip of PV inverter, battery inverter, BMS, control and monitoring system, or Inverter AC Combiner box; (ii) no active export to PLN; (iii) successful completion of at least one intentional transfer to grid-connected mode and one return to island mode without unsafe operation; (iv) all mandatory alarms, interlocks, and emergency shutdown functions demonstrated; (v) all mandatory measurement points available in the monitoring platform with time-synchronised logging; (vi) automatic bypass to PLN grid during inverter failure; (vii) minimum PV plant performance ratio achieved with 80% (without battery); (viii) daily intended energy throughput of battery achieved (108 kWh); (ix) demonstrate with island operation during PLN blackout at low SOC (i.e. 20%-30%).
TR-CMS-04	Availability and reliability	Following successful performance testing, the Contractor shall complete a minimum fourteen (4) consecutive day reliability run. During this period the PV-BESS system shall achieve technical availability of not less than 100%, excluding outages caused by upstream PLN failure, force majeure, Employer-directed shutdowns, or unavailability of refrigerated process loads not within the Contractor scope. Technical availability shall be calculated as: Availability (%) = [Total scheduled test hours – Contractor attributable unavailable hours] / [Total scheduled test hours] x 100. Contractor-attributable unavailable hours shall include any period during which the PV generation, battery inverter, Inverter AC Combiner box, control and monitoring system, export limitation control, or essential monitoring system is unavailable due to design, equipment, software, workmanship, settings, or integration defects. Failure to meet the required availability, failure of mandatory protective functions, or repeated nuisance trips shall require corrective action and repetition of the affected portion of the reliability run.

H. Warranty and After-Sales-Support

The Contractor shall provide comprehensive warranty coverage and after-sales support for the complete PV and BESS system delivered under this EPC contract. The Contractor shall remain fully responsible for system integration, workmanship, and performance during the warranty period.

Minimum requirements:

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1. A minimum 24-month warranty shall apply to all supplied and installed equipment, commencing from the date of final acceptance. This warranty shall cover defects in design, materials, workmanship, installation, configuration, and system integration.
2. Warranty coverage shall include, as a minimum, workmanship and installation warranty, roof waterproofing reinstatement warranty, pass-through manufacturer warranty, preventive maintenance visits, remote diagnostics, corrective maintenance response times, spare-parts availability commitment, and a clear escalation matrix. Battery warranty shall state minimum retained usable energy/capacity and reference operating conditions.
3. Where manufacturer warranties exceed 24 months, such extended warranties shall apply in full and be transferred to the Contracting Authority. The Contractor shall remain responsible for coordination and facilitation of all warranty claims with manufacturers.
4. The Contractor shall demonstrate availability of spare parts and qualified service personnel within Java, Indonesia for the full warranty period. The proposal shall specify: List of recommended critical spare parts, Location of spare parts storage, Lead time for replacement components.
5. The Contractor shall provide preventive maintenance services at:
 - 6 months after commissioning
 - 12 months after commissioning.
6. Each preventive maintenance visit shall include inspection, functional checks, and a written service report.
7. During the warranty period, The Contractor shall provide remote diagnostic support throughout the warranty period. The Contractor shall provide corrective maintenance with a maximum response time of 24 hours from fault notification. On site intervention shall occur within a maximum of 72 hours (subject to travel logistics to Biak). Critical system faults affecting energy supply shall be prioritized.
8. Warranty terms shall clearly define:
 - Claim procedure
 - Responsibilities of the Contractor, Vendor and the Contracting Authority

I. Qualification of the contractor

The Contractor shall demonstrate verifiable experience and capacity in the following areas. All claims shall be supported by documentary evidence.

1. Proven experience in the design, supply, installation, testing, and commissioning of rooftop photovoltaic (PV) and battery energy storage systems (BESS) of comparable scale and complexity.
2. Demonstrated experience in delivering PV-BESS systems supplying electrically driven industrial or commercial loads, including understanding of load characteristics, start-up currents, and power quality considerations. Evidence shall include completion of certificates and/or client reference letters, including contact details for verification.
3. Contractor shall be a legally established EPC contractor or consortium member legally permitted to execute the Works in Indonesia and shall demonstrate capability for engineering, procurement, installation, testing, commissioning, and after-sales support of small commercial rooftop PV plus BESS systems.

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4. The Contractor shall have, directly or through committed subcontractors, Indonesian-registered construction capability, valid business licenses, tax registration, and applicable certifications required for electrical installation, structural steel works, and occupational health and safety. Bidders shall also identify the proposed commissioning party for the Inverter package and demonstrate access to authorized Inverter manufacturer technical support in Indonesia.
5. The Contractor shall submit with the offer:
 - Company profile, certificates, etc
 - List of similar projects with year, location, photos, size, scope, and client contact
 - Completion certificates or signed reference letters
 - CVs and qualification certificates of proposed key personnel
 - Organization chart
6. The Contractor shall demonstrate availability of sufficient in-house capacity for this contract, including at minimum:
 - Project Manager – overall contractual, technical, schedule, and interface responsibility from kickoff to handover. Experience in managing five projects with similar configuration.
 - Site Manager or Site Supervisor – full-time on-site coordination of daily works, subcontractors, interfaces, and reporting during construction. Experience in managing three projects with similar configuration in remote areas.
 - Electrical, instrumentation, and control Design Engineer – responsible for detailed electrical design, SLDs, protection, cable sizing, panel design review, metering, and interlocking philosophy. Experience in conducting detail design for three projects
 - Civil / Structural Engineer – responsible for roof assessment, canopy and foundation design, anchoring, waterproofing interfaces, and structural verification.
 - PV / BESS System Engineer or Integrator Engineer – responsible for PV system design, battery integration, control philosophy, zero-export logic, and performance alignment.
 - Procurement / Expediting Engineer or Coordinator – responsible for material tracking, vendor document coordination, and delivery follow-up.
 - QA/QC Engineer or Inspector – responsible for material inspections, test record control, FAT / SAT coordination, and non-conformance tracking.
 - HSE / K3 Supervisor – responsible for site safety, toolbox talks, permit-to-work support, work-at-height safety, lifting safety, and environmental controls.
 - Licensed Electrician / Electrical Technician team – adequate in number for safe installation, testing, termination, and troubleshooting activities.
7. The Contractor shall provide the staff list, organization chart, and CVs of the proposed personnel. The change of personnel shall be approved by the Contracting Authority.
8. Availability of certified K3 (Occupational Health & Safety) personnel in accordance with

Terms of Reference (ToR) for the procurement of goods and services
Procurement and Installation of Solar PV Systems for KNMP Biak, Papua

- Indonesian regulations.
9. Installation personnel shall hold relevant professional certifications aligned with their roles, including but not limited to Licensed or certified electrical technicians under applicable Indonesian frameworks (e.g. SKKNI / KKNi).
 10. **The contractor shall have an established local office or formal service partner in Java, Indonesia, to ensure timely after-sales support, maintenance, and warranty response. The Contractor shall define expected response times for remote support and on-site intervention for the Kalamo Biak location.**
 11. The contractor shall comply with all applicable Health, Safety, and Environmental (HSE) requirements during execution of the work.

Terms of Reference (ToR) for the procurement of goods and services
Procurement and Installation of Solar PV Systems for KNMP Biak, Papua

J. Document submission

The following minimum document matrix shall apply for submission during bidding stage and execution stage. A check mark (✓) indicates the document shall be submitted at the corresponding stage. Bidding-stage submissions shall be sufficient for technical evaluation and commercial completeness. Execution-stage submissions shall be detailed, project-specific, and approved prior to procurement, installation, testing, or handover as applicable.

The contractor should submit a more detailed Master Document List including the project management documents, engineering documents, vendor documents, QC documents, Inspection and commissioning documents.

No	Document / Deliverable	Bidding Stage	Execution Stage	Remarks
1	Compliance matrix against TOR / technical specifications	✓	X	Mandatory with technical offer.
2	Deviation / exception / clarification list	✓	X	Mandatory with technical offer. No deviation, exception, or clarification shall also be provided with blank response.
3	Schedule of assumptions, exclusions, and battery performance assumptions	✓	X	Mandatory with technical offer.
4	Preliminary project execution plan	✓	✓	Detailed revision required during execution stage.
5	Preliminary project schedule	✓	✓	Execution version to include procurement, FAT, SAT, and commissioning milestones with L4 schedule.
6	Company profile, similar project references, and EPC qualification documents	✓	X	Tender evaluation document as mentioned
7	Preliminary single-line diagram and operating philosophy	✓	✓	Execution version shall be final approved SLD and philosophy.

Terms of Reference (ToR) for the procurement of goods and services

Procurement and Installation of Solar PV Systems for KNMP Biak, Papua

8	Preliminary PV layout and equipment arrangement	✓	✓	Execution version shall be IFC drawings.
9	Preliminary bill of quantities / bill of materials / compensation table. Price and unprice BOQ during bidding stage for technical and commercial.	✓	✓	Execution version shall be detailed MTO / BOM with approved make and models.
10	Outline structural concept for roof reinforcement and canopy	✓	✓	The execution version shall include calculations, simulation and drawings.
11	Manufacturer datasheets for offered major equipment	✓	✓	Execution stage to include final approved datasheets and certificates.
12	Detailed design basis memorandum and applicable codes / standards list	X	✓	Required for approval before procurement.
13	Preliminary energy yield assessment showing the PV generation, performance ratio, and the RE share (%) based on offered equipment and stated assumptions	✓	✓	Tender stage to submit preliminary estimate; execution stage to submit final PVsyst and HOMER studies using approved models.
14	Preliminary method statement index / construction methodology summary	✓	✓	Tender stage to confirm execution approach and major method statements; execution stage to submit detailed approved procedures.
15	Detailed discipline-specific design basis documents (civil/structural, mechanical/HVAC, electrical, instrumentation/monitoring, energy yield)	X	✓	Required for approval before procurement and detailed engineering freeze.
16	Detailed civil and structural engineering dossier and calculations	X	✓	Includes roof strengthening, canopy, foundation, connection, concrete and reinforcement details.

Terms of Reference (ToR) for the procurement of goods and services**Procurement and Installation of Solar PV Systems for KNMP Biak, Papua**

17	Preliminary powerhouse design including HVAC engineering and lighting dossier	✓	✓	Detailed design will include powerhouse GA, foundation, HVAC load calculation, HVAC layout, lighting calculation, lighting and small power layout and penetration details where applicable.
18	Detailed electrical engineering dossier	X	✓	Includes SLDs, schematics/wiring diagram, panel drawings, cable schedule, tray/conduit routing and all calculations.
19	Detailed instrumentation, monitoring and communications dossier	X	✓	Includes control philosophy, control and monitoring architecture, I/O list, data point list, Modbus map, network topology and settings backup.
20	Detailed execution method statements	X	✓	Mandatory approved method statements prior to commencement of the related activity.
21	Detailed fire alarm and fighting system	X	✓	Fire alarm drawing, firefighting location, emergency evacuation route
23	Detailed electrical calculations: cable sizing, voltage drop, short-circuit, protection coordination, earthing	X	✓	Required prior to procurement / installation.
24	Cable schedule, indoor and outdoor tray / conduit routing drawings, cable route, and termination schedules	X	✓	Required prior to cable installation.
25	Detailed lightning and grounding	X	✓	Lightning protection study and layout, grounding

Terms of Reference (ToR) for the procurement of goods and services**Procurement and Installation of Solar PV Systems for KNMP Biak, Papua**

	system			calculation, grounding layout
26	Material Approval Requests (MAR) with catalogues, type test, routine test, and certificates	X	✓	Required before procurement / installation.
27	Preliminary Project Quality Plan, Inspection and Test Plan, and HSE Plan	✓	✓	Approved versions required before site mobilisation.
28	Factory Acceptance Test procedure and report for applicable equipment	X	✓	Where FAT is specified or proposed.
29	Site Acceptance Test, cold commissioning, hot commissioning, and performance test procedures	X	✓	Approved procedures required prior to energization.
30	As-built drawings, settings files, O&M manuals, training records, warranties, and spare parts list	X	✓	Mandatory handover package.

Terms of Reference (ToR) for the procurement of goods and services
Procurement and Installation of Solar PV Systems for KNMP Biak, Papua

K. Contract Period

This assignment shall cover a 12-month period including supply of equipment, installation, commissioning and maintenance. The assignment shall commence on **the date of signature**.

Activities	Timeline
Contract signature	July 2026
Coordination with Facility Owner / Facility Operator/access to site	1 week after signature
Submission of final design engineering (DED)	July 2026
Approval of final design engineering (DED)	August 2026
Supply and transport of equipment to site	September 2026
Civil works and Installation of PV–BESS system	September- October 2026
Testing and commissioning (TOC)	November 2026
Date of operation including the PLN approval	November 2026
Preventive maintenance visit (1)	Q1 2027
Preventive maintenance visit (2) (FAC)	Q4 2027

Terms of Reference (ToR) for the procurement of goods and services

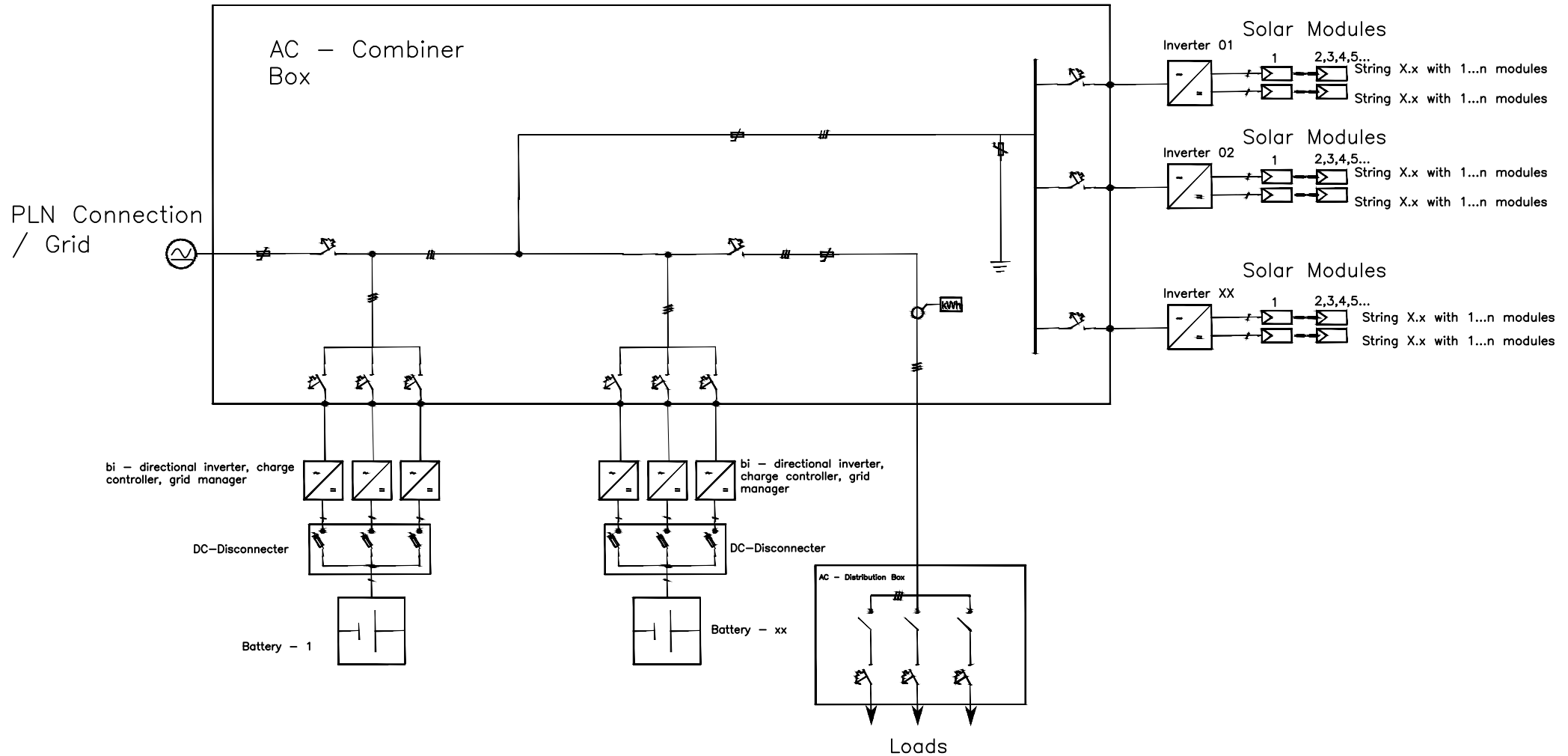
Procurement and Installation of Solar PV Systems for KNMP Biak, Papua

L. Payment Term

Payment shall be made within 2–3 months after issuance of the relevant Milestone Acceptance Certificate by the Contracting Authority and submission of the Supplier's corresponding invoice. Payment shall follow the following milestones:

Milestone	Payment (%)	Trigger / Deliverable	Key Supporting Documents
Advance Payment	25%	Payable upon contract effectiveness and readiness for mobilization	Advance payment guarantee, performance security, project management plan, approved project schedule, mobilization plan, insurance certificates.
Interim Payment 1: Detailed engineering approval and Supply and delivery to site	40%	Upon approval of the detailed engineering and procurement package, and delivery of all major equipment and bulk materials to site.	Approved layouts, structural calculations, SLDs, protection philosophy, cable sizing, equipment datasheets, MAR log, procurement plan; delivery inspection records, packing lists, serial number registers, test certificates, warranty certificates, shipping and insurance documents
Interim Payment 2: Installation and Provisional acceptance	30%	Upon completion of installation and readiness for commissioning; and successful cold & hot commissioning, training, and handover for operation	Installation completion certificate, inspection records, IR/continuity results, punch list, as-built markups, mechanical completion dossier; commissioning reports, SAT results, training records, O&M manuals, as-built drawings, PAC
Final Payment Retention release	5%	Upon expiry of defects liability period and closure of outstanding defects.	FAC, defect closure log/punch list/NCR, warranty dossier, final as-built document index.

PV System - Principle Layout



Project Name:XXX

Single Line Diagram

Particular:	Name	Initial	Date
Designed:	AR		
Drawn:	YK		
Checked:	UF		
Revised:			
Approved:	UF		

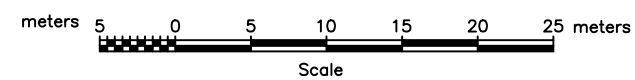
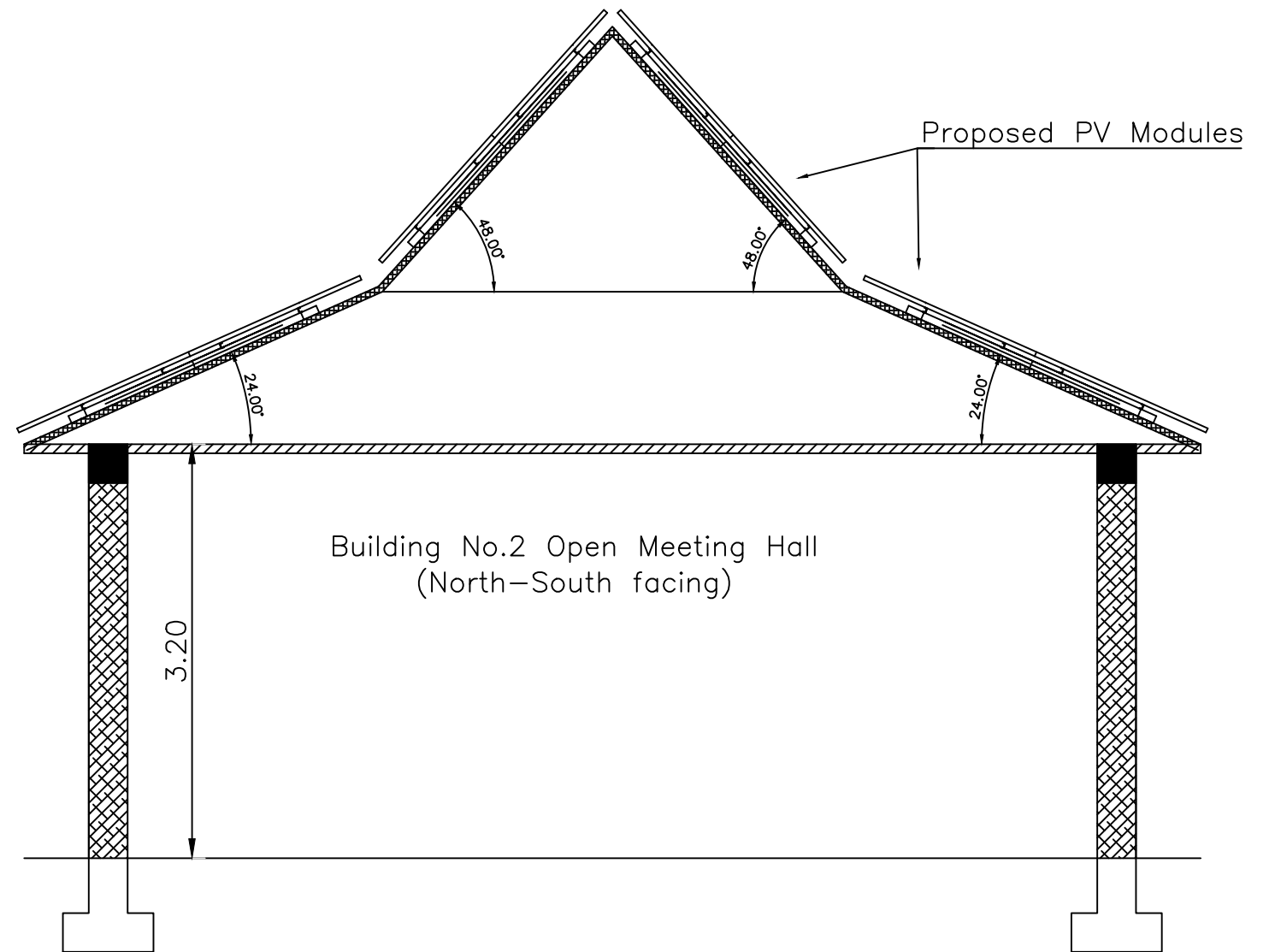
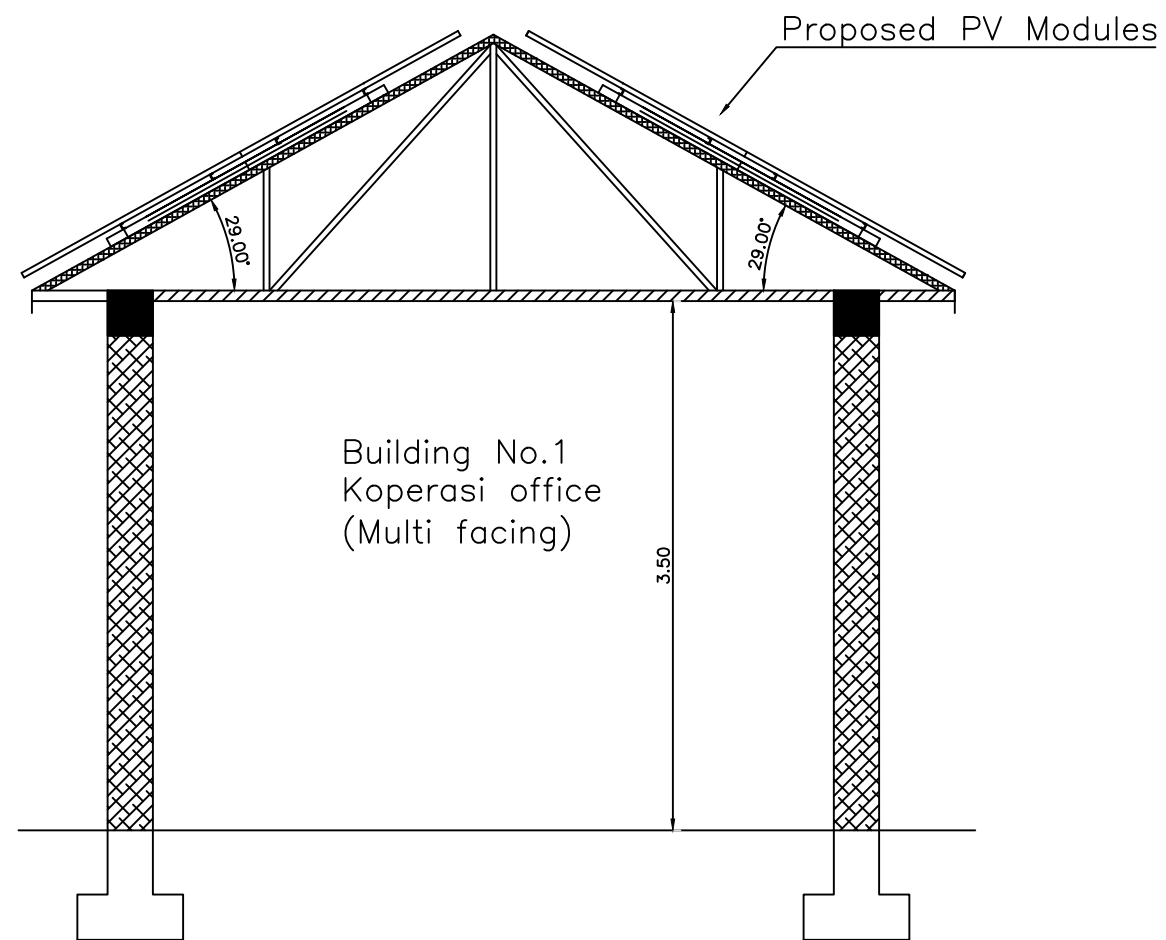
SHEET 1 OF 1

PLOT DATE: February 2026

Drawing No. :



INTEGRATION Environment & Energy
 Bahnhofstrasse 9, D-91322 Gräfenberg, Germany.
 Tel: +49 9192 9959-0, Fax: +49 9192 9959-10
 E-mail: int-ee@integration.org
 Web: <http://www.integration.org>



NOTE:.. Drawing is only to scale when printed in A3 paper format.

Project Name:XXX

LAYOUT

Building 1-2

SHEET 1 OF 5

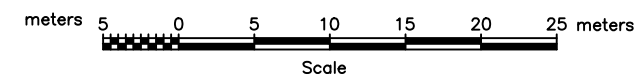
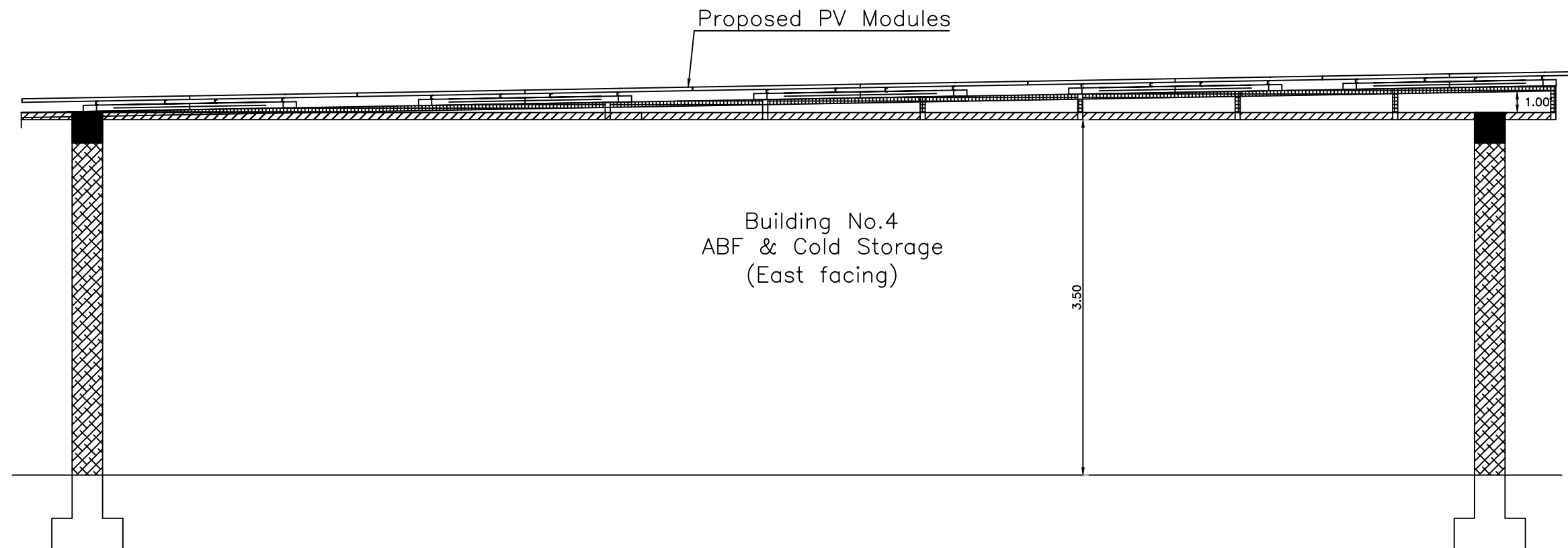
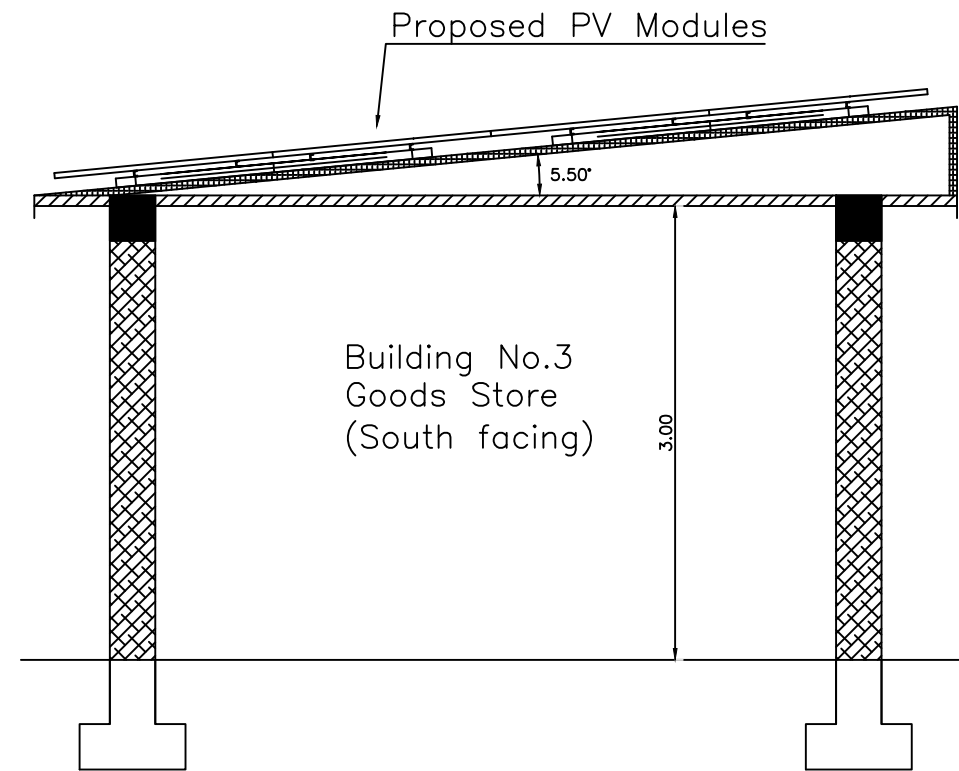
PLOT DATE: February 2026

Particular:	Name	Initial	Date
Surveyed:	AR		
Drawn:	YK		
Checked:	UF		
Revised:			
Approved:	UF		

Drawing No. :



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E-mail: int-ee@integration.org
Web: <http://www.integration.org>



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Project Name:XXX

LAYOUT

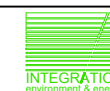
Building 3-4

SHEET 2 OF 5

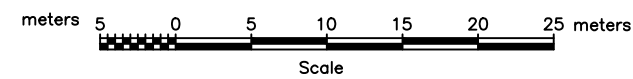
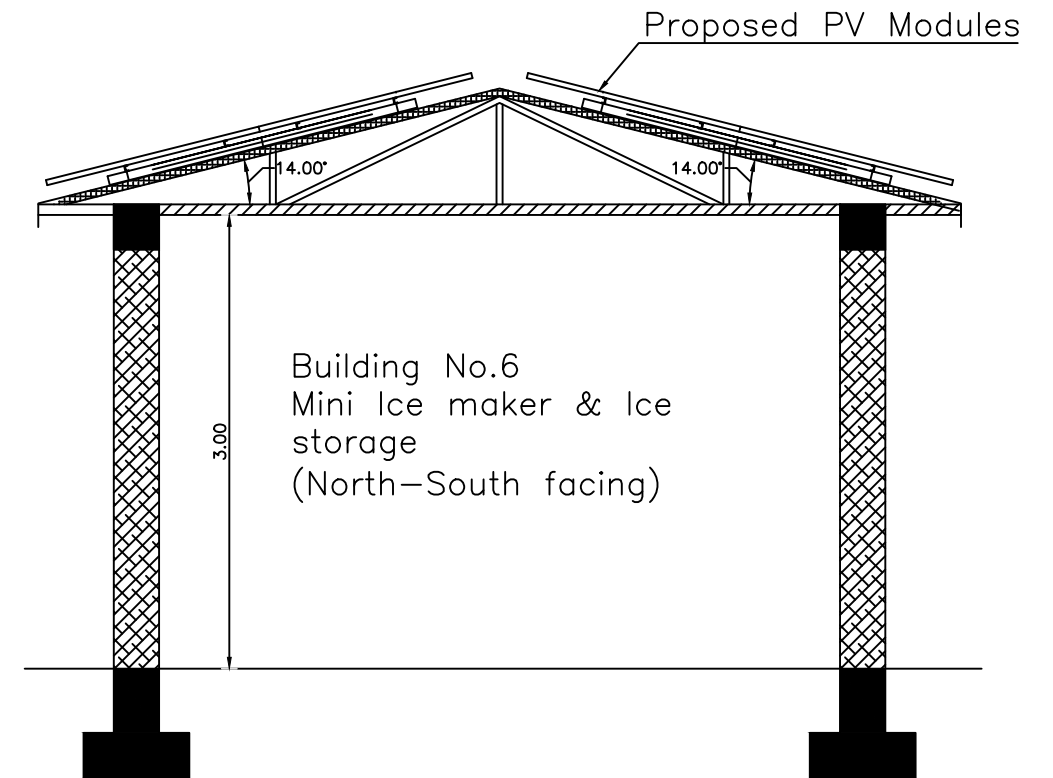
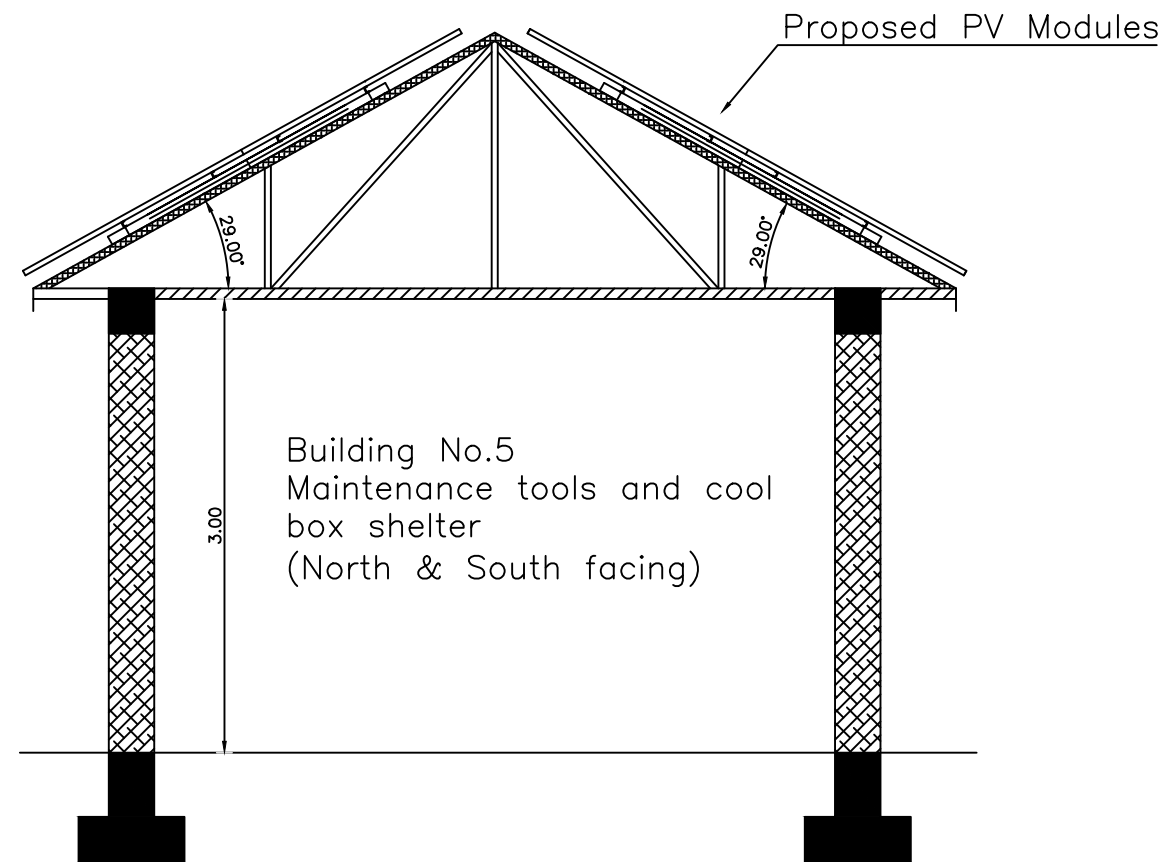
PLOT DATE: February 2026

Particular:	Name	Initial	Date
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Drawn:	YK		
Checked:	UF		
Revised:			
Approved:	UF		

Drawing No. :

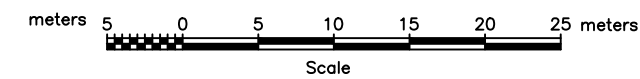
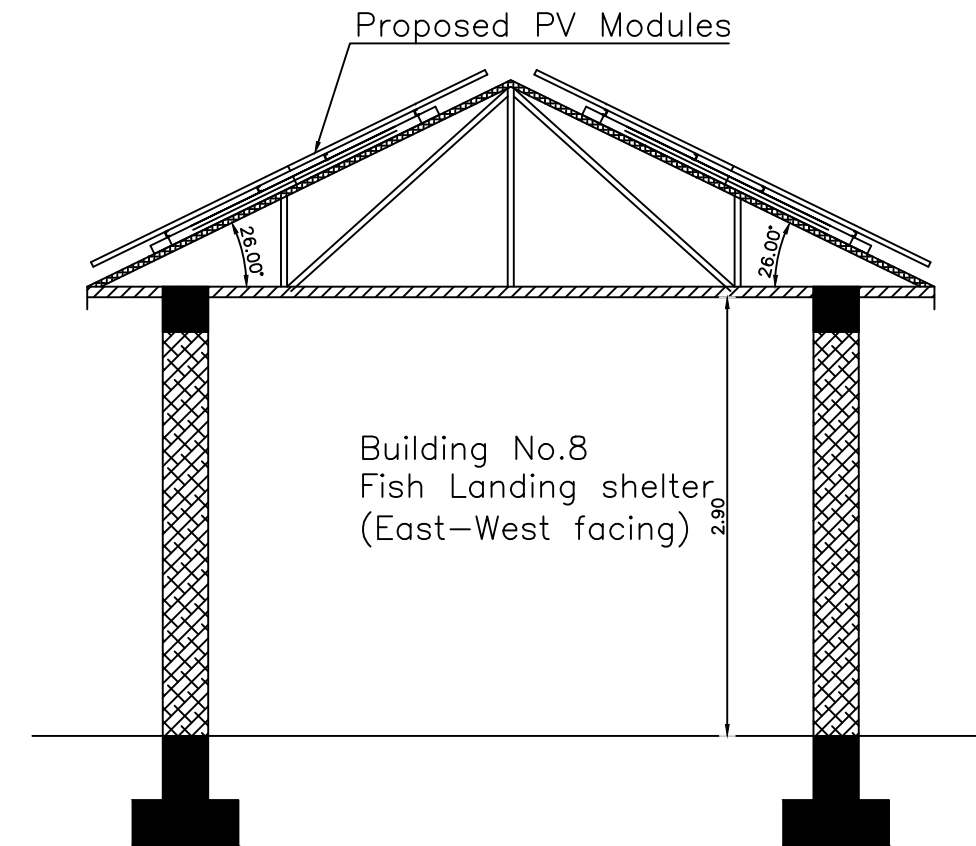
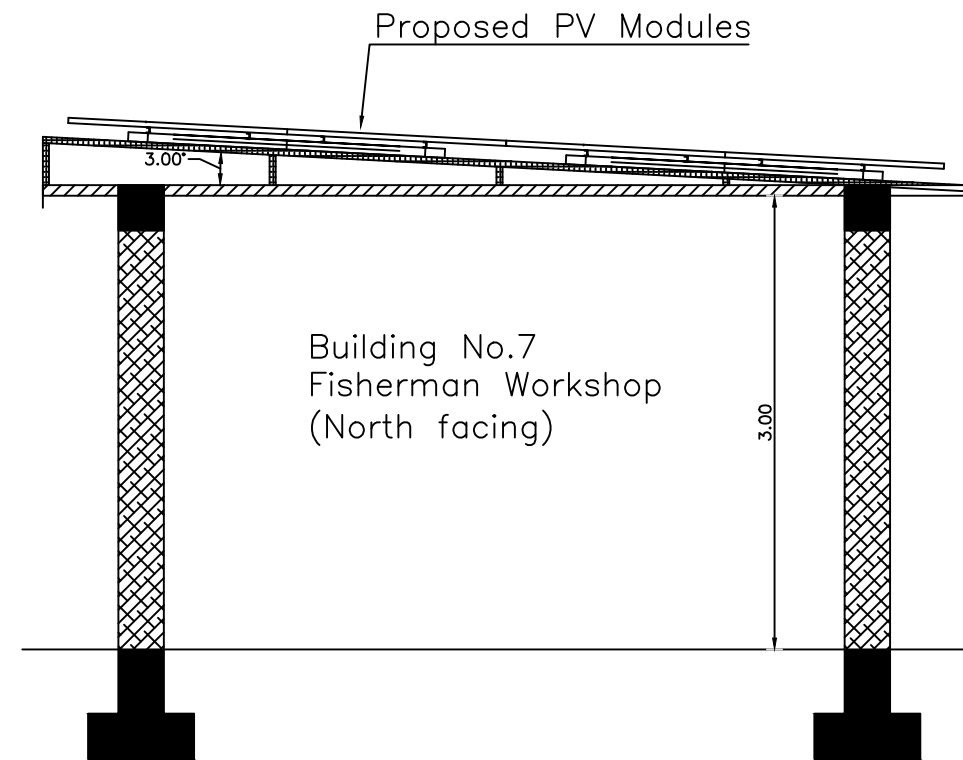


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Tel: +49 9192 9959-0, Fax: +49 9192 9959-10
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Web: <http://www.integration.org>



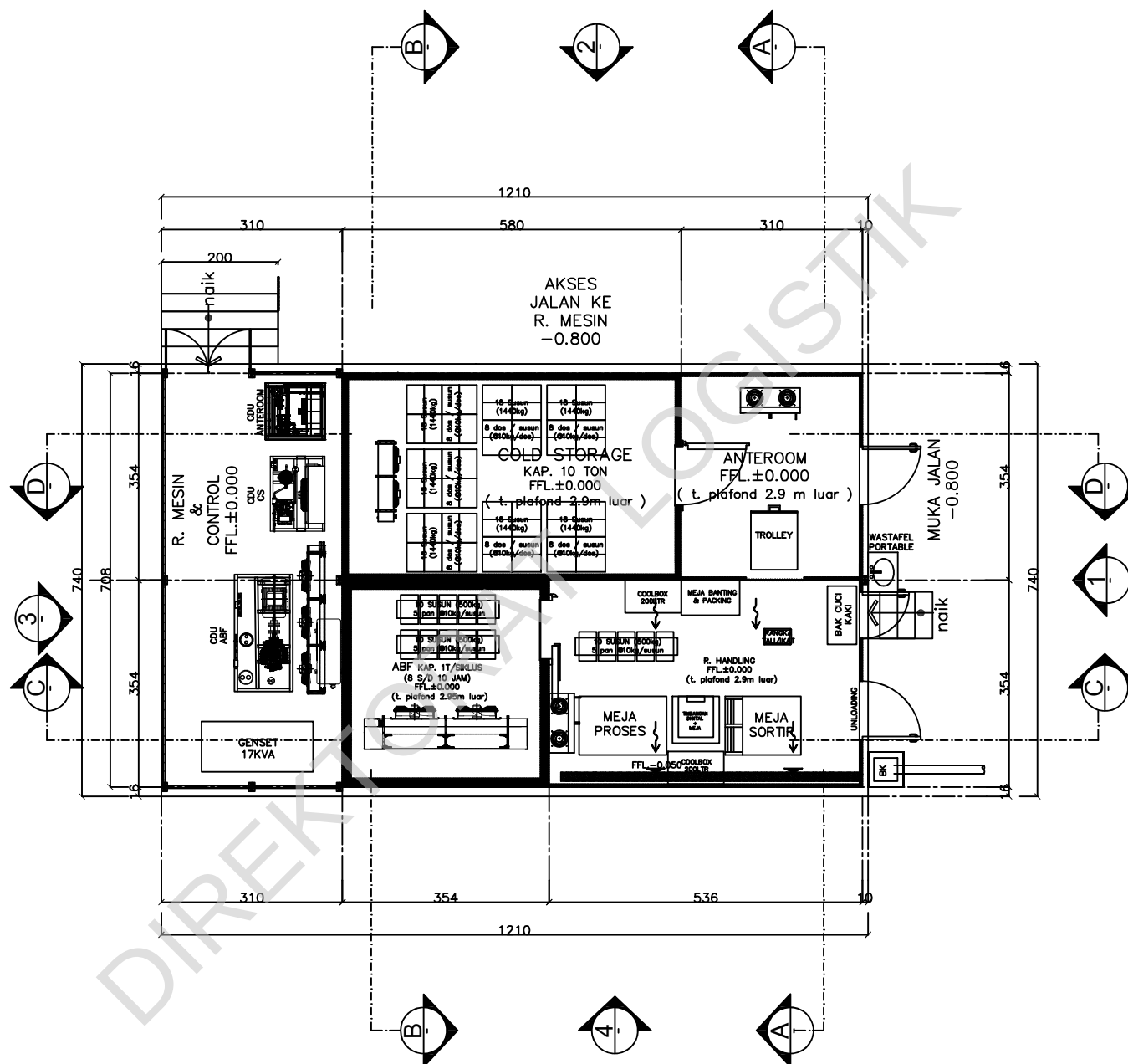
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Project Name:XXX				
LAYOUT Building 5-6 SHEET 3 OF 5	Particular:	Name	Initial	Date
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	Drawn:	YK		
	Checked:	UF		
	Revised:			
	Approved:	UF		
PLOT DATE: February 2026		Drawing No. :		
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NOTE: Drawing is only to scale when printed in A3 paper format.

Project Name:XXX				
LAYOUT Building 7-8 SHEET 4 OF 5 PLOT DATE: February 2026	Particular:	Name	Initial	Date
	Surveyed:	AR		
	Drawn:	YK		
	Checked:	UF		
	Revised:			
	Approved:	UF		
Drawing No. :				
 INTEGRATION Environment & Energy Bahnhofstrasse 9, D-91322 Gräfenberg, Germany. Tel: +49 9192 9959-0, Fax: +49 9192 9959-10 E-mail: int-ee@integration.org Web: http://www.integration.org				



SKALA (1 : 75)

SUBJECT :

GUDANG BEKU KNOCKDOWN DENGAN AIR BLAST FREEZER - KAPASITAS 10 TON SIMPAN & 1 TON (20-25HP ED) PEMBEKUAN PER SIKLUS 8 S/D 10 JAM - GNCS NONRP - LAYOUT UMUM

DRAW NO.: 000623KEL-DRW

DATE ISSUED : 07 JUN 2023

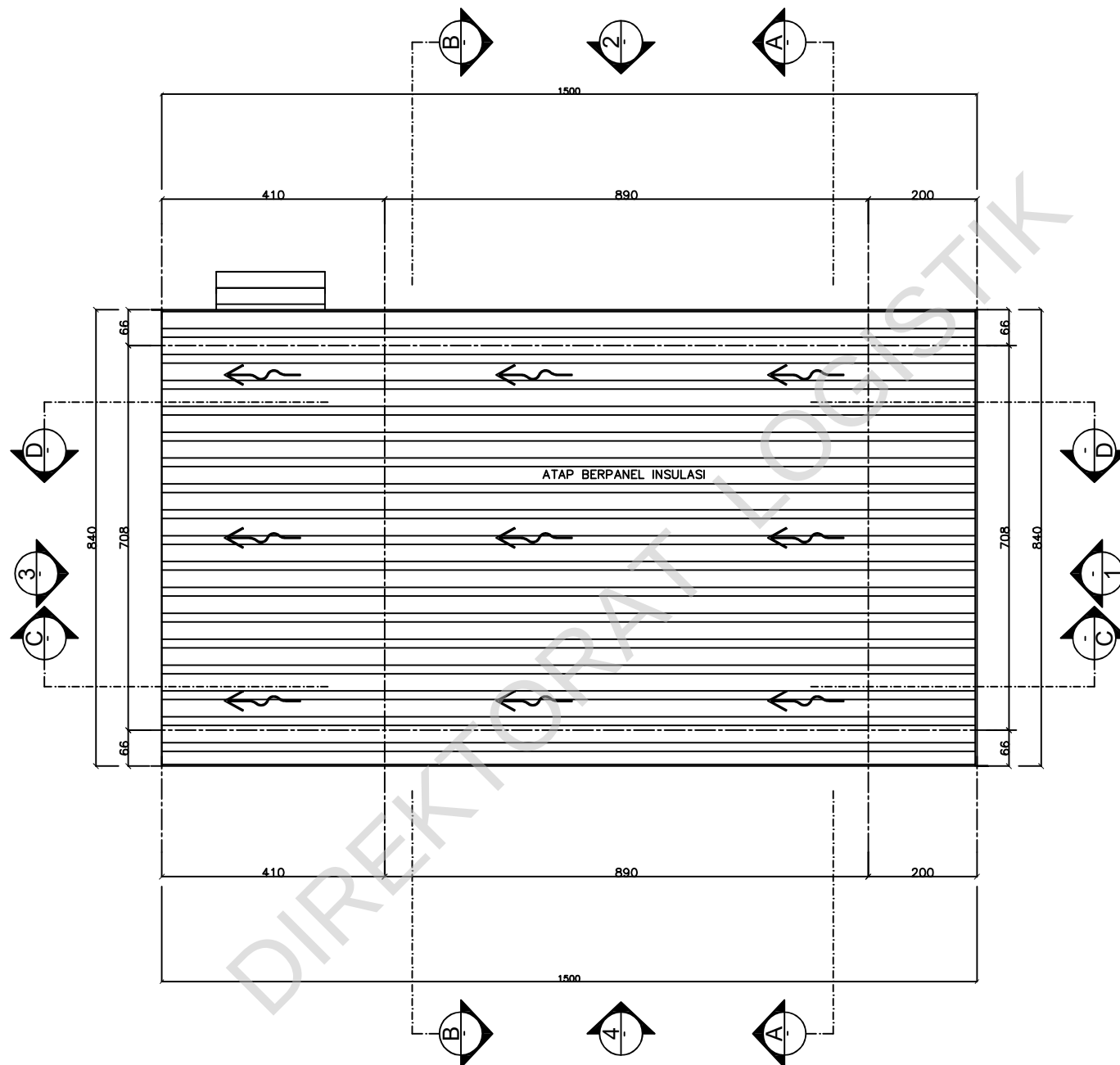
REVISION NO.: 00

REVISION DATE:

DESIGNED BY :

PT. TAMAC  SUKSES PERKASA

NO. JD :



SKALA (1 : 75)

SUBJECT :

GUDANG BEKU KNOCKDOWN DENGAN AIR BLAST FREEZER - KAPASITAS 10 TON SIMPAN & 1 TON (20-25HP ED) PEMBEKUAN PER SIKLUS 8 S/D 10 JAM - GNCS NONRP - DENAH ATAP

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DATE ISSUED : 07 JUN 2023

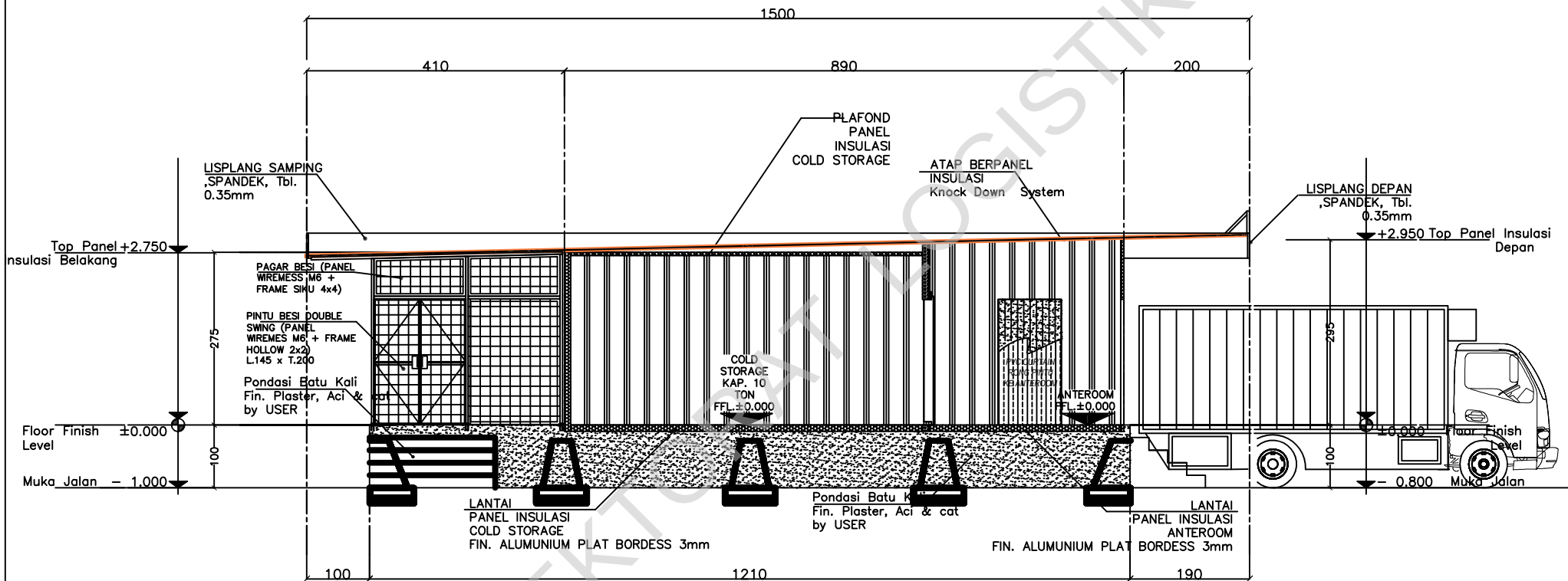
REVISION NO.: 00

REVISION DATE:

DESIGNED BY :

PT. TAMAC L SUKSES PERKASA

NO. JD :



SKALA (1 : 75)

SUBJECT :

GUDANG BEKU KNOCKDOWN DENGAN AIR BLAST FREEZER - KAPASITAS 10 TON SIMPAN & 1
TON (20-25HP ED) PEMBEKUAN PER SIKLUS 8 S/D 10 JAM - GNCS NONRP - PDT. C-C

DRAW NO.: 000623KEL-DRW

DATE ISSUED : 07 JUN 2023

REVISION NO.: 00

REVISION DATE:

DESIGNED BY :

PT. TAMAC L SUKSES PERKASA

NO. JD :

Annex E – Preliminary Structural Assessment (Reference only)

A1. Purpose of this Annex

This Annex provides a preliminary structural assessment summary, assumptions, and indicative reinforcement considerations prepared by the Owner/Consultant to assist bidders in understanding the existing structural conditions of the project site.

This Annex also provides a conceptual design and estimation by the consultant to assist the basic requirement of Solar PV Canopy needed by the client.

The information is provided solely for reference during the tender stage and is intended to support preliminary evaluation and cost estimation by bidders.

A2. Disclaimer and Limitation of Reliance

The structural assessment, assumptions, and reinforcement concepts included in this Annex are preliminary and conceptual in nature and have been prepared based on limited available data, assumptions, and preliminary observations.

The Owner does not warrant the completeness, accuracy, or adequacy of the information contained herein.

This Annex shall not be considered as the final structural design, engineering certification, or construction-ready documentation.

Bidders and the EPCIC Contractor shall not rely solely on this preliminary structural assessment for design or construction purposes.

A3. Existing Structure Information

The following information summarizes available data regarding the existing structure. Such information is provided based on available documentation and preliminary observations.

Parameter	Information
<i>Structure type</i>	<i>light steel structure – reinforced concrete</i>
<i>Roof type</i>	<i>Zincalume</i>
<i>Estimated slab thickness</i>	<i>Approx. 100 – 200 mm (refer to as-built drawing)</i>
<i>Existing structural drawings</i>	<i>partially available</i>
<i>Building usage</i>	<i>Existing facility building</i>

Actual conditions shall be verified by the EPCIC Contractor during detailed engineering and site

A4. Structural Analysis Assumptions (Conceptual)

The preliminary structural assessment was developed based on the following indicative assumptions:

Parameter	Assumption
<i>PV system dead load</i>	<i>15 kg/m² (PV Module & mounting rail)</i>
<i>Equipment load</i>	<i>5 kg/m² (Cable, Tray, Pipe, plafon each)</i>
<i>Rain load</i>	<i>NA</i>
<i>Wind load</i>	<i>380 N/m (SNI 1727 2020)</i>
<i>Earthquake load</i>	<i>Ss : 1,500 S1 : 0,600 Sds : 1,000 Sd1 : 0,68</i>
<i>Maintenance & Worker load</i>	<i>133 Kg (For the Canopy only)</i>
<i>Safety factors</i>	<i>NA</i>
<i>Load distribution</i>	<i>Assumed uniform distributed loads</i>

These assumptions are indicative only and may not represent actual site conditions.

Annex E – Preliminary Structural Assessment (Reference only)

Terms of Reference (ToR) for the procurement of goods and services

Solar PV + Battery Energy Storage System (BESS) - [Kalamo Biak Fishing Community Facility](#)

A5. Preliminary Structural Assessment Summary

Based on the preliminary review and available information, the following observations may apply:

- Ice Factory Building

Stress Ratio					
No	Profile	Ratio	Comparison	Limit	Status
1.	Rafter C 75x35 (Double)	1,191	>	1	NOT OK
2.	Column C 75x35 (Double)	0,701	<	1	OK
3.	Purlin Hat 40x40	0,861	<	1	OK
*Note: the structure is modelled using additional Solar PV Load and without Maintenance Load (133 Kg Point Load)					

Deflection					
No	Profile	Deflection (mm)	Comparison	Deflection Limit (mm)	Status
1.	Rafter C 75x35 (Double)	4,23	<	14,58333333	OK
2.	Purlin Hat 40x40	5,13	<	6,94	OK
*Note: the structure is modelled using additional Solar PV Load and without Maintenance Load (133 Kg Point Load)					

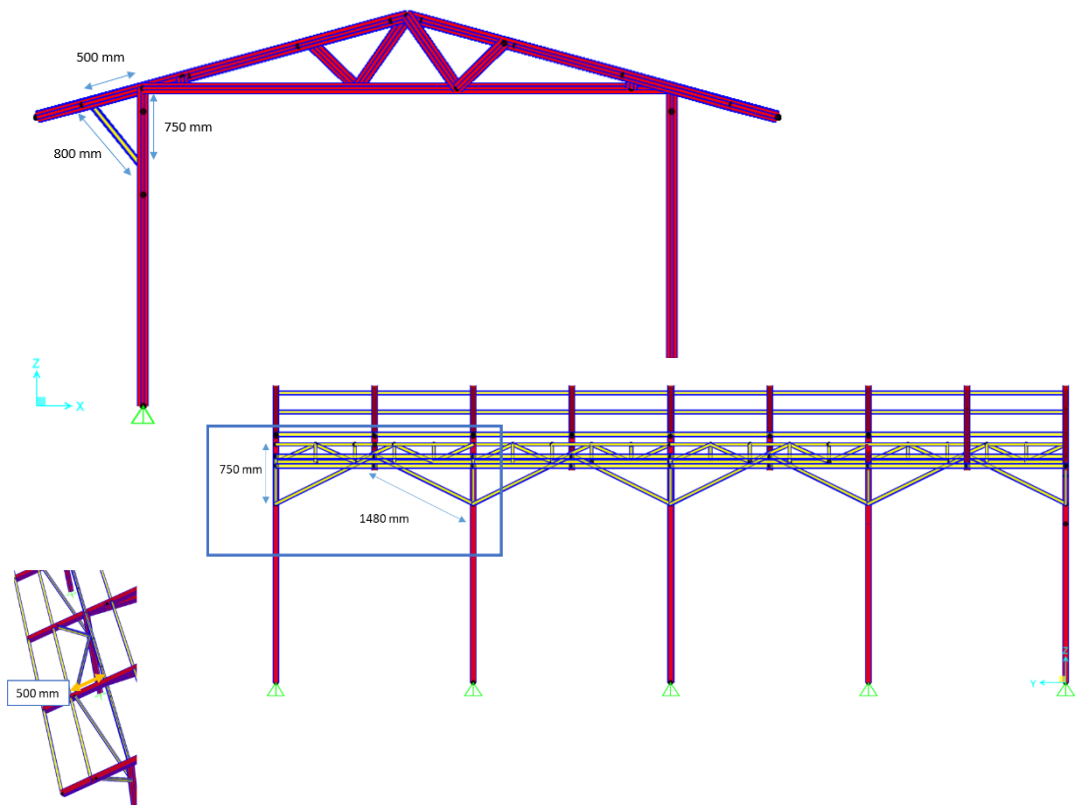
- Cold Storage Building

Stress Ratio					
No	Profile	Ratio	Comparison	Limit	Status
1	Rafter Hollow 40x40	1,208	>	1	NOT OK
2	Column C 75x35 (Double)	0,29	<	1	OK
3	Purlin Hat 40x40	0,578	<	1	OK
*Note: the structure is modelled using additional Solar PV Load and without Maintenance Load (133 Kg Point Load)					

Deflection					
No	Profile	Deflection (mm)	Comparison	Deflection Limit (mm)	Status
1	Rafter Hollow 40x40	9,38	<	14,75	OK
2	Purlin Hat 40x40	7,78	<	8,33	OK
*Note: the structure is modelled using additional Solar PV Load and without Maintenance Load (133 Kg Point Load)					

A6. Conceptual Structural Assessment & Reinforcement Considerations for each building

- Ice Factory Building

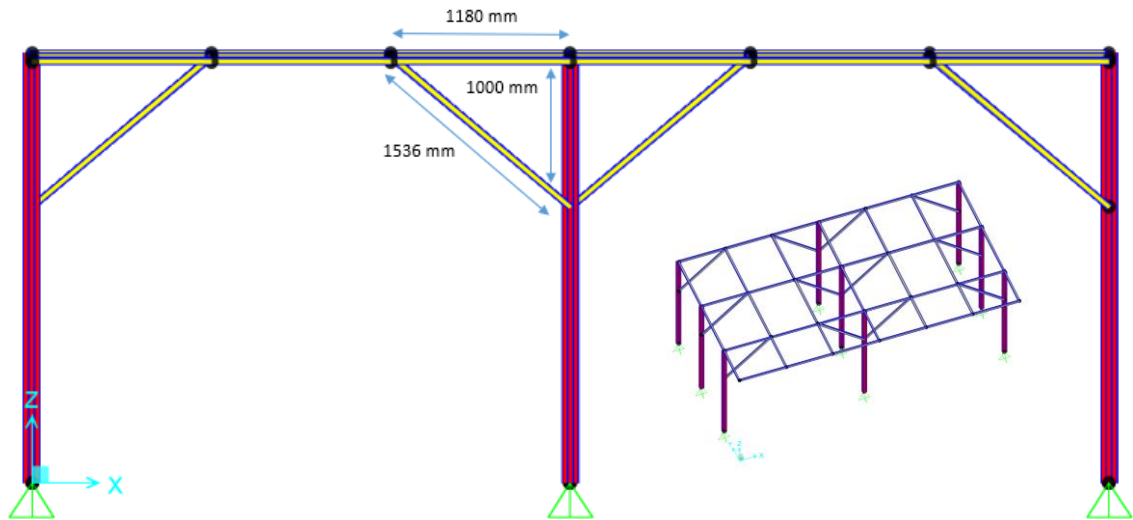


Annex E – Preliminary Structural Assessment (Reference only)

Terms of Reference (ToR) for the procurement of goods and services

Solar PV + Battery Energy Storage System (BESS) - [Kalamo Biak Fishing Community Facility](#)

- Cold Storage Building



B Pekerjaan Perkuatan Ice Factory Building			
1	Pengadaan dan Pemasangan penambahan Baja Ringan Box 40	Kg	28,64
2	Pengiriman dari Workshop ke Lokasi	Kg	28,64
3	Jasa pemasangan elemen perkuatan struktur: Erection, Fitting, Welding ke struktur existing.	Kg	28,64
4	Pemasangan Scaffolding dan Shoring	Ls	1
5	Pemasangan Safety net & Proteksi	Ls	1

F Pekerjaan Perkuatan Cold Storage Building			
1	Pengadaan dan Pemasangan penambahan Skoor bracing hollow 40x40	Kg	33,42
2	Pengiriman dari Workshop ke Lokasi	Kg	33,42
3	Jasa pemasangan elemen perkuatan struktur: Erection, Fitting, Welding ke struktur existing.	Kg	33,42
4	Pemasangan Scaffolding dan Shoring	Ls	1
5	Pemasangan Safety net & Proteksi	Ls	1

These observations are not definitive engineering conclusions and shall be validated during detailed engineering.

A7. Preliminary Conceptual Design for Canopy

Based on the preliminary review and available information, the following observations may apply:

- Calculation Summary

Stress Ratio					
No	Profile	Ratio	Comparison	Limit	Status
1.	Column WF 150X75x5x7	0,626	>	1	OK
2.	Rafter WF 150X75x5x7	0,175	<	1	OK
3.	Purlin CNP 125x50x20x2,3	0,604	<	1	OK
*Note: the structure is modelled using additional Solar PV Load					

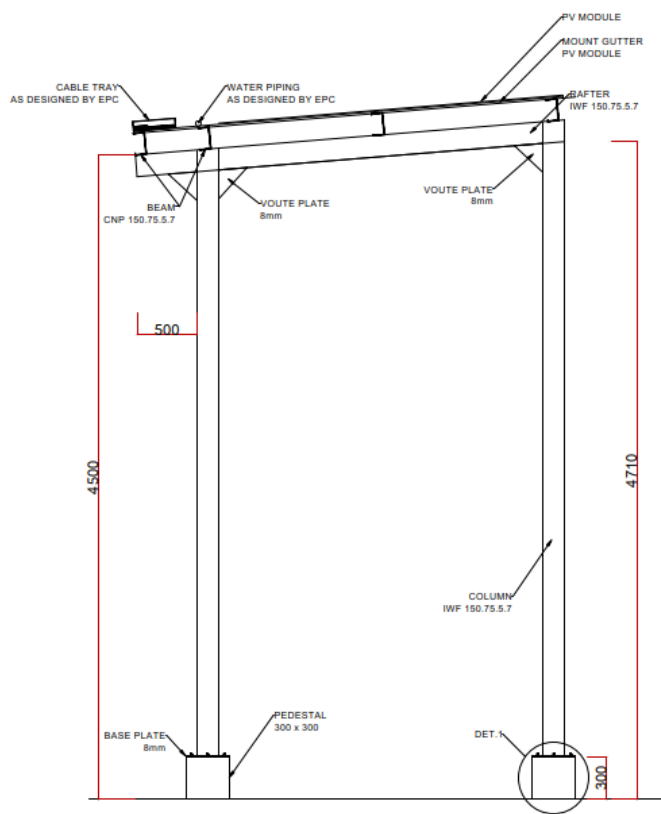
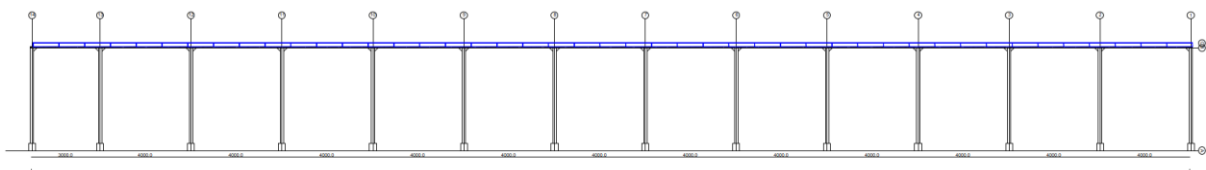
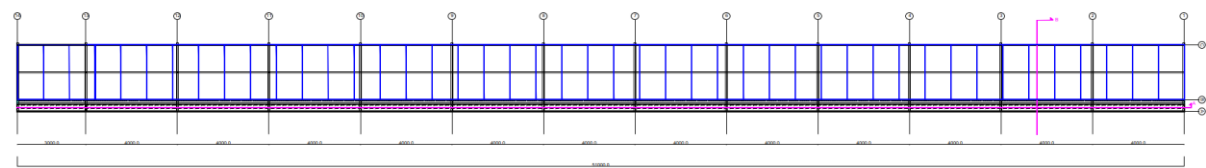
Deflection					
No	Profile	Deflection (mm)	Comparison	Deflection Limit (mm)	Status
1.	Rafter WF 150X75x5x7	2,52	<	10	OK
2.	Purlin CNP 125x50x20x2,3	9,54	<	16,67	OK
*Note: the structure is modelled using additional Solar PV Load					

Annex E – Preliminary Structural Assessment (Reference only)

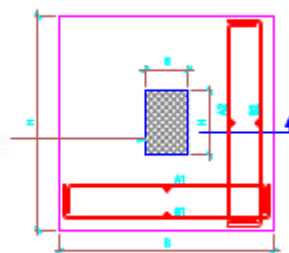
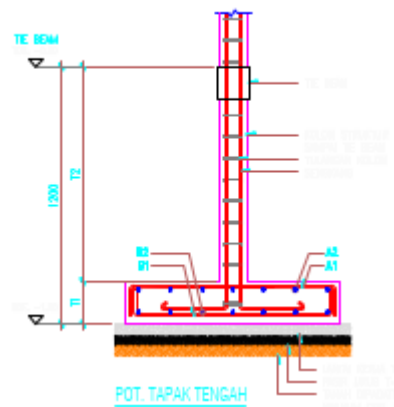
Terms of Reference (ToR) for the procurement of goods and services

Solar PV + Battery Energy Storage System (BESS) - **Kalamo Biak Fishing Community Facility**

- Conceptual Design and BoM



1 POTONGAN B-B
SKALA 1:100



2 DETAIL PONDASI P1
SKALA 1:100

Annex E – Preliminary Structural Assessment (Reference only)

Terms of Reference (ToR) for the procurement of goods and services

Solar PV + Battery Energy Storage System (BESS) - [Kalamo Biak Fishing Community Facility](#)

A	Pekerjaan Canopy 51 m		
1	Rafter WF 150x75	Kg	553,47
2	Column WF 150x75	Kg	1751,07
3	Purlin CNP 125x50x20x2,3	Kg	904,1
4	Joint Connection (bolts, voute plate etc)	Kg	192,5184
B	Pekerjaan Canopy 27 m		
1	Rafter WF 150x75	Kg	197,67
2	Column WF 150x75	Kg	625,38
3	Purlin CNP 125x50x20x2,3	Kg	265,91
4	Joint Connection (bolts, voute plate etc)	Kg	65,3376
C	Pekerjaan Canopy 15 m		
1	Rafter WF 150x75	Kg	316,27
2	Column WF 150x75	Kg	1000,61
3	Purlin CNP 125x50x20x2,3	Kg	478,64
4	Joint Connection (bolts, voute plate etc)	Kg	107,7312
D	Hot-Dip Galvanized		
1	All Item	Kg	6458,707

The buildings should be equipped with Hot Dipped Galvanize 80-90 Micron, with additional paint coating for corrosion protection with the Papuan-style Pattern finishing.

A8. Indicative Reinforcement Considerations (Conceptual)

The following reinforcement concepts may be considered depending on the final system design:

- Local reinforcement of structural members supporting PV mounting points
- Load distribution plates or mounting base reinforcement
- Additional steel members or structural frames if required
- Local slab strengthening where equipment loads are concentrated
- Due to the geometry inability to withstand the seismic load, the strengthening recommendations are focusing to withstand the gravity loads (such as SDL and Solar PV Load), without seismic load considerations.

These reinforcement concepts are indicative only and shall not be considered as final engineering solutions.

A9. EPC Contractor Responsibility

The EPCIC Contractor shall be fully responsible for structural engineering verification, including but not limited to:

1. Conducting detailed structural analysis and engineering calculations.
2. Verifying actual structural conditions through site inspection and measurements.
3. Confirming structural capacity to support PV systems, BESS equipment, and associated loads.
4. Designing and implementing any required structural reinforcement.
5. Ensuring compliance with applicable structural codes, standards, and safety requirements.
6. Submitting structural calculations and drawings signed by a qualified professional engineer where required.
7. The Canopy Concept Design should be double checked by the EPC when the stake out phase is started, considering the re-calculated that most likely will be needed in the construction phase.

Annex E – Preliminary Structural Assessment (Reference only)

Terms of Reference (ToR) for the procurement of goods and services

Solar PV + Battery Energy Storage System (BESS) - [Kalamo Biak Fishing Community Facility](#)

A10. Risk Allocation

Any structural reinforcement, modification, strengthening works, or additional structural measures *necessary to safely support the proposed system shall be included in the EPCIC Contractor's scope* and contract price, unless explicitly stated otherwise in the Contract.

No claims for additional cost, variation orders, or schedule extensions shall be accepted on the basis of reliance on the preliminary structural information contained in this Annex.

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