NATIONAL ENERGY AUTHORITY

Papua New Guinea's Independent Regulator of the Electricity and Downstream Energy Sector

Regulatory Framework
Grid Connected Photovoltaic (PV)
and
Battery Energy Storage System (BESS)

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NATIONAL ENERGY AUTHORITY

Regulatory Framework
Grid Connected Photovoltaic (PV and Battery Energy Storage System (BESS)

Revision Status Tracker

As necessary, authorized revisions will be issued to all users of the document. Revisions shall take the form of replacement or additional pages. Upon receipt, revision pages are to be incorporated in this document and all superseded pages removed.

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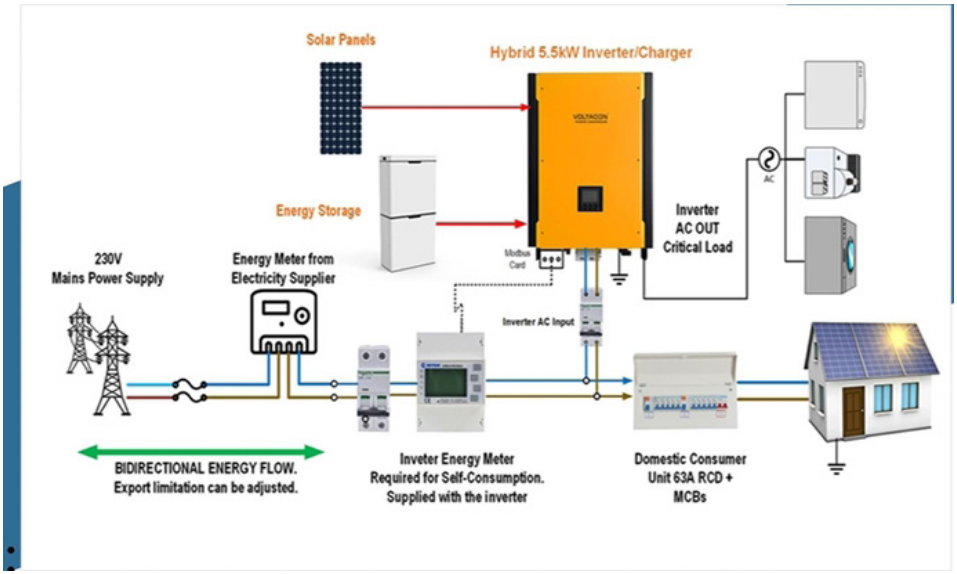
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1. Introduction

1.1 Purpose

This regulatory framework establishes the technical standards, procedures, and safety requirements for the integration (design, installation, operation, and maintenance) of Grid-Connected solar photovoltaic (PV) systems, including rooftop solar panel mounting, with or without Battery Energy Storage Systems (BESS) in the National Electricity Grid of Papua New Guinea (PNG). The framework aims to support and promote renewable energy deployment while ensuring compliance with safety standards and grid stability are maintained.

1.2 Scope

The framework applies to all grid-connected PV systems (residential, commercial, and utility-scale) with or without integrated BESS, including specific provisions for building rooftop solar panel mounting and addressing design, installation, operation, and maintenance.

1.3 Objective

- Ensure grid stability, safety, and reliability.
- Promote renewable energy adoption
- Encourage safe and sustainable practices in solar PV and BESS installation and operation

1.4 Legal Basis

This framework is issued in accordance with the National Energy Authority Act 2021 (No. 6 of 2021) and is enforced by the Regulator.

2. Definitions

For the purposes of this guideline, the definitions below shall apply:

TERM	MEANING
Grid-Connected Solar PV System	A solar energy system connected to the national grid that generates electricity for consumption and /or export.
Battery Energy Storage System (BESS)	A technology that stores electrical energy for later use, often integrated with solar PV systems or the main utility grid.
Independent Power Producer (IPP)	An entity that generates electricity for sale to the national grid, often using renewable energy sources like PV.
Rooftop Solar PV System	Solar PV panels mounted on the roofs of the buildings to generate electricity.
Mounting System	The structure used to attach solar panels to rooftops, ensuring stability, safety, and optimal energy generation.
Inverter	A device that converts the direct current (DC) from solar panels to alternating current (AC) for use in the grid.
Solar System Designer	A certified professional engineer from IEPNG specialized who specializes in solar system designing.
Installer	A certified professional responsible for interpreting design drawing and installing solar PV and BESS systems, including rooftop mounting systems.
Photovoltaic (PV) System	A renewable energy generation system that converts sunlight into electricity.
Net Metering	A billing mechanism that credits PV system owners for the electricity they add to the grid.
Regulator	The National Energy Authority is the Energy Regulator.

3. Legal and Policy Framework

- *The National Energy Authority Act 2021*
- National Energy Policy 2017-2027: Alignment with PNG's energy policy for increasing renewable energy penetration.
- *PNG Conservation and Environment Protection Authority (CEPA) Act 2014* & Regulations: Ensure adherence to environmental and sustainability laws.
- *National Institute of Standards & Industrial Technology (NISIT) Act 1993*
- *PNG Building Act 1971 and Building Regulation 1994*
- *PNG Fire Service Act 1962 and Fire Service Regulation 1966*
- *PNG Customs Act 2014*

4. Regulatory Authority

4.1 Oversight Body

- The Regulator oversees compliance, licensing, permitting, inspections (monitoring), auditing, approval and certification for grid-connected PV and Battery Energy Storage systems (BESS), including rooftop solar panel mounting.

4.2 Responsibilities

- Issue permits and licenses for all types of solar On Grid PV and BESS systems.
- Review and approval of Design Proposal for Solar On Grid PV and BESS systems.
- Ensure compliance through inspections and audits.
- Monitor performance and safety of grid-connected systems.

5. Licensing and Permits

5.1 System Licensing

- All grid-connected solar PV and BESS installations must be licensed or permitted by the Regulator.
- Installations on commercial or public buildings require a structure safety assessment before approval.
- Utility-scale systems require an Environmental Impact Assessment (EIA) and approval from the Regulator before construction.
- Solar on grid PV and BESS system design should be done by a Certified Registered Engineer from IEPNG.

5.2 Installer Certification

- Only certified technical personnel authorized by the Regulator are required to do installation, and commissioning of grid connected PV and BESS systems.
- Certification requires completing a recognized training program and passing the Regulator's certification assessments.

6. Technical Standards and Equipment Guidelines

6.1 Grid Connected PV and BESS Equipment Guidelines

- All components within the grid connected PV system and Battery Energy Storage Systems should comply with the standards specified in this guideline.
- A test certificate from an accredited laboratory confirming that the specified product (manufacturer and model number) complies with the required standards must be provided as the evidence that the product complies with required standards.
- Since it is difficult for any company or individual to verify that the certificates that have been supplied by the manufacturer/supplier are genuine, it is recommended that National Energy Authority (NEA) takes advantage of the Australian Approved Product List. If not, then NEA would need to undertake the time-consuming process of approving products and developing of product list.

6.2 Testing Laboratories

- Quality system components in the PV and BESS industry are typically tested and certified by qualified test laboratories. Grid connected PV system components and BESS components shall be tested in accordance with relevant standards listed in this guideline by a testing laboratory accredited to **ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories**.
- The test laboratory shall have ISO/IEC 17025 accreditation for the standard / test method used.

6.3 Solar Modules

When selecting a solar module to be used in a Grid Connected PV system, the solar modules shall comply, as a minimum, with the following IEC standards:

- IEC 61215 Terrestrial photovoltaic (PV) modules – Design qualification and type approval
  - IEC 61215-1 Part 1: Test Requirements (see below for more details)
  - IEC 61215-2 Part 2: Test Procedures
- IEC 61730 Photovoltaic (PV) module safety qualification
  - IEC 61730-1 Part 1: Requirements for construction
  - IEC 61730-2 Part 2: Requirements for testing

The modules shall be certified as Application Class II per IEC 61730.

- With respect to IEC61215-1, the modules shall be qualified by the following relevant standard depending on the cell technology:
  - IEC 61215-1.1, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.1 Special requirements for testing of crystalline silicon photovoltaic (PV) modules
  - IEC 61215-1.2, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.2 Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules.
  - IEC 61215-1.3, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.3 Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules.

6. Technical Standards and Equipment Guidelines cont.

- IEC 61215-1.4, Terrestrial photovoltaic (PV) modules - Design qualification and type approval Part 1.4 Special requirements for testing of thin-film Cu(In,Ga)(S,Se)2 based photovoltaic (PV) modules.

It is recommended that the modules also comply with:

- IEC 61701 Photovoltaic (PV) modules - Salt mist corrosion testing
- IEC 62804 – (2020) Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation (PID) - Part 1-1: Crystalline silicon – Delamination

These are mentioned on the Clean Energy Council's enhancement list.

The solar module should have the following warranties:

- 10-year limited product warranty
- Limited Power Warranty with 25 years at 80% of the minimal output power

6.4 Inverters

When selecting an inverter to be used in a Grid Connected PV system the inverter(s) shall comply with all the following standards:

- AS/NZS 4777.2 Grid Connection of energy systems by Inverters
  - Part 2: Inverter Requirements
- IEC 62109 Safety of power converters for use in photovoltaic power systems
- IEC 62109-1 Part 1: General requirements
- IEC 62109-2 Part 2: Particular requirements for inverters

When selecting an inverter to be used in a BESS, the inverter(s) shall comply with the following standards:

- IEC 62109 Safety of power converters for use in photovoltaic power systems
- IEC 62109-1 Part 1: General requirements
- IEC 62109-2 Part 2: Particular requirements for inverters

In addition, if the inverter is capable of interacting with the grid and potentially supplying power onto the grid, then it shall also comply with the following standard:

- AS/NZS 4777.2 Grid Connection of energy systems by Inverters
  - Part 2: Inverter Requirements

The inverter should have a minimum 5-year manufacturing warranty.

6.5 Lead Acid Battery Systems

Lead acid batteries shall comply with one of the following standards:

- AS/NZS 4029.1 Stationary batteries - Lead acid, Part 1: Vented type
- AS/NZS 4029.2 Stationary Batteries - Lead acid, Part 2: Valve regulated type
- IEC 60896 Stationary lead-acid batteries (series)

The lead acid batteries should have a minimum 5-year warranty or a minimum cycle life of 2500 cycles down to 50% depth of discharge.

6.6 Lithium-Ion Battery Systems

The individual cells and for lithium-ion batteries shall comply with either the following standard:

- IEC 62619 Secondary cells and batteries containing alkaline or other non-acid electrolytes -Safety requirements for secondary lithium cells and batteries, for use in industrial applications.

or

A Pre-Assembled Battery System comprising lithium-ion batteries can comply with

- Australian Best Practice Guide - Battery Storage equipment - Electrical safety Requirements

The lithium-ion batteries should have a minimum 10-year warranty or a minimum cycle life of 5000 cycles of usable energy.

6.7 Pre-assembled BESS containing Lithium- Battery Systems

The pre-assembled BESS should comply with:

- Australian Best Practice Guide - Battery Storage equipment - Electrical safety Requirements

The lithium-ion batteries should have a minimum 10-year manufacturing warranty or a minimum cycle life of 5000 cycles of usable energy.

6.8. Nickel Cadmium Batteries

Nickel cadmium batteries shall conform to the following standard:

- AS IEC 60622 Secondary cells and batteries containing alkaline and other non-acid electrolytes - Sealed nickel-cadmium prismatic rechargeable single cells

The Nickel Cadmium batteries should have a minimum 10-year manufacturing warranty or a minimum cycle life of 5000 cycles down to 50% depth of discharge.

6.9 Flow Batteries

Flow battery systems shall conform to the following standards:

- IEC 62932-1 Flow battery energy storage systems for stationary applications- Part 1 Terminology and general aspects.
- IEC 62932-2 Flow battery energy storage systems for stationary applications- Part 2 Performance general requirements and test methods
- IEC 62932-3 Flow battery energy storage systems for stationary applications- Part 3 Safety requirements

The flow batteries should have a minimum 5-year manufacturing warranty or a minimum of 2500 cycles of its total energy.

6.10 Solar Module Array Mounting Structure

The mounting system structure shall comply with the requirements set in:

- AS1170.0 Structural design actions – Part 0: General principles
- AS1170.1 Structural design actions – Part 1: Permanent, imposed and other actions
- AS1170.2 Structural design actions – Part 2: Wind actions.

The array mounting structure should have an expected life of 20 years.

6. Technical Standards and Equipment Guidelines cont.

6.11 Solar Cables

The cables used in wiring a PV array to the inverter or controller shall conform to IEC 62930: Electric cables for photovoltaic systems with a voltage rating of 1.5 kV DC (Note: cables meeting IEC 62930 are not to be installed directly underground, they must be installed in appropriate conduit).

6.12 Solar Plugs and Connectors

Plugs, sockets and connectors shall - conform to AS/NZS 62852: Connectors for DC application in photovoltaic systems - Safety requirements and tests.

6.13 DC Switch Disconnectors

DC switch connectors shall conform with the switch disconnector requirements of AS/NZS 60947.3 Low-voltage switchgear and control gear switches, disconnectors, switch-disconnectors and fuse-combination units. The switch disconnectors shall conform with utilization category DC PV2.

6.14 Other Electrical Equipment

Section 12,13 and 14 reference specific standards for balance of system components that are included in grid connected PV systems and BESS. There are many balance of system components for other sections of the system e.g. circuit breakers, AC wiring and these all shall meet the many equipment standards referenced in AS/NZS 3000, AS/NZS 5033, AS/NZS 4777 and AS/NZS 5139.

6.15 Australian Approved Products List

The Australian government over 10 years ago funded the Clean Energy Council (CEC) to develop the approved products list. Manufacturers or importers submit the relevant paperwork to the CEC who undertake the due diligence to verify that the submitted products do meet the required standards. If the submitted products do comply, they are added to the approved products list. The approved products list includes solar modules, inverters, solar controllers, pre-assembled Battery Systems (BS) and pre-assembled Battery Energy Storage systems (BESS). The list is web based and free to access at the following site: https://www.cleanenergycouncil.org.au/industry/products.

The link directly to the list of approved solar modules is:

https://www.cleanenergycouncil.org.au/industry/products/modules/approved-modules

The link directly to the list of approved inverters and solar controllers is:

https://www.cleanenergycouncil.org.au/industry/products/inverters/approved-inverters

The link directly to the pre-assembled BS and BESS is:

https://www.cleanenergycouncil.org.au/industry/products/batteries/approved-batteries

Using this option, NEA could require that all products installed within grid connected PV systems or BESS that shall connect to within PNG Electricity grid, shall be on the approved products list.

However, battery systems that are not pre-assembled Battery systems and pre-assembled Battery Energy Storage systems (BESS) are not on the approved products. These pre-assembled systems

only include lithium-ion battery systems. So, any other battery system technology, e.g., lead acid batteries, flow batteries would not be on this list. A companion guide will be developed to help NEA verify that products from the other battery technologies do comply with the required standards. This role could possibly be managed by National Institute for Standards and Industrial Technology (NISIT).

6.16 Grid Compliance & Equipment Requirement

- Compliance with PNG Grid Codes and AS/NZS 3000 wiring rules, AS/NZS 3008.1.1 cable selection.
- PV systems should comply with International Standards and Australian or New Zealand (AS/NZS) Standards (e.g. AS/NZS3000, AS/NZS4777.1, AS/NZS5033).
- BESS must meet international standards and AS/NZS Standards for energy storage (e.g., IEC 62933, AS/NZS 5139)
- Inverter standards should meet IEC 62109 and AS/NZS4777 for grid compatibility and safety.
- PV and BESS systems must have anti-islanding protection to prevent the system from energizing the grid during outages.

6.17 Design and Installation Standards

- All systems must adhere to the Regulator's design guidelines for Grid-Connected PV system and BESS.
- For PV installations, follow solar design guidelines (AS/NZS 5033 for PV arrays)
- All installations must follow AS/NZS 3000:2018 Wiring Rules, AS/NZS 3008.1.1 and relevant PNG Electrical Trade Circulars 35 for safety and performance.
- System designs must consider local environmental conditions (e.g., temperature, humidity) and grid constraints.
- BESS must meet international safety standards (e.g., IEC 62619) for energy storage systems and design should follow the battery management system and Regulators guidelines, including fire safety measures.

7. Power Quality Standards

- Grid-Connected PV and BESS systems must maintain power quality and voltage within acceptable limits (e.g., Voltage regulation, frequency control).

8. Installation and Inspection Guidelines

8.1 Installation Requirements

- Installations must be performed by certified professionals.
- Compliance with Regulator's PV and BESS installation guidelines, including safety, structural integrity, and fire protection requirements.
- Proper commissioning procedures for both PV and BESS systems to follow.

8.2 Inspection and Certification

- The Regulator will establish a certification process for system commissioning.
- Regular inspection and testing by the regulator or an authorized Inspector's to ensure ongoing compliance.

9. Rooftop Solar Panel Mounting Technical Standards

9.1 Structure Integrity

- Rooftop solar mounting systems must be designed to ensure structural integrity of the roof and the building.
- Installations must comply with local building codes and safety standards (e.g., wind load resistance, seismic considerations).

9.2 Design and Materials

- All mounting systems must use durable, corrosion-resistant materials, suitable for local environmental conditions.
- Mounting structures must allow for proper roof drainage and must not compromise roof waterproofing or insulation.

9.3 Tilt and Orientation

- Solar panels must be mounted at an optimal tilt and orientation to maximize energy generation based on geographic location.
- Panels must be placed to allow access for maintenance and cleaning without compromising the integrity of the roof.

9.4 Load Capacity (Weight)

- The total load (including panels, mounting structure systems, and accessories) must not exceed the load bearing capacity of the roof structure.
- A structure engineer's approval is required for rooftop installations exceeding certain weight thresholds.

10. Electrical Compliance

10.1 Wiring Standards

- All rooftop systems must comply with AS/NZS 3000 Wiring Rules, and AS/NZS 3008.1.1 Cable Selection with appropriate protections for DC and AC wiring.

10.2 Inverter and Grid Connection

- Inverters must be grid-compliant, with protections against overvoltage, undervoltage, and grid outages.

11. Connection to the Grid

11.1 Interconnection Agreement

- Solar PV and BESS operators must enter into an interconnection agreement with the utility company.
- Rooftop PV systems must enter into an interconnection agreement with the utility for grid access and power export.
- The utility is responsible for reviewing the system's technical specifications to ensure grid compatibility.

11.2 Metering and Monitoring

- All grid-connected PV systems must be equipped with bi-directional metering for accurate monitoring of energy exports and imports.
- Large-scale installations exceeding one mega watt (1MW) are not under NEAs Small power system regulations and must have remote monitoring capabilities to ensure Realtime performance tracking.

11.3 Net Metering and Feed-in Tariffs

- Eligible rooftop solar systems may benefit from net metering or feed-in tariffs for exporting surplus electricity to the grid.

12. Safety and Protection Requirements

12.1 System Protection

- PV and BESS systems must have protection mechanisms, including overvoltage, undervoltage, and fault detection systems, to ensure safety during grid outages or faults.
- Inverters must have an automatic disconnection feature to protect the grid from unintentional islanding.
- **System Isolation:** rooftop systems must be equipped with easily accessible isolation switches to disconnect the solar panels and BESS in case of an emergency.
- **Surge protection:** Systems must include surge protection devices to safeguard the solar panels and inverters from lightening and grid-induced surges.

12.2 Fire Safety

- BESS installations must be equipped with fire suppression systems as per international fire safety standards and *PNG Fire Service Act 1962* and PNG Building Regulation 1994.
- Adequate spacing and ventilation are required to prevent overheating of battery units (Refer to the Regulator's BESS Design & Installation Guideline).
- Rooftop mounting systems must maintain clearances around chimneys, skylights, and ventilation to prevent fire hazards.
- Rooftop systems must include adequate fire pathways, and local fire departments must be consulted during design for large commercial installations.

12.3 Rooftop Installer Safety

- Installers must follow all occupational safety guidelines, including fall protection, personal protective equipment (PPE), and safe work practices for rooftop installations.

13. Operation and Maintenance Standards

13.1 Ongoing Compliance

- System operators are required to maintain PV and BESS systems in good working order and comply with Regulator's inspection schedules and guidelines.
- All rooftop solar PV systems must undergo periodic inspections to ensure structural and electrical safety.
- System owners must keep detailed maintenance logs and ensure that the system is regularly cleaned and checked for damage.

13.2 System Monitoring

- Continuous monitoring systems for PV and BESS must be installed to track performance and system health.
- Grid operators should have real-time access to data for large systems (e.g., SCADA for utility scale systems)

13.3 Maintenance Protocols

- Regular maintenance schedules for PV and BESS components.
- Emergency protocols for system shutdown in case of faults or failures.

13.4 Battery Safety

- BESS system must have stringent fire safety protocols.
- Battery recycling or disposal must comply with environmental regulations.

13.5 Performance Reporting

- Operators of commercial building, industrial building and utility-scale systems PV on Grid and BESS systems must submit regular performance reports to the Regulator, detailing system efficiency, faults, and energy output.

13.6 Maintenance

- Regular maintenance must be conducted as per manufacturer guidelines and the Regulator's guidelines and standards to ensure the longevity and safe operation of the system.
- Maintenance records must be kept for review during inspections.
- **Maintenance Accessibility:** The rooftop mounting system must allow for safe access to panels for maintenance, cleaning, and repairs without damaging the roof or system components.

14. Financial Provisions

14.1 Feed-in Tariffs (FiT)

- Eligible grid-connected PV system owners may be entitled to feed-in tariffs or compensation mechanisms for surplus energy exported to the grid, subject to approval by the Regulator and national energy policies and guidelines.
- Tariffs will be reviewed and set annually by the Regulator.
- NEA will establish clear tariff structures in the future for energy produced by PV systems and stored/ released by BESS.

14.2 Cost Recovery

- System operators may recover costs through power purchase agreements (PPAs) with utility companies or consumers.
- All financial agreements must comply with national electricity with the regulators tariff Regulation.

14.3 Incentives

- Homeowners and businesses may qualify for government incentives, including tax credits, rebates, or grants for installing rooftop solar PV systems and BESS.

15. Environmental and Social Impact

15.1 Environmental Impact

- Utility-scale solar PV projects must undergo an Environmental Impact Assessment (EIA) before approval, ensuring minimal disruption to local ecosystems.
- BESS installations must follow proper waste disposal and recycling procedures to mitigate environmental harm from hazardous materials.
- Large-scale rooftop systems (e.g., on commercial buildings) must undergo environmental impact assessments to evaluate any potential environmental concerns.

15.2 Social Impact

- Community consultations are required for large projects, ensuring local stakeholders are informed and involved in project planning.
- Land use considerations must be addressed, and appropriate compensation must be provided to affected landowners.
- Installations in residential or urban areas must consider the visual and aesthetic impact of rooftop solar PV systems. Appropriate design considerations should mitigate any negative impacts on neighbours or the surrounding community.

16. Compliance and Enforcement

16.1 Monitoring and Audits

- The Regulator will conduct regular periodic inspections and audits on all installations (rooftop solar PV systems, solar farms, ground mounted, etc..) to ensure compliance with design, technical specification, safety, operational and maintenance standards.
- Non-compliant systems may be subject to suspension/ termination of licences, fines, penalties, or disconnection from the grid.

16.2 Penalties for Non-Compliance

- Failure to comply with this regulatory framework or non-compliance with design, technical specifications, safety, or installation standards may result in fines, suspension or revocation of licenses, financial penalties, or legal action or disconnection from the grid.
- **Dispute Resolution:** A formal process will be available to resolve dispute between system owners, installers, and utilities, overseen by NEA.

16.3 Appeals Process

- Stakeholders have the right to appeal Regulator's decisions through a formal appeals process overseen by the Regulator.

17. Review and Amendment Process

17.1 Review Cycle

- This regulatory framework, including the provisions on rooftop solar panel mounting shall be reviewed every three (3) years or as needed to incorporate technological advancements, market developments, and lessons learned from implementation or feedback from stakeholders.

17.2 Amendments

- Any amendments to the framework must be approved by the Regulator following a public consultation process to ensure transparency and stakeholder participation.

18. Roadmap for Future Updates

- Periodic review of the regulatory framework to accommodate technological advances and changes in energy policy.
- Engage stakeholders, including utilities, developers, and IPPs, in the framework's development and evolution.
- This comprehensive framework provides the necessary structure for managing the growth of grid-connected solar PV and BESS installations. This also includes rooftop solar panel installations and comply with all structural, design and technical requirements, promoting renewable energy while protecting buildings and grid from potential risks and ensuring they contribute to national energy goals while maintaining safety, reliability, and environmental sustainability.

19. References

1. Grid Connected PV Systems with Battery Energy Storage Systems Design Guidelines[1]
2. Grid-Scale Battery Storage: Costs, Value, and Regulatory Framework in India[2]
3. Battery Energy Storage Optimize Integration of Renewable Energy to the Grid[3]
4. PPL Grid Connected PV and BESS Guidelines
5. ISO, IEC & AS/NZS Standards

20. Appendices

20.1 Appendix 'A' List of Applicable Technical Standards

20.1.1 On-Grid PV System Design Applicable Standards

Standard	Description
AS/NZS 3000	Wiring Rules
AS/NZS 3008	Electrical Installation-Selection of Cables
AS/NZS 4777	Grid Connection of Energy Systems by Inverters (series)
AS/NZS 5033	Installation and Safety Requirements of PV arrays
AS/NZS 1170	Structural Design Actions
AS/NZS 1170.2	Structural Design Actions - Wind Actions
AS 1768	Lightning Protection
IEC 61215	Crystalline silicon terrestrial photovoltaic (PV) modules – design qualification & type approval
IEC 61215-1	Part 1: Test Requirements
IEC 61215-1-1	Part 1-1: Special Requirements for testing of crystalline silicon photovoltaic (PV) modules
EC 61215-1-2	Part 1-2: Special requirements fore testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules
IEC 61215-1-3	Part 1-3: Special requirements of testing of thin-film amorphous silicon based photovoltaic (PV) modules
IEC 61215-1-4	Part 1-4: Special requirements of testing of thin-film Cu (In,GA) (S,Se)2 based photovoltaic (PV) modules
IEC 61215-2	Part 2: Test Procedures
IEC 61730	Photovoltaic (PV) module safety qualification
IEC 61730-1	Part 1: Requirements for Construction
IEC 61730-2	Part 2: Requirements for Testing
IEC 61701	Photovoltaic (PV) modules - Salt mist corrosion testing
IEC 62804	Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation (PID) – Part 1-1: Crystalline Silicon-Delamination
IEC 62109	Safety of power converter for use in photovoltaic power systems
IEC 62109-1	Part 1: General requirements
IEC 62109-2	Part 2: Particular requirements for inverters
IEC 62930	Electric cables for photovoltaic systems with a voltage rating of 1.5 kV DC Solar plugs and connectors
AS/NZS 62852	Connectors for DC application in photovoltaic systems – Safety requirements and tests
AS/NZS 60947.3	Low-voltage switchgear and control gear switches, disconnectors, switch-disconnectors and fuse-combination units. The switch disconnectors shall confirm with utilisation category DC PV2.

20. Appendices Cont.

20.1.2 On Grid BESS System Design Applicable Standards

Standard	Description
AS/NZS 3000	Wiring Rules
AS/NZS 3008	Electrical Installations - Selection of Cables
AS/NZS 4777	Grid Connection of Energy Systems by Inverters
AS/NZS 4777.1	Part 1 Installation Requirements
AS/NZS 4777.2	Part 2 Inverter Requirements
AS/NZS 5139	Electrical Installations - Safety of Battery Systems for use with Power Conversion Equipment
AS 3011	Electrical Installations - Secondary batteries installed in buildings (series)
AS 3011.1	Part 1: Vented type
AS 3011.2	Part 2: Valve regulated type
AS 2676	Guide to the installation, maintenance, testing and replacement of secondary batteries in building
AS 2676.1	Part 1: Vented type
AS 2676.2	Part 2: Valve regulated type
AS/NZS 4029.1	Stationary batteries
AS/NZS 4029.1	Part 1: Vented type
AS/NZS 4029.2	Part 2: Valve regulated type
AS/NZS IEC 60622	Secondary cells and batteries containing alkaline and other non-acid electrolytes - Sealed nickel-cadmium prismatic rechargeable single cells
AS/NZS 5033	Installation and safety requirements for PV Arrays
AS 1768	Lightning Protection
AS/NZS 1170.1	Structural design actions
AS/NZS 1170.1	Structural design actions; Part 1: Permanent, imposed, and other actions
AS/NZS 1170.2	Structural design actions; Part 2: Wind actions
AS/NZS 1170.4	Structural design actions; Part 4: Earthquake actions in Australia
IEC 61215	Terrestrial photovoltaic (PV) modules - Design qualification and type approval
IEC 61215-1	Part 1: Test requirements
IEC 61215-1-1	Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
IEC 61215-1-2	Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules

Standard	Description
IEC 61215-1-3	Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules
IEC 61215-1-4	Part 1-4: Special requirements for testing of thin-film $Cu(In,GA)(S,Se)_2$ based photovoltaic (PV)modules
IEC 61215-2	Part 2: Test Procedures
IEC 61730	Photovoltaic (PV) module safety qualification
IEC 61730-1	Part 1: Requirements for construction
IEC 61730-2	Part 2: Requirements for testing
IEC 62109	Safety of power converter for use in photovoltaic power systems
IEC 62109-1	Part 1: General requirements
IEC 62109-2	Part 2: Particular requirements for inverters
IEC 62619	Secondary cells and batteries containing alkaline or other non-acid electrolytes-Safety requirements for secondary lithium cells and batteries, for use in industrial applications
IEC 62932	Flow battery energy storage systems for stationary applications
IEC 62932-1	Part 1 Terminology and general aspects
IEC 62932-2	Part 2 Performance general requirements and test methods
IEC 62932-3	Part 3 Safety Requirements
Relevant Australian Guideline:	
Best Practice Guideline: Battery Storage Equipment- Electrical Safety Requirements	
The Relevant Papua New Guinea Technical Documents Include:	
Department of Works Earthquake Advice Notice	

20.1.3 Grid Connected PV System Installation Applicable Standards

Standard	Description
AS/NZS 3000	Wiring Rules
AS/NZS 3008	Electrical Installations - Selection of Cables
AS/NZS 3010	Electrical Installations - Generating Sets
AS/NZS 4777	Grid Connection of energy systems by Inverters (series)
AS/NZS 5033	Installation and Safety Requirements of PV Arrays
AS/NZS 1170	Structural design actions
AS/NZS 1170.2	Structural design actions – Wind actions
AS 1768	Lightning Protection

20. Appendices Cont.

Standard	Description
IEC 61215	Crystalline Silicon Terrestrial photovoltaic (PV) modules – Design qualification and type approval
IEC 61215-1	Part 1: Test Requirements
IEC 61215-1-1	Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
IEC 61215-1-2	Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules
IEC 61215-1-3	Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules
IEC 61215-1-4	Part 1-4: Special requirements for testing of thin-film Cu(In,GA) $(S,Se)_2$ based photovoltaic (PV) modules
IEC 61215-2	Part 2: Test Procedures
IEC 61730	Photovoltaic (PV) module safety qualification
IEC 61730-1	Part 1: Requirements for construction
IEC 61730-2	Part 2: Requirements for testing
IEC 61701	Photovoltaic (PV) modules - Salt mist corrosion testing
IEC 62804	Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation (PID) - Part 1-1: Crystalline silicon – Delamination
IEC 62109	Safety of power converter for use in photovoltaic power systems
IEC 62109-1	Part 1: General requirements
IEC 62109-2	Part 2: Particular requirements for inverters
IEC 62930	Electric cables for photovoltaic systems with a voltage rating of 1.5 kV DC Solar Plugs and Connectors
AS/NZS 62852	Connectors for DC application in photovoltaic systems - Safety requirements and tests
AS/NZS 60947.3	Low-voltage switchgear and control gear switches, disconnectors, switch-disconnectors and fuse-combination units. The switch disconnectors shall conform with utilization category DC PV2.
IEC 62446	Grid connected photovoltaic systems – Minimum requirements for system

Note: AS/NZS 3000, AS/NZS 5033 and AS/NZS 4777 do reference other balance of systems equipment standards.

20.1.4 Grid Connected BESS System Installation Applicable Standards

Standard	Description
AS/NZS 3000	Wiring Rules
AS/NZS 3008	Electrical Installations - Selection of Cables
AS/NZS 4777	Grid Connection of Energy Systems by Inverters
AS/NZS 4777.1	Part 1 Installation Requirements
AS/NZS 4777.2	Part 2 Inverter Requirements
AS/NZS 4509	Stand-alone power systems
AS/NZS 5139	Electrical installations - Safety of battery systems for use with power Conversion equipment
AS 3011	Electrical Installations - Secondary batteries installed in buildings (series)
AS 3011.1	Part 1: Vented type
AS 3011.2	Part 2: Valve regulated type
AS 2676	Guide to the installation, maintenance, testing and replacement of secondary batteries in building
AS 2676.1	Part 2: Vented type
AS 2676.2	Part 2: Valve regulated type
AS/NZS 4029.1	Stationary Batteries
AS/NZS 4029.1	Part 1: Vented type
AS/NZS 4029.2	Part 2: Valve regulated type
AS/NZS IEC 60622	Secondary cells and batteries containing alkaline and other non-acid electrolytes - Sealed nickel-cadmium prismatic rechargeable single cells
AS/NZS 5033	Installation and Safety Requirements for PV Arrays
AS 1768	Lightning Protection
AS/NZS 1170	Structural design actions
AS/NZS 1170.1	Structural design actions; Part 1: Permanent, imposed and other actions
AS/NZS 1170.2	Structural design actions; Part 2: Wind actions
AS/NZS 1170.4	Structural design actions; Part 4: Earthquake actions in Australia
IEC 61215	Terrestrial photovoltaic (PV) modules - Design qualification and type approval
IEC 61215-1	Part 1: Test Requirements
IEC 61215-1-1	Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
IEC 61215-1-2	Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules

20. Appendices Cont.

Standard	Description
IEC 61215-1-3	Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules
IEC 61215-1-4	Part 1-4: Special requirements for testing of thin-film $Cu(In,GA)(S,Se)_2$ based photovoltaic (PV) modules
IEC 61215-2	Part 2: Test Procedures
IEC 61730	Photovoltaic (PV) module safety qualification
IEC 61730-1	Part 1: Requirements for construction
IEC 61730-2	Part 2: Requirements for testing
IEC 62109	Safety of power converter for use in photovoltaic power systems
IEC 62109-1	Part 1: General requirements
IEC 62109-2	Part 2: Particular requirements for inverters
IEC 62619	Secondary cells and batteries containing alkaline or other non-acid electrolytes-Safety requirements for secondary lithium cells and batteries, for use in industrial applications
IEC 62932	Flow battery energy storage systems for stationary applications
IEC 62932-1	Part 1 Terminology and general aspects
IEC 62932-2	Part 2 Performance general requirements and test methods
IEC 62932-3	Part 3 Safety requirements
Relevant Australian Guideline:	
Best Practice Guideline: Battery Storage equipment - Electrical safety requirements	
The relevant Papua New Guinea Technical documents include:	
Electrical Trade circular No. 35: Solar Standby Facility	
Department of Works Earthquake Advice Notice	

20.1.5 Grid Connected PV System Auditing Applicable Standards

Standard	Description
AS/NZS 3000	Wiring Rules
AS/NZS 3008	Electrical Installations - Selection of Cables
AS/NZS 3010	Electrical Installations - Generating Sets
AS/NZS 4777	Grid Connection of energy systems by Inverters (series)
AS/NZS 5033	Installation and Safety Requirements of PV Arrays
AS/NZS 1170	
AS/NZS 1170.2	Structural design actions – Wind actions
AS 1768	Lightning Protection
IEC 61215	Crystalline Silicon Terrestrial photovoltaic (PV) modules – Design qualification and type approval
IEC 61215-1	Part 1: Test Requirements
IEC 61215-1-1	Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
IEC 61215-1-2	Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules
IEC 61215-1-3	Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules
IEC 61215-1-4	Part 1-4: Special requirements for testing of thin-film Cu (In,GA) $(S,Se)_2$ based photovoltaic (PV) modules
IEC 61215-2	Part 2: Test Procedures
IEC 61730	Photovoltaic (PV) module safety qualification
IEC 61730-1	Part 1: Requirements for Construction
IEC 61730-2	Part 2: Requirements for Testing
IEC 61701	Photovoltaic (PV) modules - Salt mist corrosion testing
IEC 62804	Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation (PID) - Part 1-1: Crystalline silicon – Delamination
IEC 62109	Safety of power converter for use in photovoltaic power systems
IEC 62109-1	Part 1: General requirements
IEC 62109-2	Part 2: Particular requirements for inverters
IEC 62930	Electric cables for photovoltaic systems with a voltage rating of 1.5 kV DC Solar Plugs and Connectors
AS/NZS 62852	Connectors for DC application in photovoltaic systems - Safety requirements and tests.

20. Appendices Cont.

Standard	Description
AS/NZS 60947.3	Low-voltage switchgear and control gear switches, disconnectors, switch-disconnectors and fuse-combination units. The switch disconnectors shall conform with utilisation category DC PV2.
IEC 62446	Grid connected photovoltaic systems – Minimum requirements for system documentation, commissioning tests and inspection.
Note: AS/NZS 3000, AS/NZS 5033 and AS/NZS 4777 do reference other balance of systems equipment standards.	
The relevant Papua New Guinea Technical documents include:	
Department of Works Earthquake Advice Notice	
Industrial Safety, Health and Welfare Act 1961	
All grid connected PV systems that are connected to the PPL network shall be designed by a Solar Certified Designer and installed by a Certified Solar Electrician and shall be installed in accordance with these PNG Grid connected PV System Install Guidelines.	

20.1.6 Grid Connected BESS System Auditing Applicable Standards

Standard	Description
AS/NZS 3000	Wiring Rules
AS/NZS 3008	Electrical Installations - Selection of Cables
AS/NZS 4777	Grid Connection of energy systems by inverters
AS/NZS 4777.1	Part 1 Installation Requirements
AS/NZS 4777.2	Part 2 Inverter Requirements
AS/NZS 5139	Electrical installations - Safety of Battery Systems for use with Power Conversion Equipment
AS 3011	Electrical Installations - Secondary batteries installed in buildings (series)
AS 3011.1	Part 1: Vented type
AS 3011.2	Part 2: Valve regulated type
AS 2676	Guide to the installation, maintenance, testing and replacement of secondary batteries in building
AS 2676.1	Part 2: Vented type
AS 2676.2	Part 2: Valve regulated type
AS/NZS 4029.1	Stationary batteries
AS/NZS 4029.1	Part 1: Vented type
AS/NZS 4029.2	Part 2: Valve regulated type
AS/NZS IEC 60622	Secondary cells and batteries containing alkaline and other non-acid electrolytes - Sealed nickel-cadmium prismatic rechargeable single cells
AS/NZS 5033	Installation and safety requirements for PV Arrays
AS 1768	Lightning Protection
AS/NZS 1170.1	Structural design actions
AS/NZS 1170.1	Structural design actions; Part 1: Permanent, imposed and other actions
AS/NZS 1170.2	Structural design actions; Part 2: Wind actions
AS/NZS 1170.4	Structural design actions; Part 4: Earthquake actions in Australia
IEC 61215	Terrestrial photovoltaic (PV) modules - Design qualification and type approval
IEC 61215-1	Part 1: Test requirements
IEC 61215-1-1	Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
IEC 61215-1-2	Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules

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Standard	Description
IEC 61215-1-3	Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules
IEC 61215-1-4	Part 1-4: Special requirements for testing of thin-film Cu(In,GA)(S,Se)2 based photovoltaic (PV) modules
IEC 61215-2	Part 2: Test Procedures
IEC 61730	Photovoltaic (PV) module safety qualification
IEC 61730-1	Part 1: Requirements for construction
IEC 61730-2	Part 2: Requirements for testing
IEC 62109	Safety of power converter for use in photovoltaic power systems
IEC 62109-1	Part 1: General requirements
IEC 62109-2	Part 2: Particular requirements for inverters
IEC 62619	Secondary cells and batteries containing alkaline or other non-acid electrolytes-Safety requirements for secondary lithium cells and batteries, for use in industrial applications
IEC 62932	Flow battery energy storage systems for stationary applications
IEC 62932-1	Part 1 Terminology and general aspects
IEC 62932-2	Part 2 Performance general requirements and test methods
IEC 62932-3	Part 3 Safety requirements
Relevant Australian Guideline:	
Best Practice Guideline: Battery Storage equipment- Electrical Safety Requirements	
The relevant Papua New Guinea Technical documents include:	
Department of Works Earthquake Advice Notice	
All grid connected BESS that are connected to the PPL network shall be designed by a BESS certified designer in accordance with the PPL Grid connected BESS Design Guidelines and installed by Certified Solar Electricians in accordance with the PPL Grid connected BESS Install Guidelines.	

20.2 Appendix 'B' Grid-Connected PV System Inspection Checklist

NATIONAL ENERGY AUTHORITY

Grid Connected PV System Inspection Checklist

Name of Inspector: _____

Position: _____

Signature: _____

Location of System: _____

Solar Array Information	
Total Size of Array	kW
Total Number of Modules	
Array Ground-Mounted or Roof Mounted	
Array Configuration	
Number of modules in series (one string)	
Number of these strings in parallel (total)	
Number of modules in series (if different string)	
Number of these strings in parallel (total)	
(Add more based on the configuration and size if required)	

Solar Modules	
Module Brand	
Module Model	
Module Power Rating	
Module Voltage Open Circuit	
Module Current Short Circuit	
Do the modules meet the following standards? Check the label on the back of the module. Tick if they meet the standard or cross if they do not.	
IEC 62109 Safety of power converter for use in photovoltaic power systems.	
AS/NZS 4777.2: 2020 Grid connection of energy systems via inverters - Inverter requirements	
Single phase or three phase inverter	
Inverter AC Power Rating (W or kW)	
Inverter Nominal ac Current (A)	

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Grid Connected PV System Inspection Checklist

Inverter Ingress Protection Rating
Is the Inverter Galvanically Isolated
Number of MPPTs
Inverter MPPT 1 DC Voltage Range Lower Limit
Inverter MPPT 1 DC Voltage Range Upper Limit
Inverter DC Maximum Voltage
MPPT 1 Maximum DC Input Current
Number of parallel strings attached to MPPT 1
Maximum current from strings less than maximum input current of MPPT 1 (**Yes/No**)
Number of modules in series in each string
String V_{mp} is greater than the minimum MPPT 1 voltage window at 75 °C (**Yes/No**)
String V_{oc} is less than the inverter maximum dc input voltage at 15 °C (**Yes/No**)
Inverter MPPT 2 DC Voltage Range Lower Limit
Inverter MPPT 2 DC Voltage Range Upper Limit
Inverter DC Maximum Voltage
MPPT 2 Maximum DC input current
Number of parallel strings attached to MPPT 2
Maximum current from strings less than maximum input current of MPPT 2 (**Yes/No**)
Number of modules in series in each string
String V_{mp} is greater than the minimum MPPT 2 voltage window at 75 °C (**Yes/No**)
String V_{oc} is less than the inverter maximum dc input voltage at 15 °C (**Yes/No**)
Inverter DC maximum input Current
Maximum array current connected to inverter less than maximum DC input current of inverter

Array Structure
Brand
Model
Meets Wind Loading Requirements for location
Does the mounting system comply with AS/NZS 1170?
The information on the isolators will be dependent on the actual system configuration.
Please specify if disconnection points have been used (**Yes/No**):

DC Isolators	
DC Isolator Location (circle):	Adjacent to Inverter/ Integrated / Elsewhere
DC Isolator Non-Polarised	
DC Isolator Rating	
Has the DC isolator been selected based on the AS/NZS 5033 requirements (i.e. thermal operational and fault conditions)? (**yes/no**)	

AC Isolators
AC Isolator Rating
AC Isolator Inside Switchboard (circuit breaker)
AC Isolator Next to Inverter

String Cables	
Cross Sectional Area of String Cables	mm^2
Current Carrying Capacity of String Cables	A
Maximum Current on each string (I_{sc})	A

Array Cables - If String Cables Join Combiner Box	
Cross Sectional Area of String Cables	mm^2
Current Carrying Capacity of String Cables	A
Maximum Current on each string ($I_{sc\ array}$)	A

Voltage Drop	
Maximum Length of String cables	m
Maximum Voltage Drop in string cables	V
String V_{mp}	V
Maximum voltage drop (string cables) as %	%
Maximum Length of array cables	m
Maximum Voltage Drop in array cables	V
Array V_{mp}	V
Maximum voltage drop (array cable) as %	%
Total DC voltage drop from array to inverter	V
Total maximum voltage drop from array to inverter	V

Compliance with Standards

Item	Clause	Description	Compliant	Notes
General Wiring and Installation Work				
1	AS/NZS 3000 1.5.3.1	There are no exposed LV live parts on any installed equipment		
2	AS/NZS 3000 1.6 & 1.7	All electrical equipment for the system is installed in accordance with AS/NZS3000		
3	AS/NZS 3000 4.1.3	Inverter is of appropriate IP rating for its location.		
4	AS/NZS 3000 3.7.2.3	There are no visible loose connections in LV cables		
Compliance with Standards and Guidelines- Array Installation and DC Wiring				
5	AS/NZS 5033:2021 4.3.2.2	PV mounting structure and attachment to roof visually inspected and appears to be secure.		
6	AS/NZS 5033:2021 4.3.2.2	Any freestanding PV structure was visually inspected and appears to be secure.		
7	AS/NZS 5033:2021 4.3.2.2.8	All array supports, brackets, screws and other metal parts are either: (a) of similar material or stainless steel to minimise corrosion; or (b) where dissimilar metals that can have a galvanic reaction are used, they are galvanically isolated		

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Grid Connected PV System Inspection Checklist

Item	Clause	Description	Compliant	Notes
8	PNG Grid Connected PV System Guidelines	Roof penetrations and/or the roof top components used in the wiring system including secondary shields, isolator shrouds, conduits and conduit glands are suitably installed, sealed and waterproof		
9	PNG Grid Connected PV System Guidelines	The PV Array structure allows sufficient clearance to facilitate self-cleaning of the roof to prevent any build-up of leaves and other debris.		
10	PNG Grid Connected PV System Guidelines	Modules have sufficient ventilation space to minimise temperature rise.		
11	AS/NZS 5033:2021 4.4.2.4	PV Wiring Losses (voltage drop losses) are less than 5% of V_{mp} of the array (>120V).		
12	PNG Grid Connected PV System Guidelines	Voltage rise is less than 2% between the inverter and the point of connection to the grid		
13	AS/NZS 5033:2021 4.5.3, 4.5.4	Disconnection means has been provided to isolate PV array from inverter to allow for maintenance and inspection		
14	AS/NZS 5033:2021 4.1 (a)	String protection and DC Isolators are rated for DC use		
15	AS/NZS 5033:2021 4.3.4.2	All disconnectors have a voltage rating greater than or equal to PV array maximum voltage		
16	AS/NZS 5033:2021 4.3.4.2.3 (b)	The DC disconnector meets the current rating specified in Table 4.3/4.4 of AS/NZS 5033		
17	AS/NZS 5033:2022 3.1, AS/NZS 4777.1:2016	**FOR DOMESTIC DWELLINGS** The maximum voltage of the array does not exceed 600 VDC. **Note:** *AS/NZS 4777.1:2016 2.3 still does not allow over 600V in domestic setting despite recent changes in AS/NZS 5033*		
18	AS/NZS 5033:2021 4.4.5.2.2	The entire PV array and associated wiring and protection have restricted access where the maximum voltage of the array exceeds 600 VDC in a non-domestic installation		
19	AS/NZS 5033:2021 2.1.6	Modules in the same string are installed in the same orientation within +/- 5 degrees		
20	AS/NZS 5033:2021 5.3.1	The PV array cabling is distinctively marked SOLAR in permanent, legible and indelible English, or where the cable is not distinctively marked, distinctive coloured labels marked 'SOLAR' attached at intervals not exceeding 2 metres		
21	AS/NZS 3000:2018 3.9.4.1; AS/NZS 5033:2021 4.4.3, 4.4.5	Array wiring and wiring to the inverter is protected from mechanical damage. This requires a visual inspection of all cables related to the system and therefore might require checking on the roof		

Grid Connected PV System Inspection Checklist

Item	Clause	Description	Compliant	Notes
22	AS/NZS 3000 1.5.14; AS/NZS 5033:2021 4.1 (d)	Array wiring and wiring to the inverter is protected from UV. This requires a visual inspection of all cables related to the system and therefore might require checking on the roof		
23	AS/NZS 5033:2021 4.4.3.3, AS/NZS 5033:2021 4.4.6.2	Double insulation has been maintained between any live conductor and any earthed or exposed conductive part		
24	AS/NZS 5033:2021 4.4.5.2.2	All DC cable installed within the ceiling space, wall cavity or floor is enclosed in heavy duty [HD] conduit		
25	AS/NZS 5033:2021 4.3.9.1	All DC connectors are of the same type/model from the same manufacturer where they are married at a connection point		
26	AS/NZS 5033:2021 4.4.2.2	Array cables meets the current rating i.e. If overcurrent protection is not provided, then the current rating of DC cable is 1.25 x I_{array} (or 1.25 x I_{bf}) If overcurrent protection is provided, then the current rating for dc cable is equal to the rating of overcurrent device		
27	AS/NZS 3000:2018 3.9.3 & 3.3.2.8; AS/NZS 5033:2021 4.4.3.1	All cables/wiring in the installation are securely fixed in place to minimise any movement of the cable		
28	AS/NZS 5033:2021 4.4.4.1	Any conduit is installed such that they are protected from UV or the conduit is UV stabilised		
29	AS/NZS 3000:2018 1.5.14, 3.3.2.10	Array wiring and inverter wiring is protected from fauna where deemed necessary		
30	AS/NZS 3000:2018 3.1.2; AS/NZS 5033:2021 4.4.21	Array wiring is rated for the expected voltage (i.e. PV array maximum voltage)		
31	AS/NZS 3000:2018 3.7.3, AS/NZS 5033:2021 4.4.6.1	All joints in cables are enclosed e.g. in junction boxes and/or comply with the exceptions of AS/NZS3000 Clause 3.7.3		
32	AS/NZS 5033:2021 4.4.3.3	Double insulation has been maintained between the positive and negative conductors/terminations within all enclosures		
33	AS/NZS 3000:2018 3.3.2.6	There is no evidence of mechanical damage to LV cables		
34	AS/NZS 5033:2021 4.4.2.1	Wiring from array to isolator/inverter is single conductor cable both insulated and sheathed		
35	AS/NZS 5033:2021 4.4.2.1	All array cables are (a) temperature rated to the application; (b) UV resistant if exposed to the environment; (c) flexible (multi-stranded) to allow for thermal/wind movement of arrays/modules		

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Grid Connected PV System Inspection Checklist

Item	Clause	Description	Compliant	Notes
36	AS/NZS 3000:2018 3.9.4	LV array and inverter cables are not directly installed near building surfaces as per AS/NZS 3000 requirements		
37	AS/NZS 3000:2018 3.9.8	Any DC wiring located in the AC switchboard complies with the segregation, insulation and labelling requirements of AS/NZS 3000		
38	AS/NZS 3000:2018 4.1.2 & 4.1.3; AS/NZS 5033:2021 4.4.6.1, 4.4.7.2	DC enclosure/s at the array have a minimum IP 55 rating and have been correctly installed to maintain IP rating. Any disconnector in a dedicated individual enclosure must not have top entry conduit or glands. If the number of cable entries to the enclosure is two or less, the entries are on the lower entry face of the enclosure Where conduit systems have a section in an outdoor environment and terminates into an enclosure with a DC isolator, the conduit has a drain device fitted at the lowest point		
39	AS/NZS 3000:2018 4.1.2 & 4.1.3; AS/NZS 5033:2021 4.4	PV cable junction boxes mounted outdoors have a minimum IP 55 rating, and have been correctly installed to prevent water ingress		
40	AS/NZS 5033:2021 4.3.6	Where there is a number of PV array strings, and could result in a potential fault current in any one string greater than reverse current of an individual module - appropriate string protection is provided. [e.g. Fuses or non-polarised circuit breakers]		
41	AS/NZS 5033:2021 3.3.4	Has string overcurrent protection been installed? It will be required if: I_{SC} x (number of strings at the array) > or equal to Module reverse current rating		
42	AS/NZS 5033:2021 3.3.5	The string and sub-array protection current rating is according to AS/NZS 5033 Table 3.5 String protection (if required): $1.2 \times I_{STRING\ MAX} < I_n \leq I_{MOD\ MAX\ OCPR}$ Which becomes: $1.2 \times 1.25 \times K_i \times I_{SC\ MOD} < In \leq I_{MOD\ MAX\ OCPR}$		
43	AS/NZS 5033:2021 3.3.5	The current rating (I_n) of the PV array overcurrent device (if required) is as per the following: (No DCU's) $In \geq S_A \times I_{STRING\ MAX}$ Where: S_A = strings in parallel. $I_{STRING\ MAX}$ (if no DCUs) = $1.25 \times K_i \times I_{SC\ MOD}$		
44	AS/NZS 5033:2021 4.3.6.4	If string protection is installed, the fuse holders have a current rating equal to or greater than the corresponding fuse		

Grid Connected PV System Inspection Checklist

Item	Clause	Description	Compliant	Notes
45	AS/NZS 3000:2018 5.1.2; AS/NZS 5033:2021 4.6	The PV array mounting frames and modules have an equipotential bond connected to the earthing terminal on the switchboard/ distribution board to which the inverter is connected, either directly or via the inverter main earth conductor. (Refer figure 4.13 of AS/NZS 5033)		
46	AS/NZS 5033:2021 4.6.3	The PV array frame and/module earthing connections and methods comply with standards requirements		
47	AS/NZS 5033:2021 5.3.2	PV cable junction boxes are labelled 'WARNING: HAZARDOUS DC VOLTAGE'		
48	AS/NZS 5033:2021 Cl 4.6.7	If a transformer-less inverter (non-galvanically isolated) is installed, a functional earth is not connected to the DC positive or negative		
49	AS/NZS 5033:2021 Cl 4.6.7	If the PV array is functionally earthed an Earth Fault Interrupter is installed		
50	PNG Grid Connected PV System Guidelines	The DC cables connecting to the inverter are mechanically secured in such a manner that they cannot be inadvertently unplugged from the inverter		
Compliance with Standards and Guidelines-Inverter, AC Cabling and DC and AC Switchgear				
51	AS/NZS 3000:2018 4.1.3 and PPA/ SEIAPI Guidelines	Inverter is of appropriate IP rating for its location		
52	AS/NZS 3000:2018 1.7.1 & 1.7.2	Inverter (or any heavy part of system) is installed/mounted safely and there appears no imminent risk of the item falling		
53	AS/NZS 3000:2018 1.7.1 & 1.7.2	Inverter has been installed in a location that has safe access and adequate working space		
54	AS/NZS 3000:2018 1.7.1	There is adequate clearance around the inverter in accordance with inverter manufacturer's recommendation with adequate space and ventilation		
55	AS/NZS 5033 3.5.3	Where the calculated PV DC circuit maximum voltage is above 120V or the PV array is connected to a non-separated inverter conforming to IEC 62109-2, an earth fault alarm system has been installed		
The following relates to DC isolator beside inverter - it can be part of the inverter as per PNG Grid connected PV System Guidelines and AS/NZS 5033 and IEC standards				
56	AS/NZS 5033 5.5.2.2	Where a disconnection point is used, an appropriate sign has been attached to the PV module or structure within 300mm of the disconnection point to identify the location of the disconnection point: "PV String Disconnection Point''		

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Grid Connected PV System Inspection Checklist

Item	Clause	Description	Compliant	Notes
57	AS/NZS 3000:2018 2.4.2; AS/NZS 4777.1:2016 3.4.3; AS/NZS 5033:2014 4.3.1	The load breaking DC isolator located adjacent to the inverter is correctly rated for actual required DC voltage and current in accordance with AS/NZS:5033		
58	AS/NZS 3000:2018 2.2.4.2; AS/NZS 4777.1:2016 3.4.3; AS/NZS 5033:2021 4.1	The Isolator [or C/B] at the inverter, connected to the array, is DC rated		
59	AS/NZS 5033:2021 4.5.4	The DC Isolator [or DC C/B] is mounted close to inverter input and the inverter is in sight or less than three metres from the array		
60	AS/NZS 3000:2018 2.3.2.2.1; AS/NZS 5033:2021 4.3.4.2.2 (e)	The DC Isolator [or DC C/B] is lockable in the off position		
61	AS/NZS 3000:2018 2.1.2 (f), 4.1.2 & 4.1.3	The DC Isolator at the inverter is correctly wired		
62	AS/NZS 5033:2021 4.3.4.2.2 (d)	The DC isolator at the inverter is not polarised and activates in all active conductors		
63	AS/NZS5033:2021 4.3.5.3.1 (b)	The DC isolator/s at the inverter are readily available		
64	AS/NZS 5033:2021 4.5.4.2	If multiple DC isolators are installed at the inverter, they are grouped and ganged so they operate simultaneously or grouped in a common location		
65	AS/NZS 5033:2021 5.5.2.1	If multiple DC isolators are installed at the inverter the correct warning sign indicating the need to operate all dc isolators to isolate the equipment is present		
AC Isolator, AC Cabling and Signage				
66	AS/NZS 3000:2018 7.3.4.1 (a)	If there is not a clear line of sight between the switchboard connected to the inverter and any person working on the inverter, an AC isolator is provided at the inverter and is labelled ''Inverter AC Isolator''		
67	AS/NZS 4777.1:2016 3.4.3	AC circuit breaker on switchboard can be secured in the open position		
68	AS/NZS 3000:2018 7.3.5.2 & 7.3.8.2.2	An AC circuit breaker is mounted within the switchboard to act as a main switch for the PV/inverter system and to protect the cable from the switchboard to the inverter		
69	AS/NZS 4777.1:2016 3.4.3	The AC circuit breaker is correctly rated to protect the AC cable installed between the inverter and switchboard to which it is connected		

Grid Connected PV System Inspection Checklist

Item	Clause	Description	Compliant	Notes
70	AS/NZS 4777.1:2016 3.4.3	The AC cables installed between the inverter and the switchboard to which it is connected are rated at a minimum of the inverter's maximum output current		
71	AS/NZS 3000:2018 3.9.4	Inverter cables are not directly installed near building surfaces as per AS/NZS 3000 requirements		
72	AS/NZS 5033:2021 4.4.3.2	Connection of AC and DC components in same enclosure are segregated i.e. there must be physical separation between AC and DC in an enclosure where wiring from both components are terminated		
73	AS/NZS 5033:2021 5.7	Shutdown procedure is correct and is permanently fixed at inverter and/or on main switchboard		
74	AS/NZS 4777.1:2016 6.3	If the solar system is connected to a distribution board, the following sign is located on main switchboard & all immediate distribution boards; 'WARNING', 'MULTIPLE SUPPLIES' 'ISOLATE INVERTER SUPPLY AT DISTRIBUTION SWITCHBOARD' and 'MAIN SWITCHBOARD'		
75	AS/NZS 4777.1:2016 6.2 (b)	The AC circuit breaker in the switchboard is labelled: 'MAIN SWITCH (INVERTER SUPPLY)' or similar		
76	AS/NZS 4777.1:2016 6.2 (a)	Sign – 'WARNING', MULTIPLE SUPPLIES', 'ISOLATE ALL SUPPLIES BEFORE WORKING ON SWITCHBOARD' located on the switchboard		
77	AS/NZS 4777.1:2016 6.2	Where the inverter is not adjacent to the main switchboard, inverter location information should be displayed on the switchboard to which the inverter system is directly connected		
78	AS/NZS5033:2021 5.6; AS/NZS 5033:2021 5.44	A green 'PV' sticker is permanently fixed within the buildings main switchboard and site plan is located at the switchboard and/or meter panel. The words ''DP'' or ''SW'' or ''AC'' are stated below ''PV'' to denote the type of disconnection for emergency workers		
79	AS/NZS 5033:2021 5.5.1	Disconnection devices near inverter is appropriately labelled		
80	AS/NZS 4777.1:2016 6.2	Grid supply main switch is labelled 'MAIN SWITCH (GRID SUPPLY)' or similar		

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20.3 Appendix 'C' Grid-Connected BESS Inspection Checklist

NATIONAL ENERGY AUTHORITY

Grid Connected BESS Inspection Checklist

Name of Inspector: _____

Position: _____

Signature: _____

General Comments: _____

_____

Customer Name: _____

Specify Installation Type: **Domestic / Residential / Commercial / Industrial**

Location of System: _____

Please define the BESS system, is it pre-assembled BESS (A), pre-assembled battery system (B) or battery system (C) based on the definition in the BESS Design/Install guidelines? Fill details for A or B or C (whichever is applicable) _____

_____

_____

A. Pre-assembled BESS (Skip if not applicable and write N/A in top row)
Manufacturer
Model No.
Battery chemistry (e.g. Li-Ion, etc)
Number installed & configuration
IP rating
Usable Capacity (Wh or kWh)
Minimum operating voltage (V)
Maximum operating voltage (V)
Maximum fault current (A)
Maximum discharge current
Maximum charge current (A)

Round-trip Efficiency	
Warranty	
AC voltage	
Rated AC power	
Feed-in type (single phase or three phase)	
Frequency	
Power factor	
Other details	
Does the preassembled BESS comply with the following? Tick if they meet the guide or cross if they do not.	
Australian Best Practice Guide - Battery Storage equipment - Electrical safety Requirements	

AC Cables	
Cross Sectional Area of String Cables	mm^2
Current Carrying Capacity of String Cables	A
Maximum Output Current from pre-assembled BESS	A

Voltage Drop	
Maximum length of AC cable to switchboard	m
Maximum Voltage Drop in AC cable	V
Maximum voltage drop (string cables) as %	%

AC Isolators/Circuit Breakers for BESS
AC Isolator/circuit breaker Rating
AC Isolator/circuit breaker Inside Switchboard
AC Isolator next to Battery Inverter

B. Pre-assembled Battery System (Skip if not applicable and write N/A in top row)
Manufacturer
Model No.
Battery chemistry (e.g. Li-ion, etc)
Number installed & configuration
IP rating
Usable Capacity (Wh or kWh)
Minimum operating voltage (V)
Maximum operating voltage (V)
Maximum fault current (A)
Maximum discharge current
Maximum charge current (A)
Round-trip Efficiency
Warranty
Does the preassembled battery system comply with **either** of the following? Tick if they meet the standard or cross if they do not.

Harnessing Energy for Life

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Grid Connected BESS Inspection Checklist

Australian Best Practice Guide - Battery Storage equipment - Electrical safety Requirements	
OR	
IEC 62619 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications	

Battery Cables	
Cross Sectional Area of Battery Cables	mm^2
Current Carrying Capacity of Battery Cables	A
Maximum Charging Current	A
Maximum Discharge Current	A

Voltage Drop	
Length of battery cable from battery system to Battery isolator	m
Length of battery cable from battery isolator to Battery inverter	m
Maximum Voltage Drop (battery system to battery inverter	V
Maximum voltage drop (battery system to battery inverter) as %	%

Battery Isolator / Overcurrent Protection	
Specify if the isolator/overcurrent protection is a single unit (**yes/no**)	
Battery Isolator Location (circle)	**Adjacent to Battery System / Adjacent to Battery Inverter / Elsewhere**
Battery Isolator Non-Polarised	
Battery Isolator Rating	

AC Isolators/Circuit Breakers for Battery Inverter
AC Isolator/Circuit Breaker Rating
AC Isolator/Circuit Breaker Inside Switchboard
AC Isolator Next to Battery Inverter

C. Battery System (Skip if not applicable and write N/A in top row)
Manufacturer
Model No.
Battery chemistry (e.g. VRLA, Ni-Cd, Flow etc)
Number installed & configuration
Capacity (Wh or Ah)
Minimum operating voltage (V)
Maximum operating voltage (V)
Maximum fault current (A)
Maximum discharge current
Maximum charge current (A)
Specify the standard the battery system complies with based on the battery technology e.g., AS/NZS 4029/ IEC 62619/ AS IEC 60622/ IEC 62932 etc.

Grid Connected BESS Inspection Checklist

Battery Cables	
Cross Sectional Area of Battery Cables	mm^2
Current Carrying Capacity of Battery Cables	A
Maximum Charging Current	A
Maximum Discharge Current	A

Voltage Drop	
Length of battery cable from battery system to Battery isolator	m
Length of battery cable from battery isolator to Battery inverter	m
Maximum Voltage Drop (battery system to battery inverter	V
Maximum voltage drop (battery system to battery inverter) as %	%

Battery Isolator / Overcurrent Protection	
Specify if the isolator/overcurrent protection is a single unit (**yes/no**)	
Battery Isolator Location (circle)	**Adjacent to Battery System / Adjacent to Battery Inverter / Elsewhere**
Battery Isolator Non-Polarised	
Battery Isolator Rating	

AC Isolators/Circuit Breakers for Battery Inverter
AC Isolator/Circuit Breaker Rating
AC Isolator/Circuit Breaker Inside Switchboard
AC Isolator Next to Battery Inverter

Battery Inverter	
Define your battery inverter (PV battery grid connect, battery grid connect, etc.) based on the definition in the Grid connected BESS Design/Install guidelines	
Number of Battery Inverters	
Number of different models/brands of battery Inverter	
Duplicate the following for each different brand/model of inverter	
Battery Inverter Brand	
Battery Inverter Model	
Does the battery inverter meet the following standards? Check the label on the side of the inverter(s). Tick if they meet the standard or cross if they do not.	
IEC 62109 Safety of power converter for use in photovoltaic power systems	
AS/NZS 4777.2: 2020 Grid connection of energy systems via inverters - Inverter requirements	
Single phase or three phase inverter(s)	
Inverter AC Power Rating (kW / kVA	
Inverter Nominal AC Current (A)	
Inverter Ingress Protection (IP) Rating	
Is the Inverter Galvanically Isolated (separated/non-separated)	

Grid Connected BESS Inspection Checklist

Grid Connected PV System

If a grid connected PV system is being installed with BESS, refer to the grid connected PV system inspection checklist.

Item	Clause	Description	Compliant	Notes
General Wiring and Installation Work				
1	AS/NZS 3000 1.5.3.1	There are no exposed LV live parts on any installed equipment		
2	AS/NZS 3000 1.6 & 1.7	All electrical equipment for the system is installed in accordance with AS/NZS3000		
3	AS/NZS 3000 4.1.3	Inverter is of appropriate IP rating for its location.		
4	AS/NZS 3000 3.7.2.3	There are no visible loose connections in LV cables		
Compliance with Standards and Guidelines - BESS				
Pre-Assembled BESS				
5	AS/NZS 5139 4.2.1	No damaged equipment has been installed. Additional requirements by the equipment manufacturer have been followed safety/ hazards, installation, commissioning, etc		
6	AS/NZS 5139 4.2.1	The AC interconnection of the pre-assembled BESS is in accordance with AS/NZS 3000		
7	AS/NZS 5139 4.2.2.1	The preassembled BESS's location is selected such that there is protection from mechanical damage, environmental conditions and external influences		
8	AS/NZS 5139 4.2.2	The preassembled BESS's location is selected such that it is accessible for installation, operation and maintenance		
9	AS/NZS 5139 4.2.2.2	The preassembled BESS's location is selected such that it is not installed in a restricted location (such as habitable rooms, under stairways, walkways, ceiling spaces, wall cavaties, etc.)		
10	AS/NZS 5139 4.2.2.2	No appliances not associated with the preassembled BESS have been mounted in the restricted zone (i.e 600mm horizontal & 900mm vertical clearances have been followed where applicable)		
11	AS/NZS 5139 4.2.3.2	The pre-assembled BESS has appropriate IP rating the location (minimum IP2X and at least IP23 - for outdoor/suitable for the location)		
12	AS/NZS 5139 4.2.4.2	Where mounted near a surface/wall next to a habitable room, the pre-assembled BESS has been mounted on a non-combustible barrier (Note: Preassembled BESS should not be mounted in habitable rooms for domestic / residential)		

Item	Clause	Description	Compliant	Notes
13	AS/NZS 5139 4.2.4	Where the pre-assembled BESS is mounted within 300mm of a wall with a habitable room on the other side of that wall then a non-combustible barrier with similar dimensions as the exclusion zone has been installed		
14	AS/NZS 5139 4.2.5	The preassembled BESS room has clear access, is clean, dry and ventilated. Also has sufficient clearance forequipment handling, installation and maintenance		
15	AS/NZS 5139 4.2.6	The preassembled BESS has been installed to withstand the seismic (earthquake) forces		
16	AS/NZS 5139 4.3.5	The manufacturer's ventilation requirements have been followed		
17	AS/NZS 5139 4.2.4	Where required, protection against the spread of fire has been installed		
18	AS/NZS 5139 4.4.1.1	All the required documentation for the pre-assembled BESS has been provided		
19	AS/NZS 5139 Section 7	The signage recommended in section 7 have been installed. E.g. • the ''ES'' signage with the United Nations number • BESS system location layout • Danger / restricted access • Danger / No smoking (if risk of explosion) • Danger / Toxic fume (if applicable) • 'WARNING', 'MULTIPLE SUPPLIES' and 'ISOLATE ALL SUPPLIES BEFORE WORKING ON THIS SWITCHBOARD'		
Pre-Assembled Battery Systems				
20	AS/NZS 5139 5.2.1	No damaged equipment has been installed. Additional requirements by the equipment manufacturer have been followed safety/ hazards, installation, commissioning, etc.		
21	AS/NZS 5139 5.2.2.1	The pre-assembled battery system's location is selected such that there is protection from mecchanical damage, environmental conditions and external influences		
22	AS/NZS 5139 5.2.2	The preassembled battery system's location is selected such that it is accessible for installation, operation and maintenance		
23	AS/NZS 5139 5.2.2.2	The preassembled battery system's location is selected such that it is not installed in a restricted location (such as habitable rooms, under stairways, walkways, ceiling spaces, wall cavaties, etc.)		

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Grid Connected BESS Inspection Checklist

Item	Clause	Description	Compliant	Notes
24	AS/NZS 5139 5.2.2.2	No appliances not associated with the pre-assembled battery system have been mounted in the restricted zone (i.e. 600mm horizontal & 900mm vertical clearances have been followed where applicable)		
25	AS/NZS 5139 5.2.3.2	The pre-assembled battery system has appropriate IP rating for the location (minimum IP2X and at least IP23- for outdoor/ suitable for the location)		
26	AS/NZS 5139 5.2.4.2	Where mounted near a surface/wall next to ahabitable room, the pre-assembled battery system has been mounted on a non-combustible barrier (Note: Preassembled battery system should not be mounted in habitable rooms for domestic/residential)		
27	AS/NZS 5139 5.2.4	Where the pre-assembled battery system is mounted within 300mm of a wall with a habitable room on the other side of that wall then a non-combustible barrier with similar dimensions as the exclusion zone has been installed		
28	AS/NZS 5139 5.2.5	The preassembled battery room has clear access, is clean, dry and ventilated. Also has sufficient clearance for equipment handling, installation and maintenance		
29	AS/NZS 5139 5.2.6	The preassembled battery system (associated mounting) has been installed to withstand the seismic (earthquake) forces		
30	AS/NZS 5139 5.3.1.2	Overcurrent protection has been provided on all live conductors. Where parallel preassembled battery systems are installed, each battery system includes a separate overcurrent protection device or manufacturer's requirements on parallel strings have been met		
31	AS/NZS 5139 5.3.1.2	The overcurrent protection device is non-polarized, dc rated, has appropriate voltage and current ratings and meets the requirements of AS/NZS 3000		
32	AS/NZS 5139 5.3.1.3	Disconnection means has been provided to isolate the pre-assembled battery system from PCE and is appropriately rated. Where an overcurrent protection device has been used, it is rated for isolated function		
33	AS/NZS 5139 5.3.1.3.8	Where the pre-assembled battery system includes multiple PCEs, a separate isolation device is adjacent to each PCE		

Grid Connected BESS Inspection Checklist

Item	Clause	Description	Compliant	Notes
34	AS/NZS 5139 5.3.1.4	Flexible battery cables have been used. Inductive loops have been avoided and the voltage drop between preassembled battery system and PCE is < 5%		
35	AS/NZS 5139 5.3.1.4.5	The cable for the pre-assembled battery system to overcurrent device and PCE is rated for the maximum current rating of the pre-assembled battery system and fault current rating for the expected duration/tripping time of the overcurrent device		
36	AS/NZS 5139 5.3.1.6	The PCE and pre-assembled battery system's instructions have been followed on earthing arrangements		
37	AS/NZS 5139 5.2.4	Where required, protection against the spread of fire has been installed (non-combustible barriers, ventilation requirements, etc.)		
38	AS/NZS 5139 5.3.1.2	The battery system protection is correctly installed and rated for normal and fault conditions		
39	AS/NZS 5139 5.3.1.3.7	Where the cables connecting the pre-assembled battery system to the PCE are greater than 2m in length, an isolating device has been installed at both the pre-assembled battery system and PCE		
40	AS/NZS 5139 5.3.1.2.5	Where an external overcurrent protection device is required for the pre-assembled battery system, overcurrent protection has been installed as close as practical to the output of the battery system but no greater than 2m away		
41	AS/NZS 5139 5.3.1.4.7	Overcurrent protection has been installed at the battery port of the inverter where: a. the inverters charing (or load) current current under fault current is greater than the current carrying capacity of the cable between the battery system and inverter and b. the length of cable to the inverter is greater than 3m from the battery systems overcurrent protection device		
42	AS/NZS 5139 5.4.1.1	All documentation for the pre-assembled battery system has been provided		

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Grid Connected BESS Inspection Checklist

Item	Clause	Description	Compliant	Notes
43	AS/NZS 5139 Section 7	The signage recommended in section 7 (AS/NZS 5139) have been installed. E.g. • the "ES" signage with the United Nations number • preassembled battery system location layout • Preassembled battery system voltage and current rating sign • Danger / restricted access • Danger / No smoking (if risk of explosion) • Danger / Toxic fume (if applicable) • 'WARNING', 'MULTIPLE SUPPLIES' and 'ISOLATE ALL SUPPLIES BEFORE WORKING ON THIS SWITCHBOARD'		
Battery Systems				
44	AS/NZS 5139 6.2.1	No damaged equipment has been installed. Additional requirements by the equipment manufacturer have been followed on safety / hazards, installation, commissioning, etc.		
45	AS/NZS 5139 6.2.2.1	The battery system's location is selected such that there is protection from mechanical damage, environmental conditions and external influences		
46	AS/NZS 5139 6.2.2	The battery system's location is selected such that it is accessible for installation, operation and maintenance		
47	AS/NZS 5139 6.2.2.1	The battery system has been either installed in a dedicated enclosure or a dedicated room		
48	AS/NZS 5139 6.2.2.2	The battery system's location is selected such that it is not installed in a restricted location (such as habitable rooms, under stairways, walkways, ceiling spaces, wall cavities, etc)		
49	AS/NZS 5139 6.2.2.2	No appliances not associated with the battery system have been mounted in the restricted zone (i.e., 600mm horizontal & 900mm vertical clearances have been followed where applicable)		
50	AS/NZS 5139 6.2.3.1	The battery system has been installed in a location where the minimum and maximum temperatures are within the temperature range specified by the battery system manufacturer		
51	AS/NZS 5139 6.2.3.1	The battery system is protected against presence of water, humidity, dust, vermin and direct solar radiation. Also, the battery system has not been installed near combustible materials		

Item	Clause	Description	Compliant	Notes
52	AS/NZS 5139 6.2.3.2	The battery system, battery terminals and other connected live parts has appropriate IP rating for the location (i.e., IP2X and at least IP23 if outdoors / suitable for the location)		
53	AS/NZS 5139 6.2.4.2	Where mounted near a surface/wall next to a habitable room, the battery system has been mounted on a non-combustible barrier		
54	AS/NZS 5139 6.2.5	Where enclosure has been used, it has clear access and is clean, dry and ventilated		
55	AS/NZS 5139 6.2.5.2.1	Where enclosure has been used, it prevents unauthorised access to the battery system components		
56	AS/NZS 5139 6.2.5.2.2	Where enclosure has been used, the spacing requirements have been met (i.e. >3mm between cells, >25mm from wall, required clearance on top etc). The batteries have been mounted (highest point) <2.2m above floor level		
57	AS/NZS 5139 6.2.6	Where battery room has been used, it prevents unauthorised access to the battery system components. The battery room has sufficient ventilation, is clean and dry, free from insects and vermin and provides protection against detrimental environmental conditions		
58	AS/NZS 5139 6.2.6.2	Where battery room has been used, the minimum unimpeded access is at least 900mm / 600mm (DVC-A) from the working side of the battery/aisle		
59	AS/NZS 5139 6.2.6.2	Where battery room has been used, there is 25mm clearance between battery cells/ modules and any wall/structure		
60	AS/NZS 5139 6.2.8	The battery system/stand has been installed to withstand the seismic (earthquake) forces		
61	AS/NZS 5139 6.3.1.2.1	Overcurrent protection has been provided on all live conductors. Where parallel battery systems are installed, each battery system shall include a separate overcurrent protection device or manufacturer's requirements on parallel strings have been met		
62	AS/NZS 5139 6.3.1.2.1 / 6.3.1.2.3	The overcurrent protection device is non-polarized, DC rated, has appropriate voltage and current ratings and meets the requirements of AS/NZS 3000. The fuse holders are appropriately rated		
63	AS/NZS 5139 6.3.1.3.1	Disconnection means has been provided to isolate the battery system from PCE and is appropriately rated. Where an overcurrent protection device has been used, it is rated for isolation function		

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Grid Connected BESS Inspection Checklist

Item	Clause	Description	Compliant	Notes
64	AS/NZS 5139 6.3.1.3.8	Where the battery system includes multiple PCEs, a separate isolation device is adjacent to each PCE		
65	AS/NZS 5139 6.3.1.3.7	Where the cables connecting battery systems and PCEs are less than 2m in length, the isolation device has been installed either adjacent to the battery system or the PCE		
66	AS/NZS 5139 6.3.1.3.7	Where the cables connecting the battery system to the PCE are greater than 2m in length, an isolating device has been installed at both the battery system and PCE		
67	AS/NZS 5139 6.3.1.5.7	Overcurrent protection has been installed at the battery port of the inverter where: a. the inverters charging (or load) current under fault current is greater than the current carrying capacity of the cable between the battery system and inverter and b. the length of cable to the inverter is greater than 3 metres from the battery systems overcurrent protection device		
68	AS/NZS 5139 6.3.1.5.2 / 6.3.1.5.4	Flexible battery cables have been used. The voltage drop between battery system and PCE is < 5%		
69	AS/NZS 5139 6.3.1.5.5	The cable for the battery system to overcurrent device and PCE is rated for the maximum current rating of the battery system and fault current rating for the expected duration/tripping time of the overcurrent device		
70	AS/NZS 5139 6.3.5.3	No equipment has been mounted above explosive and/or corrosive gas emitting battery systems (e.g. lead acid batteries) within an enclosure		
71	AS/NZS 5139 6.3.1.8.1	Where the battery system is greater than DVC-A, and the battery system stand is conductive then the stand has been earthed (bonding is minimum 6mm sq/size of earth conductor size whichever is greater)		
72	AS/NZS 5139 6.3.5.5	Where batteries categorised as explosive gas hazards have been used, a minimum clearance of 600mm is provided and 100mm clearance below the battery terminals (unless separation barrier is used)		
73	AS/NZS 5139 6.3.5.2.1	Where batteries categorised as explosive gas hazard have been used, the battery system room/enclosure is ventilated. The ventilation is as per the requirements of Clause 6.3.5.2 (AS/NZS 5139)		

Item	Clause	Description	Compliant	Notes
74	AS/NZS 5139 6.3.2.2	An arc flash risk assessment has been done by the installer and the arc flash incident energy level has been classified as either insignificant, minor, moderate, major or catastrophic. (Refer to the table below for guidance.) List the arc flash incident energy level.		
75	AS/NZS 5139 6.3.2.3	Where the battery system has arc flash incident energy greater than 4.0cal/cm^2, the battery system has been installed: a. In a dedicated battery system room or enclosure not attached to building containing habitable rooms or b. At least to the requirements of fire hazard level 1		
76	AS/NZS 5139 6.3.1.9	Where the battery system is separated from earth (i.e floating) or connected to earth via a resistor and is operating at DVC-B or DVC-C, an earth fault alarm system has been installed		
77	AS/NZS 5139 6.3.1.7.1	The PCE and battery manufacturer's instructions has been followed to determine the earthing arrangement		
78	AS/NZS 5139 6.3.1.7.1	Battery systems connected to inverters that do not have separation between the DC port and the AC port or grid port has not been earthed		
79	AS/NZS 5139 6.4.1.1	All the required documentation for the battery system has been provided upon completion		
80	AS/NZS 5139 Section 7	The signage recommended in section 7 (AS/NZS 5139) have been installed. E.g. • the ''ES'' signage with the United Nations number • battery system location layout • battery system voltage and current rating sign • Danger / restricted access • Danger / No smoking (if risk of explosion) • Danger / Toxic fume (if applicable) • Electrolyte burns (if applicable) • 'WARNING', 'MULTIPLE SUPPLIES' and 'ISOLATE ALL SUPPLIES BEFORE WORKING ON THIS SWITCHBOARD'		

Consequence level	Arc flash incident energy level cal/cm^2
Insignificant	≥0.0, <1.2
Minor	≥1.2, <4.0
Moderate	≥4.0, <8.0
Major	≥8.0, <40
Catastrophic	≥40

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Grid Connected BESS Inspection Checklist

Item	Clause	Description	Compliant	Notes
Compliance with Standards and Guidelines - Battery Inverter, AC Cabling and DC and AC Switchgear				
81	AS/NZS 3000:2018 4.1.3	Battery Inverter is of appropriate IP rating for its location		
82	AS/NZS 3000:2018 1.7.1 & 1.7.2	Battery Inverter (or any heavy part of system) is installed/mounted safely and there appears no imminent risk of the item falling		
83	AS/NZS 3000:2018 1.7.1 & 1.7.2	Battery Inverter has been installed in a location that has safe access and adequate working space		
84	AS/NZS 3000:2018 1.7.1	There is adequate clearance around the battery inverter in accordance with inverter manufacturer's recommendation with adequate space and ventilation		
AC Isolator, AC Cabling and Signage				
85	AS/NZS 3000:2018 7.3.4.1 (a)	If there is not a clear line of sight between the switchboard connected to the battery inverter and any person working on the inverter, an ac isolator is provided at the inverter and is labelled ''battery inverter ac isolator''		
86	AS/NZS 4777.1 3.4.3	An a.c isolator has been installed on the cable connecting the battery inverter to the main switchboard where the inverter is greater than 3 metres from the switchboard or not in line of sight. Note: In accordance with clause 5.4.3 of AS/NZS 4777.1 (and AS/NZS3000), overcurrent protection device is required at the battery inverter for the cable between the battery inverter and the switchboard if the fault current from the battery inverter is greater than the current carrying capacity of the cable		
87	AS/NZS 4777.1:2016 3.4.3	AC circuit breaker on switchboard can be secured in the open position		
88	AS/NZS 3000:2018 7.3.5.2 & 7.3.8.2.2	An AC circuit breaker is mounted within the switchboard to act as a main switch for the battery inverter system and to protect the cable from the switchboard to the battery inverter		
89	AS/NZS 4777.1:2016 3.4.3	The AC circuit breaker is correctly rated to protect the AC cable installed between the battery inverter and switchboard to which it is connected		
90	AS/NZS 4777.1:2016 3.4.3	The AC cables installed between the battery inverter and the switchboard to which it is connected are rated at a minimum of the battery inverter's maximum output current or as recommended by the battery inverter manufacturer		

Item	Clause	Description	Compliant	Notes
91	AS/NZS 3000:2018 3.9.4	Battery Inverter cables are not directly installed near building surfaces as per AS/NZS 3000 requirements		
92	AS/NZS 4777.1:2016 6.2	Where the inverter is not adjacent to the main switchboard, battery inverter location information should be displayed on the switchboard to which the inverter system is directly connected		
93	AS/NZS 4777.1:2016 5.4.3	The AC cables from the battery inverter dedicated load port (in AS/NZS 4777, it is called standalone port) has been connected to a dedicated stand-alone load centre or a distribution board as specified in clause 5.4.3. of AS/NZS 4777.1		

20. Appendices Cont.

20.4 Appendix 'D' Grid-Connected PV System Application

NATIONAL ENERGY AUTHORITY

Grid Connected PV System Application

National Energy Authority Application number *(completed by NEA upon receiving the application)*:

Date application submitted:

Name of customer as stated in the electricity account:

Customer's premises number and complete address:

Telephone numbers:

Email:

Electricity customer account no:

Maximum demand averaged over the past 12 months (kVA):

Rated capacity of the proposed solar PV system (on the AC output side of the inverter) (kVA):

PV Array Information

W_p rating of PV Module	Number of Modules
kWp rating of Array	Module Manufacturer
	Model Number

Module is listed on the Australian Clean Energy Councils Approved Product List: **YES / NO**

Test certificate from an accredited laboratory have been provided for the following standards:

IEC 61215 Terrestrial photovoltaic (PV) modules – Design qualification and type approval

IEC 61730 Photovoltaic (PV) module safety qualification

Which of the following enhancements do the modules comply with:

IEC 61701 Photovoltaic (PV) modules - Salt mist corrosion testing Test Certificate Supplied

IEC 62804 – (2020) Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation (PID) - Part 1-1: Crystalline silicon – Delamination

Grid Connected PV System Application

Inverter Information	
kVA rating of Inverter	Number of Inverters
kWp rating of Array	Inverter Manufacturer
	Model Number

Inverter is listed on the Australian Clean Energy Councils Approved Product List: **YES / NO**

Test certificate from an accredited laboratory have been provided for the following standards:

IEC62109 Safety of power converters for use in photovoltaic power systems _____

AS/NZS4777.2 Grid Connection of energy systems by Inverters Part 2: Inverter Requirements

Information to be Submitted with the Application

- Single-line diagram of the proposed installation showing cable sizing, all switch disconnectors and protection devices.
- Layout of proposed Solar PV System
- List of protective devices between the inverter output and the point of interconnection to the PNG Power grid, and their protection settings
- Voltage Rise Calculation
- A tentative Bill of Material of proposed Solar PV System (includes name of component, component description, make, and quantity)
- AC Isolator next to Battery Inverter

Certification by the Customer

I attach the receipt number _____ dated _____ for the payment of _____ Kina as the fee for this application, to the Regulator.

I certify that the Rooftop Solar PV System will be located at the premises served by the electricity account stated above and that the power from solar PV system to be harnessed is within the property served by the existing electricity supply.

I agree to install all the required equipment and to provide information whenever requested by the Regulator.

I certify that the Solar PV System shall be in compliance with all aspects of the Regulator's Notice on the Grid Connection of Rooftop Solar PV Systems Design and Installation Guidelines, as published on the date of this application.

Signature: _____

Customer Name: _____

Date:

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20. Appendices Cont.

20.5 Appendix 'E' Battery Energy Storage System Application

NATIONAL ENERGY AUTHORITY

Battery Energy Storage System Application

National Energy Authority Application number *(completed by NEA upon receiving the application)*:

Date application submitted:

Name of customer as stated in the electricity account:

Customer's premises number and complete address:

Telephone numbers:

Email:

Electricity customer account no:

Rated capacity of the proposed BESS (on the AC output side) Inverter (kVA):

Inverter (kVA):

Storage Capacity (kWh):

If battery system is lithium ion: battery system ratings:

Voltage (DC)

If battery system is lead acid: battery system ratings:

Voltage (DC)

Capacity (Ah)

Arc Flash Incident Energy Value (if BESS is not a pre-assembled BESS) (cal/cm^2)

Battery Energy Storage System Application

BESS Information		
If BESS is a Pre-assembled BESS		
BESS Manufacturer	Model Number	
Pre-assembled BESS is listed on the Australian Clean Energy Councils Approved Product List:		**YES / NO**
If BESS is a seperate battery system inverter		
Battery System		
If Battery System comprises Lithium-Ion Batteries		
Is battery system a pre-assembled battery system?		**YES / NO**
If yes, is Pre-Assembled battery system listed on the Australian Clean Energy Councils Approved Product List?		**YES / NO**
Manufacturer	Model Number	
Capacity (Wh)	Voltage (V)	
If not an approved pre-assembled battery system, complete the following:		
Manufacturer	Model Number	
Individual Battery (or module) Capacity (Wh)	Voltage (V)	
Number of Battteries (or Modules)	Number of batteries (or modules) in series	
Number of parallel battery (or module) strings	Total capacity of battery system (Wh)	
Voltage of battery system (V)		
Test certificate from an accredited laboratory have been provided for the following standard:		
IEC 62619 Secondary cells and batteries containing alkaline or other non-acid electrolytes -Safety requirements for secondary lithium cells and batteries, for use in industrial applications		
If Battery System comprises Lead Acid Batteries		
Manufacturer	Model Number	
Type of Battery **Vented / Valve Regulated**	Voltage (V)	
Individual Battery Capacity (Ah)	Number of Battteries	
Number of batteries in series	Number of parallel battery strings	
Voltage of battery system (V)	Total capacity of battery system (Ah)	
Test certificate from an accredited laboratory have been provided for the following standard:		
AS/NZS 4029.1 Stationary batteries - Lead acid, Part 1: Vented type		
AS/NZS 4029.2 Stationary Batteries - Lead acid, Part 1: Valve regulated type		
IEC 60896 Stationary lead-acid batteries (series)		

20. Appendices Cont.

Battery Energy Storage System Application

Battery Inverter	
kVA rating of Inverter	Number of Inverters
Inverter Manufacturer	Model Number
Inverter is listed on the Australian Clean Energy Councils Approved Product List:	**YES / NO**
Test certificate from an accredited laboratory have been provided for the following standards:	
IEC62109 Safety of power converters for use in photovoltaic power systems	
AS/NZS 4777.2 Grid connection of energy systems by Inverters	

Information to be Submitted with the Application

Single-line diagram of the proposed installation showing cable sizing, all switch disconnectors and protection devices
Layout of proposed BESS
List of protective devices between the inverter output and the point of interconnection to the PNG Power grid
A tentative Bill of Material of proposed BESS (includes name of component, component description, make, and quantity)

Certification by the Customer

I attach the receipt number _____ dated _____ for the payment of _____ Kina as the fee for this application, to the Regulator.

I certify that the BESS will be located at the premises served by the electricity account stated above and that the power from BESS to be used within the property served by the existing electricity supply.

I agree to install all the required equipment and to provide information whenever requested by the Regulator.

I certify that the BESS shall be in compliance with all aspects of NEA/PPL's Grid Connected BESS - Design Guideline and NEA/PPL's Grid Connected BESS Systems Installation Guideline, as published on the date of this application.

Signature: _____

Customer Name: _____

Date:

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20. Appendices Cont.

20.6 Appendix 'F' Certificate of Completion

NATIONAL ENERGY AUTHORITY

Certificate of Completion

National Energy Authority Application number *(completed by NEA upon receiving the application)*:

Date application submitted:

Name of customer as stated in the electricity account:

Customer's premises number and complete address:

Telephone numbers:

Email:

Electricity customer account no:

Details of Installation

Type of Installation

Single Phase of Three Phase

Details of Work Carried Out

Details of Installed Products

Equipment	Rating	Quantity	Model Number
PV Module			
Inverter			
BESS			

Installer Details

Name of Installer:

Name of Company:

Address:

Telephone numbers:

Email:

20. Appendices Cont.

Certificate of Completion

Information to be Submitted with the Application

As built wiring diagram showing cable sizing, all switch disconnectors and protection devices

Completed Installation and commissioning checklist

Declaration

I would like to notify you that the connection of the grid connected PV system with the above rating and at the above premises is now complete and ready for operation.
The work throughout has been done in accordance with the AS/NZS 3000:2018. Wiring Rules, AS/NZS 5033 and AS/NZS 4777 standards and the PNG Grid Connected PV System Installation Guidelines.

I hereby declare that this installation has been tested as per the applicable standards and regulations and that it has been observed to be safe and compliant:

Name: _____

License Number: _____

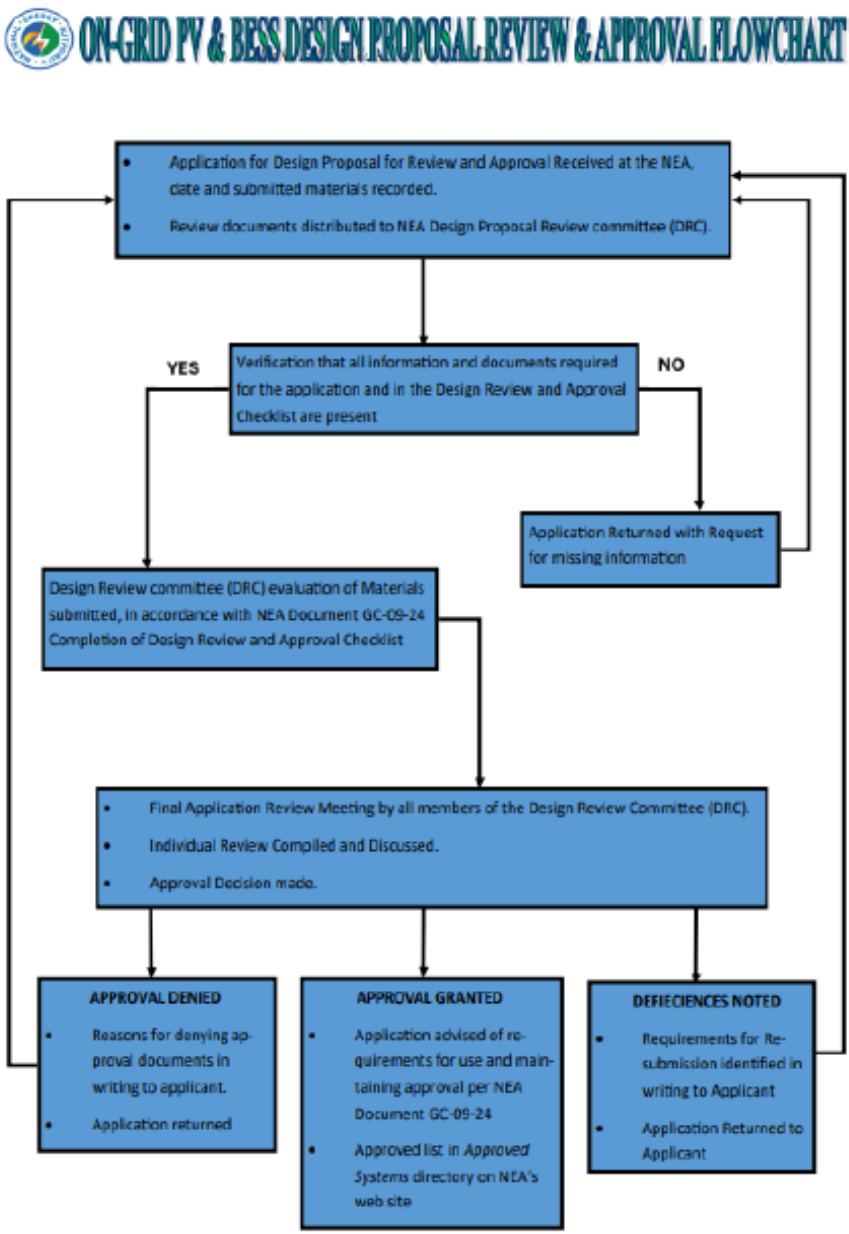
Accreditation Number: _____

Signature of Installer: _____

Date:

20. Appendices Cont.

20.7 Appendix 'G' Design Review and Approval Flowchart



Notes

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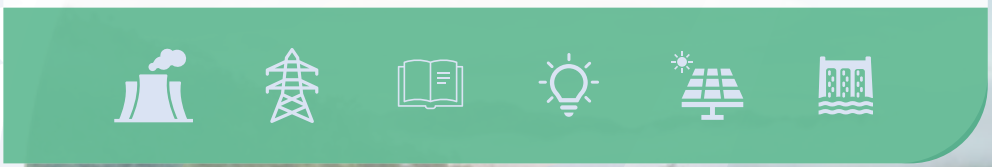
Contact Information

Office Address
Goada Herea Building
Section 58 Allotment 3
WAIGANI DRIVE, Port Moresby
Papua New Guinea

Postal Address
PO Box 494, VISION CITY 131, NCD

Contact
Phone: 3253233
Email: info@nea.gov.pg

Website
Website: https://www.nea.gov.pg



NATIONAL ENERGY AUTHORITY

www.nea.gov.pg

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