0933 Power Generation - Photovoltaic

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00 Design principles

0.01 Main considerations

It is a requirement to undertake the 00 PLANNING AND DESIGN/0001R - DESIGN REFERENCE and GLOSSARY OF TERMS information into all aspects of design, detailing and delivery when developing the content here within. Clear demonstration of adherence to these requirements is part of the services and will be called upon at key points in the project and during at the discretion of the Department of Education (DoE).

0.02 Scope

This design guide details the design requirements for new solar PV systems. It also details the requirements for upgrades to existing PV systems.

For new schools and new building/s (on an existing school site) a photovoltaic (PV) solar power grid-connect rooftop system must be provided to offset power consumption costs at the school.

0.03 System Design

System Size

For a new school provide the system size as tabled below:

Table 01: New School PV System Size

Primary School	Secondary School	SSP
Up to 7 core - 10 kW system	Up to 4 stream - 70 kW system	No hydrotherapy pool - 20 kW system
14 core - 25 kW system	7 stream - 90 kW system	Hydrotherapy pool onsite - 45 kW system
21 core - 40 kW system	9 stream and above - 99 kW system	
28 core - 60 kW system		
35 core- 70 kW system		

For a new building at an existing school site the PV system must be sized to offset at least the power consumption of the new building/s using predicted energy consumption data for the site and a current energy bill.

All proposed PV systems on a new or existing school must show a simple payback period of 7 years or less.

Personnel

The designer of any PV system must be fully accredited by the Clean Energy Council (CEC) of Australia for Grid-Connected PV Systems (Design).

The Contractor engaged to install the PV system must be fully accredited by the Clean Energy Council of Australia for Grid-connect PV Systems (Installation). The CEC accredited installer(s) must, as a minimum, supervise the installation throughout the duration of the project.

PV array arrangement

Location

Selection of PV array location(s) must consider the following:

- CEC Design Guidelines Cl. 7. Site-specific information
- Replacement schedule of existing roofs
- Heritage listing of building – solar array must not be located on heritage listed buildings
- Roof cladding type – solar arrays must not be located on tile roofs.

Arrangement

PV modules must be arranged so that they are grouped together where possible and are symmetrically or geometrically arranged.

The arrangement of the PV array must be designed to available space:

- PV array must be arranged such that shading of PV modules by nearby buildings, trees, obstacles or the PV modules themselves between the hours of 9:00am and 3:00pm during all months is avoided or minimised. Note: SG933 section 1.5 specifies the requirements for quantification of shading losses.
- All modules must be installed with a minimum incline of 10° to ensure self-cleaning by rainfall.
- PV arrays must be designed so that debris does not catch underneath panels, especially if there are trees in the vicinity. This may be achieved by:

- Positioning the mounting system so that it runs vertically in line with the corrugations of the roof and ensuring a minimum of 50mm clearance between roof cladding and module frame.
- Installation of tray or mesh guard around the perimeter of the array where debris build-up is likely. This must be installed in a manner that does not hinder module performance or system maintenance.

To minimise mismatch losses, PV arrays must be arranged such that:

- All strings connected in parallel to the same MPPT input comprise the same number of panels and have the same module brand and model.
- All modules in the string have the same tilt and the same orientation unless prior approval has been obtained.

Maintenance access

Arrays must be arranged as follows so that adequate access is provided for maintenance of the array:

- 500mm clearance around the perimeter of the PV arrays
- For flush mounted arrays, provide at least 700mm gap at every fourth row to create maintenance access way;
- Ensure that access to individual PV modules does not require the removal of more than one other PV module.

PV array in shared spaces

PV systems may be installed at a location adjacent to open play space used by students. This arrangement must be considered as ‘PV array in shared space’.

Where PV arrays or other PV system components are installed in shared spaces, a permanent fencing structure may be required to separate PV array and PV system components from unauthorised access.

Fencing must be located minimum 3 metres away from array, and such that shade cast onto the array is minimised. There must be no shading from the fence between 10am and 2pm in winter months.

See 02 SITE URBAN AND OPEN SPACES/0242 LANDSCAPE STRUCTURE - FENCES AND BARRIERS for fencing requirements. Fencing for the purpose of preventing access in shared spaces must meet requirements for 02 SITE URBAN AND OPEN SPACES/0242 LANDSCAPE STRUCTURE - FENCES AND BARRIERS Cl 3.4 Chain Link Fabric Security

Fencing and Gates or 02 SITE URBAN AND OPEN SPACES/0242 LANDSCAPE STRUCTURE - FENCES AND BARRIERS Cl.3.9 section 'Weldmesh Fencing, security'.

Where PV arrays are installed in shared spaces, all cables must be concealed in covered cable tray, ducting and/or conduit.

The final design for PV arrays in shared spaces must be reviewed by SINSW Sustainability and Advisory Services SINSW, Department of Education.

PV system inverter station arrangement

The area surrounding the inverter and all associated protective devices such as PV array DC isolator, inverter AC isolators, and wiring must be considered as the inverter station.

The inverter station must be located and specified such that:

- Requirements as per CEC Design Guidelines Cl.8. Inverter Installation are met.
- The ventilation, clearance and other requirements specified by the inverter manufacturer are met. This includes DC and AC protective switchgear unless explicitly approved by manufacturers in writing.
- Inverter station has a Data Outlet cabled via CAT6A cabling to the nearest BCR. If the inverter station is outside the cabling must be Cat6A external grade and outlets weather proofed accordingly.
- Inverter station must be located away from student access.

Where possible inverters and all associated protective devices must be located within the main switchboard (MSB) switchroom, electrical distribution board (EDB) cupboards, or risers closest to the PV array.

Locate cupboards so that access is available only directly from general circulation areas. It is not acceptable to walk through classrooms etc. to gain access to inverter stations, or to locate inverter stations in store rooms.

Where the EDB cupboard is unsuitable to house the inverter and associated equipment due to its size, ventilation or other issues, installation of the inverter station/s must be in one of the following locations:

- Plant room
- Purpose built enclosures/shelters

Where the inverter station location may be exposed to direct sunlight or rain, additional shading/protection must be provided.

Equipment at the inverter station must be arranged as follows:

- Arrange DC cables and isolator switches to the left side of each inverter.

- Arrange AC cables and isolator switches to the right side of each inverter.
- Arrange all switching devices and inverters no lower than 0.5 m and no more than 2.0m above the ground, floor or platform.
- Allow 0.6m access clearance in front of all switching devices and inverters.
- Where the PV system contains multiple PV array and/or inverters, provide additional description indicating location of system components and electrical distribution boards to which the inverter systems are connect.

PV system electrical design

The design of the PV system must meet requirements as set out by the Clean Energy Council Grid Connected Solar PV systems – Design guidelines for accredited installers.

Array and Inverter Matching

Inverters must be sized and selected adhering to requirements of CEC Design Guidelines Cl.9 Inverter Selection. In addition:

- Safety margin of 5% must be applied to inverter maximum input voltage
- The inverter and PV array must be sized such that the PV array nominal capacity rating is greater than 95% of the inverter's nominal AC power rating.

The oversizing restrictions of the CEC design guidelines must be met for systems intended to create Small-scale Technology Certificates.

Cable selection

DC and AC cables must be selected to meet requirements outlined by CEC design guide and AS4777.1. Additional DNSP requirements may apply.

The distance between the inverter and the most remote PV module must be used to calculate DC voltage drop.

Where there are multiple inverters, the distance between the inverter furthest from the point of common coupling must be used to calculate AC voltage rise.

The cable between the inverter and the AC circuit breaker must have a higher current carrying capacity than the AC circuit breaker rating and the maximum rated AC current output of the inverter.

AC isolators and circuit breakers

AC circuit breaker ratings must be above inverter maximum rated AC current output rating to avoid unnecessary tripping of circuit breaker.

Where multiple inverters are installed at the inverter station, an AC isolator must be provided for each inverter. Additionally, a single AC isolation switch must be provided for isolation of all inverters connected to the same electrical distribution cupboard.

Design Drawings

The designer of the PV system must provide electrical schematics of the system, including electrical ratings of all isolators and switches etc. This may be presented as a wiring diagram or a single line diagram.

The designer of the PV system must also provide plan view drawings of the array layout and inverter station layout.

All drawing(s) must identify the building and room on/in which PV system components are located, in accordance with the AMS room coding.

Distribution network service provider approval

The system provider must apply for and obtain the approval for connection of the proposed system from the relevant electricity distribution network service provider (DNSP) prior to installation of the PV system.

The system provider must meet all requirements set out by NSW Service and Installation rules and DNSP connection requirements.

System provider must submit all paperwork and be responsible for liaison with the DNSP until the DNSP has offered a connection agreement and the agreement has been accepted by the school. A copy of all paperwork submitted to the DNSP and a formal copy of the approval must be included in the PV system documentation.

Where an existing electricity meter requires upgrading or reconfiguration to facilitate bi-directional metering, the PV system installer must facilitate this upgrade with the sites electricity retailer.

Refer to 00 PLANNING AND DESIGN/0001C DESIGN CHECKLIST - ELECTRICAL SERVICES for additional information on electricity contract & metering.

Planning Approval under the EP&A Act and Compliance with SINSW Heritage Interim Guidelines for the Installation of Solar Panels

Under the SEPP Infrastructure 2007 (the Infrastructure SEPP) roof mounted solar can be installed at any NSW public school as exempt development if it meets certain conditions. Installations that comply with 00 PLANNING AND DESIGN/0001C DESIGN CHECKLIST - POWER SYSTEM and requirements here within will satisfy the majority of these conditions, but in addition, in order to satisfy the exempt development criteria the roof mounted installation:

- **must** not involve no more than minimal impact on the heritage significance of a heritage item* or conservation area.
- **must** not be installed facing a primary road if the school is on land that contains a State or local heritage item, or is in a heritage conservation area, or on land zoned:
  - (a) R1 General Residential,
  - (b) R2 Low Density Residential,
  - (c) R3 Medium Density Residential,
  - (d) R4 High Density Residential,
  - (e) R5 Large Lot Residential,
  - (f) RU5 Village

* According to the SINSW Heritage Interim Guidelines for the Installation of Solar Panels, roof mounted solar systems are not permitted to be installed on a heritage item as listed in the Department's S170 Heritage and Conservation Register or pre-1950 buildings as designated in AMS as being on the Draft S170 Register.

Solar installations that do not meet the exempt development criteria set out in clauses 20 and 39(3) of the Infrastructure SEPP, and are not prohibited under the SINSW Heritage Interim Guidelines, will require the preparation of a Review of Environmental Factors (REF) in accordance with Part 5 of the Environmental Planning Assessment Act 1979. The REF must take into consideration the factors outlined in Section 228 of the Environmental Planning and Assessment Regulation 2000. If the development is judged by the Department of Education to 'significantly affect the environment', then an environmental impact statement will need to be prepared and considered by the public authority.

It must be noted that a Statement of Heritage Impact will need to be prepared by a Heritage Professional where heritage impact needs to be assessed. For further heritage advice please contact SINSW Heritage at sinsw.heritage@det.nsw.edu.au

NOTE: For any proposed ground mounted system refer to Statutory Planning team for planning advice.

0.04 System Documentation

Refer to Specifications section of this document for a full list of schedules.

The system provider must keep copies of the PV system installation information for a minimum period of 5 years including installation and commissioning photographs.

The system provider must explain to the system owner the operation and maintenance requirements of PV system components upon completion.

A paper copy of the PV system documentation must be given to school office and one soft copy must be emailed to PVsolar@det.nsw.edu.au in PDF file format with file name coded:

<school code>_PVO_DDMMYY_<report description.pdf>

For example, a file name may be titled '3065_PVO_010118_PublicSchoolPVinstallationhandover.pdf'.

Upgrade of Existing PV System

Installation and documentation for PV system alterations (upgrade)

This section assumes that the PV system modification is considered an addition or alteration of system in accordance with clause 1.9.3 of AS/NZS 3000:2007 Wiring Rules. Recommendations for system alteration and addition by the Clean Energy Council guideline Installation requirements for alterations, additions, repairs and upgrades to existing grid-connected PV arrays must be followed. In addition, where possible, the whole system must be modified to be compliant with standards applicable at the time of the upgrade.

If any additional PV strings are added to the system and these additions are PV modules of a different electrical characteristic to the original, the additional PV string/s must be installed and connected to an inverter's separate MPPT and within the input constraints of the inverter.

If a PV system's combined inverter capacity exceeds 30kW as a result of an upgrade, the system must be retrofitted with central protection.

Refer to System Documentation section of this document for paper copy of the PV system documentation procedures.

The system provider must update system specifications and warranty information in schedules under Solar Asset Data Capture Sheet.

Removal and reinstallation of PV system due to building work

This section assumes that the PV system reinstallation at the same location is considered repair of system in accordance with clause 1.9.3 of AS/NZS 3000:2007 Wiring Rules. Recommendations for system repair works by the Clean Energy Council guideline. Installation requirements for alterations, additions, repairs and upgrades to existing grid-connected PV arrays must be followed. In addition, where possible, the whole system must be modified to be compliant with standards applicable at the time of the repair

Where PV system equipment have been replaced, relevant system documentation must be updated. The system provider must also update system specifications and warranty information in schedules under Solar Asset Data Capture Sheet.

Refer to System Documentation section of this document for paper copy of the PV system documentation procedures.

Where the PV modules are required to be removed to carry out renovation or repair work on the building, the removal and reinstall of PV modules must be carried out by CEC accredited installers.

Where a PV system is deemed redundant and will not be replaced, the removed PV panels must be recycled where this option is available. An email must be sent to pvsolar@det.nsw.edu.au to notify that the solar PV system has been removed so the PV Asset Register can be updated.

Renewable Energy Scheme Benefits

PV system must be designed and installed such that they are eligible for creation of STCs and/or LGCs.

NSW Department of Education retains ownership of the PV system and any benefits arising from generation of Small-scale Technology Certificates (STCs), Large-scale Generation Certificates (LGCs) and any future renewable energy schemes unless otherwise negotiated.

Battery Energy Storage System in Conjunction with PV Solar System

Battery Energy Storage System must only be designed in consultation with SINSW Sustainability sustainability.enquiries@det.nsw.edu.au

Specification

01 General

As per NATSPEC except as follows:

This section specifies the minimum requirements of system equipment, system documentation and workmanship of photovoltaic solar power systems installed at new or existing schools.

Standards and Reference Files

The PV system must be designed and installed in accordance with the most recent Australian Standards and Clean Energy Council guidelines including, but not limited to, the following:

- Australian Standard AS/NZS 1170.2:2011 - Structural Design Actions - Wind Actions
- Australian Standard AS/NZS 1768:2007 Lightning protection
- Australian Standard AS/NZS 3000:2007- Wiring Rules
- Australian Standard AS/NZS 3008:2017 - Electrical Installation – Selection of Cables
- Australian Standard AS 4777 Series - Grid connection of energy systems via inverters (Parts 1 and 2 inclusive)
- Australian Standard AS/NZS 5033:2014 - Installation and safety requirements for photovoltaic (PV) arrays
- Clean Energy Council - Grid Connected Solar PV systems: No Battery Storage – Design guidelines for accredited installers
- Clean Energy Council - 30 - 100 kW Grid-Connected Solar PV Systems: No Battery Storage, Design Guidelines for Accredited Installers
- Clean Energy Council - Grid Connected Solar PV systems – install and supervise guidelines for accredited installations
- Clean Energy Council – Installation requirements for alterations, additions, repairs and upgrades to existing grid-connected PV arrays.

The designer of any PV system must be fully accredited by the Clean Energy Council (CEC) of Australia for Grid-Connected PV Systems (Design).

The Contractor engaged to install the PV system must be fully accredited by the Clean Energy Council of Australia for Grid-connect PV Systems (Installation). The CEC accredited installer(s) must at a minimum supervise the installation throughout the duration of the project.

02 Product

As per NATSPEC except as follows:

Product performance requirements

Table 02: PV Module Requirements

Element	Requirement
Certification	All PV modules supplied must be compliant with AS/NZS 5033 All PV modules must be listed on the Clean Energy Council approved PV modules list at time of installation
General	All PV modules proposed in a single state PV array must have the same manufacturer and be the same model
Protection	PV module junction boxes must be at least IP65 compliant and must be UV resistant. Crystalline photovoltaic modules must be tested for potential-induced degradation and be certified to IEC/TS 62804 ed 1.0 Test methods for detection of potential-induced degradation of crystalline silicon photovoltaic (PV) modules. PV modules installed in a coastal environment or areas with high agricultural activities must be certified to the following IEC standards respectively: IEC 61701 Ed 2.0 Salt mist corrosion testing of photovoltaic (PV) modules IEC 62716 Ed 1.0 Ammonia corrosion testing of photovoltaic (PV) modules Preference is given to PV modules certified to the above IEC standard in all installations.
Temperature Coefficient	Voc temperature coefficient ≥ -0.3% / °C. Pmax temperature coefficient ≥ -0.4% / °C
Module Efficiency	Crystalline: > 17% Thin film: > 13%
Operating Temperature	Operating module temperature -20°C to +80°C

Element	Requirement
Mechanical Protection	Hailstone impact testing: Required Minimum permissible wind load rating: 2.4KPa Minimum permissible snow/mechanic load: 5.4KPa
Connectors and Cables	Datasheet and/or installation manual must indicate the brand and type of the connector.
Warranty	Modules must come with a minimum 13 year product warranty documented in the modules standard warranty statement or brochure. This warranty is in addition to any performance warranty offered. Minimum manufacturer's power warranty:10 years at 90% power output and 25 years at 80% power output or better.
Manufacturer	Manufacturer must participate in the CER Validation Initiative. Manufacturer must operate an Australian-based office for warranty claims.

Table 03: Inverter Requirements

Element	Requirement
Selection of Inverter	Inverter supplied must meet all requirements specified by AS 4777 series, AS/NZS 5033:2014 and any additional DNSP requirement. String inverters must be one of the following brands as they are the only manufacturers which have been approved for network connectivity by the DoE Information Technology Directorate (ITD): SMA or Fronius Micro inverters and Optimisers must not be used unless prior approval has been obtained from the SINSW Sustainability Team and identified as a prequalified proprietary item.
Certification	The inverter(s) must be listed on the Clean Energy Council's list of compliant inverter and power conversion equipment
Technical Requirements	Inverter must have efficiency: ≥ 90% at 10% load
Communications	The schools network and Cat 6a wired connection are to be used for communication. All inverters and communication devices must be Sunspec Modbus TCP compatible. All inverters and communication devices must allow for Modbus TCP communication over TCP port 502. All inverters must provide system operation status to an online monitoring platform. SMA Cluster controllers are not to be included in any system proposal

Element	Requirement
Other Requirements	Connectors must be compliant with EN 50521 (2012) Datasheet and/or installation manual must indicate the brand and type of the connector. Inverters installed in an outdoor environment must have Ingress Protection of IP54 or greater.
Warranty	10 years warranty.

Table 04: Mounting System Requirements

Element	Requirement
Selection of Mounting System	The mounting frame and associated parts, including but not limited to parts such as bolts, splices, etc. must be a suitable proprietary made product. Custom made products are not acceptable. Building Integrated PV mounting system must not be used unless prior approval has been obtained from, SINSW, Sustainability
Certification	Mounting system must be compliant with AS/NZS 1170.2 for the terrain category and wind speed applicable to the installation site As a minimum, the mounting frame must be suitable for Region B (intermediate) and Terrain Category 2 maximum wind speed region. The PV mounting system must meet the CEC guideline requirements.
Warranty	10 years warranty.

Table 05: Balance of System Component Requirements

Element	Requirement
Selection of BOS equipment	All equipment must be selected as per AS/NZS 5033:2014 Equipment must be selected to withstand expected environmental effects.
DC Cables	PV cables must comply with requirement set out by AS/NZS 5033:2014 Cl. 4.3.6 Cables

Element	Requirement
DC Isolators	DC switch-disconnectors ('isolators') must comply with AS/NZS 5033:2014 Cl. 4.3.5 Disconnection Devices. DC switch-disconnectors must meet the following additional specifications: Type: Rotary type DC isolator IP rating: IP66 Provide within specification sheet Operational ambient temp (before de-rating); Temperature de-rating factors provided by manufacturer; Single pole voltage and current rating provided by manufacturer
AC Cables	The cable between the inverter and the AC circuit breaker must have a higher current carrying capacity than the AC circuit breaker and the maximum AC current output of the inverter.
AC Circuit Breaker	AC circuit breaker acting as the main switch (inverter supply) must be rated to protect the cable against overcurrent to AS/NZS 3000 AC circuit breaker ratings must be above inverter maximum AC current output rating to avoid unnecessary tripping of circuit breaker.
DC String protection	String overcurrent protection, if needed, must adhere to sizing and location requirements as set out by AS/NZS 5033 Circuit breakers must not be used for string overcurrent protection.
Plugs, Sockets and connectors	Plugs, sockets and connectors used in the PV system must comply with AS/NZS 5033:2014 4.3.7 Plugs, sockets and connectors. Note: Mating of plugs and sockets that are compatible but do not meet the above criteria (e.g. mating of MC4 sockets with MC4 compatible sockets from another manufacturer) is not acceptable.
Cable management	Conduit installed at the roof or any location exposed to direct and indirect sunlight must be UV rated. This includes conduits under modules on roof. HD conduit or lidded cable trays must be selected for all cable arrangement between the inverter and the PV array.
Central Protection	PV system central protection device must have, as a minimum, the following parameters unless exempted by DNSP: Vector Shift ROCOF (Rate of Change of Frequency) Phase Balance Current (Current imbalance)
Roof Penetration	Fit for purpose roof flashing or risers which can provide a guaranteed seal for up to 20 years

Element	Requirement
PV system signage	Signs installed for the purpose of identify PV system components must be engraved plastic or metallic labels Signage must be consistent throughout the site and clearly labelled to distinguish between strings and/or inverters
Lightening Protection	Where a lightning protection system (LPS) is present, PV systems must be integrated into the existing LPS system as per AS/NZS 5033, AS/NZS 1768 and AS/NZS 3000
Purpose Built Enclosure and/or Shelter	All inverters installed outdoors must have shading from the sun and rain. Any inverter installed in a location that is accessible by a student must be located in an enclosure with IP2X rating whilst maintaining minimum inverter clearance requirements

Table 06: PV System Documentation

Element	Requirement
General	Site-specific system documentation must comply with AS/NZS 5033 and AS4777.1 Documentation must be consistent in terminology and references to system components must match installed system labelling. The system provider must keep copies of the PV system installation information for a minimum period of 5 years including installation and commissioning photographs. The system provider must explain to the system owner the operation and maintenance requirements of PV system components upon completion.
Distribution	The system provider must explain to the system owner the operation and maintenance requirements of PV system components upon completion. A paper copy of the PV system documentation must be given to school office and one soft copy must be emailed to PVsolar@det.nsw.edu.au in PDF file format with file name coded <school code>_PVO_DDMMYY_<report description.pdf>For example, a file name may be titled '3065_PVO_010118_PublicSchoolPVinstallationhandover.pdf'.

Element	Requirement
System Photograph	Installation photographs showing key system components. Photographs must show, as a minimum: The complete extent of the PV array(s); Mounting (demonstrating pitch angle eg with inclinometer) and external cabling Inverter station layout Electrical distribution board showing inverter system isolation switches and corresponding signage; Meter changeover (where applicable).
PV system operation information	A procedure to verify the correct operation of the system; The shutdown and isolation procedure for emergency and maintenance, including any electrical safety warnings; A list of actions to be taken in the event of an earth fault alarm. This information must also be present adjacent to physical earth fault alarms where installed.
PC system components information	A list of equipment supplied, with serial numbers of all equipment where applicable; As-built plan view of the PV array, clearly showing the PV array wiring configuration and location of system equipment and switches; As-built electrical diagram/s showing connection of all PV system equipment to electrical distribution board, including the electrical ratings of the PV array and electrical ratings of all overcurrent devices, isolators and switches etc.; Details of any additional system controls installed, such as central protection and export limitation control. This includes: Device model System setting Wiring diagram (if applicable)
PC system communications configuration	Data connection diagram showing how each inverter is communicating to web portal Modbus topology, including Modbus unit IDs Screenshot showing connection to the school IP address on the DHCP network Screenshot showing Modbus TCP – port 502 enabled on the inverter and Data Manager/Controller
PV system performance estimates	System performance estimates, providing monthly generation estimates and considering expected seasonal, operational and site-specific variation. The system performance estimate must as a minimum quantify effects of the PV array orientation and shading and de-rating factors such as temperature and equipment efficiency. Any assumptions made must be clearly stated;

Element	Requirement
PV system maintenance information	Recommended maintenance for the system; Maintenance procedure and timetable
Installation and commission checklists	The commissioning sheet and installation checklist; The date of system commissioning; PV module recycling recommendations
Equipment and information certifications	Equipment manufacturer's documentation and handbooks for all equipment supplied. As a minimum the following must be included: Panels, mounting frame, inverter, isolators, cable, monitoring devices. A description of the function and operation of the system's installed equipment; Array mounting engineering certificate for wind and mechanical loading; Installer/designer's declaration of compliance to AS/NZS 5033:2014 2.2 Mechanical design; Equipment warranty information
System support	PV system approval to connect and connection offer The supplier's contact personnel for installation queries and system support; Warranty of workmanship to specification
Remote monitoring	Provide instructions on accessing and monitoring system via remote monitoring platforms

03 Execution

As per NATSPEC except as follows:

Workmanship Specifications

The system provider must install the photovoltaic system to meet all relevant standards, building codes and local council requirements, and in such a way that the manufacturers' warranties on all system equipment remains valid.

Table 07: System workmanship specifications requirements

Element	Requirement
PV Array installation	• Modules and mounting system must be installed following the respective manufacturer's specifications to meet expected mechanical loads at the installation site. • Where concealed-fastener roof profile is present, mounting frames must be fixed to the roof cladding using non-penetrative purpose made products. • All modules must be installed with a minimum incline of 10° to ensure self-cleaning by rainfall. • For flush-to-roof type mounting, clearance between roof sheeting and modules must be minimum 60 mm to prevent debris accumulation and improve airflow. • A gap must be provided between PV modules to allow for thermal expansion. Minimum gap of 5mm must be maintained. • Do not drill into module frames
General Fixing	• Where practicable, install rubber grommets between dissimilar metals to prevent corrosion from galvanic reaction. Common locations include: o Array fixing to roof o Isolator enclosure fixing to rail • Ensure that bolts, washers, screws, nails or other metal objects in contact with the mounting frame are of a similar metal to reduce the likelihood and severity of galvanic reaction. Stainless steel fasteners must be used on aluminium frames and rails.
Invertor station installation	• Inverter/s must be installed according to AS4777 series requirements. In addition, where multiple inverters are installed connecting to the same switchboard, the inverters must be installed grouped in a common location. • Inverter manufacturer's recommendations must be followed. This includes recommendations for fixing screw diameter, cable size, and inverter clearance. • PV systems connected to multiple phases must be balanced to DNSP requirements and AS4777.1 requirement. • Each inverter must be provided with an AC isolation switch at an electrical distribution board. A main switch (inverter supply) must be provided to isolate all inverters installed on the distribution board. • The inverter earth fault alarm must be installed such that any fault indication is detectable by the school's administrative office and NSW Department of Education. See Remote Monitoring Setup

Element	Requirement
Inverter Communications Infrastructure	• A double Cat 6A LAN point is to be installed adjacent to the inverter station with CAT6 cabling back to the nearest Building Communication Room (BCR), with inverter(s) connected to the school's network (including patching). • If the inverter station has been installed in an external location cabling must be Cat 6A external grade and outlets weather proofed accordingly. • Raise a request with the DoE ICT team through Edconnect. Reference the school data port used for communication connection, and request an IP reservation for each inverters MAC address in the DHCP servers. • Connect to "proxy.det.nsw.edu.au" and request proxy account details if the inverter or data manager device allows. • Use dynamic/ DHCP settings for network configuration, ensure the IP addresses are the same as DHCP reservations. • Enable Modbus Communication on TCP port 502. • If there are more than 1 inverters, give a unique Modbus ID for each device. • Record Modbus topology in a single line diagram and lodge as part of as-built documentation Refer to 09 ELECTRICAL/0900s SCHEDULES - ELECTRICAL SERVICES for where devices are installed in distribution boards.

Element	Requirement
Remote Monitoring Setup	Input data to the inverter supplier's online monitoring portal for monitoring and maintenance supervision by School Infrastructure NSW and the school: • Add **pvsolar@det.nsw.edu.au** and the school's email address as administrators on the inverter supplier's online monitoring portal. • Input system profile details, including an image of the system and description identifying the location within the school of the panels and inverter(s) • Input installer details • Input manufacturing and warranty details for inverter, and panels if available. • Input string configuration details for each inverter if available • Input performance monitoring parameters, e.g. blended tariff, yield expectations • Configure report/alert settings for pvsolar@det.nsw.edu.au and the school's email address to receive the following notifications, if available: o Detection of earth fault o Connection to online monitoring is lost for more than 72 hours o One or more inverters is down for more than 72 hours o Actual yield of the system is less than 75% of the expected yield for three consecutive months • Reconcile local data using Modbus TCP and remote data to ensure consistency in readings. Provide screenshots in the as-built documentation.

Element	Requirement
Balance of System Components Installation	Enclosures • Cable penetration through wall into isolator enclosures must be sealed to AS3000:2007 to prevent the spread of fire. DC isolator • DC Isolator enclosures must be installed according to manufacturer's specifications and in a manner, which maintains IP rating. • DC isolator enclosures constructed of metal must be bonded to earth. • DC Isolators adjacent to the array must be located such that its location is easily identifiable from likely roof access points. Labels must be installed to aid with locating the DC isolator if this is not possible. • When external fixing points are provided on DC isolator enclosures, they must be used to fix DC isolators. Plugs, sockets and connectors • Ensure that the equipment warranty will not be voided in the event that pre-installed connectors need to be replaced. • To avoid the need to replace pre-installed connectors it is recommended to only use PV modules and inverters for which matching connectors can be sourced Cable management • PV array cables must be installed to AS5033, AS3000, and CEC guideline requirements. • DC cables between the inverter and array must be completely enclosed in HD conduit or lidded cable trays. • Conduits must be installed up to and including the cables at the inverter input. • The conduits must be supported in such a way that it is not subjected to mechanical strain. This may be achieved with the use of additional saddles or cable tray. • Cables entering junction boxes must comply with AS/NZS 5033. • Install cable ducting or cable trays for AC cables that are not internally wired

Element	Requirement
Roof Penetration	• Roof penetrations due to PV system installation, include cable entry and array mounting points, must be suitably sealed and waterproofed for the expected life of the system. • Penetration of cables must be through roof flashing(s) or riser(s) which can provide a guaranteed seal for up to 20 years. • All cables at roof penetration must be enclosed in conduit or similar for protection against mechanical damage and environmental effects. • Cable entry into conduit must face downwards and be appropriately sealed e.g. with a multi-cable gland. If spare cable entries exist at the gland, they must be sealed. • Where silicone is required as additional sealant, a maintenance schedule must be included in the system maintenance procedure to inspect and service the sealant over the life of the system.
Central Protection and export limitation device	• System central protection must be installed to AS4777.1 and local DNSP requirements. • System central protection which requires use of IT infrastructure must communicate over the school's IT infrastructure. • System export limitation device, where required by DNSP, must be install to manufacturer's instructions and programmed to DNSP requirements.

Element	Requirement
Signage	• All PV system components must be labelled, as per AS/NZS 5033 and AS4777. • Additional information must be provided in a manner which renders the information indelible for the life of the system. Engraving the additional information will ensure they are indelible and will last the life of the system. • In addition: ○ Provide a copy plan view of PV system at the EDB to which inverters are connected, clearly describing location of all system disconnection points. The plan view must show the location of the array, the inverter(s), and the point(s) of interconnection with the school's electrical and communications network. ○ All PV system components must be clearly identified and consistent throughout the installation and documentation, including shut-down procedure and as-built drawings. ○ Install a label "Do not switch off power supply" on PV output monitoring devices that are connected to socket-outlets. ○ Provide the system's shutdown procedure at the administration office and main switchboard. ○ A list of action/s to be taken if the earth fault alarm is activated must be placed next to earth fault alarm. ○ If micro-inverters are installed, the micro-inverter model and product information must be displayed at the switchboard to which it is connected.
Lightning Protection	When surge protection is required, SPDs must be installed for each inverter.
Workmanship Warranty	The System Provider must provide an installation workmanship warranty for a minimum of 5 years. This includes a full onsite replacement of a faulty inverter if required. The system provider must also provide a 12 months operations and maintenance service. This may entail remote monitoring, module cleaning and general inspections.

Table 08: System Commissioning and Maintenance Specifications

Element	Requirement
Commissioning	• PV system must be commissioned according to AS/NZS 5033:2014 Appendix D and Appendix E • At the completion of system commissioning, the system provider must provide system specifications and warranty information in schedules under Solar Asset Data Capture Sheet
Maintenance procedure	• Maintenance procedure and timetable must follow the recommendations of AS/NZS 5033:2014 Appendix C Maintenance Requirements and NSW Department of Education PV system Operation and Maintenance Procedures. • System over 30kW must follow Operation and Maintenance manual requirements specified by Clean Energy Council Guideline - 30 - 100 kW Grid-Connected Solar PV Systems: No Battery Storage, Design Guidelines for Accredited Installers. • Maintenance actions must adhere to procedures provided by system documentation. • All maintenance actions performed on the PV system must be clearly documented in the maintenance timetable. • Items pertaining to maintenance of electrical parts must be performed by a CEC accredited solar electrician. • All maintenance actions performed on the PV system must be clearly documented in the maintenance timetable.

04 Selections

As per current NATSPEC.