Solar PV Specification:

Design, install and maintain Solar PV systems at La Trobe University

La Trobe University

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1 General Specifications

1.1 Description of Works

The work covered by this specification consists of supplying all labour, expertise, supervision, materials and equipment necessary in designing, installation, commissioning and maintenance of a solar PV system ("the system"). This work is being provided for La Trobe University ("the client").

The solar PV contractor ("the contractor") shall design, supply, deliver, install, test, commission and maintain the system, which shall be complete with all necessary ancillary and minor items to facilitate the correct completion of the work. This shall also apply to all requirements of relevant standards and/or authorities having jurisdiction over these works.

In general, these works shall include but not be limited to:

- Design of the solar PV system in accordance with CEC guidelines and appropriate Australian standards including solar PV modules, grid connect solar inverters, solar mounting systems, new AC and DC switchgear, solar framing, cabling, cabling protection and monitoring system
- Provide 'Shop Drawing' and OHS manuals for client approval prior to site works
- Provide structural certification of the suitability of the building for the proposed works
- Provide continuous onsite management and supervision by an experienced full-time employee (FTE) of the head contractor during all site works and inspections
- Supply and install additional temporary roof safety hardware as required for lifting materials and working at heights for construction
- Design, supply and install permanent safe roof access hardware and fall protection in accordance with AS1657 & AS1891, to allow safe on-going operation and maintenance of the installed solar PV system
- Supply and install of solar PV modules, grid connect solar inverters, solar mounting systems, new AC and DC switchgear, cabling, cabling protection, monitoring system and associated equipment
- Electrical connection of Solar PV array to low voltage system via existing switchboards including electrical safety certificates
- Remove and dispose of all associated wrapping, rubbish or debris related to the installation of the solar system
- Grid connection application and approval including inspections and any witness testing of the Solar system as required by the DNSP
- Protection system and relays to the requirements of the DNSP
- Meter reconfiguration or changeover required for solar installation
- Supply and install the approved La Trobe University utility meter to meter all solar generation
- "As-built" drawings and Operation & Maintenance manuals on completion of project
- Safety shutdown procedure documentation and training in the basic operation, maintenance, and trouble-shooting of the system to onsite staff and maintenance staff
- Commissioning and testing of the complete electrical installation
- Provision of 5-year-warranty and 5-year defects liability period from the date of practical completion
- Equipment warranties as stated in this document
- Full maintenance and cleaning of the system, in accordance with the CEC guidelines for period of five (5) years.
- Training of client maintenance staff for ongoing maintenance post the contracted maintenance period.
- Sundry minor works as specified herein

1.2 Ancillary works required

In addition to any other attendances and facilities noted, the following building-related works shall be provided:

- Forming openings in roof slabs, walls, firewalls, etc for the penetration of cable trays/ladders, conduits and wiring, including the supply of any seals fixings, sleeves, etc;
- Patching, painting and making good all building works after installation of Solar PV system;
- Installation of any additional safe access infrastructure to ensure safe installation and ongoing maintenance of the system and roof access
- Switchboard upgrades or reconfiguration as required for the installation of the proposed PV system
- Metering re-configuration or changeover as required, to ensure metering is suitable for the solar installation
- Works in partnership with customer for processing of power station application for LGCs purpose and create LGCs from system's electricity generation (if above 100kW).

1.3 Project Management

The client, at their discretion, may nominate a third party to manage the project ("the project manager"). The contractor shall accept the project manager to act on behalf of, and with the authority of the client.

The head contractor must have an experienced senior in-house employee, preferably CEC accredited that maintains continuous onsite management of the installation and all sub-contractors, and is fully responsible for liaison with key La Trobe University staff and project managers at all times.

In addition to the day to day coordination during the project duration, the contractor is to allow for fortnightly project progress meetings. These meetings will discuss progress, OH&S, public liaison matters, etc. The contractor shall minute fortnightly meetings and minutes of the meetings should be provided within 2 days of the meeting date. These meetings would be attended by the University's project representative and the contractor, required consultants and subcontractors. A phone meeting is adequate.

The contractor shall report on a fortnight basis the followings:

- All OH&S and Environmental incidents
- All quality non-conformances
- Project program compared to contract program
- Register of extension of time claims
- Register of variations showing items to be approved and date approval is required
- Register of design changes
- Register of request for information showing items to be responded to and date response required
- Forthcoming hold points and witness points
- Works progress photographs
- Schedule of deliveries required for University supplied items

1.4 Contractor requirements and selection

1.4.1 Contractor Experience and team

Table 1-1: Contractor experience and preferences

Experience	The head contractor must have a minimum of 5 years' experience in the solar PV industry, including documented evidence of similar sized commercial solar PV systems (with references).
Experience: commercial solar	The head contractor must have direct experience in the supply, design and installation of commercial solar systems of a similar size, with preference for local and Victorian based projects.
Experience: Universities	Experience with Universities or similar organisations in the Government, Education or Health sectors is desirable.
Experience: grid connection	The head contractor must have direct experience with solar PV grid connection approvals in the DNSP distribution network, for systems of a similar capacity.
Local presence	Contractor to have in-house staff based in local area for the project duration, are preferred.
Referees	The contractor must provide at least three reference project outlines, including description, design input requirements, technical performance, construction program, budget and client contact.

1.4.2 Accreditations and Industry awards

Table 1-2: Contractor accreditations and awards

CEC solar PV retailer code of conduct	Strong preference provided to solar providers that are listed on the CEC solar PV retailer code of conduct approved list.
Environmental Management	Preference given to solar providers that have third party certified environmental management system certificated to ISO14001.
Quality Management	Preference given to solar providers that have third party certified environmental management system certificated to ISO9001.
Project Management	Preference given to contractors with project management procedures certified to ISO21500:2012.
OHSE and safety	The contractor shall have no Worksafe infringements in the last five years. The contractor must have written solar installation specific documented OHSE procedures. Preference given to contractors that have a third party certified safety management system certified to AS4801.
Industry awards	Preference given to contractors with solar industry awards such as CEC, University awards or similar.

1.4.3 Project team and capabilities

Table 1-3: Project team and capabilities

Project manager	The contractor shall have an in-house locally based project manager responsible for continuous attendance on site during installation periods, contractor management and liaison with staff and the public.
CEC accredited in-house staff	Contractors must have in-house FTE CEC accredited electricians and/or designers.
CEC accredited electricians	Strong preference provided to contractors that have CEC accredited electricians on staff who will be fully responsible for commissioning, certification and sign-off of the solar installations.
Project Management	Preference given to contractors with accredited project management procedures and a dedicated project manager.
Submission	Preference given to contractors that provide a professional submission which outlines details of their understanding of a solar PV project from inception to commissioning and ongoing maintenance, including site specific installation and safety issues at a publically accessible buildings and areas.

1.4.4 Sub-Contractors

Sub-contractors can be used to assist within the installation and/or design of the solar PV systems; however, the head contractor must have an experienced senior in-house employee, preferably CEC accredited, that maintains continuous onsite management of the installation and all sub-contractors, and is fully responsible for liaison with key staff and project managers.

All anticipated sub-contractors to be utilised for project delivery must be clearly stated in the submission, key personnel for project delivery must not be subcontracted. Should the selected sub-contractors be altered during the contract term, La Trobe University is required to approve the incoming sub-contractors.

1.5 Renewable Energy Certificates

1.5.1 Systems eligible for LGC's

Where the system is eligible for Large-Scale Generation Certificates (LGCs) under the Australian Government's Large-scale Renewable Energy Target (LRET), the contractor shall:

- Install and commission a Clean Energy Regulator approved LGC meter (Azzo Metering is a requirement of the project)
- Complete and lodge power station applications with the Clean Energy Regulator
- Create large-scale generation certificates (LGCs) from power stations' electricity generation
- Provide annual performance report on the Solar PV system evaluated against local meteorological data
- Act as the primary point of contact for all regulator communication and compliance related issues

The Clean Energy Regulator (CER) have ruled that a University Campus is considered a single 'site', and where the aggregate of solar PV system exceeds 100kW, no system on campus will be eligible for STC's.

2 General Requirements

2.1 Standard of Materials and Workmanship

All electrical equipment shall be of first-grade quality in regards design, manufacture and installation and shall be completed for satisfactory operation, control, maintenance and safety under all conditions of service.

2.2 Internal works

The site is a University facility and the safety of the students, parents and teachers as well as the normal operation of the facility is critical. The solar contractor must provide a minimum **96 hours' notice** to the University prior to internal works within occupied spaces. The timing of these works will be required outside normal operating hours of the facility.

All internal works must be conducted at a convenient time to the site operators and may be required to be conducted outside normal operation hours of the facility.

2.3 Noise

At all times, and at the request of the site operator, construction noise must be kept to a minimum at critical times. This may require staging or ceasing roof installation works to reduce noise during critical times to the site operator.

Where practical noisy installation works should be conducted before 9:00am and after 3:30pm, or when the building is not in operation. The contractor should allow for reasonable after-hours installation works if installation is proposed during the University term. Required installation dates are proposed in the solar PV installation and design briefs, these times are when the site is not in full operation.

2.4 Hours of Work

Unless otherwise approved, it is anticipated that the hours of work will be as follows:

- Non-residential facilities: Monday – Friday 8am – 5pm.
- Residential facilities: Monday – Friday 9am – 5pm

No work within the University will be permitted during weekends, public and University holidays without prior approval. The solar contractor must provide a minimum 3 days' notice to University prior to commencement of any work onsite outside permitted working hours.

2.5 Compliance with Codes

2.5.1 Structural Safety

The support structure of the Solar PV shall be compliant with worst-case wind loadings for the region specified in AS1170.2 including allowance for the building height.

All PV framing must conform to AS1170.2 and documentation must be sighted by the client or nominated agent prior to commencement and adhered to throughout the installation. The tenderer is responsible for adequate connection of PV framing to the roof structure with reference to AS1170.2 and the building height.

2.5.2 Electrical Safety

All inverters of the solar PV system shall be compliant with AS4777 and AS3100 and approved by a state regulator for safe use in Australia. All inverters must be on the approved list of inverters supplied by the Clean Energy Council.

Documented proof of the listing of the selected inverters on the Clean Energy Council list of approved inverters must be provided.

The installation shall also be compliant with:

- The Electrical Network Service Provider ("the distributor") requirements.
- Australian Standard AS/NZS 3000 (S.A.A. Wiring Rules).

The successful tenderer shall be responsible for:

- Ensuring that all components and equipment used are approved for use in Australia, meet relevant Australian Standards, are C-tick approved and are accredited for use in solar PV installations by the Clean Energy Council;
- Ensuring all components, equipment and wiring including cabling, electrical protection, controls, inverters, circuit, breakers, fuses, fire protection fuses and lightning protection are installed in accordance with the provisions of AS/NZS 3000, AS/NZS 5033 and all other applicable Australian Standards;
- The roof mounting positions, cabling reticulation, switch box locations, and any other coordination necessary for the correct, safe and proper installation and commissioning of the PV system;
- All DC and AC wiring to complete the installation including wiring and cabling between the PV panels, inverters, meters and distribution boards, as required.

The successful tenderer shall:

- Design, engineer, construct and commission the PV system in accordance with Australian Standards and best industry practices;
- Adhere to all earthing requirements as outlined in Australian Standards, with particular attention to the new requirements under AS 5033;
- Install all PV wiring and components to minimize exposure to detrimental environmental effects where they are protected from ultraviolet radiation, corrosion, abrasion, tension, compression & cutting forces. Plastic cable ties are not to be used as a primary means of support for cables and wiring;
- Install connectors that are mated with connectors of the same type from the same manufacturer;
- Install DC switch disconnection devices that are not polarity sensitive and comply with the requirements of AS5033;
- Install DC Circuit breakers that are not polarity sensitive. They must also be rated to interrupt the full load when operated and have a voltage rating greater than the open circuit voltage V_{OC};
- Ensure that all equipment and appliances provided under this contract are not capable of causing any interference with any electronic or radio equipment, local or otherwise. Should any item of equipment cause interference to electronic or radio equipment, provide efficient devices to eliminate such interference and install without additional cost to this contract.

Additional payments will not be made for any costs involved in testing or obtaining certificates or proofs of compliance. Such costs, where applicable, shall be included in the tender price.

2.6 Notices and Fees

The contractor shall forward all relevant notices, arrange for inspections and pay all fees to the distributor and other authorities as required in electrical connection with this system.

2.7 Site Access and Component Storage

The Contractor will ensure prior to accessing the Site, that it has discussed and agreed with the Client or their representative a designated location(s) for storage of materials, components, equipment and all other related items associated with the installation or other processed associated with delivery of the Works.

The Contractor will provide the Client or their on-site representative with a site access plan which details the method the Contractor is seeking to employ in accessing the site both for personnel of the Contractor and equipment/supplies; particularly where it may be impeded the operations of the facility or access to the Site by the Principal's employees or patients. Site access will be subject to:

- The provision of a Site access plan;
- Approval by the Client or their site representative in writing.

The Contractor will be entirely responsible for the security and storage of its plant, equipment and any related materials; as well as protection from damage or theft.

The Contractor will ensure that all items, components or equipment that form the photovoltaic system shall be stored in such a way so as to protect the items from damage or excessive exposure to the elements prior to installation.

The Contractor will only deliver components of the System on and as needs basis so that excessive quantities of the components are not left on site unnecessarily.

2.8 Licensed Electricians

All electrical site work including the installation of meters, solar PV panels and inverters shall be done by electricians licensed to carry out such work at the particular locality.

All installation work must be performed by accredited CEC installers and documentation proving such accreditation must be submitted to the University.

2.9 Design

Electrical design of the system must be completed and signed off by an accredited solar PV designer accredited with the CEC. All appropriate design documentation shall be submitted to the client for approval prior to any works being undertaken.

2.10 Materials

Supply materials, fittings, accessories and apparatus of first grade design and manufacture throughout shall comply with the latest relevant S.A.A. specifications. Uniformity of accessories and fittings throughout the installation shall be preserved.

2.11 Supply and Metering

The complete electrical installation shall be suitable for connection to the standard voltages and frequencies of the distributor.

The contractor shall liaise with the distributor and provide all notices in connection with the supply of electricity to the installation. It shall be the contractor's responsibility to ensure that the requirements for the installation of meters and other equipment shall be provided for in the installation.

2.12 Setting Out

The position of equipment as shown on the drawings shall be considered as approximate only, and the contractor shall determine the exact locations while meeting the stated constraints.

All equipment shall be mounted square to building lines walls; shall be levelled, plumbed and in alignment with similar equipment. The installation shall present a neat and orderly appearance on completion, to the satisfaction of the University.

2.13 Cutting, Fixing, Drilling and Making Good

The Solar PV Contractor shall carry out all cutting, boring and fixing necessary to install equipment, conduits, etc. relating to the electrical installation and its associated works.

Under no circumstances shall explosive powered fastenings be used by this trade to secure the works in position. Only approved bolts, screws, metal thread fasteners or Loxins shall be used to secure items of equipment in position.

Any damage to the building or its attachments caused by the contractor shall be made good at the expense of the contractor. If it is found necessary to alter the finished work through fault of the contractor; then such work will be performed at the expense of the contractor.

No cutting, chasing, drilling or excavation shall be performed by the contractor without prior notice or approval by the Project Manager in regard to the type, location, method or timing of such works.

2.14 Roof penetrations

The contractor must provide a certified plumbing certificate for all roof penetrations.

The contractor will be required to ensure that all penetrations through any building elements, such as fire rated walls and ceiling or any other component of the building structure, will be undertaken in such a way as to comply with:

- AS 1530 – *Methods for fire tests on building materials, components and structures*
- AS 4072 – *Components for the protection of openings in fire-resistant separating elements – Service penetrations and control joints*

The contractor will ensure that any penetrations in any form of roofing system, structure or material, will be fully sealed and made waterproof so that will continue to offer this protection for the expected life of the system; being not less than 25 years.

2.15 Wiring Methods

All electrical wiring shall be installed in accordance with the requirements of the Distribution Company and the current version of the AS3000 and AS5033.

Unless otherwise specified, wiring shall be carried out in thermoplastic insulated and sheathed cables. Cables should be concealed wherever practical in false ceilings, under floors, in wall or block work cavities, *etc.* Wiring shall not be directly embedded in concrete, plaster, sandwich panels, etc; but shall be enclosed by PVC or steel conduit.

Main generator cables shall be sheathed cable enclosed in heavy duty insulating conduit, in accordance to AS/2053, or on cable tray with adequate mechanical protection. Refer to Energy Safe Victoria document dated July 2011 for specific recommendations.

2.16 Fastening and Fastening Materials

Conduits, pipes, cable, switches, receptacles, wall boxes, panels, distribution boards, outlets and similar equipment must be firmly secured in place. Use expansion shields or concrete inserts with concrete or brick; toggle bolts on hollow tile or wire lathe; wood screws of adequate gauge on wood. Wood, lead or composite plugs will not be permitted.

Secure all fastenings directly to the building structure. Do not secure to work of other trades such as ceiling lath, pipes or pipe racks, unless specified or noted otherwise.

Nuts, bolts, screws, washers, etc. used as terminals shall be brass. Bolt heads shall be chrome plated and polished

2.17 Reticulation

All wiring routes must be concealed where practical and not affect adversely the aesthetics of the building internally or externally.

All cables shall not be positioned in locations of water drainage or in locations that are likely to prevent the egress of rainwater

Provide weatherproof isolators adjacent to direct connected appliances. Make connection between the isolator and the equipment termination via a suitable length of PVC flexible type conduit with couplings at each end.

The contractor must allow for the shortest possible DC/AC cable run with facilitated cable installation and cable access without obstructing any walkways, passages or windows.

Cabling installed in ceiling spaces shall be supported above and clear of ceiling fabric and suspension systems by means of cable ladder, catenary support or approved alternatives. Cabling supports must not interfere with access

The Solar PV Contractor shall ensure that all penetrations through fire walls are filled with fire stop compound on completion of installation to ensure compliance with building regulations.

All submains cables shall be run on cable tray or cable ladder or similar.

All cables and cable management equipment are not to obstruct the roof gutters.

All cables to be double insulated.

In long runs with large expected temperature variance, expansion joints need to be installed in HD conduit.

2.18 Electrical Isolation

The solar contractor must provide a minimum of **2 Weeks'** notice to the consultant project manager and the University project representative prior to electrical isolation shutdown, and conducted at a convenient time to the site operators. The timing of any shutdowns will be required outside normal operating hours of the facility.

Any disconnection event will require the presence of the Client or their designated Site representative.

The Contractor will have been deemed to have included all costs associated with any shutdowns in the agreed Contract Sum, including the requirements for after hours shutdown.

The contractor is responsible for ensuring that all electrical plant and comms are in operation following electrical shutdown, and that normal operation of the facility is ensured following shutdown.

2.19 Testing and Commissioning

The installation shall be deemed to be completed when it has passed all necessary tests and has been approved to the satisfaction of the distribution company.

All necessary facilities including all necessary instruments and test equipment and labour for carrying out tests shall be provided by the Solar PV Contractor at no extra cost to the Client.

The contractor shall provide training to the client's operating personnel on the operation and use of all equipment and systems installed under the contract.

The contractor shall carry out commissioning and final acceptance tests as required by the project manager and as specified. Commissioning test must be performed in accordance with AS/NZS 5033:2014 Appendix I. to ensure all the solar equipment are operating correctly including solar panels, panel strings, inverters, meter, data logger and electrical protection devices. Final acceptance tests shall be done **in the presence of the project manager** and shall conform to AS/NZS 3000 and AS/NZS 3017 standards.

The contractor shall provide a Certificate of Electrical Safety for the installation and include a copy in the manuals. The contractor must also provide a report that includes voltage and temperature measurements, the current and irradiance measurements, the earth fault protection test and also states the conditions of the PV array wiring after the test, including any repairs and corrections carried out as a result of the inspections.

2.20 Defects Liability Period

All workmanship and installation shall be guaranteed for a minimum period of five years from the date of Practical Completion.

The cost of all labour and materials expended in complying with the above shall be borne by the contractor.

All required material warrantees are provided in section 3.16. Copies of any warranty documents must be forwarded to the client.

2.21 Safety

The contractor shall ensure safe installation and ongoing maintenance/cleaning of the solar system by providing additional roof safety hardware as required. The contractor, as part of the tender submission, shall detail and outline site specific safety issues and additional safety hardware to be installed to ensure safe installation and ongoing maintenance.

The contractor is responsible for:

- Replacing any anchors which are covered or not accessible due to the solar array,
- Installing new anchor points where required to ensure safe roof access to all areas of the solar array.

Anchors shall be installed in accordance with AS5532:2013, and checked and certified on annual basis for the maintenance period.

In compliance with AS/NZS 4801 Occupational health and safety management systems, the contractor is required to have in place a documented project Work Health and Safety Management System (WHSMS) that complies with the standard.

Major elements of the system should include processes and procedures for:

- Roles and responsibilities for WHS management
- Staff training and induction processes
- Responding to and managing complaints, non-compliances and incidents
- Health and safety reporting and correspondence for the project
- Internal auditing and monitoring of environmental performance
- Project risk identification, assessment and management
- Setting WHS objectives and measurable performance targets
- Identifying and complying with legal and other requirements
- Review and update of project environmental documentation

La Trobe University recognizes its obligations under the Occupational Health and Safety Act and is committed to promoting a healthy and safe working environment. All contractors must be accredited in accordance with La Trobe University's RapidInduct system before commencing work on site. All contractors requested to perform works will be invited by Infrastructure and Operations to register with RapidInduct.

(http://www.latrobe.edu.au/io/working-with-us/contractors/ohse-and-induction-system).

2.22 As-Installed Drawings and Maintenance Manuals

On completion of the works, the Solar PV Contractor shall provide as-installed drawings of the installation. The Solar PV Contractor shall also provide three (3) sets of prints of these drawings bound into the operating and maintenance instructions, as further specified herein under section 3.10.1. Soft copies in pdf format are also required.

The contractor shall provide to the Project Manager three (3) copies of detailed operating and maintenance instructions and manuals. Instructions shall be supplied with the "as installed" drawings in approved bindings and shall be supplemented by diagrams and spare parts schedules.

The supply of all necessary information for the satisfactory operation and maintenance of the services shall form part of this contract. Tenderers should note that the supply of instructions and "as installed" drawings is a condition of Practical Completion.

2.23 Inspection of Documents and Site

Tenderers shall, by submitting a tender, acknowledge that they have adequate knowledge of the site constraints and proposed installation details, consulted with all relevant authorities having jurisdiction over the project, and have assessed their full liabilities for all such works and costs required in carrying out the works specified and shown. No recognition will be granted of any claims for additional costs resulting from the Tenderer's failure to comply with the above.

3 Technical Requirements

3.1 General

Design, supply and install a grid interactive photovoltaic generating system(s) as documented, incorporating the following:

- Photovoltaic arrays and necessary support structure
- Grid connected inverter/(s)
- Balance of System components including DC and AC cabling and switchgear, data cabling, junction boxes, switchboard, conduits, cable tray, mounting brackets, etc
- Connection to low voltage power system to The DNSP's requirements
- Grid connection application and approval, including all secondary protection requirements require by the DNSP
- Bi-directional metering to the requirements of the DNSP and retailer
- Data-logger and Web-service for displaying and monitoring PV system performance
- LGC metering for LGCs purpose
- Testing and commissioning
- Training of University staff in the basic operation, maintenance, and trouble-shooting of the PV system
- Operation and Maintenance manual
- All permanent and temporary safety and access equipment necessary for lifting materials and working at heights
- All supports, brackets, drilling, penetrations, fire stops, water proofing and other building works associated with the above

Where site specific design and install documents are supplied, the location and orientation of the PV arrays on the roof is given as a guide. The tenderer can suggest alternative options on the roof layout, however; must ensure a minimum total PV capacity is maintained and all shading and roof obstacles adequately considered, in addition to heritage, planning, structural and architectural issues.

3.2 Standards and Guidelines

For the purpose of this work, compliance with the all relevant sections of the following standards shall be adhered to.

Table 3-1: Standards

CEC	Clean Energy Council- Grid Connected Solar PV systems – install and supervise guidelines for accredited installations
CEC	Clean Energy Council- No Battery Storage Grid Connected Solar PV systems – Design guidelines for accredited installers
AS/NZS 5033	Installation of photovoltaic arrays
AS 4777.1	Grid connection of energy system via inverters Part 1: Installation requirements
AS 4777.2	Grid connection of energy system via inverters Part 2: Inverter requirements
AS 4777.3	Grid connection of energy system via inverters Part 3: Grid protection requirements
AS/NZS 3000	Wiring Rules
AS/NZS 1768	Lightning Protection

AS/NZS 2053	Conduits and Fittings for Electrical Installation
AS/NZS 3008	Selection of cabling
AS/NZS 1170.2	Structural design actions – Wind actions
AS/NZS 3439.1	Low voltage switch gear and control gear
AS/NZS 3017	Electrical installations – Testing guidelines
ESAA	Electricity Supply Association of Australia – Guidelines for grid connection of energy systems via inverters
SIR	Victorian electricity distributors services & installation rules
Energy Safe Victoria	Installation of grid connected PV systems, July 2011
BCA	Building Code of Australia
	Local supply authority renewable energy systems technical guidelines

3.3 Grid connection

The contractor is responsible for grid connection approval, required grid connection studies and any secondary network grid protection relays as required by the distributor and Australian Standards.

The contractor is responsible for all relevant notices, arranging for inspections and testing, paying all fees to the distributor and other authorities as required in connection with the solar PV installation.

The contractor is responsible for managing and organising any meter upgrades or replacements at the site required for the solar installation.

In the case of systems connected to the La Trobe Bundoora HV Main network in the campus; the contractor is responsible for any processing, approval and compliance with statements and procedures required by the distributor regarding the existing embedded generator (Co-generation plant).

The contractor is responsible for ensuring that the required feed in tariff for exported solar is accepted by the retailer prior to practical completion. Paperwork required includes:

- Solar (renewable or low emissions technology) Connection Form
- Electrical Works Request (EWR)
- Certificate of Electrical Safety (CES)

3.4 Solar PV panel technical requirements

Table 3-2: Solar PV Panel requirements

Standards	Approved list of CEC panels IEC61215 and IEC 61730 certified (including the MST-23 Class C fire test)
Bloombergs New Energy Finance Tier Rating listing (March 2014)	Tier 1

Design Wp DC	290Wp, dimensions of 1.0mx1.65m (indicative)
Cell:	Mono-crystalline or Poly or multi-crystalline
Power tolerance:	0 to +5W
Maximum Temperature co-efficient (P max)	-0.45%/^{0}C or less (i.e. between zero and -0.45)
Normal Operating Cell temperature	45^{0}C +/-2^{0}C
Glass	Tempered or toughened glass minimum 3mm thickness
Frame Material	Panels installed >5^0 above horizontal: Panel framing shall be anodized aluminium alloy or equivalent; or frameless glass on glass panels Panels installed <5^0 above horizontal: frameless glass on glass panels shall be provided.
Cable size	4mm
Connectors	Staubli Group Multi Contact MC4 or approved equivalent (IP65 min), must be in accordance with EN50521 and be corrosion resistant. Connectors elsewhere in the solar installation shall be of exactly the same type and manufacture as those provided on the solar PV modules.
Integral bypass diode protection:	Solar PV modules shall be furnished with 3 (min) bypass diodes integrated into the module junction box.
Performance Warranty:	At least 90% at 10 years At least 80% at 25 years Any insurance guarantee underwriting the long-term performance warranty should be specified, such as third party insurance arrangements.
Manufacturing warranty	10 years from date of installation Any insurance guarantee underwriting the long-term manufacturing warranty should be specified, such as third party insurance arrangements.

The contractor must provide technical datasheets of the proposed solar PV panels.

3.5 Preferred Solar PV panels

Table 3-3: Preferred Solar PV Panel manufacture requirements

Manufacturer Australian Presence	Preference will be given to panel manufacturers that have an Australian office and employees. Preference given to manufacturers that have Australian based technical support, servicing and warranty claim service.
Warranty and Degradation	Preference given to panels that have annual lineal performance output warranty. In addition, independently tested degradation (PID) performance characteristics shall be preferred.
Manufacturer's Company History and experience	Longer than 5 years in PV manufacturing

Manufacturer's MW capacity installed	Preference given to panel manufactures with a higher manufacturing volume
Manufacturers quality assurance procedures	Documented quality assurance required. ISO accreditation highly regarded
Vertical integration	Preference given to manufactures that control and manage the supply line from manufacture of silicon cells through to final product manufacture
Research and development	Preference given to manufacturers that invests significantly in research and development.
Projected company growth and financial stability	Preference given to panel manufactures with strong projected growth and financial stability

Table 3-4: Preferred Solar PV panel certifications, standards and schemes.

Standard/Certification scheme	Description/parameter
VDE Quality Tested	Preference given to panels that are VDE quality tested and certified, or certified with a similar independent third party testing organisation that provides continuous quarterly testing for reliability and degradation.
Photon Laboratory International test results	Preference given to panel manufacturers that have PV panels highest on the most current Photon Test result.
'Solar Scorecard' by The Silicon Valley Toxins Coalition	Preference given to panel manufacturers that rank higher on the ranking on the 2015 solar scorecard. http://www.solarscorecard.com/2015/ Panel manufacturers which demonstrate their recycling commitment and toxic material reduction through alternative documentation which does not involve the Solar Scorecard will be given consideration also.
IEC61853 – 1	Preference given to panels that have documented evidence of IEC61853 compliance/certification and details of module performance at 23 different temperature and irradiance conditions
Atlas 25+	Preference given to panels with Atlas 25+ certification with a basic tier classification or above
PV+ test (TÜV Rheinland and Solarpraxis AG)	Preference given to panels that are on the PV+Test listing
Thresher mark certification with TUV SUD?	Preference given to panels have Thresher mark certification
Fraunhofer I PDVI testing	Preference given to panels with Fraunhofer I PDVI testing with a ranking of greater than 3.
PVUSA	Preference given to panels which are published on the California 'Incentive Eligible Photovoltaic Modules' list: http://www.gosolarcalifornia.ca.gov/equipment/pv_modules.

	php and have a ratio of PTC (PVUSA Test Conditions) / STC (Standard Test Conditions) of 89% or greater.

3.6 Inverters

Table 3-5: Inverters technical requirements

Standards	Approved list of CEC inverters AS4777.2 and A4777.3, IEC612109, IEC61727
Efficiency	>96.5% European weighted inverter efficiency factor or equivalent >96.5% Peak efficiency
Ingress protection rating	IP65 (min), or suitable for the proposed inverter location
Three-phase	Provide a fully balanced three phase AC output
Metering	Be compatible with the University approved meter provider (Azzo)
Warranty	10 years required from date of installation, and include full onsite replacement of a faulty unit Any insurance guarantee underwriting the long-term performance warranty should be specified, such as third party insurance arrangements.

Table 3-6: Inverters manufacturer requirements

Manufacturing history	Inverter manufacturers shall have a minimum of 7 years inverter manufacturing history.
Manufacturer Australian Presence	Inverter manufactures shall have an Australian office and Australian based employees.
Engineering Technical support	Inverters shall have Australian based engineering technical support services, including a dedicated customer support local phone number.
Servicing	Inverters shall have an in-house Australian based servicing team, or team of certified A-grade electrician servicing partners.
Warranty support	Inverter shall have an Australian based warranty support team and systems.

With the tender response, the contractor must provide documented proof that technical information on the proposed inverter is in compliance with above.

3.7 Solar system monitoring and metering

3.7.1 Azzo meter supply and installation

The contractor is responsible for the supply and installation of the University approved metering system, to ensure remote monitoring of the full solar generation for the solar system. The approved metering provider is Azzo Pty. Ltd. (www.azzo.com.au), who have been briefed on the proposed solar systems and metering requirements for each specific system.

The supply and installation of Azzo metering is a required component of all solar installations. The contractor is responsible for supply and installation of the required Azzo metering solution.

The contractor is responsible for liaising with Azzo to ensure inverter compliance with the metering solution.

Inverters (generic) must support:

- Support Modbus RTU or TCP slave
- Connections to SolarWeb / Sunny Power or similar via AZZO 3G modem connection via Ethernet connection
- Support registers for: A/C Active, Reactive, Apparent Power (kW, kVAr, kVA) / Real Energy (kWh)
- Support Active & Reactive Power Setpoint Control (for curtailment, export control, and Power Factor control)

Recommended supported solutions:

- SMA: Inverters connected to SMA Cluster Controller or Inverter Manager including Modbus TCP
- Schneider: Inverters connected to XW Controller or direct to Conext TL/CL including Modbus TCP
- Fronius: Inverters connected to Data Manager including Modbus TCP
- Enphase microinverters are not recommended as they don't support the kind of monitoring and control that is standard today. If required due to arrangements; the Enlighted API may be used via the Envoy system, but the costs for this integration are covered by the solar provider.

Installation of Comms:

- IP addressing provided by AZZO to be programmed into Inverter/Data Manager
- Latest firmware to be upgraded by solar installation for all inverters and inverter/data managers
- AZZO to remotely commission inverter Modbus communications for LTU integration

The following Azzo Metering kits are available, refer to site installation briefs for the required metering Kits for each system. Further information is provided via the following link: (https://www.dropbox.com/sh/499iuh4ip0ljy8a/AACxl7ltmgJ5kDh3OdxZC7v9a?dl=0)

- Kit A
    - Enphase (per consolidation point) or Small Sized Systems 10-20 kW - with SMA/Fronius/SolarEdge/Schneider Inverters Directly Connected via Modbus TCP
    - AZZO-LTR-611-485-3G + SIM / Antenna
    - Azzo provide engineering, commissioning, and management/integration into LTU software
- Kit B
    - Medium Sized Systems (typically only 1 connection) – LGC Metering

- AZZO-LTR-611-485-3G + SIM / Antenna
- AZZO-LTR-5560-PQM with optional remote display
- Azzo provide engineering, commissioning, and management/integration into LTU software

- Kit C
  - Large Sized Systems (typically only 1 connection) – LGC & Power Quality Metering including Inverter Control and Alarm Monitoring
  - - AZZO-LTR-611-485-3G + SIM / Antenna
  - - AZZO-LTR-8000-PQM with optional remote display
  - Azzo provide engineering, commissioning, and management/integration into LTU software

In all cases of meters, CTs provided by switchboard builder or DB manufacturer.

The Azzo metering solution is approved by the Clean Energy Regulator for the purpose of creating LGC's (if required). Azzo metering is to be used across all La Trobe University Campuses for the metering of solar generation and electrical consumption.

3.7.2 System performance reports and alarms

The Azzo Metering platform will provide quarterly reports on system performance to a designated email account provided by the contractor. The Azzo metering will send alarms to designated email accounts on underperformance and faults. The contractor is to provide the parameters to Azzo on underperformance or faults.

3.8 Azzo Metering internet connection

The required Azzo metering kit to be supplied and installed by the contractor comes with an integrated 3G/4G modem and Sim card for all required metering and monitoring required by the University, and communications to La Trobe University's online monitoring platform.

Should the contractor require additional online monitoring, fault alarms or the normal operation of the inverter system requires an internet connection, it is recommended that the inverter system is connected to the chosen solar monitoring portal via an Ethernet cable to the Azzo modem.

The contractor is responsible for providing sufficient information of the inverter/monitoring system and requirements to Azzo to allow connection, and provide information on the required monthly download requirements of the system in MB per month.

3.9 LTU Internet connectivity and requirements

3.9.1 Connection

1. If an Ethernet connection is used, Latrobe University (LTU) ICT prefers wired (UTP) connections over the use of 802.11 wireless (Wi-Fi) for security and reliability reasons.

2. Wired connections:
   a. Will get a Private DHCP leased address. The address will be in the 10.141.x.y range. Where 'x' will campus specific, 'y' will be the device
   b. The device will have access to the outside world via a NAT IP address 131.172.X.X or 149.144.X.X. This address is from a pool and will change.
   c. Access to the device from off campus will only be via the Latrobe VPN. On campus access will be to the 10.141.x.y address.
   d. Devices WILL be able to talk to other wired devices at LTU sites.
   e. POE power should be available on request.

f. Cabling is to be done as per the ICT Cabling standard by pre-approved PCI contractors. Surge and lightening protection will be addressed by the design.

The contractor must contact ICT before planning ANY UTP cable runs, and advise OCT of the approved PCI contractor responsible for installation.

3. Wi-Fi connections:
   a. Reliability and service guarantees are not available.
   b. Connections are made to LTU Wireless Access Points (WAPs) that are preconfigured to advertise the Internet of Things (IOT) SSID.
   c. Until the device's wireless MAC address get registered by ICT, it will not be able to connect to LTU Wi-Fi network (ltu-iot SSID)
   d. It can take up to 4 days to complete the registration and propagate the SSID to the WAP.
   e. Devices that only use 802.11b are not supported on the LTU Wi-Fi network.
   f. Dual band devices should be used (5GHz & 2.4GHz) and connect to LTU Wi-Fi network on the 5GHz band. The 2.4 GHz band will be scaled back in the next 3 to 5 years.
   g. Devices should support WPA2 security method (WPA2-enterprise or WPA2-personal).
   h. DHCP leases will be for 7 to 8 days. The IP addresses will change.
   i. Broadcast forwarding is not supported on LTU Wi-Fi network. Hence devices that require local subnet broadcast feature will not work on LTU Wi-Fi network.
   j. ANY use of ZigBee or 802.11 devices or frequencies needs to be approved by ICT BEFORE they are to be powered up on site. Channel allocations will be made by ICT.

3.10 PV mounting systems

3.10.1 Framing and roof attachment

The contractor is to provide mounting details of the selected PV array. The documentation is used as a guideline. Specific details of the mounting structure are to be provided in the tender submission.

Non-penetrative are to be used for the Kliploc or similar roofing materials. Non-penetrative frame fixing must comply with appropriate pull-out tests as specified by the CEC.

Where penetrative methods are used, weatherproofing of the fixing method must be maintained and ensured for the design life of the installation.

The contractor shall:

- Provide the installation manual identifying methods for safely constructing and securing the equipment on sites,
- Provide verification of the framing to AS1170.2 including obtaining from the frame supplier a copy of the engineering certification stating that the array frame is certified to AS1170.2 for a Universities location;
- Contractor shall provide information on how the frame is to be mounted on the roof to maintain this certification;
- The array frame shall be installed to the manufacturers recommendations to ensure the array frame meets AS1170.2 certification, with consideration of the following:
  - Minimum spacing between fixing for the specific wind regime;
  - Type, length and gauge of screws to be used;
  - Number of screws required per fixing;
  - Size of batten/purlin required for fixing
  - Foot spacing tables for internal and edge/corner intermediate zones at the specific AS1170.2 wind region and roof height.
  - Number of fixing and purling locations for non-penetrative fixtures

- The mounting frame/support for the PV arrays is to be weatherproof and corrosion resistant. The lifetime of the mounting structure must exceed the lifetime of the PV arrays.
- All dissimilar metals must be mechanically separated to prevent galvanic corrosion
- Provide a minimum 10-year warranty on framing

The contractor is responsible to ensure adequate and safe connection of the roof framing to the building/roof structure. The contractor is required to provide structural certification of the installed solar mounting system and the suitability of the building structure for the installed solar PV system.

3.10.2 Structural engineering approval

The contractor is responsible for providing a letter and certification from a professional structural engineer on the structural suitability of the building(s) for the proposed solar PV installation(s).

The site-specific structural engineering letter should include:

- Confirmation of the structural suitability of the existing buildings for the proposed PV system framing and panels including additional dead and wind loads;
- Maximum short-term dead loads possible during construction and recommended locations for dead loads, including total load from any unit of plant or equipment and total load to any single support point;
- Confirmation of the suitability of the recommended fixing systems of the solar PV framing, if not incompliance with the framing manufacturer instructions including maximum roof height and purlin spacing.

The contractor is responsible for any short-term loads during construction and adequate and safe attachment to the roof structure for the life of the system.

3.10.3 Warranty

The solar array mounting system and connection must be provided with a minimum manufacturing warranty of 10 years.

3.11 Design and Installation

3.11.1 General

The system must comply with AS/NZS 5033 and Clean Energy Council Installation guidelines.

3.11.2 Solar PV Array location and design

The contractor is responsible for conducting a shading assessment

A shading analysis has been conducted for the roof areas where required, in addition to identification of roof obstacles restricting the placement of solar PV arrays.

Designs that depart from that indicative PV array layout on the attached drawings are only permitted with the project manager's written approval, provided the required overall solar PV capacity is maintained, and that all shading, roof obstacles, heritage and architectural issues are duly considered and confirmed.

General design rules that must be strictly adhered are:

- The spacing of tilted panels must ensure that subsequent rows of panels are not adversely effected by shade between 10am and 2pm at the winter solstice.
- Panel arrays shall be located to ensure ease of access for maintenance and repair of the solar system

- Panel arrays shall be located to ensure ease of access to all roof areas including all existing roof plant, anchor points and guttering
- Flush mounted (non-tilted) panels must provide maintenance access of 600mm width every four rows of panels as a minimum or maintenance access of 300mm width every two rows of panels
- All panels must be able to be safely and easily accessed, with any one panel able to be accessed by removed only one other panel
- A minimum of 1.2m clearance shall be provided around significant items of plant that require ongoing maintenance, such as chillers or HVAC systems
- A minimum of 0.6m clearance shall be provided around fixed items of minor plant such as fans and vents
- A minimum of 0.65m between the panel and the edge of the roof sheeting
- Be configured square to the roof line in an orderly and visibly appealing fashion
- Be located to minimise the effects of shade from surrounding infrastructure and vegetation

Panel orientation:

- It is preferred that panels are installed at 10^0 or greater above horizontal
- Panels may be installed between 6^0 and 9^0 tilt provided that:
    - The roof area is generally clean and not subject to roof litter, bird droppings, vegetal material, dirt or similar
    - Cleaning intervals are reduced to one every six months during the five year maintenance period
- Panels may be installed at 5^0 or less provided that:
    - The roof area is generally clean and not subject to roof litter, bird droppings, vegetal material
    - Frameless glass on glass panels are installed
    - Cleaning intervals are reduced to one every six months during the five year maintenance period
- Panels shall be installed at azimuths between 270^0 (W) and 90^0 (E)

Where existing safety hardware exists the panel layout and design must consider the safe usage and access of this equipment, to ensure the safe ongoing usage of the equipment and original intended purpose of the equipment. Particular attention must be given to ensuring that either the existing or new anchors can be easily accessed by providing maintenance access channels at appropriate locations near the anchors.

3.11.3 Solar PV Design

The solar PV design must comply with all the recommendations provided in the most current Clean Energy Council 'Grid Connected Solar PV systems – Design Guidelines for accredited installer'.

The design must be conducted by a solar PV designer with full accreditation from the CEC. All appropriate documentation must be provided to the client prior to installation and at practical completion.

3.11.4 PV array installation

The installation must comply with all recommendations provided within the Clean Energy Council installation guidelines section 7.

Wiring
Refer to the Clean Energy Council installation guidelines section 7.7.

Earthing
Refer to the Clean Energy Council installation guidelines section 7.8.

String Protection

Refer to the Clean Energy Council installation guidelines section 7.9. and AS5033 Clause 3.3.4 and Clause 3.3.5.1.

PV isolator at array
Refer to the Clean Energy Council installation guidelines section 7.10.

PV array cable between array and inverter
Refer to the Clean Energy Council installation guidelines section 7.11, and general recommendations above.

Note that the site and client may have specific guidelines which must be adhered to.

3.11.5 Inverter Installation

The inverter installation shall be installed as per section 8 of the Clean Energy Council Installation Guidelines, and the Design Guidelines.

For string inverters

- Inverters must be located where they can receive adequate ventilation to not compromise inverter efficiency;
- Inverters are to be located so that they are not exposed to the weather, and not be in a location which has direct sun light between 9am and 3pm at the equinox, the contractor is responsible for adequate shade and weatherproofing of the inverter location
- Inverters are to be accessible to maintenance staff via a safe access point;
- Inverters must be protected by a vandal resistant steel cage/ventilated box or similar where the inverter is otherwise accessible to the public;
- Inverter shall have appropriate restricted access of the inverters must be provided where the system maximum voltage exceeds 600V,
- Inverters shall be installed as per the manufacturers guidelines

All proposed locations for inverters are subject to approval by the client and site tenant.

3.11.6 Earthing

All Systems installed as part of the delivery of the Works shall include an earthing system which is compliant with all aspects of AS/NZS 3000 and AS/NZS 5033.

As a minimum, all conductive components of the system shall be earthed using a protective earthing conductor with a minimum cross section area of sufficient capacity to provide total earthing capacity to the System; as required by the System's size, capacity and configuration.

The earthing conductor must also connect to all cabinets and inverters, using either the cabinet proprietary attachment or other solution to obtain a permanent earthing fixture.

All hinged doors to cabinets must be fitted with a suitable sized and configured earthing strap between door and cabinet.

All components that have the potential to experience a differential in voltage (e.g. frames/mounting systems) particularly under fault conditions, shall be equipotential bonded using a bonding conductor which complies in terms of material, type, insulation, identification, installation and connection requirements as outlined AS3000. The cross section sizing of the bonding conducted will be of sufficient capacity to accept the voltage levels produced by the System.

Standard:
Equipotential bonding required in compliance with AS/NZS 5033 and AS/NZ5033 and CEC installation guidelines.

3.11.7 Cabling

Standard:
To AS/NZS 3000 & AS/NZS 5033 or equivalent

General:

- DC Voltage drop shall be below 3% between the solar PV array or string and the respective inverter.
- AC Voltage drop shall be below 1% between inverter and the "POC" at the MSB.
- Normal AC cable shall be of type 0.6/1kV X-90 insulated, PVC sheathed to AS/NZS500.1 copper conducted 900C (XLPW) insulated and TPE sheathed to AS3191 and where applicable 500.1
- DC cabling shall be fine stranded tinned copper conductors.
- Main generator cabling shall be sheathed cable enclosed in heavy duty insulating conduit to AS2053. Refer the Energy safe document July 2011 for specifics.
- Phase colouring shall be in accordance with AS/NZS3000 (A: Ref, B: White, C: Blue)
- Installation of cabling shall be grouped together, parallel to each other, parallel to the building structure and penetration in accordance with AS/NZS3006 and to minimise magnetic fields.
- Installation in a logical and reasonable way such that cables are easily accessible and not subject to damage.
- Any cabling subject to rain, UV, or the like shall be designed for that location.
- Where cabling is likely to be subject to mechanical stress or potential damage, appropriate cover strips and shielding shall be used.
- Wiring through cavity walls shall protect against moisture bridging
- Do not run wiring through damp course or flashing,
- Installation of cables within walls shall be run vertically.
- Installation of cables within solid walls shall use conduit.

Labelling
All labelling of the system shall be of trifoliate engraved type, adequately secured and screwed where exposed, and comply with the requirements in the CEC installation guidelines.

3.12 Testing and Commissioning

General: To AS 4509.1 and the Clean Energy Council installation guidelines

Prior to practical completion, the contractor shall submit test reports from manufacturers or suppliers, verifying the performance of safety and control functions of each system.

The commissioning sheets as per the Clean Energy Council Guidelines must be filled in and provided to the client as the Clean Energy Council guidelines.

All appropriate signage must be provided as per section 12 of the Clean Energy Council Guidelines.

3.13 Documentation Requirements

3.13.1 Pre-installation and shop drawings

Prior to commencement of the installation of the solar system, the contractor shall provide detailed documentation and shop drawings for approval by La Trobe University manager. The contractor shall provide shop drawings a **minimum of 2 weeks** prior to the proposed commencement date for approval.

The Pre-installation and shop drawings shall include as a minimum:

- 'For construction' drawings including
    - Proposed roof panel layout drawings which are fully labelled and scaled in A3 format. This shall include proposed panel orientation, spacing between panel rows and proposed mounting/fixing to the roof structure
    - Single line electrical wiring diagrams clearly stating: DC and AC electrical design including string layout, isolator sizing, wiring sizing, solar DB's and proposed AC connection details
    - Location of proposed inverters and mounting, including a photo of the proposed location and schematic diagrams.
    - Description of proposed AC and DC wiring runs including location of wiring runs, fixing and mechanical protection
    - Detailed descriptions and models of all equipment proposed in the installation including panels, inverters, isolators and monitoring equipment as a minimum
- Fully detailed Scope of works document including details of all equipment supplied and description of works
- Project Safety Plan which, includes site specific information on project details, first aid representation of the install team, evacuation procedures and locations, site isolation and signage requirements, proposed work areas and access, project roles and responsibilities and OH&S site specific issues
- Site specific Safe Work Method Statement and/or JSA
- The DNSP grid connection approval form, deed or letter

3.13.2 Documentation general

The installed solar systems manuals shall be supplied with three (3) copies of Operator and User Manual as specified in AS/NZS 5033 and the CEC installation guidelines:

The manuals shall include the following as a minimum:

- The Manuals shall be supplied in a ring binder with the project name clearly displayed on the cover.
- The Manuals shall be split into sections such as Solar PV panels, inverter accessories, monitoring system log-on, as-built drawings, equipment shop drawings, certificates, schedules, warranties, maintenance history etc., with appropriate dividers and an index.
- All equipment information sheets shall be supplied.
- A set of hard-copy as built drawings shall be supplied within the Manuals.
- The as-built drawings shall include locations/mounting of all equipment, ratings of all equipment, catalogue references numbers for all equipment, circuit numbers, routes of cable trays/submains/conduits/cables etc., schematic diagrams.
- The Solar contractor shall insert their own company name and details to each drawing (as-built drawings become the responsibility of the contractor).
- All as-built drawings shall be clear and legible to the satisfaction of the project manager.
- Space within the manual must be provided for the maintenance history of PV installation to be recorded.

3.13.3 Technical information and drawings

The manuals must include the following technical information and drawings:

- List of equipment supplied including technical specification and user manuals for all supplied panels and inverters
- Proof of the selected solar panel type being on the approved CEC listing, plus additional information below;
- Proof of the selected inverter being on the approved CEC listing.
- A list of actions to be taken in the event of an earth fault alarm

- Step-by-step operating procedure
- Emergency shutdown procedure documentation
- Maintenance guidelines for the system
- Commissioning sheet and installation checklist as per the CEC installation guidelines
- Array frame engineering certificates for wind and mechanical loading,
- Site-specific structural engineering certificate signed by a structural engineer
- Installer/designer declaration of compliance
- Warranty information on all supplied equipment
- A copy of Certificate of Electrical Safety
- Drawings including
    - General arrangement of equipment
    - A circuit diagram, including the electrical ratings of the PV systems, and the ratings of all fuses, circuit breakers and cable specifications
    - Support details

3.14 Training and handover

The contractor shall provide training and handover of the solar system after a certificate electrical safety has been issued and meter changer over/re-configuration had been completed.

The training shall be conducted for onsite maintenance staff, project manager and the building occupiers. The training must be organised in advance and conducted at a convenient time for all stakeholders.

The training shall be undertaken on site and include the following subjects as a minimum:

- Solar PV operation
- Inverter operation
- System isolation
- System monitoring
- Fault diagnosis
- Safety and emergency shutdown procedure
- User manuals and drawings explanation

The contractor is responsible for switching on the system at handover. This is a requirement for practical completion.

3.15 Practical Completion

All of the following items must, without exception, be completed prior to requesting the client to make final inspections for Practical Completion and the final invoice:

- Test the complete installation works and leave the work area in perfect clean condition.
- Thoroughly clean all equipment and parts.
- Prepare complete operating and maintenance instructions, warranty documentation and 'as built' records to the approval of the Superintendent.
- Carry out all specified testing and commissioning.
- Supply Authority inspection of the completed installation and Certificate of Electrical Safety.
- Supply all grid connection approval documentation from the distributor
- Conduct training to University staff and project managers on safe operation of the system
- Physically switch on the system

- Ensure that the monitoring systems are configured.

3.16 Warranty

3.16.1 General:

The head contractor shall provide electrician/installer/workmanship warranties including a minimum 5-year warranty and defects liability period on the entire installation of the system. Individual system components must meet further warranty requirements as specified.

3.16.2 Solar Panels

Provide solar PV panel manufacturer's warranty:

- Manufacturer's Warranty: A minimum period of 10 years manufacturer warranty is required.
- Performance warranty: minimum performance of at least 90% at 10 years and at least 80% at 25 years.

Any insurance guarantee underwriting the long-term performance warranty should be specified, such as third party insurance arrangements.

3.16.3 Inverters

Provide inverter manufacturer's warranty:

- Manufacturer's warranty for 10 years is required and must include full onsite replacement of a faulty unit

Any insurance guarantee underwriting the long-term performance warranty should be specified, such as third party insurance arrangements.

3.16.4 Framing

Provide framing manufacturer's warranty:

- Manufacturer's warranty for 10 years is required

3.16.5 Cabling and isolators

Provide manufacturer's warranty:

- Manufacturer's warranty for 10 years is required

3.17 Maintenance Requirements

3.17.1 Call out

The contractor shall respond to call outs for breakdowns or other faults requiring corrective maintenance for 5 years. Attend on site within 48 hours of notification. Rectify faults and replace faulty materials and equipment.

3.17.2 Ongoing maintenance

A maintenance plan is to be provided to the client with recommended maintenance actions, clearly stating instructions to complete the task and the frequency of which the tasks should be completed. The maintenance plan must be included in the manuals.

Ongoing maintenance by the contractor for a period of 5 years shall be included in the tender response. This shall include as a minimum:

- Bi-annual inspection and maintenance of the system for the five years, including 1 at 6 months and 1 at 12 months from the date of practical completion
- Written maintenance schedule and report submitted project manager at each required inspection. This document should be emailed to the La Trobe University representative in pdf format, in additional to completion of the maintenance log on site.

The inspection and maintenance shall be conducted by an accredited CEC electrician and as a minimum shall include:

- Inspection of the solar PV array to check:
  - Cleanliness of the modules and the modules cleaned if required
  - Adequacy of the panel connections and mounting structure
  - Mechanical condition of the array cabling
  - Electrical condition of the array cabling
  - Record array output voltage
  - Record array output current
- Inspection of the inverter to check
  - Cleanliness
  - Adequate connections of cables to the inverter
  - Adequate functioning of the inverter
- Inspection of the balance of system, to check
  - Switches/circuit breakers are operating correctly
  - Cables/conduits mechanically okay
  - Electrical connections okay
- Annual testing of all installed anchor points

An ongoing maintenance log shall be conducted and recorded within the supplied manuals for each PV installation with associated paperwork provided to the client.

3.17.3 Maintenance handover and training

At the completion of the contracted maintenance period, the contractor is responsible for training of La Trobe University maintenance contractors. This may be conducted at the final maintenance visit.

4 Safe roof hardware

4.1 General

The contractor is responsible for the design, supply and installation of safety hardware and fall arrest systems to ensure safe access to the proposed Solar PV installation area.

It is the contractor's responsibility to design the proposed safety hardware and system in accordance with the appropriate Australian Standards and regarding their proposed solar system design.

The roof safety hardware system must be designed by a competent person who is trained in height safety to AS/NZ1891 and has the experience, knowledge and skills to ensure the pendulum effect is eliminated to the greatest possible level.

The system must be installed by competent height safety installers using NATA approved products which comply with the loads for one and two person fall arrest applications. The height safety system will consist of safe access and egress to the roof ensuring the end user is restrained when at a height of 2m and within 2m of the roof edge. Each component installed on a roof for height safety purposes must meet all current load ratings as stipulated in AS1891:2009. Test Certificates shall be provided.

The installer shall provide a statement of the systems compliance and must install in accordance to the manufacturer's instructions. The installer cannot use 'mix & match' hardware and must use proprietary hardware to comply with the Australian Standards.

4.2 Existing roof hardware

Where existing roof safety hardware is removed, not accessible due to the solar installation, or restricts the current intended purpose of the hardware following solar installation; it is the contractor's responsibility to design and supply replacement safe roof hardware to ensure safe roof access is maintained and the original purpose of the safe roof hardware is achieved.

The relocated anchor points/safe roof hardware must include certification of compliance, a new rigging plan, the same load bearing ratings to the existing anchor systems and comply with all appropriate Australian Standards.

There is a strong preference to maintain the existing safe roof hardware by providing appropriate solar PV designs and installation to allow the ongoing safe usage of the equipment.

The design of panel arrays should provide sufficient access to be achieved while tethered with a safety harness to the new or existing anchors. The rope arc shall not be inhibited, and there must be access to walk back to the anchor, detach from the anchor, then move safely to the next anchor, tether and move to the gutter or area required to be accessed.

4.3 Codes and Standards

The design, installation, materials and equipment shall comply with the following standards and Codes:

- AS 1657 Fixed Platforms, Walkways and Ladders: design, construction and installation
- AS5532 Manufacturing requirements for single point anchor devices for working at height
- AS1170.2.2:2011 Structural designs Part 2- Wind actions
- AS1499-1998 Steel Structures
- AS1891.1 1995 Industrial safety belts and harnesses
- Australian Standard AS 1891.1 - Safety belts and Harnesses
- Australian Standard AS 1891.2 - Horizontal life line and rail systems

- Australian Standard AS 1891 - Horizontal life line and rail systems - Prescribed configurations (Supplement 1)
- Australian Standard AS 1891.3 - Fall arrest devices
- Australian Standard AS/NZ 4488 - Parts 1 & 2 - Industrial Rope Access
- Australian Standard AS 1891.4 - Selection, use and maintenance AS480 Health and Safety Compliance

4.4 Fall Arrest Systems

Anchors, static lines and fall arrest systems shall:

- be located to allow safe access to any panels which are located within 2m of an unprotected vertical edge
- be located to comply with the requirements for safe use, safe access, the pendulum effect and signage, as stipulated in clause 3.2 of AS 1891.4
- be supported by a structural support that is assessed separately by a suitably qualified engineer (as stipulated in AS 1891.4, clause 3.1.2.) or by a competent person, as appropriate, and the assessment documented
- shall be inspected for compliance with the requirements in clause 9.3.3 of AS 1891.4 and the inspection documents. The documentation should specify any ongoing requirement to carry out testing of anchor points
- be properly labelled as per the Australian standards
- include instructions for safe use and appropriate rigging plans
- include roof plan showing locations of all new equipment
- provide information on the fixing method of the anchor/fall arrest system
- provide a list of components serial numbers