



Australian Government

UEENEEK148A Install, configure and commission LV grid connected photovoltaic power systems

Release 2

UEENEEK148A Install, configure and commission LV grid connected photovoltaic power systems

Modification History

Not applicable.

Unit Descriptor

Unit Descriptor

1) Scope:

1.1) Descriptor

This unit covers the installation, adjustment and set-up of photovoltaic power systems and connecting to a supply grid inverter. It encompasses working safely and to installation standards, matching components with that specified for a given location, placing and securing system components accurately, making required circuit connections and completing the necessary installation documentation.

Application of the Unit

Application of the Unit 2)

This competency standard is suitable for employment-based programs under an approved contract of training at the AQF level of the qualification in which the unit is first packaged or higher.

The unit may be selected as an elective from the relevant schedule (see qualification packaging rules) provided that all prerequisite units are undertaken or addressed through recognition processes.

This unit may be included in a skill set provided that it is listed in the schedule of electives (see Qualification Framework) and all prerequisite units are undertaken or addressed through recognition processes.

Delivery and assessment of this unit should be undertaken within regard to the requirements of License to Practice (1.2 above), Prerequisite Competencies and Literacy and Numeracy skills (2 above) and the

recommendations for concurrent assessment and relationship with other units (9.5 below).

Practice in the workplace and during training is also subject to regulations directly related to occupational health and safety and where applicable contracts of training such as apprenticeships.

Note:

1. Compliance with permits may be required in various jurisdictions and typically relates to the operation of plant, machinery and equipment such as elevating work platforms, powder operated fixing tools, power operated tools, vehicles, road signage and traffic control and lifting equipment. Permits may also be required for some work environments such as confined spaces, working aloft, near live electrical apparatus and site rehabilitation.
2. Compliance may be required in various jurisdictions relating to currency in First Aid, confined space, lifting, risk safety measures etc.

Licensing/Regulatory Information

License to practice 3)

The skills and knowledge described in this unit require a license to practice in the workplace subject to regulations for undertaking of electrical work. Practice in workplace and during training is also subject to regulations directly related to occupational health and safety and where applicable, contracts of training such as apprenticeships.

Note.

Competency requirements to be granted a license to carry out installations, fault finding, repair or maintenance on low voltage electrical installations is incorporated in unit UEENEEG105A and all prerequisite units it specifies

Pre-Requisites

Prerequisite Unit(s) 4)

Competencies 4.1)

Granting competency in this unit shall be made only after competency in the following unit(s) has/have been confirmed.

UEENEEK1 25A Solve basic problems in photovoltaic energy apparatus and systems

UEENEEG1 03A Install low voltage wiring and accessories

Literacy and numeracy skills 4.2)

Participants are best equipped to achieve competency in this unit if they have reading, writing and numeracy skills indicated by the following scales. Description of each scale is given in Volume 2, Part 3 'Literacy and Numeracy'

Reading 3 Writing 3 Numeracy 3

Employability Skills Information

Employability Skills 5)

The required outcomes described in this unit of competency contain applicable facets of Employability Skills. The Employability Skills Summary of the qualification in which this unit of competency is packaged will assist in identifying Employability Skill requirements.

Elements and Performance Criteria Pre-Content

- 6) Elements describe the essential outcomes of a competency standard unit. Performance Criteria describe the required performance needed to demonstrate achievement of the element. Assessment of performance is to be consistent with the Evidence Guide.

Elements and Performance Criteria

ELEMENT

PERFORMANCE CRITERIA

- | | |
|--|--|
| 1 Prepare to install photovoltaic power systems. | 1.1 OHS procedures for a given work area are obtained and understood |
| | 1.2 Health and safety risks are identified and established risk control measures and procedures in preparation for the work are followed |
| | 1.3 Safety hazards that have not previously been identified are noted and established risk control measures are implemented |
| | 1.4 Installation of the system is prepared in consultation with others effected by the work and sequenced appropriately |
| | 1.5 The nature and location of the work is determined from documentation or appropriate person to establish the scope of work to be undertaken |
| | 1.6 Location of system components is planned within the constraints of the building structure, significants and regulations |
| | 1.7 Advice is sought from appropriate persons to ensure the work is coordinated effectively with others |
| | 1.8 Material needed for the installation work is obtained in accordance with established procedures and checked against job requirements |
| | 1.9 Tools, equipment and testing devices needed to for the installation work are obtained in accordance with established procedures and |

ELEMENT	PERFORMANCE CRITERIA
	checked for correct operation and safety
	1.10 Preparatory work is checked to ensure no damage has occurred and complies with requirements
2 Install photovoltaic power systems.	2.1 OHS risk control measures and procedures for carrying out the work are followed (Note 1: risk control measures need to incorporate risks associated with dc voltages of extra low voltage and low voltage levels)
	2.2 The need to test or measure live is determined in strict accordance with OHS requirements and when necessary conducted within established safety procedures
	2.3 Circuits/machines/plant are checked as being isolated where necessary in strict accordance OHS requirements and procedures
	2.4 System components are installed to comply with technical standards and job specifications and requirements with sufficient access to affect terminations, adjustment and maintenance (Note 2: hazards relating to photovoltaic energy apparatus and isolation need to specifically address issues of dc arcing and suitable dc protection systems for dc voltages of extra low voltage and low voltage levels.)
	2.5 Wiring is terminated at components and associated equipment in accordance with manufacturer specifications and functional and regulatory requirements
	2.6 Established methods for dealing with unexpected situations are discussed with appropriate person or persons and documented
	2.7 Unexpected situations are dealt with safely and with the approval of an authorised person
	2.8 Ongoing checks of the quality of installed apparatus are undertaken in accordance with established procedures

ELEMENT	PERFORMANCE CRITERIA
	2.9 System installation is carried out efficiently without waste of materials or damage to apparatus, circuits, the surrounding environment or services and using sustainable energy principles
3 Completion and report installation activities.	3.1 OHS work completion risk control measures and procedures are followed
	3.2 Work site is cleaned and made safe in accordance with established procedures
	3.3 Final checks are made so that the installed apparatus conforms to requirements
	3.4 'As-installed' apparatus and associated equipment is documented and appropriate person(s) notified in accordance with established procedures

Required Skills and Knowledge

REQUIRED SKILLS AND KNOWLEDGE

8) This describes the essential skills and knowledge and their level, required for this unit.

Evidence must show that knowledge has been acquired of safe working practices and installing and setting up LV grid connected photovoltaic power systems.

All knowledge and skills detailed in this unit should be contextualised to current industry practices and technologies.

KS01-EK148 Photovoltaic LV installations

A

Evidence shall show an understanding of LV photovoltaic array grid connection to the extent indicated by the following aspects:

REQUIRED SKILLS AND KNOWLEDGE

- T1 PV array installation requirements encompassing:
- OH&S requirements and methods for working on roofs.
 - common methods of roof construction (rafters and tile battens) and methods to ensure integrity of waterproofing.
 - common types of roof mounted and free-standing PV array frame construction and methods of tilt angle adjustment.
 - fixing methods for different roof types.
 - array mounting methods for north orientation roof sections and non-north facing roof sections.
 - aesthetic considerations in choosing an appropriate array location and type of mounting.
 - the mounting and fixing methods for at least one type of commercially available building integrated PV product.
- T2 Electrical PV array installation requirements encompassing:
- methods used in wiring and connecting PV arrays as per the Australian Standards AS 4509 and AS5033
 - considerations involved in wiring of series connected PV modules in order to minimise power losses due to shading.
 - PV array wiring diagram including the placement of blocking and bypass diodes.
 - considerations involved in choosing the location of associated system equipment including regulators, d.c. control board, inverters and inverters for grid connected systems.
 - cable route from PV array/s to inverters so as to minimise the route length.
- T3 System installation and maintenance encompassing:
- installation work on a PV power system in accordance with relevant standards and OH&S guidelines.
 - correct isolation and shutdown procedures prior to carrying out maintenance tasks.
 - routine maintenance tasks on PV arrays.
 - required vegetation control to remove or reduce shading or soiling on a PV array
- T4 Inverters encompassing:
- types of inverters used in grid connected systems.
 - AS symbol for a low voltage inverter
 - the basic function of an inverter.
 - simple block diagram of a typical inverter used in grid

REQUIRED SKILLS AND KNOWLEDGE

connected system

- T5 Inverter operation encompassing:
- the basic principle of operation of a single phase inverter (using switch analogue)
 - the operation of an inverter bridge and half-bridge configuration.
 - operation of a FET inverter
 - connection of a grid inverter and measurement of the inverter parameters for various loads
- T6 Inverter characteristics encompassing:
- the characteristics which distinguish inverters suitable for grid connected photovoltaic array application from standard inverters.
 - using waveform diagrams, the function of PWM techniques in square wave, modified square wave and synthesised sine wave inverters
 - output voltage waveforms for square wave, modified square wave and synthesized sine wave inverters showing typical voltages and periodic times
 - the six (6) essential inverter specifications
- T7 PV grid connected system operation encompassing:
- block diagram of a PV grid connected system.
 - operation of grid interactive PV systems including synchronisation, safety feature, power flow control, passive and active anti-islanding, and metered energy for systems.
 - schematic diagrams of common grid connected inverter circuit configurations including metering arrangements, isolation and connection with respect to RCDs in accordance with AS 4777.1.
- T8 Installation of grid connected inverters encompassing:
- major installation requirements for all system components which will ensure correct operation, long life, safety and ease of maintenance consistent with AS 4509, AS 4086.2, AS/NZS 3000 and relevant OH&S guidelines

REQUIRED SKILLS AND KNOWLEDGE

- selection of a suitable location for the PV array, inverter and other components, at a given installation site in accordance with AS2676.2 and AS3011.2, and the considerations given in AS4509 and AS4086.2.
 - typical installation configurations for grid connection of energy systems via inverters
 - the function and operation of a "grid protection device" as specified in AS4777
 - array wiring plan for series connected modules to minimise power loss due to shading at a particular site.
 - installation requirements for a grid connected system.
 - labelling and signage requirements for switchboards supplied with power from grid connected inverters, as set out in AS 4777.1.
 - the additional requirements for UPS systems as specified in AS4777.1.
 - installation of a PV grid connected system
- T9 System commissioning and maintenance encompassing:
- the isolation procedures required for grid connected inverters.
 - relevant commissioning procedures including start-up and shut-down procedures for grid connected inverter systems in accordance with AS 4509.
 - testing a grid connected inverter system for correct operation.
 - location and rectification of an electrical fault within a PV array/inverter and wiring.
 - maintenance schedule for a grid connected PV power system.
 - performing commissioning work on a PV power system in accordance with AS 4509, AS 4086.2, AS/NZS 3000 and AS 3010.1

Evidence Guide

EVIDENCE GUIDE

9) This provides essential advice for assessment of the unit and must be read in conjunction with the performance criteria and the range statement of the unit and the Training Package Assessment Guidelines.

The Evidence Guide forms an integral part of this unit. It must be used in conjunction with all parts of this unit and performed in accordance with the Assessment Guidelines of this Training Package.

Overview of Assessment 9.1)

Longitudinal competency development approaches to assessment, such as Profiling, require data to be reliably gathered in a form that can be consistently interpreted over time. This approach is best utilised in Apprenticeship programs and reduces assessment intervention. It is the industry-preferred model for apprenticeships. However, where summative (or final) assessment is used it is to include the application of the competency in the normal work environment or, at a minimum, the application of the competency in a realistically simulated work environment. In some circumstances, assessment in part or full can occur outside the workplace. However, it must be in accordance with industry and regulatory policy.

Methods chosen for a particular assessment will be influenced by various factors. These include the extent of the assessment, the most effective locations for the assessment activities to take place, access to physical resources, additional safety measures that may be required and the critical nature of the competencies being assessed.

The critical safety issues inherent in working with electricity, electrical equipment, gas or any other hazardous substance/material present a challenge for those determining competence. Sources of evidence need to be 'rich' in nature to minimise error in judgment.

Activities associated with normal everyday work have a bearing on the decision as to how much and how detailed the data gathered will contribute to its 'richness'. Some skills are more critical to safety and operational requirements while the same skills may be more or less frequently practised. These points are raised for the assessors to consider when choosing an assessment method and developing assessment instruments. Sample assessment instruments are included for Assessors in the Assessment

Guidelines of this Training Package.

Critical aspects of evidence required to demonstrate competency in this unit 9.2)

Before the critical aspects of evidence are considered all prerequisites must be met.

Evidence for competence in this unit must be considered holistically. Each element and associated performance criteria must be demonstrated on at least two occasions in accordance with the 'Assessment Guidelines – UEE11'. Evidence must also comprise:

- A representative body of work performance demonstrated within the timeframes typically expected of the discipline, work function and industrial environment. In particular this must incorporate evidence that shows a candidate is able to:
 - Implement Occupational Health and Safety workplace procedures and practices including the use of risk control measures as specified in the performance criteria and range statement
 - Apply sustainable energy principles and practices as specified in the performance criteria and range statement
 - Demonstrate an understanding of the essential knowledge and associated skills as described in this unit. It may be required by some jurisdictions that RTOs provide a percentile graded result for the purpose of regulatory or licensing requirements.
 - Demonstrate an appropriate level of skills enabling employment
 - Conduct work observing the relevant Anti Discrimination legislation, regulations, polices and workplace procedures
- Demonstrated consistent performance across a representative range of contexts from the prescribed items below:
 - Install and set up grid connected photovoltaic power systems as described in 8) and including:
 - A Reading and interpreting drawings related to and apparatus locations and circuit connections
 - B Placing and securing system components accurately

- C Maintaining fire integrity
- D Connecting system components to comply with requirements
- E Dealing with unplanned events by drawing on essential knowledge and skills to provide appropriate solutions incorporated in a holistic assessment with the above listed items

Context of and specific resources for assessment 9.3)

This unit should be assessed as it relates to normal work practice using procedures, information and resources typical of a workplace. This should include:

- OHS policy and work procedures and instructions.
- Suitable work environment, facilities, equipment and materials to undertake actual work as prescribed by this unit.

These should be part of the formal learning/assessment environment.

Note:

Where simulation is considered a suitable strategy for assessment, conditions must be authentic and as far as possible reproduce and replicate the workplace and be consistent with the approved industry simulation policy.

The resources used for assessment should reflect current industry practices in relation to installing and setting up LV grid connected photovoltaic power systems.

Method of assessment 9.4)

This unit shall be assessed by methods given in Volume 1, Part 3 'Assessment Guidelines'.

Note:

Competent performance with inherent safe working practices is expected in the Industry to which this unit applies. This requires assessment in a structured environment which is intended

primarily for learning/assessment and incorporates all necessary equipment and facilities for learners to develop and demonstrate the essential knowledge and skills described in this unit.

**Concurrent
assessment and
relationship with
other units** 9.5)

For optimisation of training and assessment effort, competency development in this unit may be arranged concurrently with unit:

UEENEEK12 Solve basic problems in photovoltaic energy
5A apparatus and systems

The critical aspects of occupational health and safety covered in unit UEENEEE101A and other discipline specific occupational health and safety units shall be incorporated in relation to this unit.

Range Statement

RANGE STATEMENT

10) This relates to the unit as a whole providing the range of contexts and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

This unit must be demonstrated in relation to installing photovoltaic power systems in at least two different types of premises construction or environment.

Generic terms used throughout this Vocational Standard shall be regarded as part of the Range Statement in which competency is demonstrated. The definition of these and other terms that apply are given in Volume 2, Part 2.1.

Unit Sector(s)

Not applicable.

Competency Field

Competency Field 11)

Renewable and Sustainable Energy