



Australian Government

UEENEEK135A Design grid connected photovoltaic power supply systems

Release 2

UEENEEK135A Design grid connected photovoltaic power supply systems

Modification History

Not applicable.

Unit Descriptor

Unit Descriptor

1) Scope:

1.1) Descriptor

This unit covers the design of grid connected photovoltaic power supply systems and their installation. It encompasses following design briefs, incorporating schemes for protection of persons and property from dangers of system malfunction, ensuring other safety and performance standards and functional requirements are met and documenting design calculations and criteria

Application of the Unit

Application of the Unit 2)

This unit is intended for competency development entry-level employment-based programs incorporated in approved contracts of training. It applies to any formal recognition for this standard at the aligned AQF 4 level or higher.

Licensing/Regulatory Information

License to practice 3)

The skills and knowledge described in this unit do not require a license to practice in the workplace. However, practice in this unit is subject to regulations directly related to occupational health and safety and contracts of training such as new apprenticeships.

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

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 5 Writing 5 Numeracy 5

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 design grid connected power supply systems.	1.1 OHS processes and procedures for a given work area are identified, obtained and understood
	1.2 The extent and nature of the system is determined from design brief.
	1.3 Safety and other regulatory requirements to which the electrical installation must comply are identified, obtained and understood
	1.4 Design development work is planned to meet scheduled timelines in consultation with others persons involved in the installation or associated work.
2 Develop grid connected power supply systems design.	2.1 Knowledge of grid connected power supply system's performance standards, compliance methods is applied to the design.
	2.2 Alternative arrangements for the hybrid power systems design are considered based on the requirements outlined in the design brief.
	2.3 Safety, functional and budgetary considerations are incorporated in the design.
	2.4 Grid connected power supply system design draft is checked for compliance with the design brief and regulatory requirements.
	2.5 Grid connected power supply system design is documented for submission to appropriate persons for acceptance and approval.
	2.6 Solutions to unplanned situation are provided

ELEMENT**PERFORMANCE CRITERIA**

		consistent with organisation policy.								
3	Obtain approval for grid connected power supply systems design	<table><tr><td>3.1</td><td>Grid connected power supply system design is presented and explained to client representative and/or other relevant persons.</td></tr><tr><td>3.2</td><td>Requests for alterations to the design are negotiated with relevant persons within the constraints of organisation policy.</td></tr><tr><td>3.3</td><td>Final design is documented and approval obtained from appropriate persons.</td></tr><tr><td>3.4</td><td>Quality of work is monitored against personal performance agreement and/or established organisational or professional standards.</td></tr></table>	3.1	Grid connected power supply system design is presented and explained to client representative and/or other relevant persons.	3.2	Requests for alterations to the design are negotiated with relevant persons within the constraints of organisation policy.	3.3	Final design is documented and approval obtained from appropriate persons.	3.4	Quality of work is monitored against personal performance agreement and/or established organisational or professional standards.
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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 designing grid connected photovoltaic power supply systems.

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

KS01-EK135A Photovoltaic power systems -design

Evidence shall show an understanding of photovoltaic power systems design principles to an extent indicated by the following aspects:

Site Survey encompassing:

- declination angle, reflectance, sunshine hours, extraterrestrial irradiation
- energy efficiency techniques relevant for domestic dwelling and commercial premises to reduce the electrical energy demand.
- energy efficient initiatives that could be implemented by the site owner.
- assessing the occupational health and safety (OHS) risks

REQUIRED SKILLS AND KNOWLEDGE

when working on that particular site.

- determining the solar access for the site.
- determining whether any shading will occur and estimate its effect on the system.
- estimation of the solar resource for the site.
- determining the available area for the solar array.
- determining whether the roof is suitable for mounting the array.
- determining how the modules will be mounted on the roof.
- determining where the switchboard or distribution board is located for connecting the output of inverter.
- determining where the array junction box (if required) and inverter will be located.
- determining the cabling route and therefore estimate the lengths of the cable runs.
- determining whether monitoring panels or screens are required and determine a suitable location with the site owner

PV arrays selection encompassing:

- selection and sizing of PV array for a grid-connected inverter system, based on any of: annual energy demand, budget constraints, architectural constraints or limitations on available inverter sizes.
- determining the minimum and maximum number of PV modules in a string for the specified voltage

System components selection encompassing:

- selection and sizing the balance of the system components including cabling, circuit protection and isolation equipment for a grid-connected PV system.
- determining the energy yield, specific energy yield and performance ratio for system
- schematic diagrams of common grid-connected inverter circuit configurations including metering arrangements, isolation and connection with respect to RCDs.
- the major installation details for a proposed grid-connected inverter system, based on the requirements set out in AS 4777 and AS5033

Other design considerations encompassing:

- major non-technical considerations impacting on the design, installation and operation of grid-connected PV systems

REQUIRED SKILLS AND KNOWLEDGE

including economic, financial, contractual, institutional, legislative and regulatory.

- calculation of the annual reduction in greenhouse gas emissions achieved by a given PV power system at a given location.

Inverters encompassing:

- types of inverters used in grid connected systems.
- Australian standard symbol for a low voltage inverter
- the basic function of an inverter.
- simple block diagram of a typical inverter used in grid connected system

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

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

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.

REQUIRED SKILLS AND KNOWLEDGE

Grid connect inverter selection encompassing:

- determining the operating window of the inverter for the expected minimum and maximum effective cell temperatures
- selection of an inverter rating with respect to the output power of the array/s.
- 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
- 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
- draft 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.

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, policies and workplace procedures
- Demonstrated consistent performance across a representative range of contexts from the prescribed items below:
 - Design grid connected photovoltaic power supply systems as described in 8) and including:

A Developing outlines of alternative designs

B Developing the design within the safety and functional requirements and budget limitations

- C Documenting and presenting design effectively
- D Successfully negotiating design alteration requests
- E Obtaining approval for final design
- F 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 designing grid connected photovoltaic power supply 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:

UEENED10 Use computer applications relevant to a workplace
1A

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 designing at least two different grid connected photovoltaic power supply systems and their installation.

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