



# REGISTERED NATIONAL STANDARD

## UNIT OF COMPETENCY

<b>Title:</b>	<b>Assist in the installation and operation of solar PV systems</b> <u>Notes:</u> 1) Due to safety issues inherent in working with electricity, all training and assessment activities must be in accordance with local industry and regulatory requirements; 2) This unit of competency has been adapted the Pacific regional unit standard <i>SE3306 Assist in the installation, operation and maintenance of systems for RE &amp; EE</i> ;		
<b>TQF Level:</b>	3	<b>Credits:</b>	6
<b>Version:</b>	1		
<b>National standard code:</b>	NS092-03		
<b>Associated qualification (and code):</b>	National Certificate in Sustainable Energy (Solar) Level 3 (QR-03-NQ-018-05-0504-23-01)		
<b>Approval date:</b>	31 August 2023	<b>Review date:</b>	31 August 2028
<b>Purpose:</b>	<p>This unit standard involves installation and operation of <i>solar photovoltaic (PV)</i> systems.</p> <p>Persons credited with this unit standard are able to:</p> <ol style="list-style-type: none"> <li>1. Identify <i>passive solar design</i> characteristics in living spaces;</li> <li>2. Prepare to install, operate, and maintain a solar PV system;</li> <li>3. Demonstrate installation of solar PV systems equipment;</li> <li>4. Demonstrate the <i>safe handling</i> and <i>safe operation</i> of solar PV systems equipment.</li> <li>5. Write completion report on installation and operation of solar PV system.</li> </ol>		

<b>Learning Outcome 1 (LO1)</b>	Identify <i>passive solar design</i> characteristics in buildings and other living spaces
<b>Performance standards</b>	<ul style="list-style-type: none"> <li>1.1 Describe, orally or in writing, what 'passive solar design' is;</li> <li>1.2 Identify specific passive solar design characteristics in a residential or commercial building;</li> <li>1.3 Explain how specific passive solar design characteristics improve energy efficiency in a residential or commercial building;</li> <li>1.4 Identify challenges to passive solar design in Tonga;</li> <li>1.5 Describe, orally or in writing, how the challenges to passive solar design in Tonga could be addressed.</li> </ul>
<b>Learning Outcome 2 (LO2)</b>	Prepare to install and operate solar PV systems
<b>Performance standards</b>	<ul style="list-style-type: none"> <li>2.1 Identify <i>occupation health and safety (OHS)</i> procedures for a given work area relevant to the installation and operation of a solar PV system;</li> <li>2.2 Determine the nature and location of the work from documentation or an appropriate person to establish the scope of work to be undertaken;</li> <li>2.3 Identify and note safety <i>hazards</i> that have not previously been identified;</li> <li>2.4 Identify and implement established <i>risk control measures</i> and procedures in preparation to install and operate solar PV systems;</li> <li>2.5 Identify others who are most likely to be affected by the installation and operation of a solar PV system and consult with them to ensure relevant activities are sequenced properly to minimize disruptions;</li> <li>2.6 Plan the location of solar PV system within the constraints of the building structure, land use issues, wind resource availability and local legislations and requirement;</li> <li>2.7 Identify and obtain the materials needed for the installation work in accordance with established procedures and checked against job requirements;</li> <li>2.8 Identify and obtain tools, equipment and testing devices needed for the installation work in accordance with established procedures and checked for correct operation and safety;</li> <li>2.9 Check preparatory work to ensure no damage has occurred to any materials, equipment, testing devices or any part of the solar PV system and ensure it complies with requirements.</li> </ul>
<b>Learning Outcome 3 (LO3)</b>	Demonstrate the <i>safe handling</i> and <i>safe operation</i> of solar PV systems equipment.
<b>Performance Standards</b>	<ul style="list-style-type: none"> <li>3.1 Identify safe handling and safe operational procedures of a solar PV system;</li> <li>3.2 Describe the safety procedures required for operational system checks on solar</li> </ul>

	<p>PV systems;</p> <p>3.3 Describe safety procedures for handling and storage of solar PV system components and materials;</p> <p>3.4 Check the installation of apparatus and associated equipment to ensure compliance with technical standards and job specifications and requirements;</p> <p>3.5 Describe procedures for finding faults and defects in solar PV systems components and materials;</p> <p>3.6 Explain safety monitoring techniques for solar PV systems and equipment.</p> <p>3.7 Operate solar PV system components and equipment safely and in accordance to OHS requirements, technical standards, job specifications and requirements.</p>
<b>Learning Outcome 4 (LO4)</b>	Demonstrate installation of solar PV systems equipment
<b>Performance Standards</b>	<p>4.1 Identify the various kinds of solar PV system configurations.</p> <p>4.2 Identify the functions and limitations of each part and components of a solar PV system and equipment;</p> <p>4.3 Select and obtain the right tools required for installing solar PV system equipment according to established procedures;</p> <p>4.4 Demonstrate the assembly and disassembly of a solar PV system components;</p> <p>4.5 Carry out apparatus installation efficiently without unnecessary waste of materials or damage to apparatus and the surrounding environment or services in compliance with sustainable energy principles;</p> <p>4.6 Carry out ongoing checks on the quality of the installed apparatus in accordance with established procedures;</p> <p>4.7 Identify and check apparatus and components as being isolated where necessary in strict accordance OHS requirements and procedures;</p> <p>4.8 Demonstrate the testing and commissioning procedures involved in the installation of solar PV systems and equipment.</p>
<b>Learning Outcome 5 (LO5)</b>	Write completion report on solar PV system installation and operation activities.
<b>Performance standards</b>	<p>5.1 Identify requirements for completion reporting in solar PV systems;</p> <p>5.2 Perform final checks to the installed and functioning solar PV systems so that they conform to requirements.</p> <p>5.3 Document 'As-installed' emergency systems apparatus and associated equipment;</p> <p>5.4 Notify appropriate person or persons in regards to solar PV installation and in accordance with established procedures;</p> <p>5.5 Compile relevant data and information in accordance with completion report requirements;</p>

	<p>5.6 Complete installation completion report as required;</p> <p>5.7 Explain procedures of identify and document faults in solar PV systems.</p>
<b>Pre-requisites</b>	N/A
<b>Co-requisites</b>	N/A
<b>Underpinning skills and knowledge</b>	<p>The following knowledge and skills underpin this unit standard:</p> <p><b><u>Knowledge:</u></b></p> <ol style="list-style-type: none"> <li>1. Knowledge of safe-handling techniques for moving, hoisting, lifting, etc. of heavy structures;</li> <li>2. Knowledge of basic tools and equipment;</li> <li>3. Knowledge of basic functions and components of solar PV systems;</li> <li>4. Basic knowledge of installing and operating solar PV systems</li> <li>5. Knowledge of basic civil works involved in a solar PV set up.</li> <li>6. Safety of solar PV systems</li> <li>7. Knowledge of the environmental and social impacts of solar PV system development.</li> <li>8. Knowledge of solar heat transfer in a built structure (by conduction, convection, and radiation) from where it is collected to where it is stored;</li> <li>9. Energy efficiency in living spaces (residential, commercial, etc.);</li> <li>10. Passive solar design principles</li> </ol> <p><b><u>Skills</u></b></p> <ol style="list-style-type: none"> <li>11. Basics of a solar pathfinder (parts and operation)</li> <li>12. Preparing to install solar PV systems</li> <li>13. Safe handling skills</li> <li>14. Installing solar PV systems</li> <li>15. Operating solar PV systems</li> <li>16. Performing checks on solar PV systems</li> <li>17. Technical report writing</li> </ol>
<b>Assessment requirements</b>	<p><b><u>Methods of assessment:</u></b></p> <p>A range of assessment methods should be used to assess students' knowledge and application of skills. These shall include but not restricted to the following:</p> <ol style="list-style-type: none"> <li>a) Direct observation of students performing certain tasks stated under context of assessment;</li> <li>b) Oral questions to test relevant skills and knowledge during observation (e.g., Interviews)</li> <li>c) Written assessment such as:</li> </ol>

- 1) Reports – installation and operation activities.
- 2) Student Portfolios – containing other activities that demonstrate what a student can do – e.g., annotated photographs, video records, completed Activity logs, marked quizzes and assignments, etc., etc.
- 3) Reviews of workplace attachment reports (e.g., Supervisor/third party reports; testimonials from Project manager or supervisor)

#### Context of assessment:

To support student assessment and to ensure they are valid, reliable, flexible, and fair, a training provider is encouraged to make the necessary arrangements to involve the relevant key industry organisations such as *Tonga Electricity Commission (TEC)*, *Tonga Power Limited (TPL)* and other trusted licensed private energy and electricity entrepreneurs in the assessment of the required skills and knowledge. Such collaboration between provider institutions and the industry may include but not restricted to the following:

- Experts from the industry contribute to the design and implementation of the curriculum and assessment activities;
- Experts from the industry are engaged as trainers, assessors, or assessment moderators;
- Students are placed in relevant industry organizations for workplace attachment;
- Industry experts act as supervisors of students on workplace attachment
- Etc.

To show that learners have the required competence they will need to **demonstrate** and **apply** their knowledge in the workplace (or in an environment that closely resembles the workplace) in relation to:

- a) LO1: Identify *passive solar design* characteristics in buildings and other living spaces
- b) LO2: Prepare to install and operate solar PV systems.
- c) LO3: Demonstrate the safe handling and operations of solar PV systems equipment
- d) LO4: Demonstrate installation of solar PV systems equipment.
- e) LO5: Write completion report on solar PV installation and operation activities.

Each LO and associated performance standards must be demonstrated on at least TWO occasions. Sources of evidence need to be rich in nature to minimise error judgment.

#### Re-assessment

Candidates of assessment are eligible to three (3) attempts to achieve the required competency within 14 days of their first attempt:

	<ol style="list-style-type: none"> <li>1. Feedback must be provided to the candidate and sufficient time provided to prepare for re-assessment.</li> <li>2. The trainer/assessor has the discretion to vary the assessment tasks used in each assessment attempt as long as the: <ol style="list-style-type: none"> <li>a) same competencies are being assessed;</li> <li>b) principles of assessment are adhered to.</li> </ol> </li> </ol> <p>Failure to achieve the required competency after three (3) attempts on the exam or specific part of the assessment will require the person studying this Unit to re-enrol for the same Unit.</p>
<p><b>Moderation arrangements</b></p>	<ol style="list-style-type: none"> <li>1. Training providers must have their own moderation system approved by TNQAB before accreditation is granted: <ol style="list-style-type: none"> <li>a. Relevant internal moderation processes are documented;</li> <li>b. Assessment is planned for each unit, and moderation processes are integrated into such plan</li> </ol> </li> <li>2. External moderation is conducted by the National qualifications unit of TNQAB for all unit components of national qualifications; <ol style="list-style-type: none"> <li>a. Samples of assessed activities are submitted for moderation;</li> <li>b. Moderation (external) forms are available on request from the National qualifications unit of TNQAB.</li> </ol> </li> </ol>
<p><b>Resource requirements</b></p>	<ol style="list-style-type: none"> <li>1. A textbook (or compilation of printed resources) on solar PV control system fault analysis, installation and operation, at the discretion of the course/unit coordinator or trainer;</li> <li>2. Local legislations and requirements: <ol style="list-style-type: none"> <li>a) Tonga Energy Act 2021</li> <li>b) Tonga Power Limited (TPL) small-scale distributed generation requirements;</li> </ol> </li> <li>3. Solar pathfinder;</li> <li>4. Solar PV system: <ol style="list-style-type: none"> <li>a) Solar panels</li> <li>b) Inverter</li> <li>c) Charger controller</li> <li>d) Battery</li> <li>e) Cables</li> </ol> </li> <li>5. Safety Tools and equipment, at least the following: <ol style="list-style-type: none"> <li>a) Hand gloves for electrical and mechanical lab work</li> <li>b) Safety helmet;</li> </ol> </li> </ol>

	<ul style="list-style-type: none"> <li>c) Safety glasses/goggles;</li> <li>d) Ear-mask/muff for use in noisy workshop environment;</li> <li>e) Dust mask;</li> <li>f) Electrician safety harness;</li> <li>g) Safety tags (e.g. <i>out of service, do not operate, live wire, etc.</i>).</li> </ul> <p>6. Tools and Equipment, at least the following:</p> <ul style="list-style-type: none"> <li>a) Electrician’s Tool Kit includes at least the following: <ul style="list-style-type: none"> <li>(i) Insulated screwdrivers,</li> <li>(ii) Insulated pliers,</li> <li>(iii) Electrical tester,</li> <li>(iv) Ratchet set (containing handle, universal joint, extension bar, and coupler etc.);</li> <li>(v) Measuring tape.</li> </ul> </li> <li>b) Drill set for electricians (with bits);</li> <li>c) Heat gun - for cable sleeving;</li> <li>d) Soldering iron and solder wire;</li> <li>e) Termination tools, include at least the following: <ul style="list-style-type: none"> <li>(i) Crimping tool;</li> <li>(ii) Air blower;</li> <li>(iii) Solder wire;</li> <li>(iv) Crimp lugs;</li> <li>(v) Cables and accessories.</li> </ul> </li> <li>f) Testing Equipment for electrical, include at least the following: <ul style="list-style-type: none"> <li>(i) AC Variable Power Supply;</li> <li>(ii) DC variable Power Supply ;</li> <li>(iii) Oscilloscope;</li> <li>(iv) Frequency counter;</li> <li>(v) Power factor tester;</li> <li>(vi) Three-phase power analyser;</li> <li>(vii) Fused Low-voltage test lamp.</li> </ul> </li> </ul>
<p><b>Requirements to complete this unit</b></p>	<p>There are five (5) Learning outcomes and Thirty-six (36) Performance standards to measure competence.</p> <p>To demonstrate competence, the person studying this unit is:</p> <ol style="list-style-type: none"> <li>1. Required to demonstrate all LOs to the expected standards of performance;</li> <li>2. Required to attain an <i>Achieved</i> Grade (Competent) to fulfil the requirements of the Unit Standard.</li> <li>3. Eligible to three (3) attempts to achieve the required competency within 14 days of the first attempt.</li> </ol> <p>Failure to achieve the required competency level after three (3) attempts of the exam or specific part of the assessment will require the person studying this Unit to re-enrol for the same Unit.</p>

**Important notes and definitions**

**Notes:**

1. All activities associated with this unit standard must comply with the requirements of national codes of practice, regulations and legislation for workplace health, safety, and environmental protection and any subsequent amendments.
2. Assessors must comply with Tonga national assessment and moderation requirements.

**Definitions:**

1. *Design principles* refer to important considerations (or guidelines) that 'designers' rely on when making important design decisions. In this course, these designers include those who work in the construction industry such as engineers, architects, builders, etc. (please refer to *passive solar design* below for more information).
2. *Hazard* refers to anything that could cause harm. (please compare to *Risk* below);
3. *Occupational Health and Safety (OHS)* refers to a multi-disciplinary field concerned with protecting safety, health and welfare of people working at an organization
4. *Passive solar design* (or *solar passive design*) is a 'design principle' used for buildings and living spaces. This design principle refers to the use of the energy from the sun for the heating and cooling of buildings and other living spaces, without relying on mechanical devices. This design principle relies on the natural heat transfer processes of conduction, convection and radiation in order to collect, store and redistribute the solar energy.
5. *Photovoltaics (PV)* - is the conversion of light into electricity using semiconducting materials that exhibit the *photovoltaic effect*
6. *Photovoltaic effect* is the generation of voltage and electric current in a material when it is exposed to light.
7. *Risk* refers to the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard.
8. *Risk control measures* are actions that are taken in response to a risk factor that has the potential to cause accidents or harm in the workplace.
9. *Safe handling* refers to manual 'handling' (lifting, moving, carrying, etc.) that does not create the risk of injury to a person from heavy loads, high forces, awkward movements and postures, or excess repetition.
10. *Safe operation* refers to the step-by-step instructions about how to safely perform an activity or use a tool.
11. *Silicon* is a chemical element with the symbol *Si* and atomic number 14. It is the

semiconducting material from which most solar panels are made.

12. *Solar panel (or solar photovoltaic panel)* is a piece of flat semiconducting material (usually Silicon) that transforms the sun's rays into electricity.
13. *Solar photovoltaic (PV) system or solar power system,* is an electric power system designed to supply solar power by means of photovoltaics. It is composed of one or more solar panels combined with an inverter and other electrical and mechanical components that use energy from the Sun to generate electricity.

**Public comments on unit**

Please contact TNQAB National Qualifications Unit (email [EnquireNQ@tnqab.to](mailto:EnquireNQ@tnqab.to) or Telephone 28136) if you like to discuss or suggest changes to the details of this unit.