



REGISTERED NATIONAL STANDARD

UNIT OF COMPETENCY

Title:	Operate and maintain off-grid PV systems (Hybrid systems) ¹				
TQF Level:	4	Credits:	6	Version:	1
National standard code:	NS125-04				
Associated qualification (and code):	National Certificate in Sustainable Energy (Solar) Level 4				
Approval date:	10 th June 2026		Review date:	10 th June 2031	
Purpose:	<p>This unit standard involves the maintenance and troubleshooting of off-grid PV power systems specifically, hybrid systems. Persons credited with this unit standard are able to:</p> <ul style="list-style-type: none"> • Explain and identify essential components in the hybrid system • Plan safe maintenance of the hybrid system • Produce a procurement list when required • Safely isolate the system for maintenance • Undertake service procedures and maintenance on the system • Troubleshoot a hybrid system and undertake basic repairs and replacement of equipment. • Test and confirm before switching on the system • Maintain records of the system and provide documentation to the customer 				

¹ Notes:

- 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 EQAP micro qualification (micro credential *PPAOG 303 Maintainer of Off-Grid PV Power Systems (Hybrid Power Systems)*)

Learning Outcome 1 (LO1)	Understand <i>Occupational Health and Safety</i>
Performance standards	<p>1.1 Apply safety procedures concerning operation and maintenance of hybrid power systems and equipment as specified by the designer and or supervisor;</p> <p>1.2 Apply <i>Occupational Safety and Health</i> legislations concerning worker and public safety;</p> <p>1.3 Identify personal safety hazards, both electrical and physical, associated with hybrid power system maintenance and troubleshooting, and implement preventative and remedial measures;</p> <p>1.4 Identify environmental hazards associated with hybrid power system maintenance and troubleshooting, and implement preventative and remedial measures;</p> <p>1.5 Identify the PPE equipment for maintenance.</p>
Learning Outcome 2 (LO2)	Carry out installation or replacement of system components
Performance Standards	<p>Fuel Generators</p> <p>2.1 Demonstrate the correct replacement and sound mounting techniques to:</p> <ul style="list-style-type: none"> • securely lock the generator plant to its supporting structure • provide suitable sound attenuation • provide vibration isolation, exhaust extraction and cooling ventilation to comply with manufacturer’s specification. • allow adequate access to all plant components for maintenance and fault finding <p>2.2 Explain the replacement and fixing of fuel storage tanks and fuel lines to comply with relevant standards include:</p> <ul style="list-style-type: none"> • provide a safe working environment and safe installation for the system owners • provide fuel containment systems for environmental protection in case of spillage • minimize fuel line lengths between tank and engine <p>Remote Monitoring/COMMS/ Data Logging</p> <p>2.3 Demonstrate the replacement and fixing of all remote monitoring and data logging equipment.</p> <p>General</p>

	<p>2.4 Demonstrate the replacement of all relevant components, cabling and protection typical in a hybrid system. (Ensuring minimized cable lengths between all components and installation of components in accordance with manufacturers specifications).</p> <p>Cabling for Multiple Buildings and/or Village</p> <p>2.5 Determine protection requirements for the different buildings and the interconnecting cabling to the buildings and demonstrate such wiring;</p> <p>2.6 Demonstrate precautionary measures whilst doing maintenance of overhead/underground cables including replacement of support structures/cables for both.</p>
Learning Outcome 3 (LO3)	Plan safe maintenance of the hybrid system
Performance Standards	<p>3.1 Describe all system components from those depicted in a system drawing. Familiarize with system drawings for PV-Genset hybrid system;</p> <p>3.2 Discuss service and maintenance requirements of a hybrid system (mainly maintenance requirements of fuel generators);</p> <p>3.3 Demonstrate planning of activities for maintenance based on the prevention of commonly occurring faults in a hybrid system (mainly fuel generators);</p> <p>3.4 Identify tools and equipment required for maintaining and troubleshooting hybrid systems and demonstrate proficiency in their use.</p>
Learning Outcome 4 (LO4)	Demonstrate safe isolation and maintenance procedures
Performance standards	<p>4.1 Explain general isolation procedure of the hybrid system for maintenance. (Also explain the correct sequence of switching on and switching off a hybrid system);</p> <p>4.2 Identify maintenance needs and service procedures for generators. (Discuss generic generator servicing schedules and check points.);</p> <p>4.3 Demonstration to include conducting of detailed service procedures for a generator in a hybrid system and updating of log books;</p> <p>4.4 Verify continuity of circuits in the hybrid system.</p>
Learning Outcome 5 (LO5)	Carry out troubleshooting on hybrid systems

Performance standards	<p>5.1 Discuss common fault on hybrid system;</p> <p>5.2 Measure system performance and operating parameters; compare with specifications and expectations, and assess operating condition of system and equipment;</p> <p>5.3 Demonstrate troubleshooting techniques on generators and auxiliary equipment. Discuss common electrical and mechanical faults on a generator;</p> <p>5.4 Perform diagnostic procedures and interpret results on faulty hybrid systems;</p> <p>5.5 Identify performance and safety issues, and plan safe isolation for repair or replacement;</p> <p>5.6 Develop procurement list including cost for repair or replacement;</p> <p>5.7 Perform safe isolation, service procedures and / or replacement of faulty components or faulty system.</p>
Learning Outcome 6 (LO6)	Carry out <i>testing</i> and <i>recording</i>
Performance standards	<p>6.1 Conduct visual inspection on entire system after maintenance and troubleshooting;</p> <p>6.2 Check system mechanical aspects for structural integrity and weather sealing if required;</p> <p>6.3 Check electrical system for proper wiring practice, polarity, security of terminations, and grounding if required;</p> <p>6.4 Test and verify of complete functionality and performance of system, including start-up, shut-down and normal operation;</p> <p>6.5 Compile and maintain records of system operation, performance, maintenance and troubleshooting;</p> <p>6.6 State the system documentation that should be provided to the system owners after maintenance including updating of maintenance records and preparation of a report (if required.)</p>
Pre-requisites	<ul style="list-style-type: none"> • Pass NS120-04 Determine sizing and installation of off-grid PV systems (SHS and Standalone PV systems)
Co-requisites	Concurrently attempt of NS124-04 Determine sizing and installation of off-grid PV systems (Hybrid system)
Underpinning skill and knowledge	<p>The following knowledge and skills underpin this unit standard:</p> <p>Knowledge:</p> <ol style="list-style-type: none"> 1. Safety of solar PV systems

	<ol style="list-style-type: none"> 2. Knowledge of safe-handling techniques for moving, hoisting, lifting, etc. of heavy structures 3. Knowledge of tools and equipment for solar installation 4. Knowledge of basic functions and components of solar PV systems 5. Basic knowledge of operating and maintaining solar PV systems 6. Knowledge of basic civil works involved in a solar PV set up. <p>Skills</p> <ol style="list-style-type: none"> 7. Safe working principles and equipment handling skills 8. Preparing to install, operate and maintain off-grid PV systems (hybrid systems)
<p>Assessment requirements</p>	<p>Methods of assessment:</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"> a) Direct observation of students performing certain tasks stated under context of assessment b) Oral questions to test relevant skills and knowledge during observation (e.g., Interviews) c) Written assessment such as tutorial exercises on important topics. d) Practical assessment: <p>Assessment of O&M skills to denote competency in off-grid PV hybrid systems</p>
<p>Moderation arrangements</p>	<ol style="list-style-type: none"> 1. Training providers must have their own moderation system approved by TNQAB before accreditation is granted: <ol style="list-style-type: none"> a) Relevant internal moderation processes are documented; b) Assessment is planned for each unit, and moderation processes are integrated into such plan 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"> a) Samples of assessed activities are submitted for moderation; b) Moderation (external) forms are available on request from the National Qualifications unit of TNQAB.
<p>Resource requirements</p>	<ol style="list-style-type: none"> 1. A PV/Genset hybrid system including all major equipment (battery, array, PV inverter and or solar controller, battery inverter and generator) and all associated equipment

(cabling, protection and isolating devices etc.). The system should reflect current industry practices in relation to installing and setting up hybrid systems. Both ac coupled and dc coupled configuration off-grid hybrid system need to be covered.

2. Worker's tools for undertaking installation

- Insulated screw-drivers
- Insulated pliers
- Cordless drill set with drill bits
- MC4 crimping tool
- Torque wrench
- Wire stripper
- Measuring tape
- Termination tools
- Heat gun
- Conduit bender
- Ratchet and socket set

3. Testing equipment

- DC multimeter
- Clamp meter (up to 20A d.c)
- Insulation resistance tester
- IV curve tracer
- Compass, irradiance meter, inclinometer
- IR camera

4. Personal Protection Equipment

- Harness
- Eye protection
- Apron
- Helmet
- Safety glasses
- Hand gloves

5. Recommended textbook:

- i. GSES, Stand Alone Power Systems: Design and Installation (8th ed.), Global Sustainable Energy Solutions Pty Ltd
- ii. Australia and New Zealand standards: AS/NZS 3000
- iii. Relevant national or regional technical guidelines including the Pacific Power Association/ Sustainable Energy Industry Association of Pacific Islands regional guideline: Hybrid Power Systems

	<p>(PV and Fuelled Generator) – System Design and Installation Guidelines</p> <p>iv. Relevant documentation comprising of manufacturer’s technical information such as data sheets, installation manual and user guides.</p>
<p>Requirements to complete this unit</p>	<p>To demonstrate competence, the person studying this unit is:</p> <ol style="list-style-type: none"> 1. Required to demonstrate all LOs to the expected standards of performance; 2. Required to attain an Achieved Grade (Competent) to fulfil the requirements of the Unit Standard. The person is required to be competent in the practical assessment to attain a pass grade in this unit. 3. Eligible to three (3) attempts in the practical assessment to achieve the required competency within 14 days of the first attempt. <p>Failure to achieve the required competency level after three (3) attempts of the specific part of the practical assessment will require the person studying this Unit to re-enrol for the same Unit.</p>
<p>Important notes and definitions</p>	<p>Notes:</p> <ol style="list-style-type: none"> 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. 3. The delivery of all units of competencies must be in sequential order and ensure that the pre-requisites requirements are met. <p>Definitions:</p> <ol style="list-style-type: none"> 1. <i>Cabling</i> refers to the physical assembly of multiple insulated electrical conductors (wires) grouped together within a single protective outer jacket. 2. <i>COMMs</i> (short for communications) refers to the digital transmission of data, signals, and commands between electrical devices, smart meters, and the power grid. 3. <i>Common fault</i> is any abnormal condition where electricity deviates from its intended path or fails to flow correctly in a circuit.

	<ol style="list-style-type: none"> 4. <i>Data logging</i> is the process of using specialized devices to continuously monitor and record electrical parameters such as voltage, current, and power consumption over specific period. 5. <i>Hazards</i> refer to any situation or dangerous condition where contact with electrical systems or exposed conductors can cause harm, injury, or property damage. 6. <i>Hybrid system</i> refers to a setup that combines two or more different power generation sources or generation combined with energy storage to create a more stable, reliable, and efficient power supply. 7. <i>Installation</i> is a connected assembly of electrical equipment and wiring designed to safely and efficiently distribute electricity throughout a structure. 8. <i>Occupational Health and Safety</i> refers to the policies, procedures and standards designed to protect workers from electrical hazards like shocks, electrocution, fires and arc flashes. It mandates safe work practices, proper equipment maintenance, and the use of personal protective equipment (PPE). 9. <i>Off-grid PV systems</i> is a standalone solar setup that generates and stores its own electricity without connecting to the public power grid. It relies entirely on solar panels to capture sunlight, batteries to store energy for use at night or on cloudy days, and an inverter to convert the power into usable. 10. <i>Polarity</i> refers to the directional orientation of electrical charge within a circuit, defining the positive and negative poles. It determines which direction the current flows. 11. <i>Replacement of system</i> refers to the process of upgrading, rewiring, or entirely swapping out older or faulty electrical components such as a fuse box, wiring, or a power grid with new, modern equipment that is safe and meets current safety codes.
<p>Public comments on unit</p>	<p>Please contact TNQAB National Qualifications Unit (email EnquireNQ@tnqab.to or Telephone 28136) if you like to discuss or suggest changes to the details of this unit.</p>