REGISTERED
NATIONAL STANDARD

UNIT OF COMPETENCY

Title:	**Apply basic concepts in Hybrid-wind for energy generation and consumption** 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 Pacific regional unit standard SE3302 (B) *Apply Basic Concepts in Renewable Energy for Energy Generation and Consumption*				
TQF Level:	3	**Credits:**	6	**Version:**	1
National standard code:	NS094-03				
Associated qualification (and code):	National Certificate in Sustainable Energy (Hybrid wind) Level 3 (QR-03-NQ-018-04-0504-23-01)				
Approval date:	27 April 2023	**Review date:**	27 April 2028		
Purpose:	This unit standard is for people who work, or intend to work in Energy and Energy related fields. Persons credited with this unit standard are able to: 1. Identify and describe the importance of social inclusion in energy and electrification; 2. Identify and describe basic processes of a Hybrid wind system and their applications; 3. Calculate the energy demand and wind resource requirements for a wind-based hybrid system; 4. Identify the environmental and social impacts of using wind-based hybrid system				

Learning Outcome 1 (LO1)	**Identify and describe the importance of *social inclusion* in energy and electrification**
Performance standards	1.1 Identify different social groups in Tonga society whose lives are affected by the availability of energy; 1.2 Explain why gender issues are relevant and important in sustainable energy development in Tonga (or any other Pacific Island you know a lot about); 1.3 Describe the differences in the ways men and women use domestic energy; 1.4 Identify two barriers to the participation of women in decisions related to domestic energy choices; 1.5 Identify factors that could determine the success of any small Hybrid-wind energy system at the household or community level in Tonga; 1.6 Explain how social inclusivity could improve the chances of success of any small Hybrid-wind energy system at the household or community level in Tonga
Learning Outcome 2 (LO2)	**Explain the basic processes in a wind-based hybrid system**
Performance Standards	2.1 Identify the main components that constitute the wind-based hybrid system which is being studied in this unit. *[*Range components include but not limited to*: wind turbine, solar photovoltaic cells, controllers, batteries, inverters, AC and DC loads,]* 2.2 Describe the function of each component of a wind-based hybrid system; 2.3 Identify the main energy conversion processes involved in the Hybrid system studied in this unit. *[*Range of processes include but not limited to*:* *1) Energy conversion by wind turbine - conversion from wind kinetic energy to electrical energy, or from kinetic energy to mechanical energy, etc.;* *2) Energy capturing and conversion by solar PV – light energy converted to electrical energy – the sun's energy is captured by PVs and changing it to DC electricity;* *3) Converting of DC to AC by a inverter;* *4) Storage of energy in a battery, etc. – involves the charging of storage batteries by the electrical energy either from the solar PVs or wind turbine;* *5) If a diesel generator is also part of the hybrid – then there is the process of energy conversion from chemical energy (in the fuel) to electrical energy that charges the batteries.]*

	2.4 Draw a simple process flow diagram detailing the functions of the components of the hybrid system studied in this unit as well as the key processes that take place in each 2.5 Explain the advantages of a wind-hybrid system as a preferred energy generating method for Tonga (or any other Pacific Island); 2.6 Explain the challenges of a wind-hybrid system as the preferred energy generating method for Tonga (or any other Pacific Island).
Learning Outcome 3 (LO3)	Calculate the *energy demand* for a domestic hybrid wind system.
Performance standards	3.1 Calculate a household's energy use (monthly and/or annually) from past electricity bills; 3.2 Develop an inventory of electrical appliances and equipment for a residential premises with regards to power rating, amperage, and voltage requirement; 3.3 Calculate the average energy demand of each appliance and equipment in 3.2 above; 3.4 Identify appliances and equipment that consume the most energy; 3.5 Calculate the total energy requirements of a household.
Learning Outcome 4 (LO4)	Explain the significance of the *swept area* of the blades of a turbine used in a hybrid-wind system
Performance standards	4.1 Define orally or in writing what it means by the *swept area* of a wind turbine; 4.2 Calculate the 'swept area' of a turbine; 4.3 Describe orally or in writing the relationship between the *power output* of an wind turbine and its 'swept area'; 4.4 Describe the significance of a turbine's 'swept area' to the viability of hybrid-wind systems.
Learning Outcome 5 (LO5)	Determine the wind resource requirements for a domestic hybrid-wind system
Performance standards	5.1 Identify the characteristics of a suitable site for a wind turbine; *[*Range characteristics include but not limited to*: constant access to the wind (e.g. facing prevailing wind) such as on top of a hill or tower; tower must be at least 10m higher than everything within 100m; no obstacles to wind flow; favourable wind speeds, etc.]* 5.2 Obtain and describe local (Tonga) wind speed data from relevant authority; 5.3 Identify the direction of Tonga's prevailing wind;

	5.4 Obtain and describe legal requirements regarding the construction of tall structures (e.g. towers) in Tonga; 5.5 Establish the *start-up wind speed*, *cut-in wind speed*, and *cut-out wind speed* for a domestic hybrid wind system; 5.6 Describe orally or in writing the *optimum wind speed* to generate electricity by a domestic hybrid-wind system.
Learning Outcome 6 (LO6)	**Understand the environmental and social impacts of using Hybrid wind energy**
Performance standards	6.1 Perform a simple *cost benefit analysis* of a hybrid wind system; 6.2 Outline the advantages of hybrid wind systems over other stand-alone energy generating systems; 6.3 Identify social, cultural, and governance issues that limit the use of small-scale hybrid wind systems in Tonga's rural communities such as the outer islands; 6.4 Explain how the limitations identified above can be addressed.
Pre-requisites	N/A
Co-requisites	N/A
Underpinning skills and knowledge	The following knowledge and skills underpin this unit standard: **Knowledge**: • Social inclusivity and sustainable development • Gender and sustainable energy • Conservation of energy and energy conversion processes • Wind turbine – swept area, swept area formula • Wind-based hybrid – basic operation; components and their functions • Wind resource requirements for wind energy generation • Energy demand for a household • Local legislations relevant to wind turbines and hybrid energy systems. • basic geography of Tonga and the Pacific region • local cultural norms and values • Using simple formulae to calculate **Skills:** • Siting of wind turbine • Basic operation of a hybrid-wind system • Inventory of household electrical appliances • Cost-benefit-analysis (of hybrid system)

	• Using a calculator
Assessment requirements	**Methods of assessment:** A range of assessment methods should be used to assess students' knowledge and application of skills, include but not restricted to the following: a) Direct observation of students performing certain tasks such as described in context of assessment b) Oral questions to test relevant skills and knowledge during observation and interviews; c) Written assessment such as: 1) Written theory tests on basic RE concepts 2) Student portfolios 3) Reports – such as work placement reports (by work place supervisor); reviews **Context of assessment:** To support student assessment and to ensure they are valid, reliable, flexible, and fair, provider institutions are 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 standards and competencies. Expected collaboration between provider institutions and the industry may include but not restricted to the following: • Experts from the industry have some input 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 organisations for workplace attachment; • Industry experts act as supervisors of students on workplace attachment • Etc. To show that a learner has 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 the Learning outcomes of the unit:

- LO1: Identify and describe the importance of social inclusion in energy and electrification.
- LO2: Explain the basic processes in a wind-based hybrid system.
- LO3: Calculate the energy demand for a domestic hybrid wind system.
- LO4: Explain the significance of the swept area of the blades of a turbine used in a hybrid-wind system.
- LO5: Determine the wind resource requirements for a domestic hybrid-wind system.
- LO6: Understand the environmental and social impacts of using Hybrid wind energy.

Examples:

1) A seminar presentation (or one-on-one interview) in which students are required to identify and describe the importance of social inclusion in energy and electrification, in terms of:
   (a) Differences in the opportunities available to different social groups (such as men vs women, young vs old) to sustainable energy development in Tonga (and the Pacific Islands), or
   (b) Differences in the ways men and women use domestic energy
   (c) Barriers experienced by different social groups (e.g. women) to participate in decisions making related to domestic energy choices;
   (d) Advantages (and disadvantages) of hybrid-wind systems or standalone wind energy systems at the household or community level in the Tonga.
2) An observation assessment (e.g. conducted outside beside a hybrid-wind system or during a field-trip) in which students are required to identify and describe the:
   (a) main components that constitute a hybrid wind system
   (b) roles of each component
   (c) advantages and disadvantages of a hybrid-wind system in terms of the Tongan context;
   (d) etc.
3) A written test in which students are required to:
   a) Calculate the:
      (i) 'swept area' of hybrid-wind system
      (ii) power available from a hybrid-wind system throughout the seasons of the year in Tonga;
   b) Identify the importance of having access to local data (such as long term wind and weather data)

	c) Estimate and explain the electrical power demand from a hybrid-wind system for a community over various timeframes. d) Assess the electrical power demand for a community and identify the variation in power demand over various timeframes; e) Discuss the choice of utilizing a hybrid wind system to meet the electrical power demand of the community over different timeframes. f) Provide a simple cost benefit analysis of the hybrid wind system 4) Oral or written assessment in which students are required to provide a simple economic and environmental assessment of the wind hybrid technology in the Tongan context, in terms of: (a) Potential resources and resource uses to be affected by installation, operation and decommissioning of the project (b) Potential economic growth and risks involved in implementing a hybrid wind system in Tonga using baseline reports and literature (c) Potential environmental growth and risks involved in implementing a hybrid wind system in Tonga using baseline reports and literature (d) Consultation processes conducted to justify economic and environmental assessment of the hybrid wind system in the Tongan context **Re-assessment** Candidates of assessment are eligible to three (3) attempts to achieve the required competency within 14 days of their first attempt: 1. Feedback must be provided to the candidate and sufficient time provided to prepare for re-assessment. 2. The trainer/assessor has the discretion to vary the assessment tasks used in each assessment attempt as long as the: a. same competencies are being assessed; b. principles of assessment are adhered to. 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.
Moderation arrangements	1. Training providers must have their own moderation system approved by TNQAB before accreditation is granted: a. Assessment is planned for each unit, and moderation activities are integrated into such activities; b. Relevant internal moderation processes are documented;

	2. External moderation is conducted by the National qualifications unit of TNQAB for all unit components of national qualifications; a. Samples of assessed activities are submitted for moderation; b. Moderation (external) forms are available on request from the National qualifications unit of TNQAB.
Resource requirements	1. Solar PV: Stand-alone, grid-tied, and hybrid Solar PV Systems; 2. Wind Systems: Small and Large Scale Horizontal axis wind turbine (HAWT) systems and Hybrid Wind Systems; 3. Energy Storage Systems: Lithium Ion Batteries, Lead Acid Batteries, etc.; 4. Charge Controllers: Pulse Width Modulation (PWM) or Maximum Power Point Tracking (MPPT) 5. Diesel generator. 6. Relevant printed resources on Renewable Energy for Energy Generation and Consumption (Hybrid wind) or wind-based hybrid systems at the discretion of the training provider or course/unit coordinator or trainer; 7. Computer, Printer, Internet Access 8. Conventional classroom furniture and resources - White/blackboard, tables or benches, chairs, student notice boards, A3 coloured cards or wall charts, scientific calculator.
Requirements to complete this unit	There are six (6) Learning outcomes and thirty-one (31) Performance standards to measure competence. To satisfy the required competence, the person studying this unit is: 1. Required to demonstrate ALL learning outcomes to the expected standards; 2. Required to attain an *Achieved Grade* (Competent) to fulfil the requirements of the Unit Standard; 3. Eligible to three (3) attempts to achieve the required competency within 14 days of the first attempt. Failure to achieve the required competency level after three (3) attempts of the exam or specific part of the assessment will require the person student to re-enrol for the same unit.
Important notes and definitions	**Notes:** 1. Due to safety issues inherent in working with electricity and combustible substances, all training and assessment activities must be in accordance with local industry and regulatory requirements;

2. In the event that local laws and regulations are not available, relevant laws of New Zealand or Australia should be used for training.
3. This unit of competency has been adapted the Pacific regional unit standard SE3302 (B) *Apply Basic Concepts in Renewable Energy for Energy Generation and Consumption*

Definitions:

1. *Conservation of energy* – is one important natural laws which state that energy cannot be created or destroyed but may be changed from one form to another.
2. *Cost Benefit Analysis* - refers to a procedure used to estimate costs and profits to be made from a business opportunity
3. *Cut-in wind speed* - refers to the lowest speed at which a turbine is able to generate any power. Most small turbines have a cut-in speed of around 3 or 4 m/s.
4. *Cut-out wind speed* – this refers to the maximum wind speed at which a turbine is designed to produce usable power. At this speed, a braking system, the operation of the turbine is discontinued to prevent damage. *Energy demand* - is the term used to describe the consumption of energy by human activity. When we talk about energy demand, we refer to all uses of energy: electricity, transport fuels and fuels for heating and industrial processes;
5. *Gender* refers to a range of characteristics pertaining to the state of being male or female (typically used with reference to social and cultural differences rather than biological ones).
6. *Optimum wind speed (for a wind turbine)* is the wind speed at which a turbine functions most efficiently.
7. *Power output* - is the average amount of energy which can be generated per unit time.
8. *Rated power* – refers to the maximum continuous rated power output as specified on the nameplate of a device or instrument
9. *Rated wind speed* – this is the speed at which the turbine produces its maximum 'rated power' output (typically around 11-13 m/s). The maximum capacity of a turbine is usually printed on its nameplate. For

	example, if 1.5 megawatts is the maximum power capacity specified on the nameplate, and the turbine generates this rated power (i.e. 1.5 megawatts) as soon as the wind speed reaches 12m/s then the 'rated wind speed' is 12 m/s. 10. *Social inclusion* – is the process by which efforts are made to ensure equal opportunities for everyone regardless of their background, can achieve their full potential in life 11. *Start-up wind speed* – refers to the lowest wind speed at which a wind turbine will begin rotation but not necessarily have a usable energy output. 12. *Sustainable Energy Development* - refers to the utilization of sustainable energy for economic development. *13. Swept area* refers to the area of the circle created by the blades of a turbine as they move (sweep) through the air. *14. Turbine* - is a rotating shaft (or rotor system) that changes the energy of flowing fluid (water, or steam, or air, or gas) into usable work or energy. Examples include *wind turbines*, *steam turbines*, and *hydro turbines.*
Public comments on unit	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.