



REGISTERED NATIONAL STANDARD

UNIT OF COMPETENCY

Title:	Apply basic concepts in biogas energy for energy generation and consumption <u>Notes:</u> <ol style="list-style-type: none"> 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) <i>Apply Basic Concepts in Renewable Energy for Energy Generation and Consumption</i> 				
TQF Level:	3	Credits:	6	Version:	1
National standard code:	NS100-03				
Associated qualification (and code):	National Certificate in Sustainable Energy (Biomass) Level3 (QR-03-NQ-018-03-0504-23-01)				
Approval date:	27 April 2023		Review date:	27 April 2028	
Purpose:	<p>This unit standard is for people who work, or intend to work in Energy and Energy related fields.</p> <p>Persons credited with this unit standard are able to:</p> <ol style="list-style-type: none"> 1. Identify and describe the importance of social inclusion in energy and electrification 2. Identify and describe basic processes of biogas digestion systems and their applications 3. Calculate the energy demand and feedstock requirements for a domestic-scale biogas digester under different regimes (temperature, feedstock, digester size etc.). 4. Identify the environmental and social impacts of using biomass energy 				

Learning Outcome 1 (LO1)	Identify and describe the importance of <i>social inclusion</i> in energy and electrification.
Performance standards	<p>1.1 Identify the different social groups in Tongan society whose lives are affected by the availability of energy;</p> <p>1.2 Explain why gender issues are relevant and important in sustainable energy development in the Pacific Islands;</p> <p>1.3 Describe the differences in the ways men and women use domestic energy;</p> <p>1.4 Identify two barriers to the participation of women in decisions related to domestic energy choices;</p> <p>1.5 Identify factors that could determine the success of any small-scale biogas system at the household or community level in Tonga;</p> <p>1.6 Explain how social inclusivity could improve the chances of success of any small biogas digester system at the household or community level in Tonga.</p>
Learning Outcome 2 (LO2)	Explain the basic processes of biogas digestion systems and their applications.
Performance Standards	<p>2.1 Identify the different processes involved in methane fermentation. <i>[Range processes include but not restricted to hydrolysis, acidification and methane formation].</i></p> <p>2.2 Describe the significance of each of basic processes identified in 2.1 above;</p> <p>2.3 Describe the mixture of gases that constitute “biogas”.</p> <p>2.4 Draw a simple process flow diagram showing the major components of a small-scale biogas digestion system. <i>[Range of components include but not restricted to ‘feedstock’; ‘collecting tank’; ‘inlet’ and ‘outlet’; ‘digester’; ‘gasholders’; ‘gas pipes’, ‘valves and accessories’; stirring apparatus; heating systems; pumps; weak ring; pig-pen and fresh-water collection and storage; end-use appliance].</i></p> <p>2.5 Identify the functions of each major component of the biogas digestion system in 2.4</p> <p>2.6 Discuss the advantages and disadvantages of a range of feed methods for biogas plants in terms of the Pacific community context: <i>[Range of feed methods include but not restricted to batch conversion; continuous flow; plug flow; semi-batch conversion; continuously stirred reactors]</i></p> <p>2.7 Explain the significance of a range of factors and their effect on the biogas process, in light of their use in the Pacific community context. <i>[Range of factors include but not restricted to: types of microbes; digestate temperature; nutrients; retention time; fluid dynamic/mixing; pH level; nitrogen inhibition and C/N Ratio; substrate solid content and agitation; inhibitory factors such as salt water]</i></p>

Learning Outcome 3 (LO3)	Calculate the energy demand and feedstock requirements for a domestic-scale biogas digester under different operating conditions (temperature, feedstock, digester size etc.)
Performance standards	<p>3.1 Determine the different kinds of energy requirements for a household (or community) to ensure they are met by a domestic scale biogas digester. <i>[Range of energy requirements include but not restricted to: Cooking requirements; Lighting requirements; Refrigeration requirements; Engine requirements; Miscellaneous requirements]</i></p> <p>3.2 Use a range of methods to calculate the <i>biogas generation potential</i> of a digester based on its biomass production. <i>[Range of methods include but not restricted to: measuring the biomass availability; determining the biomass supply via pertinent literature/ data; determining the biomass supply via regional reference data; determining biomass supply via user survey].</i></p> <p>3.3 Compare the energy demand against potential energy generation of a biogas system and decide on the size and viability of biogas plant.</p> <p>3.4 Describe how a wide range of local conditions affect the operation of a biogas system. <i>[Range of local conditions include but not restricted to type of end-user (e.g. household or farm or community), governance and management, climate, soil conditions, substrate for digestion and building material availability, technology, use of digestate as fertilizer, etc.]</i></p>
Learning Outcome 4 (LO4)	Understand the environmental and social impacts of using biomass energy.
Performance standards	<p>4.1 Perform a simple <i>cost benefit analysis</i> of a biogas system;</p> <p>4.2 Identify the compositions of sludge and its fertilizing effect;</p> <p>4.3 Outline the advantages of biogas replacing <i>fossil fuels</i>;</p> <p>4.4 Describe how the use of biogas systems can reduce the amount of methane released to atmosphere;</p> <p>4.5 Identify the limitations of small-scale biogas systems in rural and outer-island communities in the Pacific Island Countries;</p> <p>4.6 Describe how to address the limitations identified in 4.5 above.</p>
Pre-requisites	N/A
Co-requisites	N/A
Underpinning skills and knowledge	<p>The following skills and knowledge are required:</p> <p><u>Knowledge:</u></p> <ul style="list-style-type: none"> • Social inclusivity and sustainable development • Gender and sustainable energy • Conservation of energy and energy conversion processes

- Biogas system operation
- Energy demand – for household
- Local legislations relevant to Biogas systems.
- Basic geography of Tonga and the Pacific region
- Local cultural norms and values

Skills

- Basic operation of a small-scale biogas digester system.
- Inventory of household electrical appliances
- Siting of biogas system
- Cost-benefit-analysis

Assessment requirements

Methods of assessment:

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:

- a) Direct observation of students performing a seminar or 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:
 - 1) Maintenance and repair reports;
 - 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) Review 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 competencies. 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

	<ul style="list-style-type: none"> • Etc. <p>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:</p> <ol style="list-style-type: none"> a) LO1: Identify and describe the importance of social inclusion in energy and electrification. b) LO2: Explain the basic processes of biogas digestion systems and their applications. c) LO3: Calculate the energy demand and feedstock requirements for a domestic-scale biogas digester. d) LO4: Understand the environmental and social impacts of using biomass energy. <p><u>Re-assessment</u></p> <p>Candidates of assessment are eligible to three (3) attempts to achieve the required competency within 14 days of their first attempt:</p> <ol style="list-style-type: none"> 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: <ol style="list-style-type: none"> a) same competencies are being assessed; b) principles of assessment are adhered to. <p>Failure to achieve the required competency after three (3) attempts on the assessment or specific part of the assessment will require the person studying this unit to re-enrol for the same Unit.</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. Calculator. 2. Documents (such as manuals and wall-charts) showing relevant schematics, wiring and mechanical diagrams and equipment and cable/piping connection

	<p>schedules, site and architectural drawings and plans showing the location of biogas system services, apparatus, plant and machinery.</p> <ol style="list-style-type: none"> 3. Printed resources with relevant information the basic processes of biogas digestion system (such as anaerobic fermentation) and their applications; 4. Printed resources with relevant information on biogas feedstock requirements for domestic scale biogas digester, and how to calculate energy demand of a biogas plant. 5. Printed resources with relevant information on social, cultural and environment implications of energy and electrification initiatives;
<p>Requirements to complete this unit</p>	<p>There are four (4) Learning outcomes and twenty-three (23) Performance standards to measure competence.</p> <p>To satisfy the required competence, the person studying this unit is:</p> <ol style="list-style-type: none"> a. Required to demonstrate ALL learning outcomes to the expected standards; b. Required to attain an <i>Achieved Grade (Competent)</i> to fulfil the requirements of the Unit Standard; c. Eligible to three (3) attempts to achieve the required competency within 14 days of the first attempt. <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>Important notes and definitions</p>	<p><u>Legislation</u></p> <ol style="list-style-type: none"> 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) <i>Apply Basic Concepts in Renewable Energy for Energy Generation and Consumption</i> <p><u>Definition:</u></p> <ol style="list-style-type: none"> 1. <i>Biogas generation potential</i> refers to the likelihood of producing biogas from anaerobic digestion of a biomass. 2. <i>Biogas system</i> refers to the complete unit required for biogas production at a household level (apparatus and materials from feedstock collection through biogas production to storage/end use - including digestate collection/end use and may also include the use of a compressor for transfer and storage of gas). A basic economic analysis of a biogas system should consider the following (where appropriate): capital costs of the system tools, equipment and installation,

expected running costs of the system, expected replacement costs and a timetable for replacement of all system components.

3. *Civil Works* refers to work that involves civil engineering and construction of concrete base and digester including ducting for the biogas system, construction of digestate collection tanks and livestock pens.
4. *Cost-benefit analysis* – careful comparison of the costs and benefits of some kind of activity (a Biogas digester project), where both costs and benefits are expressed in monetary units. The outcome of such an analysis will show the net benefit (benefits minus cost) of such an intervention. For example:

Cost-benefit analysis of a new domestic biogas digester, with expected life of 10 years			
Costs		Benefits	
Total costs of equipment and resources	8,000.00	Sales (gas) 700.00 per year	7,000.00
Labour	5,000.00	Sales (fertilizer) 3,000.00 per year)	30,000.00
Renovations	5,000.00		
Net benefit (first 10 year) = 37,000.00 – 18,000.00 = \$19,000.00			

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. *Microbes* – refer to very small organisms (micro-organisms) which are present in nature. These micro-organisms are mostly bacteria and are responsible for breaking down organic matter. In a biogas digester, microbes are the ones responsible for the breaking down of feedstock to produce biogas.
7. *Sustainable Energy Development* refers to the utilization of sustainable energy for economic development.
8. *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

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.