Title	**Demonstrate knowledge of wind energy conversion systems**		
Level	**4**	**Credits**	**15**

Purpose	This unit standard covers knowledge of wind energy conversion systems suitable for residential and small community applications. People credited with this unit standard are able to: – describe the principles and attributes of small-scale Wind Energy Conversion System (WECS); – describe characteristics of the prevalent local wind patterns; – demonstrate knowledge of wind speed, and obtain, measure and apply direction data; and – describe considerations when determining the suitability of a site for a WECS.

Classification	Renewable Energy Systems > Renewable Energy Systems - Installation and Maintenance

Available grade	Achieved

Guidance information

1 This unit standard has been developed for learning and assessment off-job.

2 References
All Australian Standards (AS) may be found at https://www.standards.org.au/;
All Australian/New Zealand Standards (AS/NZS) may be found at http://www.standards.org.nz;
AS 4777.1:2005, *Grid connection of energy systems via inverters – Part 1: Installation requirements*;
AS 4777.2:2005, *Grid connection of energy systems via inverters – Part 2: Inverter requirements*;
AS 4777.3:2005, *Grid connection of energy systems via inverters – Part 3: Grid protections requirements*;
AS/NZS 3000:2007, *Electrical Installations (known as the Australian/New Zealand Wiring Rules)*;
AS/NZS 4509.1:2009, *Stand-alone power systems - Part 1: Safety and installation*;
AS/NZS 4509.2:2010, *Stand-alone power systems - Part 2: System design*;
and all subsequent amendments and replacements.

3 Definitions
a.c. – alternating current.
Current regulations and standards – in this unit standard this term is used to refer to

the requirements of the above references.
cO – output co-efficient.
cP – power co-efficient.
d.c. – direct current.
Enterprise policies and procedures – those practices and procedures that have been promulgated by the company or enterprise for use by their employees.
Industry practice – those practices that competent practitioners within the industry recognise as current industry best practice.
isovent – wind speed contours.
NIWA – National Institute of Water and Atmospheric Research.
OSH – Occupational Safety and Health.
OSH guidelines – Occupational Safety and Health guidelines for workplaces defined by Worksafe;
PV – photovoltaic.
PR – rated power
vC – cut-in speed.
vR – rated speed.
vF – furling wind speed.
WECS – Wind Energy Conversion Systems.

4 Range
- a All measurements are to be expressed in Système Internationale (SI) units, and where required, converted from Imperial units into SI units.
- b Candidates shall be supplied by the assessor with formulae involving more than three quantities.
- c Use of a calculator during assessment is permitted.
- d All activities must comply with any policies, procedures, and requirements of the organisations involved.
- e All activities and evidence presented for all outcomes and performance criteria in this unit standard must be in accordance with legislation, enterprise policies and procedures, ethical code, current regulations and standards, industry practice; and where appropriate, manufacturer's instructions, specifications, and data sheets.

5 It is recommended that candidates have been assessed against Unit 27433, *Demonstrate knowledge of renewable energy concepts and technologies* prior to assessment to this unit standard.

Outcomes and performance criteria

Outcome 1

Describe the principles and attributes of small-scale WECS.

Range terminology, units and symbols, wind turbines, operation, features, design factors.

Performance criteria

1.1 Define wind energy conversion system terms.

Range kinetic energy, specific wind power, vertical wind speed profile, surface roughness, temperature inversion layer, cut in (vC), rated (vR) and furling (vF) wind speeds, rated power (PR), power co-efficient (cP), output co-efficient (cO), tip speed ratio.

1.2 Describe major categories and sub-categories of WECS types.

1.3 Describe distinguishing features of different wind turbines.

Range horizontal axis, vertical axis, upwind, downwind, lift and drag propelled.

1.4 Compare the characteristics of different types of WECS in terms of power and torque, efficiency (power and output coefficients), solidity and tip speed ratio.

1.5 Describe advantages and disadvantages of each type of WECS.

Range three advantages and three disadvantages.

1.6 Describe the major specification criteria for a WECS.

1.7 Describe suitable materials for the construction of a WECS taking into consideration fatigue stresses and environmental conditions.

Range environmental conditions may include but are not limited to – salt air, humidity and ice.

1.8 Describe a typical WECS configuration and components for stand-alone power system.

1.9 Describe a typical WECS configuration and components for water pumping.

1.10 Describe strategies and/or mechanisms to control mechanical stresses on the WECS in gale force winds.

1.11 Describe strategies and/or mechanisms to control power output for battery charging.

Outcome 2

Describe characteristics of the prevalent local wind patterns.

Range direction, diurnal and seasonal patterns, the influence of topography, surface roughness, temperature inversions.

Performance criteria

2.1 Define wind characteristic terms.

Range weather charts, isobars, fronts and troughs, cyclone, anti-cyclone, atmospheric boundary layer, geotropic wind, gradient wind, wind shear, wind rose, roughness and displacement lengths.

2.2 Define quantitative measurement units and symbols used for wind and air density.

Range wind speed, specific wind power, air density.

2.3 Describe large scale wind patterns over New Zealand land areas, their causes and the effect of local terrain on wind speed, direction and turbulence.

2.4 Describe major features of the atmospheric boundary layer.

Range variation of wind speed with height according to Logarithmic and Power Laws, effects of surface roughness, atmospheric stability and temperature inversions, turbulence.

2.5 Identify prevalent local winds.

Range trade winds, sea and land breezes, katabatic and anabatic winds.

2.6 Describe likely effects on the prevalent local wind patterns in terms of local topography, surface roughness, isolated barriers and temperature inversions.

2.7 Describe typical diurnal, monthly and seasonal patterns of winds over the local area.

2.8 Describe the formation and likely effects of extreme winds and wind shear.

Outcome 3

Demonstrate knowledge of wind speed, and obtain, measure and apply direction data.

Performance criteria

3.1 Define terms relevant to wind speed.

Range porosity, internal boundary layer, speed-up factor, temperature inversion factor, wind speed frequency distribution, lull period, calms.

3.2 Describe methods of determining local and regional wind speed and direction data.

Range local records (e.g. NIWA data), ecological indicators, wind speed/energy maps.

3.3 Describe the measurement of wind speed and direction using data logging anemometers.

Range NIWA, data logging anemometers.

3.4 Describe the use of manufacturer's calibration curves to correct recorded data from anemometers.

3.5 Describe the use of software to calculate wind availability at a site from existing data or on-site measurements.

Range monthly average wind speed, yearly average wind speed, wind power density.

3.6 Describe the estimation of wind speed at a WECS tower of suitable height and location with given data.

Range wind speed data recorded at two or more elevations at the site, wind speed data recorded at one elevation and appropriate surface roughness, temperature inversion and speed-up factors at the site.

3.7 Describe the calculations for determining available wind power.

Range specific wind power for given wind speeds, wind speed at different heights above ground level, mean wind speed based on wind speed frequency distribution data in the form of a histogram.

3.8 Describe the minimum tower height for a Wind Energy Conversion System (WECS) sited downwind from an obstacle.

3.9 Interpret isovent maps.

3.10 Describe types of wind-measuring instruments and the minimum requirements for assessing wind energy at a given site.

3.11 Explain the power vs wind speed curve for a typical WECS in terms of vC, vR, vF, and PR.

Outcome 4

Describe considerations when determining the suitability of a site for a WECS.

Performance criteria

4.1 Describe local factors considered when selecting a WECS site.

Range topography, accessibility, surface roughness, shielding from isolated barriers (obstacles), turbulence, temperature inversions, power transmission distance, environmental and heritage impacts

4.2 Outline likely effects of local topography, surface roughness, isolated barriers and temperature inversions on a WECS at a given site.

4.3 Describe assessment of available local or regional wind data to determine the suitability of a site for a WECS.

Range wind speed, wind energy, wind direction.

4.4 Describe the use of a data logging anemometer to measure wind speed and direction over a sufficient period of time at an appropriate site and height(s) data.

4.5 Describe how recorded wind speed and direction data is analysed to determine if a site is suitable for wind energy utilisation.

4.6 Describe the use of tables or a nomogram to determine the size of a WECS for a given load, efficiency and annual mean wind speed.

Planned review date	31 December 2024

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	21 July 2011	31 December 2020
Review	2	24 October 2019	N/A

Consent and Moderation Requirements (CMR) reference	0003

This CMR can be accessed at http://www.nzqa.govt.nz/framework/search/index.do.

Comments on this unit standard

Please contact The Skills Organisation at reviewcomments@skills.org.nz if you wish to suggest changes to the content of this unit standard.