

1. Module details

Module name

Wind Energy Conversion Systems 2

Module duration

It is expected that students with the appropriate entry knowledge and skills will successfully complete this module in 40 hours.

Module code

NUER14

Discipline code

1105

2. Module purpose

This module provides training in the planning, system design, installation, commissioning and maintenance requirements of medium to large wind energy conversion systems connected to distribution grids for diesel generator systems for remote communities and / or larger grids.

3. Prerequisites

NUER06 – Wind Energy Conversion Systems 1;
NUER13 – Introduction to Distributed Generation

4. Relationship to competency standards

This module provides part of the underpinning knowledge and skills identified in the ‘Evidence Guide’ of specific units in the National Electro-technology Competency Standards. The relevant units are: NES411, NES709.

5. Content

1. Planning and implementing medium to large scale WECS according to AusWEA best practice guidelines:

Technical considerations:

Wind energy resource potential & detailed on-site wind energy monitoring

Site size, access, design and layout

Wind-diesel – load profile, control of gensets, and storage to optimise the wind contribution.

Grid connection requirements & constraints

Environmental considerations

Visual amenity

Noise levels and proximity to dwellings

Ecological, archaeological, historical issues

Conservation and recreation uses

RFI

Aircraft safety

Restricted areas

EIA process

EPBC Act implications

Site management – waste, restoration

Consultation processes:

- Land owner/s
- Local planning authority
- Local community
- Special interest groups

Legal considerations:

- Land ownership
- Lease and access easement arrangements
- Planning approvals
- Tender processes
- Electrical connection and energy purchase agreements
- Construction contracts
- Operation and maintenance contracts
- OH & S requirements

Economic considerations:

- Capital costs,
- Installation, operating and maintenance costs,
- Financing options,
- Return on investment and life cycle costing.

2. Site assessment in complex terrain

- Available of wind energy data or maps eg. GIS type systems
- Effectos of topography and surface roughness
- Computer models for wind energy analysis in complex terrain
- Environmental considerations
- Detailed on-site wind energy monitoring & data analysis
- Equipment calibration

3. WECS selection, performance and financial evaluation

Performance characteristics including:

- rotor diameter, Pr, Vc, Vr, Vf, Co, power VS wind speed curve
- Wind loading ratings according relevant codes such as AS1170.2
- Materials and construction

Wind turbine performance in wind-diesel systems:

- Load profile,
- System configurations,
- Capacity factor and wind penetration
- Control strategies for gensets

Energy storage to optimise wind contribution
Operational issues associate with the interaction of WECS
with small (diesel) grids eg. fault and stability issues.
Interconnection to grid requirements

Tower selection and installation:

Soil type and footings
Site access
Local government approvals
Environmental requirements
Appropriate codes such as AS1170.2
Transport of tower

Power control strategies:

Electrical – voltage, frequency, harmonics
Mechanical – start-up and shut-down.

Economic / financial viability for wind-diesel systems or grid applications:

WECS energy output by sector using computer models
Optimising tower height
Capacity factor
Selection of balance of system components
Installed capital costs, O & M costs, environmental costs,
Life cycle costs and return on investment,
Effect of Government subsidies

4. WECS Installation requirements

Road access and WECS/Tower transport
Erection method and crane type/size
Substation requirements
Lightning protection
OH & S requirements
Environmental and planning requirements

5. WECS Commissioning and operational monitoring

Commissioning and fault diagnosis procedures

WECS power output
Voltage regulation, frequency, harmonics
Transmission cable voltage drop
Manual and automatic furling
Start-up and shut-down
Noise levels

Compliance for planning, ongoing environmental monitoring and response to complaints.

OH & S requirements

Operation & maintenance schedules

6. Assessment strategy

Assessment methods

Assessment should encompass both progressive and holistic elements in recognition of the interdependence between learning outcomes and to ensure the module purpose is met. To assist in ensuring validity, reliability and fairness, assessment instruments should include both practical exercises and written exercises consisting of a number of item types, such as multiple choice, short answer and problem solving. A detailed site assessment project may serve as the major assessment item.

Conditions of assessment

Normally learning and assessment will take place in a classroom or laboratory environment.

7. Learning outcome details

Learning outcome 1

Outline the planning and implementation requirements for a large wind energy project according to AusWEA best practice guidelines.

Assessment Criteria

- 1.1 Describe briefly the major technical considerations including:
- Siting issues such as:
 - Land use
 - Ground conditions
 - Site access
 - Site design and layout
 - Grid connection requirements & constraints – eg. wind power penetration levels.
 - Wind-diesel systems – configurations, load profile, control of gensets and storage to optimise wind contribution.
- 1.2 Outline environmental considerations including:
- WECS site visual amenity, noise levels and proximity to dwellings, ecological, archaeological, historical issues, conservation and recreation uses, potential for RFI problems, aircraft safety, use of restricted areas.
 - EPBC act implications
 - Site management and waste disposal
 - Site restoration after decommissioning
- 1.3 Describe briefly the key elements of the EIA processes, approvals and on-going monitoring.
- 1.4 Describe briefly consultative processes required with:
- Land owners
 - Local and State government re planning consent
 - Local community
 - Special interest groups

Learning outcome 2

Assessment criteria

- 1.5 Outline legal and other contractual requirements including:
 - Land ownership
 - Lease and access easement arrangements
 - Planning approvals
 - Tender processes
 - Electrical connection and energy purchase agreements
 - Construction contracts
 - Operation and maintenance contracts
 - OH & S requirements

- 1.6 Identify economic considerations including:
 - Capital costs,
 - Installation, operating and maintenance costs,
 - Financing options,
 - Return on investment and life cycle costing.

Determine the suitability of a site in complex terrain for a WECS.

- 2.1 Evaluate the potential wind energy resource at a site taking into consideration:
 - Available of wind energy data or maps eg. GIS type systems
 - Local topography and vegetation
 - Surface roughness
 - Isolated obstacles
 - Temperature inversion effects
 - Speed-up effects over hills, ridges etc
- 2.2 Use an appropriate computer model/s to determine the likely wind energy potential from site wind speed and direction data analysis and projections in complex terrain.
- 2.3 Identify other siting issues according to AusWEA best practice guidelines including:
 - Land ownership and usage
 - Site size and layout
 - Electrical interconnection requirements & constraints.
- 2.4 Identify likely environmental considerations according to AusWEA best practice guidelines.

Learning Outcome 3

Assessment criteria

- 2.5 Undertake on-site wind energy monitoring and data analysis including:
 - Installation of anemometers and direction sensors at appropriate heights
 - Downloading and analysing the recorded wind speed frequency data by sector to estimate mean wind speed, Weibull shape and scale factors, Energy Pattern Factor, average wind power and energy density, turbulence intensity, vertical wind speed profile.
- 2.6 Outline calibration requirements for anemometers and wind direction sensors.

Undertake WECS selection, energy output performance analysis and financial evaluation.

- 3.1 Select appropriate wind turbine/s :
 - Performance characteristics including rotor diameter, P_r , V_c , V_r , V_f , C_o , power VS wind speed curve
 - Wind loading ratings according relevant codes such as AS1170.2
 - Materials and construction
- 3.2 Evaluate factors that effect wind turbine performance in wind-diesel systems including:
 - Load profile,
 - System configurations,
 - Capacity factor and wind penetration
 - Control strategies for gensets
 - Energy storage to optimise wind contribution
 - Operational issues associate with the interaction of WECS with small (diesel) grids eg. fault and stability issues.
 - Interconnection to grid requirements
- 3.3 Select an appropriate tower for the installation of a WECS taking into consideration:
 - Soil type and footings
 - Site constraints
 - Local government approvals
 - Environmental requirements
 - Appropriate codes such as AS1170.2
 - Transport of tower
- 3.4 Identify appropriate control strategies
 - Electrical – voltage, frequency, harmonics
 - Mechanical – start-up and shut-down, blade speed control.

	<p>3.5 Perform a detailed assessment of economic / financial viability for wind-diesel systems or grid applications including:</p> <ul style="list-style-type: none"> Analysis of commercial WECS energy output by sector using computer models Optimising tower height Capacity factor Selection of balance of system components Installed capital costs, O & M costs, environmental costs, Life cycle costs and return on investment, Effect of Government subsidies
<p>Learning outcome 4</p> <p>Assessment criteria</p>	<p>Outline requirements for large wind turbine installation.</p> <p>4.1 Outline the general and site specific installation requirements including:</p> <ul style="list-style-type: none"> Road access and WECS/Tower transport Erection method and crane type/size Substation requirements Lightning protection <p>4.2 Identify OH & S issues and strategies to address these.</p> <p>4.3 Outline requirements to meet environmental management and planning conditions.</p>
<p>Learning outcome 5</p> <p>Assessment criteria</p>	<p>Undertake WECS commissioning and operational monitoring for medium scale, wind-diesel systems.</p> <p>5.1 Undertake appropriate commissioning and fault diagnosis procedures to check all aspects of wind turbine system operation where practicable including:</p> <ul style="list-style-type: none"> WECS power output Voltage regulation, frequency, harmonics Transmission cable voltage drop Blade speed control Manual and/or automatic furling <p>Noise levels</p> <p>5.2 Outline compliance requirements for planning conditions, on-going environmental monitoring and response to complaints.</p> <p>5.3 Outline OH & S requirements.</p> <p>5.4 Prepare operation & maintenance schedules.</p>

8. Delivery of the module

Delivery strategy

Delivery strategies must be suitable for learning both theoretical and practical aspects described in the module purpose. It is considered that the most effective way to achieve this is by the integration of theory and practice where students learn by experimentation and through practical experience in working with real systems.

It is recommended that learning and assessment be facilitated in a holistic manner. A detailed site assessment project may serve as the major assessment item on which a large part of the teaching and learning will focus. This may also facilitate the integration of learning about individual process components. The learning outcome sequence may be other than that indicated in the module.

Resource requirements

Resources should be sufficient for students to carry out project work in pairs. Where necessary, this will require access to a range of commercially available system components, tools and measuring instruments, as well as access to sites or training facilities for system installation and maintenance. Copies of all relevant standards are required and appropriate software for site assessment and system performance analysis and life cycle costing.

Occupational health and safety requirements

A safe and healthy environment will be provided for students and teachers as well as safety procedures with regard to learning / teaching activity according to local OH&S regulations.

In the delivery of this module, the following Occupational Health and Safety issues are to be addressed in the appropriate learning outcome(s):

General:

- Lifting and carrying
- Eye/skin/ear protection
- Use of power tools
- Climbing eg ladders/towers and WECS to avoid injury due to falls and blade rotation, WECS yawing, falling objects such as tools.
- Keeping work areas tidy
- Rigging procedures for WECS and towers

Electrical:

- Use of measuring meters
- isolation procedures

Minimum physical resources

use of ladders

During site visits and practical work, the participation of students not holding a current electrical license must be limited to appropriate safe activities.

Two (2) data logging anemometers and one (1) direction sensor,

Mast-to-mount anemometers (preferably at least 20m high),

Computer software for analysis of wind speed and direction data and assessment WECS monthly and annual energy output,

Access to a medium to large WECS of greater than 20 kW Rate Power or blade diameters of greater than 10 metres, with appropriate balance of system components including:

- Genset/s,
- Interactive inverter/s,
- Battery storage,
- Load dump.

Appropriate metering to measure the WECS instantaneous power output and energy output over time.

Appropriate meters, tools and safety equipment to undertake commissioning, fault finding and maintenance.

Recommended References

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Standards Australia (1989) *AS1170.2 Wind Forces – Part 2*. Available from Standards Australia.

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