

1. Module details

Module name

Introduction to Distributed Generation

Module duration

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

Module code

NUER13

Discipline code

1105

2. Module purpose

This module provides an introduction to distributed generation issues relevant to photovoltaic and wind turbine installations, co-generation systems and other distributed generation technologies.

3. Prerequisites

NUER02 – Photovoltaic Power Systems;
NE42 – Generation and Distribution of Electrical Energy

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 Electrotechnology Competency Standards, namely NES411 - Assess renewable energy apparatus and systems and NES709 - Design a renewable energy system.

5. Content

Distributed generation basics

- Structure of the existing generation, transmission and distribution system
- Definition of distributed generation (DG)
- Overview of benefits, issues and impacts of DG
- DG technologies

Electrical power distribution systems – operation

- Electrical characteristics of feeders
- Causes of voltage problems in a power distribution system
- Voltage regulation limits
- Example calculations for feeder voltage drops
- Methods of voltage control
- Fault types, causes and effects
- Determination of fault levels
- Fault level limitation

Protection and relaying

- Protection system purpose and features
- Application of protection in a distribution network
- Protection system terminology
- Feeder protection systems - overview

Distributed generation issues:

- Utility requirements for interconnection
 - Safety of personnel
 - Islanding
 - Grid Stability
- Voltage regulation
- Potential benefits of DG
- Limitations in design of distribution circuits (designed for 1-way operation)
- Match between supply and demand
- Operation: dispatchable and non-dispatchable supplies
- Factors affecting the sizing of distributed generation
- Use of energy storage
- Case studies
- Renewable energy supplies – issues
 - Limits to penetration
 - Factors affecting the value of renewables on the grid
 - Implications of renewable input on power system operation
- Connection of energy systems via inverters: AS 4777

Non-technical issues

- Factors affecting the uptake of distributed generation
- Institutional factors
- Regulatory factors
- Policy including mandated targets
- Green power market
- Financial issues
- Contractual issues
- Case studies

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 consist of a number of item types, such as multiple choice, short answer, and case study analysis.

Conditions of assessment

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

7. Learning outcome details

Learning outcome 1

Describe the main features of distributed generation.

Assessment criteria

- 1.1 Describe the main features of distributed generation in contrast with centralised generation systems.
- 1.2 List the main technologies used or potentially usable for distributed generation.

Learning outcome 2

Describe the main features of the operation of power distribution systems.

Assessment criteria

- 2.1 Describe the predominant electrical characteristics of overhead transmission and distribution feeders.
- 2.2 Describe the predominant electrical characteristics of underground transmission and distribution feeders.
- 2.3 List the type of voltage problems which may occur in distribution systems, and their causes.
- 2.4 List the accepted levels of voltage regulation for transmission and distribution feeder systems, taking into account local requirements.
- 2.5 List the methods used for overcoming voltage problems.
- 2.6 List the types of electrical fault that occur on a power distribution system.
- 2.7 Describe the cause and effect of the electrical faults that occur on a power distribution system.
- 2.8 Given the source impedance or fault capacity, calculate the three-phase symmetrical fault level at a given point in a power distribution system.
- 2.9 List the reasons for fault level limitation at particular points in a power distribution system.
- 2.10 Describe typical causes and effects of voltage surges in a power distribution system.

Learning outcome 3

Describe the main features of protection systems used in the distribution network.

- 3.1 Outline the purpose of protection systems in a power distribution system.
- 3.2 List the major parts of a distribution system to which protection is applied.
- 3.3 Define the following terms in relation to protection systems: reliability, selectivity, protection zones, speed, stability, sensitivity, primary protection and back-up protection.
- 3.4 Outline the major types of protection used on distribution feeders.

Learning outcome 4

Describe the major technical issues relating to the implementation of distributed generation.

Assessment Criteria

- 4.1 List the major technical considerations affecting utility requirements for interconnection.
- 4.2 Define the meaning of the terms stability and islanding in relation to grid operation.
- 4.3 Describe the general requirements for ensuring the safety of personnel in relation to islanding.
- 4.4 Outline the protection systems required on distributed generators.
- 4.5 Outline the benefits that distributed generation may provide to a power distribution system.
- 4.6 Outline the limitations of distribution circuit design in relation to distributed generation and voltage regulation.
- 4.7 Outline the implications of match or mismatch between distributed generation supply profile and demand profile.
- 4.8 List the factors affecting the sizing of distributed generators.
- 4.9 Outline the role of energy storage in power distribution systems incorporating distributed generation.
- 4.10 Outline typical limits to penetration of renewable energy supplies into existing grids, and the factors affecting these.
- 4.11 Outline the scope and content of AS 4777.

Learning outcome 5

Outline the major impacts of non-technical issues on a particular distributed generation project.

Assessment criteria

5.1 Outline the major impacts of non-technical issues on a particular distributed generation project, using a published case study or other sources of information.

8. Delivery of the module

Delivery strategy

Delivery strategies should encompass the presentation of theoretical material along with extensive use of documented case studies to illustrate relevant principles. Strategies should also include field trips or other exposure to real systems, to facilitate the grounding of theoretical knowledge.

It is recommended that learning and assessment be facilitated in a holistic manner. The learning outcome sequence may be other than that indicated in the module.

Resource requirements

Copies of all relevant standards are required.

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.

Minimum physical resources

Access to at least one distributed generation installation, such as co-generation site, wind farm, large commercial or utility scale photovoltaic installation, mini-hydro system, micro-turbine or fuel cell installation, internal combustion engine genset installation.