# Next Generation Higher National Unit Specification

## Renewable Energy: Generation, Storage and Transmission (SCQF level 8)

**Unit code:** J7C5 48

**SCQF level:** 8 (24 SCQF credit points)

**Valid from:** session 2024 to 25

## Prototype unit specification for use in pilot delivery only (version 2.0) December 2024

This unit specification provides detailed information about the unit to ensure consistent and transparent assessment year on year.

This unit specification is for teachers and lecturers and contains all the mandatory information required to deliver and assess the unit.



This edition: December 2024 (version 2.0)

# Unit purpose

This unit provides an opportunity for learners to study and understand the need for renewable, non-fossil fuel energy, and the wide range of renewable energy generation methods that are in commercial use and development. Learners develop an understanding of how these methods operate and their advantages and disadvantages, and extend their knowledge and understanding of electrical principles related to storage and transmission.

The target learner group for the unit want to develop their knowledge of engineering in the field of renewable energy. It could also be relevant for those considering careers in mechanical, electrical or engineering systems. You could use the unit as a stand-alone learning opportunity for industry-related training.

Entry to the unit is at your centre's discretion. However, we recommend that learners already have a clear understanding of the concepts of kinetic (linear and rotational), potential, heat and electrical energy. They should be able to perform calculations linking energy conversions between these energy types and understand the concept of efficiency. An understanding of the fundamental principles of electricity would also be advantageous. They could show this by having completed an appropriate Engineering or science-based HNC, or relevant industrial experience.

The unit provides learners with suitable knowledge and skills to progress to further study, or employment in the renewable energy sector at technician level.

# Unit outcomes

Learners who complete this unit can:

1 outline a holistic overview of the global energy supply situation
2 analyse a range of renewable energy generation methods
3 describe, with the aid of diagrams, a range of electrical and hydrogen generators
4 describe, with the aid of block diagrams, energy transmission and storage methods

## Evidence requirements

You should assess the unit holistically. Evidence should principally consist of written and/or oral recorded evidence. Learners generate evidence under controlled or supervised, open-book conditions, and it must be authenticated as being all their own work. The evidence must contain a mix of knowledge and skills items that matches the evidence requirements of the unit, and include various forms of evidence, such as:

- assignments
- case studies
- reports
- essays
- simulations
- structured controlled tests
- practical evidence
- other relevant sources of evidence

To successfully achieve the unit, learners must provide evidence for the following outcomes.

### Outcome 1

- Describe the need for renewable energy.

### Outcome 2

- Analyse a range of renewable energy generation methods.

### Outcome 3

- Calculate the efficiency of electric generators.
- Describe the operation of hydrogen generators.

### Outcome 4

- Describe and evaluate energy transmission and storage methods.

# Knowledge and skills

The following table shows the knowledge and skills covered by the unit outcomes:

| Knowledge | Skills |
|---|---|
| **Outcome 1**<br>Learners should understand:<br><br>♦ why there is a need to generate electricity by low carbon means, and the historical development of renewable generating methods<br>♦ negative environmental effects of using fossil and nuclear fuel<br>♦ how sustainable development has increased in importance, with reference to the United Nations Environment Programme<br>♦ the increase in $CO_2$ levels from pre-industrial times and forecast future rises, and the role it and other greenhouse gases play in global warming and climate change<br>♦ a range of carbon sequestration methods<br>♦ the roles of a range of national and international agencies, and their agreements, protocols and policies | **Outcome 1**<br>Learners can:<br><br>♦ describe the need for renewable energy to be supplied in sufficient quantity for modern life to continue to develop in a sustainable way<br>♦ quantify the approximate levels of atmospheric $CO_2$ and other greenhouse gases from pre-industrial times to the present, and predict them into the near future<br>♦ evaluate a range of carbon sequestration methods and discuss their relative effectiveness<br>♦ summarise the roles of national and international agencies, whose remits oversee the introduction of new and additional renewable energy sources<br>♦ demonstrate skills in quantitative analysis |

| Knowledge | Skills |
|---|---|
| **Outcome 2**<br>Learners should understand:<br><br>♦ the planning sequence and permissions required to develop one type of renewable energy generation system<br>♦ the operation, advantages, disadvantages and potential levels of output of:<br>— wind power (on and offshore, horizontal and vertical axis)<br>— hydroelectric power including pump storage<br>— tidal power<br>— wave power<br>— solar power (photovoltaic and thermal)<br>— geothermal<br>— ground and air source heat pumps<br>— biomass<br>— waste heat recovery<br>— emerging technologies including hydrogen | **Outcome 2**<br>Learners can:<br><br>♦ identify a range of renewable energy generation methods<br>♦ explain the operation of a range of common renewable energy generation methods<br>♦ debate the advantages and disadvantages of a range of common renewable energy generation methods<br>♦ propose improvements to existing methods or create new methods of renewable energy generation |
| **Outcome 3**<br>Learners should understand:<br><br>♦ how a range of types of electrical and hydrogen generators operate<br>♦ the operation of a range of types of electricity and hydrogen generators, and their output type<br>♦ the following terms:<br>— magnetic field strength<br>— pole<br>— permanent magnet<br>— separately excited<br>— brush<br>— slip ring<br>— commutator<br>— electrolysis<br>— energy cell | **Outcome 3**<br>Learners can:<br><br>♦ perform calculations predicting generator outputs and efficiencies from given energy inputs; for example, predictions of the output and efficiency from a solar PV array of given size<br>♦ describe the operation of hydrogen fuel cells |

| Knowledge | Skills |
|---|---|
| **Outcome 4**<br>Learners should understand:<br><br>♦ how electricity generated at dispersed sites around the country is transmitted over the National Grid's network in a safe and efficient way<br>♦ how energy can be stored using a variety of methods such as:<br>— pumped storage<br>— Gravitricity<br>— super capacitors<br>— massive batteries<br>— electrolysing water into hydrogen gas | **Outcome 4**<br>Learners can:<br><br>♦ describe the structure of the National Grid's electricity transmission and distribution system<br>♦ describe the operation of transformers and perform simple step-up and step-down calculations<br>♦ understand the need for and operation of AC/DC and DC/AC conversions<br>♦ evaluate renewable energy storage methods, and create ideas for improvements to existing methods or new methods |

# Meta-skills

Throughout the unit, learners develop meta-skills to enhance their employability in the engineering sector.

## Self-management

Learners develop the meta-skills of integrity, adapting and initiative as they focus their research on specific topics in depth throughout the unit. Learners take initiative by creating proposals for developments in renewable energy generation and storage.

## Social intelligence

Learners develop the meta-skill of communicating when participating in group work, using a virtual learning environment (VLE) and writing technical reports. Learners could debate topics such as:

- sustainability
- rates of decarbonisation
- compensation for nations affected by climate change
- pros and cons of nuclear power
- carbon capture and sequestration

Learners develop feeling, empathy and social conscience when developing new sites for renewable generation by considering NIMBYism and those affected by extreme climate events.

## Innovation

Learners develop the meta-skill of curiosity through research, observation and questioning. Throughout the unit, they develop critical thinking skills, with divergent thinking during the creative process, followed by convergent thinking and synthesis through innovation and problem-solving activities.

# Literacies

Learners develop core skills in the following literacies:

## Numeracy

Learners develop numeracy skills by carrying out quantitative analysis of energy conversions, and generator and transformer performances and efficiencies.

## Communication

Learners develop communication skills during class learning activities and by writing on a theme of their choice. You could incorporate opportunities for group work.

## Digital

Learners develop digital skills and computer literacy by carrying out internet-based research on related topics and checking the veracity of sources. Learners could use computer-aided design (CAD) packages, presentation and word processing applications, and statistical analysis software.

# Delivery of unit

This unit is part of the Higher National Diploma (HND) in Engineering. The framework includes mandatory and optional units, and you can tailor the selected combination of units to specific engineering pathway needs.

While the exact time allocated to the unit is at your centre's discretion, the notional design length is 120 hours.

You could expand the project from this unit to meet the criteria of the mandatory unit Professional Practice in Engineering (SCQF level 8), where, for example, you could develop the generation and transmission section more fully.

# Additional guidance

The guidance in this section is not mandatory.

## Content and context for this unit

This unit gives learners an overview of the renewable energy scene at the time of study. It is designed to allow for changes in government policy and international protocols, and developments in the renewable energy sector. As such, you should keep the teaching current by regularly updating teaching materials to incorporate changes and developments. You could do this by encouraging weekly class discussions on news events.

Learners gain an understanding of the dynamic nature of the renewable energy sector, and this should enable them to focus on a particular area that is of interest to them. They should gain an understanding of the historical development of renewable generating methods, and how their tendency for distribution around geographically remote areas has caused transmission issues within the electricity distribution grids. Learners should have the opportunity to develop their own creative thinking and design skills in the context of improving existing methods and/or innovating new methods. They should also gain an understanding of the intellectual property rights process as part of this.

## Required resources

As well as internet access to enable learners to conduct up-to-date research, real-life case studies would be of real benefit. These could be in the form of operating test rigs within a college or university environment, or visits to external facilities such as local energy schemes or wind farms. You could develop links to community organisations that have ownership of renewable energy sources such as watermills, micro-hydro schemes and individual wind turbines.

## Approaches to delivery

You should deliver the outcomes in order, as the sequence follows a logical progression.

You should deliver the unit in a learning space or through a VLE.

You could start the teaching with an introductory talk, either by yourself or a guest speaker, which could lead on to individual or group research projects focusing on case studies or individual topics. You could ask learners to report back in the form of a short presentation, or collate their research into their assessment project.

## Approaches to assessment

We recommend that you assess this unit holistically. The assessment should allow learners to clearly demonstrate their understanding of the chosen theme, as well as problem-solving skills development. Their responses should include evidence of correctly performed associated calculations, for example, of predicted outputs or efficiency savings.

Because of the open-book nature of the assessment, you must take care to ensure authenticity. You could do this by using variable values in projects and coursework, making use of oral questioning, and using originality-checking software.

Learners could choose one of the following types of project assignment and produce an investigative report that demonstrates a clear understanding and numerical analysis of the selected theme.

### Option 1: Existing system performance analysis

Learners include suggestions for improvements that could increase the efficiency of the existing system. The existing system could be a micro-hydro power station, a solar meadow or farm, a domestic solar PV system, or any other system for which the learner can access the required information or collect data safely.

### Option 2: Innovation

Learners design and model (virtually or physically) a new renewable energy capture or storage method, or a significant development to an existing one. They should demonstrate an understanding of the intellectual property rights associated with any developments.

### Option 3: Investigative case study

Learners investigate and report on a company or organisation involved in the generation or storage of renewable energy. They could complete this as part of a work placement or internship.

# Equality and inclusion

This unit is designed to be as fair and as accessible as possible with no unnecessary barriers to learning or assessment.

You should take into account the needs of individual learners when planning learning experiences, selecting assessment methods or considering alternative evidence.

Guidance on assessment arrangements for disabled learners and/or those with additional support needs is available on the assessment arrangements web page: www.sqa.org.uk/assessmentarrangements.

# Information for learners

## Renewable Energy: Generation, Storage and Transmission (SCQF level 8)

This information explains:

- what the unit is about
- what you should know or be able to do before you start
- what you need to do during the unit
- opportunities for further learning and employment

## Unit information

This unit gives you the opportunity to learn about the subject area of renewable energy, which is of ever-increasing importance for the sustainability of life on this planet. You find out why renewable energy is so important, and why we need to reduce the use of fossil fuels as quickly as possible. You then explore a range of ways of generating electricity and hydrogen that can be used to replace fossil fuels.

You develop debating skills as you discuss the relative advantages and disadvantages of the different methods, and compare them with nuclear power, which is seen as a renewable source by some but not by others.

After learning about generating power, you learn about how the power is transmitted across the country before it is distributed to domestic and industrial users within local areas. You also learn about how power can be stored; for example, so that wind turbines can be used whenever there is wind, even if demand is low at that time, and the power stored for use later when demand is high.

You should have a good understanding of the concepts of kinetic energy, potential energy, heat energy and electrical energy before you start the unit. You should be able to perform calculations on these topics and understand the concept of efficiency. You could show this by having completed an appropriate Engineering or science-based HNC, or relevant industrial experience.

On completion of the unit, you can:

1 outline a holistic overview of the global energy supply situation
2 describe a range of renewable energy generation methods
3 describe, with the aid of diagrams, a range of electrical and hydrogen generators
4 describe, with the aid of block diagrams, energy transmission and storage methods

You are assessed holistically, meaning you demonstrate evidence of all the knowledge and skills in the context of renewable energy generation and its storage and distribution.

The unit provides you with suitable knowledge and skills to progress to further study, or employment in the renewable energy sector.

## Meta-skills

Throughout the unit, you develop meta-skills to enhance your employability in the engineering sector. Meta-skills include self-management, social intelligence and innovation.

### Self-management

You develop the meta-skills of integrity, adapting and initiative as you focus your research on specific topics in depth throughout the unit. You can take initiative with proposals for developments in renewable energy generation and/or storage.

### Social intelligence

You develop the meta-skill of communicating through participating in group work, working in a virtual learning environment (VLE) and writing technical reports. You could debate the topics of sustainability, rates of decarbonisation, compensation for nations affected by climate change, pros and cons of nuclear power, and carbon capture/sequestration.

You also develop feeling, empathy and social conscience when developing new sites for renewable generation by considering NIMBYism and those affected by extreme climate events.

### Innovation

You develop the meta-skill of curiosity through research, observation and questioning.

Throughout the unit you develop critical thinking skills, with divergent thinking during the creative process, followed by convergent thinking and synthesis through innovation and problem-solving activities.

# Administrative information

**Published:** December 2024 (version 2.0)

**Superclass:** QB

## History of changes

| Version | Description of change | Date |
|---|---|---|
| 2.0 | ♦ Evidence requirements updated to clarify conditions of assessment. | Dec 2024 |
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Note: please check SQA's website to ensure you are using the most up-to-date version of this document.