

SQA Advanced Unit Specification

General information

Unit title: Energy Technologies

Unit code: HT1L 48

Superclass: QB

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Version: 01

Unit purpose

The Unit is designed to enable learners to develop knowledge and understanding in a range of technologies related to energy production on an industrial scale. Traditional, renewable and emerging and/or less common technologies will be considered in relation to key components, principles of operation, operational aspects and environmental and sustainability factors as appropriate.

The Unit is optional for learners in Engineering-related SQA Advanced Awards. It could also be used as a stand-alone Unit where appropriate.

Outcomes

On successful completion of the Unit the learner will be able to:

- 1 Analyse the technologies and factors associated with traditional methods of energy production.
- 2 Analyse the technologies and factors associated with renewable methods of energy production.
- 3 Describe the technologies and factors associated with emerging and/or less common sustainable methods of energy production.

Credit points and level

1 SQA Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8).

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Recommended entry to the Unit

While entry is at the discretion of the centre, learners would normally be expected to have attained the entry requirements specific to the SQA Advanced Certificate/Diploma award.

Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes for this Unit specification.

There is no automatic certification of Core Skills or Core Skill components in this Unit.

Context for delivery

If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

SQA Advanced Unit Specification: Statement of standards

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Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the Knowledge and/or Skills section must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Analyse the technologies and factors associated with traditional methods of energy production.

Knowledge and/or Skills

- ◆ Components, principles of operation, operational aspects, energy produced and environmental and sustainability factors associated with:
 - coal based technologies
 - gas based technologies
 - oil based technologies
 - nuclear based technologies

Outcome 2

Analyse the technologies and factors associated with renewable methods of energy production.

Knowledge and/or Skills

- ◆ Components, principles of operation, operational aspects, energy produced and environmental and sustainability factors associated with:
 - onshore wind turbines
 - offshore wind turbines
 - catchment based hydroelectric schemes
 - pumped storage based hydroelectric schemes
 - solar photovoltaic based technologies
 - solar thermal based technologies
 - biomass based technologies

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Outcome 3

Describe the technologies and factors associated with emerging and/or less common sustainable methods of energy production.

Knowledge and/or Skills

- ◆ Components, principles of operation, operational aspects and environmental and sustainability factors associated with:
 - tidal based schemes
 - wave based schemes
 - geothermal based schemes
 - waste based technologies

Evidence Requirements for this Unit

Outcome 1

Evidence for the Knowledge and/or Skills in this Outcome will be generated through sampling. Each learner will need to provide evidence to demonstrate they can analyse two of the four technologies and factors associated with traditional methods of energy production. The evidence should be responses to specific questions.

To ensure that learners will not be able to foresee all the items they will be questioned about, a different sample should be used on successive assessment occasions. The new sample may contain a maximum of one of the Knowledge and/or Skills used in the previous assessment occasion.

A learner's response can be judged to be satisfactory where the evidence shows that the learner can:

- ◆ Describe the key components of the chosen technology.
- ◆ Explain the principles of operation of the chosen technology.
- ◆ Explain the operational aspects of the chosen technology.
- ◆ Describe the environmental and sustainability factors of the chosen technology.
- ◆ Determine the energy produced using supplied data for the chosen technology.

Evidence should be generated through a closed-book assessment under supervised conditions.

Outcome 2

Evidence for the Knowledge and/or Skills in this Outcome will be generated through sampling. Each learner will need to provide evidence to demonstrate they can analyse three of the seven technologies and factors associated with renewable methods of energy production. Each sample should consist of one wind and one hydro technology plus one from either solar or biomass. The evidence should be responses to specific questions.

To ensure that learners will not be able to foresee all the items they will be questioned about, successive assessment occasions should contain a different sample. As before, the requirement for one wind and one hydro to be included is valid although the choice of which wind (onshore or offshore) and which hydro (catchment or pumped storage) may be changed. The same solar technology cannot be used on the next assessment occasion. If

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biomass technology was used in the assessment occasion then one of the solar technologies must be used on the next assessment occasion

A learner's response can be judged to be satisfactory where the evidence shows that the learner can:

- ◆ Describe the key components of the chosen technology.
- ◆ Explain the principles of operation of the chosen technology.
- ◆ Explain the operational aspects of the chosen technology.
- ◆ Describe the environmental and sustainability factors of the chosen technology.
- ◆ Determine the energy produced using supplied data for the chosen technology.

Evidence should be generated through a closed-book assessment under supervised conditions.

Outcome 3

Evidence for the Knowledge and/or Skills in this Outcome will be generated through sampling. Each learner will need to provide evidence to demonstrate they can describe two of the four technologies and factors associated with emerging and/or less common sustainable methods of energy production. The evidence should be responses to specific questions.

To ensure that learners will not be able to foresee all the items they will be questioned about, a different sample of technologies should be used on successive assessment occasions. The new sample may contain a maximum of one of the technologies used in the previous assessment occasion.

A learner's response can be judged to be satisfactory where the evidence shows that the learner can:

- ◆ Describe the key components of the chosen technology.
- ◆ Explain the principles of operation of the chosen technology.
- ◆ Explain the operational aspects of the chosen technology.
- ◆ Describe the environmental and sustainability factors of the chosen technology.

Evidence should be generated through a closed-book assessment under supervised conditions.

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SQA Advanced Unit Specification:Support notes

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Unit Support Notes are offered as guidance and are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

This Unit is designed to introduce some of the current and emerging or less common technologies used in energy production. Traditional methods (coal, oil, gas and nuclear) and renewable methods (wind, solar, hydro and biomass) will be described in terms of principle of operation, system components, operational aspects and environmental and sustainability factors. Emerging and less common technologies (tidal, wave, geothermal and waste) will be described in terms of principle of operation, system components, operational aspects and environmental and sustainability factors.

Outcome 1

It is suggested that the following technologies be used in the delivery of this Outcome:

- Coal: Pulverised coal combustion (PCC)
- Gas: Combined cycle gas turbine (CCGT)
- Oil: Crude oil combined cycle
- Nuclear: Pressurised water reactors (PWR)

For each of the four technologies, diagrams should be used showing the key components in the energy conversion process from input through to output. Each stage in the process should be explained in terms of its function/operation. Operational aspects should include typical overall plant efficiencies, start-up time, utilisation for base or peak loads, reliability of supply and CO₂ emissions per Unit of energy generated (gCO₂/kWh). Environmental and sustainability factors and the significance of each will vary depending on the technology but would typically include several of the following:

- ◆ Use of finite fossil fuels
- ◆ CO₂ released into atmosphere
- ◆ Visual amenity and noise impacts
- ◆ Air, land and water pollution
- ◆ Impact on wildlife and ecological systems
- ◆ Health and safety
- ◆ Waste products

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Outcome 2

For each of the technologies, diagrams should be used showing the key components in the energy conversion process from input through to output. Each stage in the process should be explained in terms of its function/operation. Operational aspects should include typical overall plant (or Unit) efficiency, weather constraints, logistics (for offshore wind), reliability of supply and CO₂ emissions per Unit of energy generated (gCO₂/kWh). Environmental and sustainability factors and the significance of each will vary depending on the technology but would typically include several of the following:

- ◆ Use of renewable resources
- ◆ CO₂ released into atmosphere
- ◆ Visual amenity and noise impacts
- ◆ Air, land and water pollution
- ◆ Land-loss (large hydro schemes in particular)
- ◆ Impact on wildlife, marine life and ecological systems
- ◆ Waste products

Outcome 3

Marine (wave and tidal) technologies are expected to contribute to the future energy 'mix'. At present, worldwide there are only a few operational marine power plants. Technologies to harness energy from the tide include tidal barrage and tidal stream. The European Marine Energy Centre (EMEC) in Orkney is one of the world's leading marine technology research and testing centres and a useful source of information. Currently, there are several types of wave energy technologies at various stages of development. In the UK, examples include the 'Pelamis' attenuator system, the 'Limpet' oscillating water column system and the 'Oyster' oscillating wave surge convertor system. Energy production from geothermal sources utilises three main technologies and currently the US is the largest producer of geothermal energy. Historically, energy from waste has been via incineration however more recent technologies such as gasification and pyrolysis are now being commissioned. It is suggested that the following technologies be used in the delivery of this Outcome:

Tidal:	Tidal barrage and Tidal stream
Wave:	Attenuator systems, Oscillating water column systems and Oscillating wave surge convertor systems
Geothermal:	Dry steam, Flash steam and Binary cycle
Waste:	Incineration and Advanced Thermal Treatments (Gasification and Pyrolysis)

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For each of the technologies, diagrams should be used showing the key components in the energy conversion process from input through to output. Each stage in the process should be explained in terms of its function/operation. Operational aspects should include typical overall plant (or Unit) efficiency (where data is available), logistics (for waste), reliability of supply and CO₂ emissions per Unit of energy generated (gCO₂/kWh). Environmental and sustainability factors and the significance of each will vary depending on the technology but would typically include several of the following:

- ◆ Use of renewable/sustainable resources
- ◆ CO₂ released into atmosphere
- ◆ Visual amenity and noise impacts
- ◆ Air, land and water pollution
- ◆ Impact on wildlife, marine life and ecological systems (tidal barrage in particular)
- ◆ Waste products

Guidance on approaches to delivery of this Unit

This Unit should be delivered in year 2 of an SQA Advanced Diploma programme. It would be beneficial if learners had previously completed the level 7 Unit *Energy Overview*. It is unlikely that it could be delivered through integration with other Units.

It would be beneficial if learners had classroom internet access. It is suggested that an equal amount of time be allocated to each Outcome.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

All Outcomes should be assessed on a sample basis.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

The Unit may be assessed on an Outcome by Outcome basis or through a combination of Outcomes.

Outcome 1

This Outcome may be assessed individually or in combination with Outcomes 2 and/or 3. Evidence should be generated through a closed-book assessment under supervised conditions.

Outcome 2

This Outcome may be assessed individually or in combination with Outcomes 1 and/or 3. Evidence should be generated through a closed-book assessment under supervised conditions.

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Outcome 3

This Outcome may be assessed individually or in combination with Outcomes 1 and/or 2. Evidence should be generated through a closed-book assessment under supervised conditions.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at www.sqa.org.uk/e-assessment.

Opportunities for developing Core and other essential skills

Some Core Skills may be developed through the delivery of this Unit.

Information and Communications Technology (ICT) may be developed in all Unit Outcomes and in particular, the use of the internet to search for flowcharts, block diagrams and animations associated with each of the technologies.

Numeracy may be developed in Outcomes 1 and 2 in relation to the determination of energy output.

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History of changes to Unit

Version	Description of change	Date

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SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our [Centre Feedback Form](#).

General information for learners

Unit title: Energy Technologies

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

The Unit is designed to introduce a range of technologies associated with energy production. The technologies will be classified as traditional, renewable, and emerging and less common sustainable methods, for the purposes of this Unit. Traditional (existing) methods are based upon fossil fuel technologies and nuclear. Renewable methods are based upon the utilisation of non-fossil fuel based technologies. Emerging and less common sustainable methods are based upon technologies that are currently at various stages of development, implementation or operation together with technologies that are operational but are, overall, small energy producers relative to traditional and renewable methods.

The Unit is optional for learners on related SQA Advanced Engineering Awards. It could also be used as a stand-alone Unit where appropriate. No prior knowledge is required although it would be beneficial if learners have previously completed the level 7 Unit *Energy Overview* and were familiar with using the internet for research purposes.

Outcome 1 has been designed to introduce traditional methods of energy production using coal, gas, oil and nuclear fuel sources. Typical power plant operation and processes will be explained detailing energy input through to energy output. Operational aspects, environmental and sustainability issues and numerical calculations pertaining to each technology will also be considered.

Outcome 2 has been designed to introduce renewable methods of energy production using wind, hydro, solar and biomass technologies. Typical power plant or device operation and processes will be explained detailing energy input through to energy output. Operational aspects, environmental and sustainability issues and numerical calculations pertaining to each technology will also be considered.

Outcome 3 has been designed to introduce emerging and/or less common sustainable methods of energy production. Tidal, wave, geothermal and waste technologies will be considered. Typical power plant or device operation and processes will be explained detailing energy input through to energy output. Operational aspects and environmental and sustainability issues pertaining to each technology will also be considered.

In order to achieve this Unit, all Outcomes must be achieved. This Unit will be assessed by responses to structured questions under closed-book conditions.

There is no automatic certification of Core Skills or Core Skill components in this Unit.

The Unit has been designed to support articulation routes to degree programmes and also to support employment opportunities in the energy sector.