SQA Advanced Unit Specification

General information for centres

Unit title: Renewable Energy Systems: Geothermal Energy

Unit code: HV5K 48

Unit purpose: This unit has been designed to provide candidates with a knowledge and understanding of the sources and worldwide uses of geothermal energy. Candidates will also learn about both electrical generation and non-electrical generation applications of geothermal energy. Candidates will also have an opportunity to evaluate the potential for geothermal energy developments within the specific region in which the unit is being delivered.

On completion of the unit the candidate should be able to:

1 evaluate the nature and worldwide distribution of geothermal energy
2 explain the ways in which electricity can be generated from geothermal energy sources
3 explain some of the non-electrical generation uses of geothermal energy
4 evaluate the potential use of geothermal energy in a specific region

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

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to Doctorates.*

Recommended prior knowledge and skills: Entry to the unit is at the discretion of the centre however candidates should have a general knowledge and understanding of energy use, the consequences of energy use and renewable versus non-renewable energy sources. This knowledge and understanding may be evidenced by possession of the following SQA Advanced Unit HV48 47 *Renewable Energy Systems: Overview of Energy Use*.

Core skills: There are opportunities to develop the following core skill and core skill components in this unit, although there is no automatic certification of core skill or core skills components:

- Problem Solving SCQF level 6
- Communication SCQF level 6
- Information Technology SCQF level 6
- Numeracy SCQF level 6

Context for delivery: This unit has been developed for the SQA Advanced Diploma in Engineering Systems. If this unit is delivered as part of another group award, it is recommended that it should be taught and assessed within the subject area of the group award to which it contributes.

Assessment: The assessment strategy for this unit is as follows:

The assessment for Outcomes 1, 2 and 3 should be combined in the form of an assessment paper, which should be taken at a single assessment event lasting two hours. The assessment paper should be conducted under controlled, supervised conditions.

The assessment for Outcome 4 should be an assignment in which a candidate investigates the potential electrical generation or non-electrical generation applications of geothermal energy in the specific region in which the unit is being delivered. Candidates will be expected to produce a report based on their investigation.

SQA Advanced Unit Specification: statement of standards

Unit title: Renewable Energy Systems: Geothermal Energy

Unit code: HV5K 48

The sections of the unit stating the outcomes, knowledge and/or skills, and evidence requirements are mandatory.

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. Candidates 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

Evaluate the nature and worldwide distribution of geothermal energy

Knowledge and/or skills

- Sources
- Methods of extraction
- Worldwide sites

Outcome 2

Explain the ways in which electricity can be generated from geothermal energy sources

Knowledge and/or skills

- Geothermal power plants
- Current and future energy potential
- Advantages and disadvantages of generating electricity using geothermal energy

Outcome 3

Explain some of the non-electrical generation uses of geothermal energy

Knowledge and/or skills

- Medical
- Agricultural
- Aquaculture
- Industrial uses
- Desalination
- Space heating
- Heat pumps

SQA Advanced Unit Specification: statement of standards

Unit title: Renewable Energy Systems: Geothermal Energy

Evidence requirements

Evidence for the knowledge and/or skills items in Outcomes 1, 2 and 3 will be provided on a sample basis. The evidence may be provided in response to specific questions. Each candidate will need to demonstrate that she/he can answer correctly questions based on a sample of the items shown under the knowledge and/or skills items in all three outcomes. In any assessment of the outcomes **two out of three** knowledge and/or skills items should be sampled from Outcome 1, **two out of three** knowledge and/or skills items should be sampled from Outcome 2 and **three out of seven** knowledge and/or skills items should be sampled from Outcome 3.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing the candidate is able to:

Outcome 1

- describes the sources of geothermal energy
- explains three methods of extracting geothermal energy
- identify four countries that have developed geothermal energy resources, or who have the potential to develop them, and for two of these countries evaluate the benefits and drawbacks of such developments

Outcome 2

- explain the operation of two of the following geothermal power plants
  — dry steam
  — flash
  — binary
- explain current and future electrical power potential of geothermal energy
- explain three advantages and two disadvantages of geothermal energy

Outcome 3

- explain the way in which geothermal energy technology is being applied to the following:
  — medicine
  — agriculture
  — aquaculture
  — industrial uses
  — space heating
  — heat pumps
  — desalination

The assessment for Outcomes 1, 2 and 3 should be combined to form one assessment paper. This assessment paper should be taken at a single assessment event, lasting two hours, and carried out under supervised, controlled conditions. Assessment should be conducted under closed-book conditions and as such candidates should not be allowed to bring any textbooks, handouts or notes to the assessment.

Assessment guidelines

The assessment paper should be composed of an appropriate balance of short-answer, restricted-response and extended-response questions.

Outcome 4

Evaluate the potential use of geothermal energy in a specific region

Knowledge and/or skills

- Generation of electrical power or non-electrical generation applications

Evidence requirements

The evidence for Outcome 4 should be presented in response to an assignment in which the candidate is set the task of investigating the current and potential future uses of geothermal energy in the specific region in which the unit is being delivered.

A candidate's response can be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by the candidate showing that he/she has:

- evaluated the potential for generation of electrical power using geothermal energy in the specific region in which the unit is being delivered

  or

- evaluated a minimum of two non-electrical generation applications of geothermal energy in the specific region in which the unit is being delivered

Evidence for this outcome should be gathered by the candidate preparing a report which covers the knowledge and skills item for the outcome. The report should be prepared in the candidates own time. Centres should make every reasonable effort to ensure the report is the candidate's own work. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist should be used to record oral evidence of the candidate's knowledge and understanding. The report should not be less than 2,000 words long plus diagrams and appendices.

Candidates should have access to course notes, relevant textbooks, papers, reports and the internet while completing this report.

Assessment guidelines

Centres may wish to issue candidates with suitable guidance notes giving advice on the best way to structure their reports.

Administrative information

Unit code: HV5K 48

Unit title: Renewable Energy Systems: Geothermal Energy

Superclass category: XK

Original date of publication: November 2017

Version: 01

History of changes:

Version	Description of change	Date

Source: SQA

© Scottish Qualifications Authority 2007, 2017

This publication may be reproduced in whole or in part for educational purposes provided that no profit is derived from reproduction and that, if reproduced in part, the source is acknowledged.

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

For further information, please call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

SQA Advanced Unit Specification: support notes

Unit title: Renewable Energy Systems: Geothermal Energy

This part of the unit specification is offered as guidance. The support notes 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 has been written as one of the 10 renewable energy units within the SQA Advanced Diploma in Engineering Systems. These are:

- Renewable Energy Systems: Overview of Energy Use (2, 8)
- Renewable Energy Systems: Technology (2, 8)
- Renewable Energy Store: Hydrogen (1, 8)
- Renewable Energy Systems: Wind Power (1, 8)
- Renewable Energy Systems: Wave and Tidal Energy(1, 8)
- Renewable Energy Systems: Solar(1, 8)
- Renewable Energy Systems: Biomass (1, 8)
- Renewable Energy Systems: Hydroelectricity (1, 8)
- Renewable Energy Systems: Microgeneration Systems (1, 7)

This unit has been written as far as possible in generic terms to allow candidates to specialise in areas of particular interest in the field of geothermal energy.

In Outcome 1 candidates should look at both deep and shallow sources of geothermal energy. Methods of extraction can include the deep wells into 'hot dry rocks' method. Candidates should examine countries that are currently using geothermal energy, or have the potential to use this form of energy, with a view to identify not only applications of geothermal energy but the benefits and drawbacks of this form of energy over conventional energy generation methods and other forms of renewable energy technology. It is important that lecturers monitor developments in geothermal energy technology for example, with advances in drilling technology new deep sources may become economically viable in the future.

In Outcome 2 the advantages of geothermal electrical power generation could include reliability, ease of land use, flexibility (modular design of geothermal plants to meet growing power demands), minimisation of imported energy from abroad and assistance to developing countries to grow their own energy resources. Disadvantages could include costs of locating geothermal sites, drilling costs, radioactive contamination and higher cost per kWhr of electricity.

In Outcome 3 lecturers may wish to focus on applications which are currently in use or have future potential in the specific region in which the unit is being delivered. For example, in Scotland the largest potential use of geothermal energy is likely to be in the area of ground source, water source and air source heat pumps. Lecturers may wish to explain the operation of such pumps and explore their use in providing space heating, water heating and air ventilation in buildings.

Such explorations may include a consideration of the way in which geothermal energy can be combined with other forms of renewable energy such as solar to provide space and water heating in buildings. Industrial applications may include pasteurising milk, washing wool etc.

Guidance on the delivery and assessment of this unit

This unit may be delivered by a combination of lecturing, group work, investigation (including the use of the internet), case studies and practical laboratory work. Laboratory work should be actively encouraged where heat pumps are available as such work will allow candidates to gain a greater familiarity with the operation of heat pumps and a better understanding of the benefits and drawbacks of using such systems in, for example, space and water heating compared with other energy sources.

The internet contains a rich and varied range of materials relating to geothermal energy. The use of case studies can be a particularly powerful tool in illustrating the applications of geothermal energy.

Opportunities for developing core skills

All elements of the core skill of Problem Solving, that is, critical thinking, planning, organising, reviewing and evaluating, will be naturally developed and enhanced as candidates undertake the unit. An analysis of the complex factors influencing current and potential future uses of geothermal energy is integral to achievement. Candidates have to identify and seek solutions to a range of theoretical and practical problems and issues within their own region. They examine the variables involved in electrical and non-electrical generation within current safety requirements before an appropriate approach is identified and justified. Evaluation of solutions proposed is comprehensive.

Practical work can provide an environment in which to discuss, review and evaluate approaches, enhancing skills in the communication of complex technical data. Candidates may also be questioned to assure their knowledge and understanding. Reading and evaluation of complex technical information, using paper-based and internet sources, will support knowledge and develop key skills in communication and information technology. Advice on efficient systems of recording, coding and storing information, using technology to manage the practical aspects of investigation in Outcome 4 could be of benefit. Candidates could also be provided with examples of appropriate style and structure for written reports, and should be advised that complex ideas and information should be supported by technically accurate, and clearly annotated drawings and diagrams. Appropriate software packages could help ensure the effective, accurate presentation of written and graphic information.

A series of complex calculations and measurements underpins the competencies assessed in the unit. Numeracy skills will be naturally enhanced, with the focus on the practical interpretation, application and presentation of complex numerical and graphical data. Formative practical activities should be designed to develop accuracy, flexibility and confidence in handling renewable energy concepts.

Open learning

This unit could be delivered by distance learning, which may incorporate some degree of online delivery and/or support. However, with regards to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence.

Arrangements would be required to be put in place to ensure that the combined assessment paper for Outcomes 1, 2 and 3 is done under controlled, supervised conditions.

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.

General information for candidates

Unit title: Renewable Energy Systems: Geothermal Energy

It has long been recognised that there are vast energy reserves under our feet in the core of the earth. This form of energy is called geothermal energy (from the Greek *geo* meaning earth and *therme* meaning heat). Some countries, where geological circumstances are favourable, have been able to exploit this energy for both the generation of electrical energy and for other applications such as heating. In the context of the current debate in the United Kingdom about where it will get its future energy supplies from geothermal energy, it is certainly worth considering as a contributor to meeting future energy needs.

In this unit you will study where geothermal energy comes from and where it is currently used in the world. You will also look at different types of geothermal electrical generating plant and other applications of geothermal energy. You will also undertake an investigation into the potential uses of geothermal energy in the region in which you live.

The unit is likely to be delivered by a combination of lecturing, group work, case studies, investigation work and laboratory work. Case studies on geothermal energy applications can be a particularly powerful tool in illustrating many aspects of the potential of this energy resource.

Formal assessment in the unit will comprise of an assessment paper covering Outcomes 1, 2 and 3 and an assignment covering the work in Outcome 4. The assessment paper will be taken at a single assessment event lasting two hours and will be conducted under controlled, supervised conditions. The assignment will involve an investigation of current and potential applications of geothermal energy in the region where you live. Assessment evidence for Outcome 4 will be generated in the form of a report based on the investigation.