SQA Advanced Unit Specification

General information for centres

Unit title: Renewable Energy Systems: Hydroelectricity

Unit code: HV5L 48

Unit purpose: This unit has been designed to allow candidates to develop knowledge and understanding of the operating principles associated with different types of hydroelectric generation schemes. Candidates will also learn about different types of hydroelectric turbines, the power outputs from different schemes and grid interconnectivity issues. They will also compare small and large-scale schemes in terms of building costs, installation, construction and running costs and evaluate the future of hydroelectric power schemes.

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

1 explain the operating principles of different types of hydroelectric power schemes
2 determine hydroelectric generation scheme turbines, power outputs and grid connectivity issues
3 compare and evaluate small and large-scale hydroelectric power schemes
4 evaluate the future of hydroelectric power schemes

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: It is recommended that candidates have a knowledge and understanding of energy and engineering systems. This may be evidenced by possession of a SQA Advanced Unit HV48 47 *Renewable Energy Systems: Overview of Energy Use* or HV5N 48 *Renewable Energy Systems: Technology*.

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 recommended assessment strategy for this unit is as follows:

The assessment for Outcomes 1 and 2 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, closed-book conditions.

Outcome 3 should be assessed by candidates undertaking an investigation into the comparison between a small and a large-scale hydroelectric scheme. Candidate evidence should be in the form of a written report prepared in the candidates own time. The report should be between 1,400 and 1,600 words in length plus diagrams and appendices.

Outcome 4 should be assessed by the candidates undertaking an investigation into the future potential of hydroelectricity. Candidate evidence should be in the form of a written report prepared in the candidates own time. The report should be between 1,400 and 1,600 words in length plus diagrams and appendices.

Candidate evidences for Outcomes 3 and 4 could be combined into a single report the length of which should be between 2,800 and 3,200 words plus diagrams and appendices.

SQA Advanced Unit Specification: statement of standards

Unit title: Renewable Energy Systems: Hydroelectricity

Unit code: HV5L 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

Explain the operating principles of different types of hydroelectric power schemes

Knowledge and/or skills

- Energies and conversion processes
- Hydroelectric schemes

Outcome 2

Determine hydroelectric generation scheme turbines, power outputs and grid connectivity issues

Knowledge and/or skills

- Turbine types
- Power output from generation
- Grid connectivity

Evidence requirements

All knowledge and/or skills items in Outcomes 1 and 2 should be assessed.

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

- calculate the input power available to a turbine due to head
- apply Bernoulli's equation to the energy conversion process of a hydro scheme
- state three types of hydroelectric scheme and describe one of these types of scheme in detail

Outcome 2

- state three turbine types and describe, with the aid of a diagram, one of these types of turbine
- determine the following power outputs from generation
  - — average power output
  - — peak demand
  - — estimated energy supply

- Describe the following issues relating to grid connectivity
  — installation, commissioning and maintenance
  — cabling
  — substations and power smoothing
  — substation to grid

The assessment for Outcomes 1 and 2 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 controlled, supervised 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, extended response and structured questions.

Outcome 3

Compare and evaluate small and large-scale hydroelectric power schemes

Knowledge and/or skills

- Terrain
- Small-scale scheme specification
- Large-scale scheme specification
- Costs
- Environmental implications

Evidence requirements

All knowledge and/or skills items in this outcome should be assessed.

Candidates will need to provide evidence of being able to analyse hydroelectric power schemes using the knowledge and/or skills they have developed in Outcomes 1 and 2. Candidates will be expected to undertake an investigation in which they:

- identify terrain selection criteria for hydroelectric schemes to meet legislation and abstraction rights
- compare a small and a large-scale hydroelectric scheme in terms of their power capacity, selection and grid connectivity
- compare a small and a large-scale hydroelectric scheme in terms of building costs, installation, construction and running costs
- compare the environmental implications of building small and large-scale hydroelectric schemes

Candidate evidence should be in the form of a report which should be prepared in the candidate's 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 be between 1,400 and 1,600 words in length plus diagrams and appendices.

Assessment guidelines

The report format could take the following format:

- Introduction
- Terrain selection with reference to legislation, abstractions rights and permit to work
- The comparison of power capacity, criteria for selection and grid connectivity for each scheme
- System costs, installation, construction and operation and reliability and compare for each scheme
- The environmental implications and viability of small and large-scale hydroelectric power schemes
- Conclusions

A table consisting of the analysis, comparisons and conclusions may form part of this report.

Candidate evidences for Outcomes 3 and 4 could be combined into a single report the length of which should be between 2,800 and 3,200 words plus diagrams and appendices. Centres should provide candidates with guidance on the structure of a single report

Outcome 4

Evaluate the future of hydroelectric power schemes

Knowledge and/or skills

- Geographical region suitability
- Power capacity
- System cost, construction and operation
- Integrated system conceptual design
- Hydro-power generation strategy

Evidence requirements

All knowledge and/or skills items in this outcome should be assessed.

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:

- explain approaches to identify future sites for hydroelectric generation schemes
- estimate power capacities of future schemes
- examine future designs in terms of construction techniques used, types of operation and reliability
- explore options for integrated schemes involving hydroelectric power working in conjunction with another renewable energy method(s)
- explore any hydroelectric generation strategies which may be currently in place or are being proposed

Candidate evidence should be in the form of a report which should be written in the candidate's 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 be between 1,400 and 1,600 words in length plus diagrams and appendices.

Assessment guidelines

The report format could take the following format:

- Introduction
- Geographical influences of terrain and mapping potential sites
- Power capacity, including issues of 'peak power'
- System design, construction, operation and reliability
- Proposal of an integrated conceptual design for a hydroelectric scheme working in conjunction with another renewable generation method
- Conclusions

Candidate evidences for Outcomes 3 and 4 could be combined into a single report the length of which should be between 2,800 and 3,200 words plus diagrams and appendices. Centres should provide candidates with guidance on the structure of a single report.

Administrative information

Unit code: HV5L 48

Unit title: Renewable Energy Systems: Hydroelectricity

Superclass category: XK

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History of changes:

Version	Description of change	Date

Source: SQA

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: Hydroelectricity

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 credits, SCQF level 7)
- Renewable Energy Systems: Technology (2 credits, SCQF level 8)
- Renewable Energy Store: Hydrogen (1 credit, SCQF level 8)
- Renewable Energy Systems: Wind Power (1 credit, SCQF level 8)
- Renewable Energy Systems: Wave and Tidal Energy (1 credit, SCQF level 8)
- Renewable Energy Systems: Solar (1 credit, SCQF level 8)
- Renewable Energy Systems: Biomass (1 credit, SCQF level 8)
- Renewable Energy Systems: Geothermal Energy (1 credit, SCQF level 8)
- Renewable Energy Systems: Microgeneration Systems (1 credit, SCQF level 7)

The two-credit unit HV48 47 *Renewable Energy Systems: Overview of Energy Use* provides an introduction to the subjects of energy usage and trends, environmental impact of energy use, and renewable energy sources from both a global and local perspective. The two-credit unit HV5N 48 *Renewable Energy Systems: Technology* describes the basic technology associated with renewable energy devices. The remaining one-credit units take a specialised look at each of the technologies currently believed to be significant, and, as such, provide an opportunity for candidates to specialise in some of these technologies. It is important that all these units are seen as providing an integrated programme of study covering energy issues with a focus on renewable energy systems. As such every opportunity should be sought to combine the delivery and assessment of the units.

The emphasis in all the 10 units should be on allowing candidates to develop knowledge and understanding of the energy and environmental issues facing this country and others as well as giving them the knowledge and skills required to understand how renewable energy systems generate power as electricity or other energies/fuels. It is important that environmental as well as technological issues and developments are discussed as each has a bearing on the other. The one-credit specialist units will allow candidates to develop a deeper knowledge and understanding of how these systems work from an engineering systems perspective and should enhance the core units in the SQA Advanced Diploma in Engineering Systems.

In designing this unit, the range of topics expected to be covered by lecturers has been identified. Recommendations as to how much time should be spent on each outcome. This has been done to help lecturers decide what depth of treatment should be given to the topics attached to each of the outcomes.

SQA Advanced Unit Specification

Outcome 1

Energies and conversion processes:

- potential [gh]
- kinetic [v2/2]
- flow [pV]
- head loss

Hydro schemes:

- run of river scheme
- dam scheme
- high head (reservoir and dam)
- pumped storage

Outcome 2

- Turbine types
  — pelton
  — kaplan
  — francis
  — axial flow
  — propeller

- Power output from generation
  — average power output
  — peak demand
  — estimated energy supply

- Grid connectivity
  — installation, commissioning and maintenance
  — cabling
  — substations and power smoothing
  — substation to grid

Outcomes 3 and 4 as per SQA Advanced Unit Specification: statement of standards section.

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) and case studies. The internet contains a rich and varied range of materials relating to hydroelectricity. The use of case studies can be a particularly powerful tool in illustrating the principles and applications of hydroelectric generation schemes.

DVDs/videos on hydroelectric schemes may also provide a good source of learning for candidates.

Structured site visits may prove useful in allowing candidates to translate the theory they have learnt in the classroom into practice and explore issues relating to the current and future capacity and development of hydroelectric schemes.

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. Identifying and analysing a complex range of factors impacting on hydroelectric generation schemes candidates seek solutions to a number of theoretical and practical problems and issues. They examine such variables as system costs, construction and operation requirements before identifying, justifying and evaluating the potential of hydroelectric schemes within their own geographical region.

Access to 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 the Investigative reports for Outcomes 3 and 4 could be of benefit. Candidates should be provided with guidance on acceptable report format, style and structure. They should be advised that technical accuracy of complex ideas and information should be supported by clearly annotated drawings and diagrams. Resources available could include appropriate software packages to support accuracy and the effective presentation of written and graphic information. Formative work will provide many opportunities for candidates to discuss, review and compare different types of schemes, enhancing skills in oral communication of complex 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 accuracy and 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 concepts in the context of renewable energy.

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 and 2 is done under controlled, supervised conditions.

For information on normal open learning arrangements, please refer to the SQA guide *Assessment and Quality Assurance of Open and Distance Learning (SQA 2000).*

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: Hydroelectricity

Hydroelectricity (the generation of electricity from water) is not new: it has been around for a long time. Nevertheless as a renewable energy source it is likely to continue to make a significant contribution to overall energy generation in a number of countries in the world (including Scotland).

In this unit you will learn about different types of hydroelectric generation schemes including the turbines used in these schemes, power outputs and how power is transferred to a grid system where this exists. You will compare small and large-scale hydroelectric generation schemes in terms of build costs, installation, construction and running costs. You will also evaluate the future of hydroelectricity.

Delivery in the unit is likely to be by a combination of lecturing, group work, investigation (including the use of the internet) and case studies. Your lecturer may also take you on a site visit to see a hydroelectric scheme in operation.

Formal assessment is likely to comprise of a combined assessment paper covering the work of Outcomes 1 and 2. This assessment paper will be sat at a single assessment event lasting two hours. The assessment event will be conducted under controlled, supervised, closed-book conditions.

Outcomes 3 will involve an investigation into a comparison of small and large-scale hydroelectric schemes. You will be expected to produce a report based on your findings from the investigation. Likewise Outcome 4 will involve an investigation into the future of hydroelectric generation schemes. You will also be expected to produce a report based on your findings from the investigation. The centre where you are studying this unit may ask you to produce a single report to cover the work of both outcomes.