



## **National Unit specification: general information**

**Unit title:** Domestic Combined Heat and Power Systems

**Unit code:** FF2H 12

**Superclass:** XH

**Publication date:** February 2011

**Source:** Scottish Qualifications Authority

**Version:** 01

### **Summary**

This Unit is designed to provide candidates with knowledge and understanding on the provision of domestic combined heat and power systems. The Unit will introduce candidates to the basic design principles, systems components and function of domestic combined heat and power systems. The Unit will also introduce candidates to fundamental health and safety and installation requirements for domestic combined heat and power systems.

This Unit is suitable for candidates who are undertaking this study for the first time or wish to obtain a basic knowledge of domestic combined heat and power. The Unit will allow for those currently employed in the building services industry to develop further knowledge specifically related to domestic combined heat and power systems.

### **Outcomes**

- 1 Describe the basic operating principles of domestic combined heat and power systems.
- 2 Describe the component parts of a domestic combined heat and power system.
- 3 State the relevant Standards and Regulations used for the design, installation, commissioning and maintenance of domestic combined heat and power systems.

### **Recommended entry**

Entry is at the discretion of the centre.

## **National Unit specification: General information (cont)**

**Unit title:** Domestic Combined Heat and Power Systems

### **Credit points and level**

1 National Unit credit at SCQF level 6: (6 SCQF credit points at SCQF level 6\*)

*\*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 Access 1 to Doctorates.*

### **Core Skills**

Opportunities to develop aspects of Core Skills are highlighted in the support notes of this Unit specification.

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

## **National Unit specification: statement of standards**

### **Unit title: Domestic Combined Heat and Power Systems**

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.

#### **Outcome 1**

Describe the basic operating principles of domestic combined heat and power systems.

##### **Performance Criteria**

- (a) Describe clearly the basic operating principles of a domestic combined heat and power system.
- (b) Describe accurately the need to match engine size to domestic load requirements.
- (c) Describe clearly the relevant factors for optimum economic operation of domestic combined heat and power systems.
- (d) State clearly the main advantages of using domestic combined heat and power systems compared to conventional gas boiler systems.

#### **Outcome 2**

Describe the component parts of a domestic combined heat and power system.

##### **Performance Criteria**

- (a) Show clearly by means of a diagram the location of the main component parts of a domestic combined heat and power system.
- (b) Describe clearly the function of the main component parts of a domestic combined heat and power system.
- (c) Describe clearly basic external and internal combustion engines used in domestic combined heat and power systems.
- (d) Describe accurately types of Stirling engine with respect to their piston and displacer arrangement.
- (e) Describe clearly the electrical connection of a domestic combined heat and power system.

## National Unit specification: statement of standards (cont)

**Unit title:** Domestic Combined Heat and Power Systems

### Outcome 3

State the relevant Standards and Regulations used for the design, installation, commissioning and maintenance of domestic combined heat and power systems.

#### Performance Criteria

- (a) State clearly the risks associated with installing and commissioning domestic ASHP systems.
- (b) State clearly how the Water Regulations and Building Standards apply to domestic ASHP systems.
- (c) State clearly how to minimize risk for personnel when installing ASHP systems.
- (d) State clearly the basic need for earthing requirements for ASHP installations.

#### Evidence Requirements for this Unit

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

Written and/or recorded oral evidence should be produced to demonstrate that the candidate has achieved all the Outcomes and Performance Criteria. The evidence should be produced under 'open-book' supervised and controlled conditions.

### Outcome 1

- (a) The candidates must correctly describe the basic operating principles of domestic combined heat and power system. This description must include:
  - ◆ simultaneous production of heat and electricity
  - ◆ integration into the building's heating and hot water system
- (b) The candidates must correctly describe the need to match engine size to domestic load requirements. This description must include:
  - ◆ annual heat demand for space and water heating and heat output kWh(t)
  - ◆ annual electricity demand and electrical output kWh(e)
- (c) The candidate must correctly describe the relevant factors for the optimum economic operation of domestic combined heat and power systems. This description must include:
  - ◆ the economic benefit of longer running hours
  - ◆ the on site use of the electricity generated by the domestic combined heat and power system

## National Unit specification: statement of standards (cont)

### Unit title: Domestic Combined Heat and Power Systems

- (d) The candidate must clearly state at least three advantages of using a Domestic Combined Heat and Power System compared to conventional gas boiler systems. This description must include:
- ◆ domestic CHP can be used with a wide range of fuels
  - ◆ domestic CHP provides security of electricity supply
  - ◆ excess electricity supply can be sold to the grid

### Outcome 2

- (a) The candidate must show by production of a diagram the location of the main component parts of a domestic combined heat and power system. The diagram must indicate:
- ◆ engine
  - ◆ heating control
  - ◆ booster boiler
  - ◆ exhaust fan and flue
  - ◆ air supply
  - ◆ spool valve
- (b) The candidate must correctly describe the function of the following component parts of a domestic combined heat and power system:
- ◆ engine
  - ◆ heating control
  - ◆ booster boiler
  - ◆ exhaust fan and flue
  - ◆ air supply
  - ◆ spool valve
- (c) The candidate must correctly describe basic external and internal combustion engines used in domestic combined heat and power systems. This description must include:
- ◆ External
    - ◆ regenerator
    - ◆ cylinder
    - ◆ piston
    - ◆ displacer
  - ◆ Internal
    - cylinder
    - fuel injection
    - piston

## National Unit specification: statement of standards (cont)

### Unit title: Domestic Combined Heat and Power Systems

- (d) The candidate must correctly describe types of Stirling engine with respect to their piston and displacer arrangement. This description must include:
- ◆ Kinematic Stirling engines and in particular rotational motion
  - ◆ Free-Piston Stirling Engines including a description of Alpha, Beta and Gamma configurations
- (e) The candidate must correctly describe the electrical connection of a domestic combined heat and power system. This description must include:
- ◆ two way metering
  - ◆ electrical protection requirements for parallel operation with grid

### Outcome 3

- (a) The candidate must correctly state the basic planning requirements and procedures in relation to the design and installation of domestic combined heat and power systems. Design and installation factors must include:
- ◆ location of domestic combined heat and power unit
  - ◆ supply air and exhaust ventilation
  - ◆ fire resistance and fire precautions
  - ◆ fuel isolation and electrical isolation
- (b) The candidate must state clearly how the Building Regulations apply to domestic combined heat and power systems. This must include the following:
- ◆ Gas Safety Regulations
  - ◆ Engineering Standards for small scale embedded generation
- (c) The candidate must clearly state the measures required to minimise risk to personnel and building occupiers when installing domestic combined heat and power systems. This must include the following:
- ◆ avoidance of electric shock
  - ◆ avoidance of network instability
  - ◆ avoidance of generation during mains grid failure
  - ◆ avoidance of asphyxiation
  - ◆ avoidance of fire and explosion
- (d) The candidate must clearly state the basic commissioning and maintenance requirements of a domestic combined heat and power system and the importance of the following:
- ◆ installation and commissioning checklists
  - ◆ maintenance and servicing plans

## **National Unit specification: support notes**

### **Unit title: Domestic Combined Heat and Power Systems**

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**

#### **Outcome 1**

Candidates must also be able to demonstrate the basic operating principles of domestic combined heat and power systems including a description of the simultaneous production of heat and electricity and the integration of this system into an existing space and water heating system.

Candidates must be able to demonstrate an understanding of heat and electricity demand profiles and the subsequent matching of engine size to meet these demands. Candidates must also understand and demonstrate knowledge of the conditions for optimum economic operation of domestic combined heat and power systems.

Candidates must be able to demonstrate knowledge of the main advantages of domestic combined heat and power systems and in particular the variety of fuels used, the security of on site generation of electricity and the export of excess electricity for sale.

#### **Outcome 2**

Candidates must be able to demonstrate knowledge of the location and function of the main component parts of a domestic combined heat and power system. Components to be identified and located in a diagram are; engine, heating control, booster boiler, exhaust fan and flue, air supply and spool valve. The candidates must also be able to describe the function of each of these components.

Candidates must be able to describe the basic parts and function of internal and external combustion engines with respect to regenerator, cylinder, piston and displacer parts.

Candidates must be able to demonstrate a knowledge and understanding of the rotational motion of Kinematic Stirling engines and the displacer piston configurations of Free-Piston Stirling engines.

Candidates must also be able to describe the electrical connection of domestic combined heat and power systems with respect to the metering and protection requirements.

## **National Unit specification: support notes (cont)**

**Unit title:** Domestic Combined Heat and Power Systems

### **Outcome 3**

Candidates must be able to state the basic planning requirements and procedures for the design and installation of domestic combined heat and power systems. Design and installation factors will include the location of the domestic combined heat and power unit, supply air and exhaust ventilation, fire resistance and fire precautions and the isolation of fuel and electricity.

Candidates must be able to describe how the building regulations apply, in particular the Regulations for Gas Safety and the Engineering Standards for small scale embedded generation.

Candidates must also demonstrate awareness of the measures required to minimise risks when designing and installing domestic combined heat and power systems. In particular, the following risks should be detailed and avoidance measures described: electric shock, network instability, generation during mains failure, asphyxiation and the avoidance of fire and explosion.

Candidates will be able to demonstrate an understanding of the commissioning and maintenance of domestic combined heat and power systems and the importance of installation and commissioning checklists and maintenance and servicing plans.

### **Guidance on learning and teaching approaches for this Unit**

It is recommended that the Outcomes are delivered in the sequence presented in the Unit specification. The Unit may be delivered by a combination of lectures, tutorial work and practical laboratory work. The Unit should be taught very much in an electrical engineering/energy context and as such relevant engineering/energy examples should be used throughout Unit delivery.

While the majority of the Unit can be delivered in a classroom, centres should allow candidates to undertake practical experiments so that they have opportunities to relate theory learnt in the classroom to practice. For example, where domestic combined heat and power equipment exists candidates should be allowed to carry out simple performance tests on these systems.

The Internet contains a rich source of materials on Renewable Energy and Domestic Combined Heat and Power Systems. Candidates should be aware of the different regulations, climates etc when using non UK based web sites.

Component parts eg Stirling Engine can be used to support the learning. Candidates can assemble and test small systems and form opinions/evaluations on the merits or otherwise of Domestic Combined Heat and Power technology.

The Unit should be fully supported with relevant learning materials (eg handouts in paper and electronic form, textbooks, on-line materials etc.)

This Unit is not intended to endorse successful candidates as competent operatives of domestic combined heat and power systems.



## National Unit specification: support notes (cont)

**Unit title:** Domestic Combined Heat and Power Systems

### Opportunities for developing Core Skills

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

Elements of *Numeracy* at SCQF level 5 may be developed in Outcome 1 where numerical skills are required to match engine size to domestic load requirements. Using Graphical Information at SCQF level 5 may be developed in Outcome 1 where candidates are given graphical information to interpret annual energy demands.

The Core Skill *ICT* at SCQF level 5 may be developed in Outcome 1 where candidates may access and interpret information relating to the economic running of domestic combined heat and power systems.

The Critical Thinking component of *Problem Solving* at SCQF level 5 may be developed in Outcome 2 while candidates are interpreting drawings and diagrams of the main component parts of domestic combined heat and power systems. The Planning and Organisation component of *Problem Solving* at SCQF level 5 may be developed in Outcome 2 when candidates are developing the electrical connection and circuitry requirements of domestic combined heat and power systems.

Elements of *Working with Others* Core Skill at SCQF level 4 may be developed in Outcome 3 while candidates are developing their skills in design and installation factors associated with domestic combined heat and power systems. Although candidates do not have to demonstrate practical skills formative activities could enhance the skills of working with others.

### Guidance on approaches to assessment for this Unit

Centres are encouraged to use formative assessment extensively as it plays a particularly important role in allowing candidates to develop a sound knowledge and understanding of domestic combined heat and power systems.

Summative assessment may take the following form:

#### Outcomes 1 and 2

Assessment may comprise of a single assessment paper covering the outcome and performance criteria requirements for both Outcomes. The assessment paper should be taken at a single assessment event lasting 1 hour and comprise of a suitable balance of short answer, restricted response or structured questions.

#### Outcome 3

Assessment may comprise of a single assessment paper covering the outcome and performance criteria requirements. The assessment paper should be taken at a single assessment event lasting 1 hour and comprise of a suitable balance of; multiple choice, short answer, restricted response or structured questions.

## **National Unit specification: support notes (cont)**

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### **Opportunities for the use of 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 e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003)*, *SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*. The evidence may be produced on one or more than one assessment occasion. A suitable instrument of assessment covering all outcomes could be by short answer, restricted response and structured questions, lasting no more than ninety minutes in duration. An alternative is for candidates to achieve outcomes and performance criteria through an integrated assignment, this will be continually assessed in 'open book' conditions.

### **Disabled candidates and/or those with additional support needs**

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website [www.sqa.org.uk/assessmentarrangements](http://www.sqa.org.uk/assessmentarrangements).

## History of changes to Unit

Version	Description of change	Date

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