Unit 301: Understand the fundamental principles and requirements of environmental technology systems

# Handout 8: Micro-combined heat and power (Heat-led)

## Learning outcome

The learner will:

1. Know the fundamental working principles of micro-renewable energy and water conservation technologies.
2. Know the fundamental requirements of building location/building features for the potential to install micro-renewable energy and water conservation systems to exist.
3. Know the fundamental regulatory requirements relating to micro-renewable energy and water conservation technologies.
4. Know the typical advantages and disadvantages associated with micro-renewable energy and water conservation technologies.

## Assessment Criteria

The learner can:

* 1. Identify the fundamental working principles of the following co-generation technologies: micro-combined heat and power (heat-led).

2.8 Clarify the fundamental requirements for the potential to install a micro-combined heat and power (heat led) system to exist.

* 1. Confirm what would be typically classified as ‘permitted development’ under town and country planning regulations in relation to the deployment of the following technologies: micro-combined heat and power (heat-led).

3.2 Confirm which sections of the current building regulations/building standards apply in relation to the deployment of the following technologies: micro-combined heat and power (heat-led).

* 1. Identify typical advantages associated with each of the following technologies: micro-combined heat and power (heat-led).
  2. Identify typical disadvantages associated with each of the following technologies: micro-combined heat and power (heat-led).

## Micro-combined heat and power (heat‑led)

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| This technology generates heat and electricity simultaneously, from the same energy source, in individual homes or buildings. The main output of a micro combined heat and power (micro‑CHP) system is heat, with some electricity generation, at a typical ratio of about 6:1 for domestic appliances. |  |

A typical domestic system will generate up to 1kW of electricity once warmed up; the amount of electricity generated over a year depends on how long the system is able to run. Any electricity you generate and don't use can be sold back to the grid.

Micro-CHP is a technology that provides an opportunity to use an energy source (normally gas) to effectively produce heat and electricity. Unlike larger CHP systems (mini and full CHP) the application of micro‑CHP is typically limited to one property and does not include any need for ‘district’ heating.

Micro‑CHP is not classed as a renewable technology (unless fuelled by renewable biofuels) but properly applied it can reduce carbon emissions and total energy costs. CHP is sometimes referred to as ‘cogeneration’.

The term micro-CHP normally indicates that the output of the system is less than 5kWe (5kW electrical) combined with a heat output suitable to replace a domestic or small commercial boiler.

## How they work

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| There are number of different technologies that can be used for micro-CHP, including stirling engines, rankine engines, internal combustion engines and fuel cells.  The stirling engine the most prevalent technology in today's domestic micro‑CHP market and the only technology specifically recognised by the Microgeneration Certification Scheme. |  |

Unlike the internal combustion engine a stirling engine does not have any combustion process within its reciprocating engine. A sealed cylinder containing a gas (such as helium) is heated at one end by the burning gas and then cooled at the other by the return heating water so that it expands and subsequently contracts and is arranged to actuate a piston to drive an electrical generator. The specific configuration of the engine will depend on the manufacturer but the majority of the moving parts are within a sealed, and so clean, environment.

## The stirling engine operating cycles

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| **Expansion**  Most of the gas in the system has just been driven to the hot end of the cylinder. The gas heats and expands, driving the piston outward to the right. | Description: 04b Micro chp.png |
| **Transfer**  The gas has expanded. Most of the gas is still located in the hot end of the cylinder. Flywheel momentum carries the crankshaft the next quarter turn. The bulk of the gas is transferred around the displacer to the cool end of the cylinder. | Description: 04c Micro chp.png |
| **Contraction**  The majority of the expanded gas has shifted to the cool end. The gas cools and contracts drawing the piston inward to the left. | Description: 04d Micro chp.png |
| Transfer The contracted gas is still located near the cool end of the cylinder. Flywheel momentum carries the crankshaft another quarter turning, moving the displacer and transferring the bulk of the gas back to the hot end of the cylinder. | Description: 04e Micro chp.png |

The driving heat could be provided by a number of sources including recovered heat and heat from solar sources however in UK micro‑CHP applications the energy typically will be produced by burning natural gas.

Since the system relies on heating and cooling process it will take several minutes before electricity is produced whilst it heats up.

Stirling engine micro‑CHP typically will convert under 10% of the energy to electricity and the remainder goes to heat. The overall system is likely to be in excess of 90% efficient.

An animation of the operation of a stirling engine can be found at the website: <http://www.animatedengines.com/stirling.html>

## Installation location

Most micro‑CHP systems are only marginally bigger than a standard gas central heating boiler so the installation requirements are the same including the following:

* appropriate gas supply
* adequate access and space for installation and maintenance
* an appropriate flue.

Additionally, there must be a means of connecting the output from the micro‑CHP system to the building’s electricity system and, where appropriate, the provision of feed‑in tariff equipment.

## Planning requirements

Planning permission is not normally needed when installing a micro-combined heat and power system in a house, if the work is all internal. If the installation requires a flue outside, however, it will normally be permitted development if the conditions outlined below are met:

* Flues on the rear or side elevation of the building are allowed to a maximum of one metre above the highest part of the roof.
* If the building is listed or in a designated area even if you enjoy permitted development rights it is advisable to check with your local planning authority before a flue is fitted. Consent is also likely to be needed for internal alterations.
* In a conservation area or in a World Heritage Site the flue should not be fitted on the principal or side elevation if it would be visible from a highway.

## Building Regulations requirements

The ‘Low or Zero Carbon Energy Sources: Strategic Guide (LZC)’ supports the inclusion of low or zero carbon energy sources in Part L of the Building Regulation and Approved Documents L1A, L1B, L2A and 2B. Chapter 4 deals with micro-CHP.

As micro-CHP systems operate within the context of the building, the equipment, installation and testing must all comply with the relevant standards. Details of these standards are set out in full in the LZC guide.

The guide also sets out the factors to be considered for the purposes of calculating the potential of a micro-CHP system to contribute towards lowering the carbon dioxide emissions of a building in order for it to meet the compliance requirements of Part L.

Building regulations also apply to other aspects of the work such as electrical installation and plumbing work.

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| Advantages of micro‑CHP  * When the micro-CHP is generating heat, the unit will also generate electricity to be used in the home (or exported). * By generating electricity on-site the consumer could be saving carbon dioxide compared with using grid electricity and a standard heating boiler. * Micro-CHP is eligible for feed-in tariffs. Please note that the Feed In Tariff is not available in Northern Ireland. * For the householder, there is very little difference between a micro-CHP installation and a standard boiler. If the consumer already has a conventional boiler then a micro-CHP unit should be able to replace it as it’s roughly the same size. However, the installer must be approved under the Microgeneration Certification Scheme. * Servicing costs and maintenance are estimated to be similar to a standard boiler – although a specialist will be required. | Description: 08 Micro chp.jpg |
| Disadvantages of micro‑CHP  * Micro CHP’s are still in the ‘early adaptors’ phase, meaning that prices are still relatively high and that the systems are still being adjusted. * Noise production of micro CHP’s is a relatively large problem. * Payback times – payback time are still quite high, between 7–15 years depending on use and if the system can export electricity to the national grid. * Not completely renewable – A CHP system is still reliant on the use of natural gas. However there are boilers on the market, which utilise a renewable source such as biomass or solar thermal. * Seasonal variations – may be ineffectual in responding to dynamic requirements of users particularly coping with seasonal variations; often producing excess heat during the summer period. | Description: 05 Micro chp.jpg |