Alternative Sustainable Energy & Heating

Risk management considerations

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Introduction

According to the UK Green Building Council, the built environment accounts for 40% of the UK total carbon footprint.

Half of this comes from energy usage.

To reduce carbon emissions, the UK initially set a goal of achieving a reduction by 2050 of 80% compared to 1990 levels. Then in June 2019 the UK government became the first major economy to pass legislation with a target to reduce all GHG emissions to **net zero by 2050** (compared to 1990 levels).

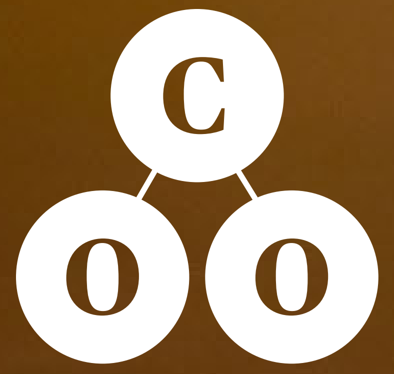
This legislative target, together with growing pressure from investors, consumers and stakeholders is leading organisations to adopt environmental policies which demonstrate their 'green credentials' as an integral part of their corporate strategy.

Alongside the methods and materials used in construction or alteration of buildings, the ongoing operational aspects are now also a key consideration. These include water usage and energy efficiency, which can involve on-site alternative sustainable power generation and heating.

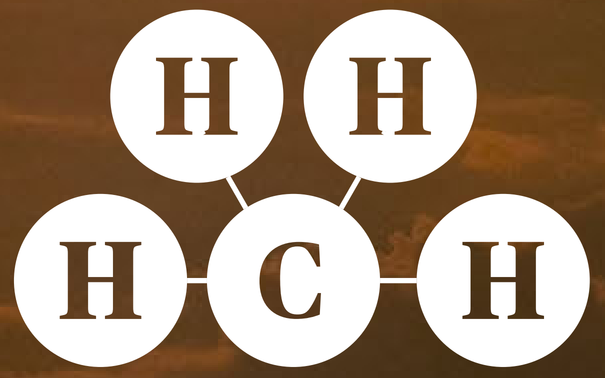
The green credentials of a building can be demonstrated by third-party certification which measures a range of factors including energy efficiency and heating.

The main standard used in the UK to validate and certify sustainability in the built environment is BREEAM (Building Research Establishment Environmental Assessment Method), launched in 1990 and applicable to both new construction projects and buildings in use.

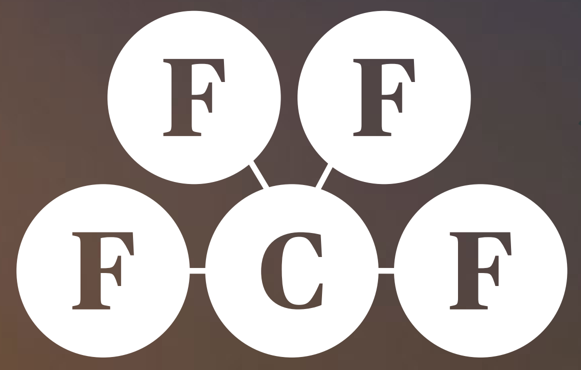
The six main Greenhouse Gases (GHG) are:



Carbon Dioxide
(CO2)

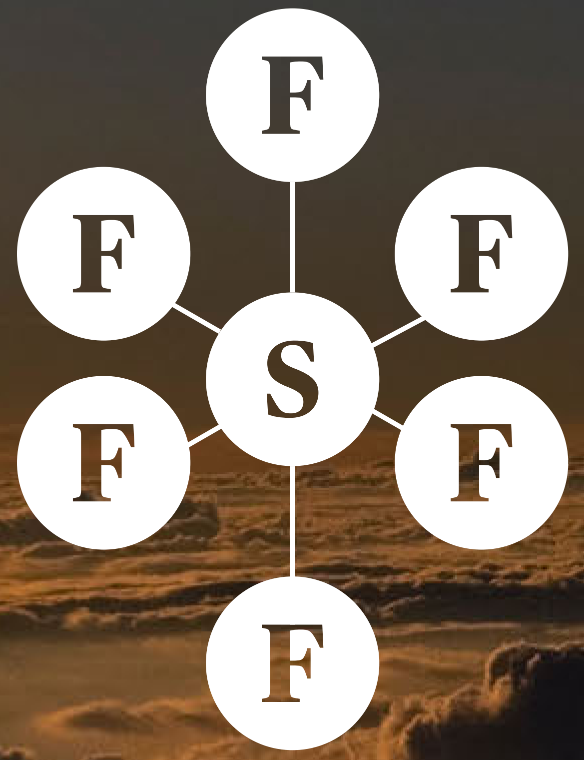


Methane
(CH4)

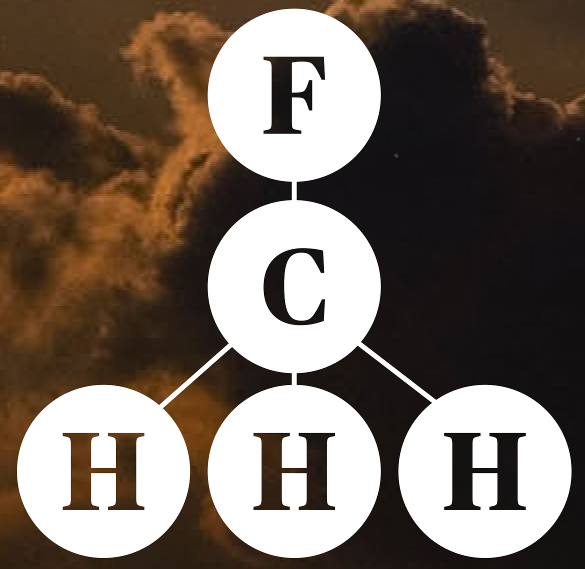


Petrofluorocarbons
(PFCs)

Nitrous Oxide
(N2O)



Sulphur
hexafluoride
(SF6)



Hydroflourocarbons
(HFCs)

Executive summary

This document covers the common alternative sustainable energy and heating sources in new construction or retrofitting to existing buildings.

The related broad risk and hazards are outlined along with the general risk management mitigations and links to further technical risk control guidance.

Every sustainable energy or heating system should be installed and commissioned by competent trained engineers and factored into site risk assessments. Day-to-day operation and ongoing maintenance should also be considered, to reduce the risk of failure and/or loss.

Common considerations

The following considerations apply across all the technologies covered in this guide:

- **Design and Installation:** Alternative energy or heating systems should be designed, installed and commissioned in accordance with the original equipment manufacturers (OEM) guidance and relevant third-party standards such as the Microgeneration Certification Scheme (MCS).
- **Product Credentials:** The equipment should be certified and listed by a relevant product certification scheme such as the one run by MCS.
- **Installer Credential:** The installer should be competent and experienced in the respective type of system and hold relevant third party accreditation where appropriate such as MCS or HETAS.
- **Maintenance:** The installation, including all condition monitoring devices, safety interlocks and fixed fire suppression systems, should ideally be inspected and maintained by appropriately qualified and competent engineers (i.e. HETAS, MCS). This should be done at least annually in accordance with the OEM recommendations. The maintenance of these systems should form part of the wider Planned Preventative Maintenance programme for the site.
- **Operational:** Staff responsible for the installation should be suitably trained (induction and refresher) in the correct safe operational and emergency procedures. Access to certain areas such as fuel bunkers, control cabinets or associated electrical switch-rooms should be restricted to trained and competent staff.
- **Fire Risk Assessment:** The site Fire Risk Assessment should be updated as appropriate by a competent person to take account any additional hazards and mitigation presented by alternative energy or heating systems, including associated fuel storage where applicable. Additional risk assessments may be necessary as discussed in the following tables in this guide.
- **BCP:** Updating of the site Business Continuity Plan should be undertaken to cater for loss of the facility and any disruptive impact this may have to the business. It should also consider the need for planning emergency temporary alternatives.

Biomass boilers

Biomass boilers generate heat from the burning of non-fossil biomass fuels such as logs, wood waste, pellets / chips, energy crops etc.

The heat produced from the combustion process is used to provide indirect space or water heating. Biomass boilers can be found in a wide range of building types such as homes, schools, warehouses, workshops, industrial and commercial premises.

Hazards

- Bulk fuel storage as additional fire load and exposure.
- Spontaneous combustion in fuel bunker.
- Dust explosion in fuel bunker / store.
- Carbon Monoxide liberated in fuel store and from combustion.
- Proximity of burner equipment to combustible building elements, stock or waste materials.
- Hot surfaces to boiler and flue as an inception hazard.
- Hot sparks and embers.
- Hot ash.

Mitigation

- Clear space separation or fire rated compartmentation for fuel store.
- Boiler location and need to be kept clear of combustible items.
- The Dangerous Substances and Explosive Atmosphere Regulations (DSEAR) risk assessment completed where there is potential for dust explosion.
- Zoned electrics per ATEX Directives (atmosphere explosive) regulations where required and identified by DSEAR risk assessment.
- Fixed Fire Suppression – water spray to biomass auger feed.
- Automatic Fire Detection.
- Automatic shut-down interlocks linked to detection/suppression systems to shut off any automated fuel feed systems.
- Automatic Sprinkler System based on risk assessment.
- Housekeeping ensuring combustible items are kept away from burner equipment.
- Procedure for removing and disposing ash safely.

Reference documents: Biomass boilers

RC64: Recommendations for fire safety with small biomass installations

RC04: Fixed Heating Equipment Burning Waste Fuel

MCS 008 Product Certification Requirements: Biomass

MCS 006 Percussive Events Guidance

Biomass – anaerobic digester

Anaerobic digesters (AD) are facilities comprising enclosed vessels and fermentation tanks with associated controls used to convert biodegradable organic material into flammable biogas.

The organic material can be from a wide range of 'feedstock' sources such as:

- Food and drink waste – household and hospitality
- Food processing residue – example from bakery or brewing
- Animal processing waste from abattoirs
- Sewage sludge or farm slurry
- Agricultural waste
- Specifically grown 'energy crops'

The feedstock is broken down in a natural anaerobic digestion process by micro-organisms in the absence of oxygen to produce biogas which is mainly comprised of methane and carbon dioxide.

The flammable biogas produced is collected and stored for use either directly in the form of the cleansed gas (following gas cleaning) for heating or more commonly to produce electricity and heat by burning in a Combined Heat & Power engine.

The remaining by-product material (digestate) from the AD process can be used as a fertilizer.

Hazards

- Fire in electrical control and plant room areas.
- Explosion from combustible gases.
- Dust explosion risk from dry feedstock.

Mitigation

- Distance separation to main buildings.
- Non-combustible construction and linings.
- Plant and control room in a separate fire compartment.
- DSEAR risk assessment and zoned electrics per ATEX regulations.
- Automatic Fire Detection.
- Fixed fire suppression to critical electrical control cabinets.
- Gas leak detection, ventilation & gas safety shut off valves (SSOV).

Photovoltaic panels

Photovoltaic panels (PV) are the most widely used form of alternative sustainable energy source in the UK for both domestic and commercial installations.

They convert energy from light during the day into Direct Current (DC)electrical energy. They do not need direct sunshine for this energy conversion to take place. Each solar PV panel is made up of individual solar cells within a frame and these are arranged together and electrically connected to form a PV array.

The DC electrical power generated from the PV array is routed to an Inverter or inverters which converts it into Alternating Current (AC) at 240 volts for direct use on site, charging storage batteries or feed in to the National Grid. In addition to converting from DC to AC current, the inverter provides feedback on power production, communicates with the National Grid and ensures safety of the PV system.

Inverters can be located within the building or externally and there are different types including ‘micro-inverters’ which are attached to each PV panel so the power collected is converted to AC at source.

Hazards

- Fire exposure to roof – especially if combustible roof construction.
- Electrical Fire at inverter or cabling.
- DC arc faults.
- Wind and storm damage.

Mitigation

- Adequate fixing to the roof.
- Preferably only install on a non-combustible roof.
- Ensure access is provided to maintain roof mounted arrays.
- Provision of DC and AC isolation switches.
- Automatic Fire Detection covering electrical equipment in building.
- Avoiding panels or cables crossing fire compartment walls.

Reference documents: photovoltaic panels

RC62: Recommendations for fire safety with PV panel installations

RE3: Need to Know Guide Rooftop mounted PV Solar Systems

MCS 005 Product Certification Scheme Requirements: Solar PV modules

Battery energy storage systems

Battery Energy Storage Systems (BESS) are modular rechargeable batteries.

They're used to store electrical energy generated from renewable sources such as solar photovoltaic panels or wind turbine and then discharge this when needed either for the customer or fed back into the supply grid.

A BESS comprises the battery cells (predominantly Li-ion) to create modules, a Battey Management System (BMS) to monitor and control the charge state, energy management system and an inverter to convert the Direct Current (DC) to Alternating Current (AC) for use. The inverter may be integrated in the BESS or a hybrid inverter shared with, for example, the solar PV generation.

BESS systems vary in size from modest 'powerpacks' in domestic use down to 1kw to larger commercial or industrial systems rated at several Mw.

Hazards

- Fire exposure.
- Li-ion battery failure leading to thermal runaway and fire.
- Electrical Fire at inverter or cabling.
- DC current.

Mitigation

- If externally located – adequate separation to adjacent buildings.
- If internal in compartment – locate in a fire rated compartmen.t
- Provision of Automatic Fire Detection.
- For large significant critical BESS systems consider ‘off-gassing’ early warning detection and fire suppression.
- Track record of installer should be established & whether re-purposed Li-ion batteries have been used (i.e. ex EV batteries) as opposed to new.

Reference documents: battery energy storage systems

RE1: Need to Know Guide BESS

Heat pumps

A heat pump is a unit which takes heat from an external source, either from the air, the ground or a water source, which is then converted by the heat pump to create hot water (heating / sanitary) or warm air (air conditioning).

Heat pumps take the ambient heat from source via an evaporator which warms up the refrigerant in the circuit. The warmed refrigerant is then compressed which increases temperature further. The refrigerant then passes through the condenser to release the heat via a heat exchanger to warm water or air. An electric heating element is required in the circuit to heat water to desired temperature, if required.

Various refrigerants are in use and most are considered as non-flammable, however systems may use Diflourmethane (R32), Chloromethane (R40), Propane (R290) and Ammonia (R717) which are considered extremely / highly flammable.

Heat pumps are significantly more efficient and use less electricity.

Hazards

- Electrical safety.
- Potential for flammable refrigerant to be present.
- Potential for legionella if correct temperatures not obtained.

Mitigation

- Commercial systems, separate boiler room (compartmentation).
- Automatic fire detection to plant rooms.

Reference documents: Heat pumps

MCS 007 Product Certification Scheme Requirements: Heat Pumps

MCS Domestic Heat Pumps – A Best Practice Guide

Solar thermal

Solar thermal systems are designed to take energy from the sun to increase the temperature of a fluid to provide hot water for heating and sanitary purposes.

The system comprises the solar collector (roof or ground mounted), pumps, fluid pipes for transfer of heat, storage systems and electrical heater for increasing temperature.

Solar thermal systems can be basic, for example where water to be used is pumped around the heating circuit and absorbs heat from sun (i.e., swimming pools).

Most common domestic / commercial system is the evacuated tube system. Each tube contains a fluid which evaporates which causes heat to rise to the top of the tube (as vapour cools it sinks to bottom). The heated vapour transfers heat to a fluid at the head of the tube, transferred by a heat exchanger. The heated fluid transfers to the accumulator (water tank) where it is stored prior to use. There will be an electrical heater for increasing temperature as required.

Hazards

- Electrical safety.
- Risk of legionella if correct temperatures not obtained.

Mitigation

- Commercial systems, separate boiler room (compartmentation).
- Maintenance in line with manufacturers requirements.
- Fire risk assessment.
- Automatic fire alarm.

Reference documents: Solar thermal

MCS 004 Product Certification Scheme Requirements: Solar Collectors

MIS 3001 The Solar Thermal Standard (Installation)

Wind turbines

Wind turbines harness the power of wind to generate AC electrical power for use by the grid or individual users.

They are primarily seen in semi-rural and rural areas, although they may be found associated with individual commercial users. They are increasingly being located offshore.

Turbines come in various sizes, the current largest onshore turbine is circa 200m tall (7.2MW), the largest offshore turbine is circa 250 metres tall (13.6MW). The wind turbine comprises base, tower and nacelle. The turbine blades are attached to the nacelle, and connected to the generator, gearbox and brake within. Rotation of the blades turn the rotor shaft connected to the great box, which turns the generator to convert kinetic energy into electrical energy.

Hazards

- Wind turbines operate automatically unattended in remotely locations.
- Wind turbines are very tall, and increasing in size, particularly offshore turbines.
- Lightning strikes – wind turbines will virtually always be the tallest structure in an area.
- Overheating of components – i.e. generator, bearings, gears, windings.
- Electrical short circuit.
- Malicious damage.
- Combustible elements within / mounted to nacelle, i.e., blades are composite structures and nacelle housing normally GRP.
- Gearbox, containing grease and oil.
- Generator insulation materials.
- Inverter systems associated with battery packs, electronics and cables.
- Transformers, oil, cables and insulation materials.
- Work at height.

Mitigation

- Wind turbine condition monitoring systems for early fault detection – a constant turbine monitoring (e.g., oil temperatures, strain gauges, temperature gauges, accelerometer, current transformer).
- Automatic alarms and / or camera monitoring
- Fire suppression systems.
- Lightning protection.
- Use of fire resistant oils and lubricants.

Reference documents: Wind turbines

MCS 006 Product Certification Scheme Requirements: Small Wind Turbines (up to 50kW)

MIS 3003 Requirements for MCS contractors undertaking the supply, design, installation, set to work commissioning and handover of micro and small wind turbine systems (up to 50kW

Energy Institute – Wind Turbine Safety Rules, 4th Edition

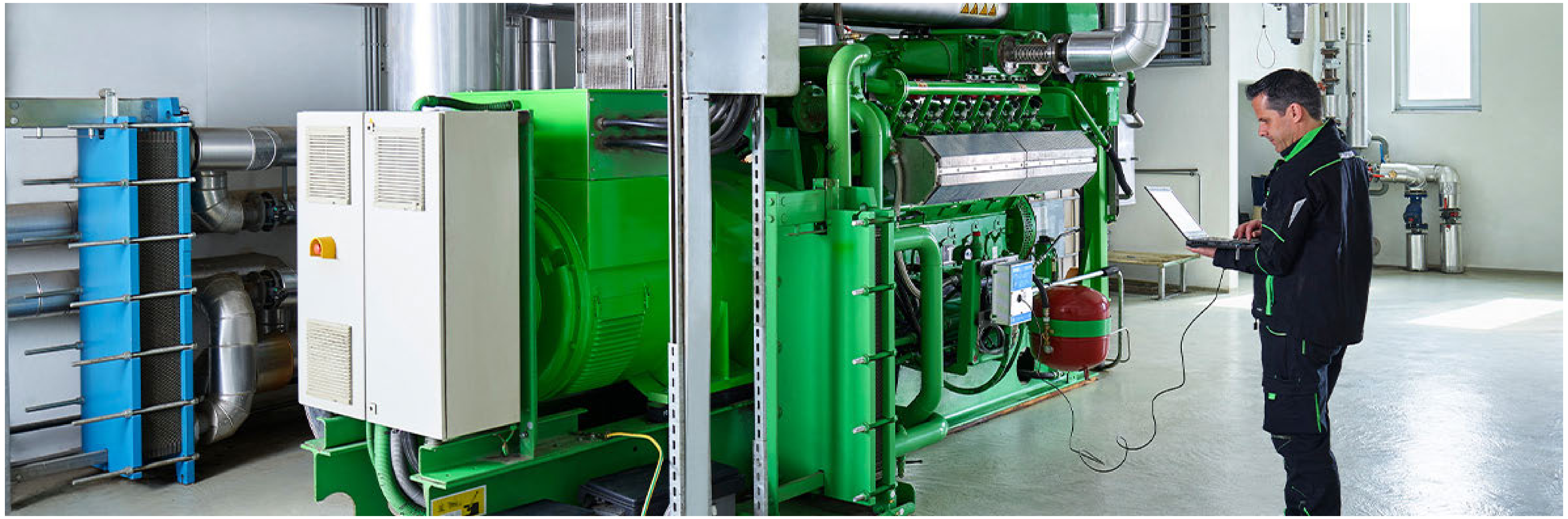
Provision and use of work equipment regulations (PUWER)

Lifting operations and lifting equipment regulations (LOLER)

Work at Height Regulations

Combined heat and power

Combined Heat & Power (CHP) is the recovery of heat produced when generating electricity, heat that is usually wasted.



The fuel can be natural gas, logs or oil, most CHP schemes in the UK use natural gas or biomass. CHP is considered more carbon efficient means to create electrical power / heat due to efficiencies; most CHP plants will operate at 80% to 90% efficiency.

CHP can be used for individual homes, commercial property (particularly popular in educational, health care and large scale governmental sites) and increasingly seen in district heating systems, i.e., one central CHP plant serving multiple buildings within an area. Most systems are made up of an engine or a turbine which drives a generator to produce electricity, plus a heat recovery system to utilise waste heat for hot water and heating.

Hazards

- The supply of high pressure gas to turbine is required at high pressure.
- Fuel leak from the fuel supply pipework.
- Gas turbine vibration during use can result in joint failure.
- Gas turbines are a noise source and are often sited in acoustic enclosures. The release of fuel within the turbine could result in build-up of flammable gases / fuel.
- Hot surfaces.

Mitigation

- Automatic fire detection.
- Fire suppression.
- Location of CHP plant to fire resistant compartment.
- Potential DSEAR risk assessment where CHP uses biomass.
- Automatic shut-down interlocks to fuel supply connected to automatic fire alarm / suppression.
- Vibration monitors for bearings for failure to minimise vibration risk
- Electrical equipment may require appropriate ATEX regulation zoning and suitable ventilation provided.
- Suitable purging and gas safety shutoff devices.

Reference documents: Combined heat and power

MCS 014 - Product Certification Scheme Requirements:
Heat-led micro-cogeneration packages or add-on units (up to electrical output of 50kW)

MIS 3007 - Requirements for MCS contractors undertaking the design, supply, installation, set to work, commissioning and handover of a heating system containing a micro-cogeneration package (up to electrical output of 50kW)

Hydrogen fuel cells

A fuel cell is a device that converts energy from a chemical reaction when combining oxygen and hydrogen to directly produce electricity with heat and water as by-products.

The oxygen is normally taken from the air and the hydrogen is mainly produced either from electrolysis of water or extracted from a hydrocarbon fuel source such as natural gas, methane, Liquified Petroleum Gas (LPG), gasoline or diesel.

Fuel cell designs differ and either have an acidic or alkaline electrolyte, but the same principle applies to produce a chemical reaction from combining hydrogen and oxygen to produce electricity. Different types include:

- Proton exchange or Polymer electrolyte membrane fuel cells
- Phosphoric acid fuel cells
- High temperature fuel cells (molten carbonate or solid oxide

The fuel cell has an anode and cathode separated by an electrolyte membrane, and works by passing hydrogen through the anode and oxygen through the cathode.

This process splits hydrogen molecules into protons and electrons. The electrons are forced through a circuit to generate electricity and heat while the protons pass through the membrane to combine with the oxygen to produce heat and water.

This is a clean, reliable and silent process and will produce electricity all the while the fuel source is available.

Hazards

- Carbon dioxide production.
- Explosive gas fuel sources – different characteristics.
- Flammable liquid in some designs.
- Electrical faults.

Mitigation

- Distance separation to main buildings if separate structure
- Fire compartmentation if in main building
- DSEAR risk assessment and zoned electrics per ATEX regulations
- Automatic Fire Detection
- Fixed fire suppression to critical electrical control cabinets
- Gas leak detection, ventilation & gas safety shut off valves (SSOV)
- Ventilation – depending on characteristics of gas fuel used

Get in touch.

If you have any questions about this document, please get in touch with your usual AXA contact or your insurance broker.

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