Section 3 – D/602/2486

Understand how to apply environmental protection measures within BSE
D/602/2486 - Understand how to apply environmental protection measures within BSE

This knowledge unit provides learning in a range of basic measures associated with protection of the environment. Areas covered include the effective use of material resources, minimising wastage. The legislation surrounding the effective use of energy and water resources including an introduction to the use of emerging environmental technologies is also covered in the unit. Upon completion of the unit the learner will:

- **LO1.** Know the energy conservation legislation that applies to the building services industry
- **LO2.** Know the applications of energy sources used in the building services industry
- **LO3.** Know the importance of energy conservation when commissioning building services systems
- **LO4.** Know the methods of reducing waste and conserving energy while working in the building services industry
- **LO5.** Know how to safely dispose of materials used in the building services industry
- **LO6.** Know the methods of conserving and reducing wastage of water within the building services industry
Learning Outcome 1

Know the energy conservation legislation that applies to the building services industry
There are two Assessment Criteria in Learning Outcome 1:

AC1.1. State the aims of energy conservation legislation
AC1.2. Identify the responsibilities of members of the construction team under energy conservation legislation

AC1.1 State the aims of energy conservation legislation

General Legislation

The Climate Change Act 2008

Adopted in November 2008, the Climate Change Act 2008 set targets to reduce carbon emissions to 80% below 1990 levels by 2050. A provisional reduction was set of 34% of 1990 levels by 2020 with a possible cut of 42% (by international agreement). It also established the idea of carbon budgets.

The Committee on Climate Change is an advisory committee to the UK Government, which sets targets and the measures to achieve them.


Across Europe, 40% of all energy generated is consumed by buildings. This accounts for 36% of all CO₂ emissions. The Directive on Energy Performance of Buildings (2002/91/EC) was initiated by the EU to achieve energy performance in buildings. There were four main objectives:

1) **Establishment of a calculation methodology**: Member States must implement a methodology for the calculation of the energy performance of buildings, taking account of all factors that influence energy use;

2) **Minimum energy performance requirements**: there must be regulations that set minimum energy performance requirements for new buildings and for large existing buildings when they are refurbished;

3) **Energy performance certificate**: there must be an energy performance certificate made available whenever buildings are constructed, sold or rented out;

4) **Inspections of boilers and air-conditioning**: there must be regulations to require inspections of boilers and heating systems (or an alternative system of providing advice as discussed below), and inspection of air conditioning systems.

In 2010, was updated to the Energy Performance of Buildings and Directive (EPBD recast). This strengthened the objectives laid down in 2002:
1) When buildings are advertised for sale or rent, energy performance certificates are to be included.

2) Larger public buildings must display a Display Energy Certificate (DEC).

3) Inspection schemes must be established for heating and air conditioning systems or measures put in place with equivalent effect.

4) All new buildings must be nearly zero energy buildings by 31 December 2020 (public buildings by 31 December 2018).

5) EU countries must set minimum energy performance requirements for new buildings, buildings that are refurbished and renovated, and for retrofitted building elements, such as roofs, walls, heating and air conditioning.

6) EU countries must draw up lists of national financial measures to improve the energy efficiency of buildings.

Energy Performance of Buildings (England and Wales) (Amendment) (No.2) Regulations 2016

The original 2007 Regulations were first updated in 2012 and again in 2016. These Regulations put into practice articles 7, 8 and 9 of the EU Energy Performance of Buildings Directive that dictates that clients and landlords must produce and display Energy Performance Certificates (shown left).

Under the 2016 amendments, local authorities must now arrange for the enforcement of obligations under the 2012 Regulations, including those relating to EPCs, Display Energy Certificates and Air Conditioning energy inspections, in relation to their own buildings with the local Weights and Measures authority of another area. In other words, local authorities cannot certificate their own buildings. Certification must be completed by another authority.

Home Energy Conservation Act (HECA) 1995

The Home Energy Conservation Act (HECA) places obligations on local authorities to increase energy efficiency in their housing stock by 30% over a 10 – 15 year timeframe. The Department for the Environment estimated that a 30% improvement on UK energy consumption was possible through improved energy efficiency of housing stock. The main objectives of the Act are to reduce carbon emissions, thereby helping climate change and reduce fuel poverty by lowering the cost of fuel bills.
Construction Industry Specific Energy Conservation Legislation

Building Regulations Part L: Conservation of fuel and power (Part J in Scotland and Part F in Northern Ireland)

Regulation 26 of the Building Regulations states:

‘Where a building is erected, it shall not exceed the target CO₂ emission rate for the building....’

Schedule 1 of Part L: Conservation of Fuel and Power states that provision for the conservation of fuel and power must be made by limiting heat gains and losses and by providing building services that are efficient, have effective controls, are properly commissioned and that information is provided so that the building can be operated efficiently.

Part L: Conservation of Fuel and Power deals with the energy efficiency of buildings. This comprehensive set of regulations is divided into 4 separate documents:

- Approved Document L1A: conservation of fuel and power in new dwellings, 2013 edition with 2016 amendments
- Approved Document L2A: conservation of fuel and power in new buildings other than dwellings, 2013 edition with 2016 amendments

The key points of Part L are:

1) The designed carbon emission rate (known as the Dwelling Emission Rate or DER) for self-contained dwellings and individual flats and Building Emission Rate (known as the BER) for buildings other than dwellings must not exceed the Target Emission Rate (TER) for a theoretical building of similar type, size and shape. DER, BER and TER are expressed in kgCO₂/m² per year.
2) Installed building services should achieve a reasonable standard of energy efficiency.
3) Solar gains (solar heat through windows and through the fabric of the building) should be limited.
4) The performance of the building should be in line with the Dwelling Emission Rate. This includes air-permeability testing and proper commissioning of all building services systems.
5) Provision should be made for energy efficient operation by issuing the building owner with information, in the form of a log book, enabling them to operate the building in such a way that uses no more fuel and power than is reasonable.
6) Limiting heat loss through the fabric of the building by stipulating the U-Values of the various building components, such external walls, internal walls, roof, glazing, doors etc.

Part F deals with indoor air quality and, as such, is not an energy efficiency document. However, Part L (see above) requires that architects design buildings that are air tight to retain heat and save energy. Ventilation is included in this, as a way of controlling the indoor temperature of a building. An air tight approach to buildings can lead to sick building syndrome (SBS) especially if the air within the building becomes stale and so it very important that ventilation is applied. The downside to ventilation of buildings is that this leads to heat loss.

Part F defines ventilation as the removal of ‘stale’ air from a building, replacing it with ‘fresh’ air from outside. Removing stale air leads to:

- The removal of airborne odours, pollutants and bacteria
- The control of humidity
- Fresh clean air for breathing.

Part F also encourages energy efficient controls as an important part of ventilation systems.

Building Services Specific Energy Conservation Guides

Domestic Building Services Compliance Guide 2013 (with 2018 amendments)

This document supports the current editions of Document L: Conservation of Fuel and Power and provides guidance on complying with the Building Regulations requirements for space heating and hot water systems, mechanical ventilation, comfort cooling, fixed internal and external lighting systems and renewable energy systems. The 2018 amended document came into effect on 6th April 2018.

The guide is divided into four fuel-based sections and nine technology-specific sections:

**Fuel based:**
- Section 2 Gas-fired space and water heating.
- Section 3 Oil-fired space and water heating.
- Section 4 Electric heating.
- Section 5 Solid fuel heating.

**Technology-specific:**
- Section 6 Community heating.
- Section 7 Underfloor heating.
- Section 8 Mechanical ventilation.
- Section 9 Heat pumps.
- Section 10 Comfort cooling.
- Section 11 Solar water heating.
- Section 12 Lighting.
- Section 13 Micro-combined heat and power.
- Section 14 Heating system circulators.
Standard Assessment Procedure 2009 (SAP2009) and Reduced Standard Assessment Procedure (RdSAP) 2012

The Standard Assessment Procedure is the method by which dwellings are energy rated. It has been adopted by the UK Government as part of the national methodology for the calculation of energy performance for buildings. It is used primarily to demonstrate that a building complies with the requirements of Document Part L 1A/B.

Central Heating System Specifications (CHeSS)

CHeSS gives recommendations for good and best practice for energy efficiency of domestic wet central heating systems. Customers and clients should consult these specifications to ensure that their heating systems meet the current good and best practice.

Unlike the Domestic Building Services Compliance Guide, CHeSS is directly aimed at central heating systems in domestic properties.

CHeSS: System description HR7 & 8

<table>
<thead>
<tr>
<th>CHeSS HR7 - Recommended good practice (2008)</th>
<th>CHeSS HR8 - Recommended best practice (2008)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System description</strong></td>
<td><strong>System description</strong></td>
</tr>
<tr>
<td>Domestic Wet Central Heating System with regular boiler (natural gas, LPG, oil) and separate hot water store.</td>
<td>Domestic Wet Central Heating System with regular boiler (natural gas, LPG, oil) and separate hot water store.</td>
</tr>
<tr>
<td><strong>Boiler</strong></td>
<td><strong>Boiler</strong></td>
</tr>
<tr>
<td>A regular boiler (not a combi) which has a SEDBUK efficiency of at least 86% (bands A and B)</td>
<td>A regular boiler (not a combi) which has a SEDBUK efficiency of at least 90% (band A)</td>
</tr>
<tr>
<td>Boiler (see Notes 5 and 6)</td>
<td>Boiler (see Notes 5 and 6)</td>
</tr>
<tr>
<td><strong>Hot water store</strong></td>
<td><strong>Hot water store</strong></td>
</tr>
<tr>
<td>EITHER</td>
<td>EITHER</td>
</tr>
<tr>
<td>Hot water cylinder, whose heat exchanger and insulation properties both meet or exceed (see note 7) those of the relevant British Standards.</td>
<td>High performance hot water cylinder (see Note 8)</td>
</tr>
<tr>
<td>OR</td>
<td>OR</td>
</tr>
<tr>
<td>Thermal (primary) storage system, whose insulation properties meet or exceed those specified in Ref [9].</td>
<td>High-performance thermal (primary) storage system (see note 9).</td>
</tr>
<tr>
<td></td>
<td>In suitable buildings, consideration should be given to fitting a cylinder with an additional heat exchanger to allow for solar water heating.</td>
</tr>
</tbody>
</table>
**BPEC Level 2 Diploma in Plumbing Foundation**

<table>
<thead>
<tr>
<th>Controls (see Notes 10, 11 and 12)</th>
<th>Controls (see Notes 10, 11 and 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Full programmer</td>
<td>• Programmable room thermostat, with additional timing capability for hot water</td>
</tr>
<tr>
<td>• Room thermostat</td>
<td>• Cylinder thermostat</td>
</tr>
<tr>
<td>• Cylinder thermostat</td>
<td>• Boiler interlock (see Note 13)</td>
</tr>
<tr>
<td>• Boiler interlock (see Note 13)</td>
<td>• TRVs on all radiators, except in rooms with a room thermostat</td>
</tr>
<tr>
<td>• TRVs on all radiators, except in rooms with a room thermostat</td>
<td>• Automatic bypass valve (see Note 14)</td>
</tr>
<tr>
<td>• Automatic bypass valve (see Note 14)</td>
<td>Installation: see Notes 1, 2, 3 and 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHeSS: System description HC7 &amp; 8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CHeSS HC7 - Recommended good practice (2008)</strong></td>
</tr>
<tr>
<td><strong>Description HC7</strong></td>
</tr>
<tr>
<td>Domestic wet central heating system with combi or Combined Primary Storage Unit CPSU boiler (natural gas, LPG, or oil)</td>
</tr>
<tr>
<td><strong>Boiler</strong></td>
</tr>
<tr>
<td>A combi or CPSU boiler which has a SEDBUK efficiency of at least 86% (bands A and B)</td>
</tr>
<tr>
<td>Boiler (see Notes 5 and 6)</td>
</tr>
<tr>
<td><strong>Hot water store</strong></td>
</tr>
<tr>
<td>None, unless included within boiler</td>
</tr>
<tr>
<td><strong>Controls:</strong> (see Notes 10, 11 and 12)</td>
</tr>
<tr>
<td>• Time switch</td>
</tr>
<tr>
<td>• Room thermostat</td>
</tr>
<tr>
<td>• Boiler interlock (see Note 13)</td>
</tr>
<tr>
<td>• TRVs on all radiators, except in rooms with a room thermostat</td>
</tr>
<tr>
<td>• Automatic bypass valve (see Note 14)</td>
</tr>
<tr>
<td>Installation: see Notes 1, 2, 3 and 4</td>
</tr>
</tbody>
</table>

**Notes applicable to CHeSS HR8, HC8, HR7, HC7 (year 2008)** (taken from the Energy Saving Trust publication ‘Central heating system specifications (CHeSS) Year 2008’)

1. **Other components**

The specifications list only the principal components of a heating system affecting energy efficiency. Other components will be required, such as radiators, circulator pumps (see note 4), cisterns (feed and expansion tanks), and motorised valves. All components must be selected and sized correctly.
2. Design, installation and commissioning

Heating systems should be designed to match the heating needs of the buildings in which they are installed. They should be installed in accordance with relevant safety regulations, manufacturers’ instructions, the Benchmark scheme, building regulations, the Domestic Heating Compliance Guide, and British Standards. For oil boilers the OFTEC forms CD/10 and CD/11 (or similar) for installation and commissioning should be completed. More detailed advice on domestic wet central heating systems is given in the Energy Saving Trust guides, and the CIBSE guide. Commissioning and handover of information on operation and maintenance is a requirement of building regulations and a suitable commissioning certificate should be issued.

3. Water treatment

Water treatment is important as it prolongs effective and trouble-free operation. Three types of water treatment should be considered:

- Cleaning and flushing of the system before use
- Corrosion inhibition
- Softening of the water supply to combi boilers for hot water service in hard water areas.

In each case the recommendation of the boiler manufacturer must be followed as damage may be caused by unsuitable treatment. For both new and replacement systems, thorough cleaning is essential. When a boiler is replaced it is essential to drain and flush all old water from the system in case it contains a corrosion inhibitor unsuitable for the new boiler. Advice on the need for treatment and on causes of problems is given in BS 7593: Code of practice for treatment of water in domestic hot water central heating systems.

4. Circulator pump

Advice on pump dimensioning is available from the BPMA (British Pump Manufacturers’ Association) website at www.bpma.org.uk. Pumps installed separately from the boiler (not supplied as part of the boiler unit) which have automatic speed control should not be used in heating systems with TRVs unless the design of the pump and system ensures that the minimum flow rate through the boiler (as specified by the boiler manufacturer) is certain to be maintained under all conditions.

5. Boiler size and type

The whole house boiler sizing method for houses and flats gives guidance on boiler size and is available on the Energy Saving Trust website at:

www.energysavingtrust.org.uk/housingbuildings/calculators/boilersizing

- A regular boiler does not have the capability to provide domestic hot water directly, though it may do so indirectly via a separate hot water store.
- A combination (combi) boiler does have the capability to provide domestic hot water directly, and some models contain an internal hot water store.
- A combined primary storage unit (CPSU) is a boiler with a burner that heats a thermal store directly.

Each of these may be either a condensing or non-condensing boiler, and condensing boilers are always more efficient. Condensing boilers are fitted with a drain to dispose of the liquid condensate. Building regulations require all new gas and oil boilers to be condensing, whether installed in new or existing housing, unless
there are exceptional circumstances that would make the installation impractical or excessively costly. All boilers in the CHeSS specifications HR7, HC7, HR8 and HC8 are condensing boilers.

## 6. Boiler efficiency

SEDBUK (Seasonal Efficiency of Domestic Boilers in the UK) is the preferred measure of the seasonal efficiency of a boiler installed in typical domestic conditions in the UK, and is used in SAP assessments and the building regulations. The SEDBUK efficiency of most current and obsolete boilers can be found on the website www.boilers.org.uk. Although SEDBUK is expressed as a percentage, an A to G scale of percentage bands has also been defined (see below).

### SEDBUK

<table>
<thead>
<tr>
<th>Efficiency range</th>
<th>Band</th>
</tr>
</thead>
<tbody>
<tr>
<td>90% and above</td>
<td>A</td>
</tr>
<tr>
<td>86% – 90%</td>
<td>B</td>
</tr>
<tr>
<td>82% – 86%</td>
<td>C</td>
</tr>
<tr>
<td>78% – 82%</td>
<td>D</td>
</tr>
<tr>
<td>74% – 78%</td>
<td>E</td>
</tr>
<tr>
<td>70% – 74%</td>
<td>F</td>
</tr>
<tr>
<td>Below 70%</td>
<td>G</td>
</tr>
</tbody>
</table>

### 7. Hot water cylinder (basic)

Vented cylinders shall comply with the performance requirements of BS 1566:2002 Type P cylinders. The performance of unvented cylinders shall comply with BS EN 12897:2006 or be approved by the British Board of Agrément (BBA) or other equivalent body. All cylinders must be factory insulated such that the standing heat loss will not exceed: \(1.6 \times (0.2 + 0.051 \frac{V^{2/3}}{10})\) kWh per 24 hours, where \(V\) is the capacity in litres. All cylinders shall be labeled with the standing heat loss in kWh/24hours.

Indirect cylinders shall also be labeled with the heat exchanger performance in kW as measured by BS 1566:2002 (vented) or BS EN 12897 (unvented). Where cylinder capacity \(V\) in litres is less than 200, the ratio of \(V\) to heat exchanger performance (in kW) shall not exceed 10; e.g. a 150 litre cylinder shall have a minimum heat exchanger performance of 15kW. Where \(V\) is 200 or above the cylinder shall have a minimum heat exchanger performance of 20kW.

### 8. Hot water cylinder (high performance)

A high performance cylinder may be either vented or unvented. The manufacturer must confirm that the heat exchanger and insulation properties exceed the requirements of the relevant British Standards. The standing heat loss must not exceed: \(1.28 \times (0.2 + 0.051 \frac{V^{2/3}}{10})\) kWh per 24 hours, where \(V\) is the capacity in litres. All cylinders shall be labelled with the standing heat loss in kWh/24hours.

High performance cylinders shall comply with the heat exchanger performance and labelling requirements of basic cylinders, as set out in Note 7.

Solar-compatible cylinders contain an additional heat exchanger or other provision for connection to a solar water heating system. They offer the opportunity to install a solar water heating system at greatly reduced cost and with less disruption in the future. In the case of solar-compatible cylinders the heat exchanger performance of the upper coil (connected to the boiler) shall relate to the volume of water heated by that coil; i.e. the dedicated solar volume shall be subtracted from the total cylinder capacity for the purposes of heat exchanger assessment.
9. Thermal store (high performance)

A high-performance thermal (primary) storage system must have insulation properties exceeding by at least 15% those given in the WMA Performance Specification for Thermal Stores, and comply with the specification in other respects. Note that the WMA Performance Specification for Thermal Stores is shortly to be superseded by a revised 2008 specification from the HWA (Hot Water Association).

10. Circuits and zones

Systems with regular boilers must have separately controlled circuits to the hot water cylinder and radiators, and both circuits must have pumped circulation. Large properties must be divided into zones not exceeding 150m² floor area, so that the operation of the heating in each zone can be timed and temperature controlled independently.

11. Heating controls

- **A time switch** is an electrical switch operated by a clock to control either space heating or hot water, or both together but not independently.
- **A full programmer** allows the time settings for space heating and hot water to be fully independent.
- **A room thermostat** measures the air temperature within the building and switches the space heating on and off. A single target temperature may be set by the user.
- **A programmable room thermostat** is a combined time switch and room thermostat that allows the user to set different periods with different target temperatures for space heating, usually in a weekly cycle. Some models also allow time control of hot water, therefore replacing a full programmer.
- **A cylinder thermostat** measures the temperature of the hot water cylinder and switches the water heating on and off.
- **A thermostatic radiator valve (TRV)** has an air temperature sensor which is used to control the heat output from the radiator by adjusting water flow.

12. Wireless controls

Wireless controls are susceptible to radio transmissions and should therefore be designed to a satisfactory level of immunity, otherwise they may become unreliable as nearby frequency bands become increasingly utilised by communication services.

Compliance with the essential requirements of the European Radio and Telecommunications Terminal Equipment (RTTE) Directive 1999/5/EC is insufficient, as the directive is designed only to ensure that wireless products do not cause harmful interference to other transmissions. It does not give any assurance that the product has a satisfactory level of immunity to interference from other radio transmissions.

13. Boiler interlock

Boiler interlock is not a physical device but an arrangement of the system controls (room thermostats, programmable room thermostats, cylinder thermostats, programmers and time switches) that ensure that the boiler does not fire when there is no demand for heat.
In a system with a combi boiler this can be achieved by fitting a room thermostat. In a system with a regular boiler this can be achieved by correct wiring interconnection of the room thermostat, cylinder thermostat, and motorised valve(s). It may also be achieved by more advanced controls, such as a boiler energy manager. TRVs alone are not sufficient for boiler interlock.

14. **An automatic bypass valve**

An automatic bypass valve controls water flow in accordance with the water pressure across it, and is used to maintain a minimum flow rate through the boiler and to limit circulation pressure when alternative water circuits are closed.

A bypass circuit must be installed if the boiler manufacturer requires one, or specifies that a minimum flow rate has to be maintained while the boiler is firing. The installed bypass circuit must then include an automatic bypass valve. Care must be taken to set up the automatic bypass valve correctly, in order to achieve the minimum flow rate required (but not more) when alternative water circuits are closed.

**AC1.2 Identify the responsibilities of members of the construction team under energy conservation legislation**

**Designers, builders and installers**

The Building Regulations give clear guidance as to who is responsible for ensuring that the work completed complies with all aspects of the Regulations. It states that:

> ‘People who are responsible for building work (for example the agent, the designer, the builder or the installer) must ensure that the work complies with the applicable requirements of the Building Regulations.’

**Clients (customers)**

The Building Regulations state that:

> ‘The building owner may also be responsible for ensuring that the work complies with the Building Regulations. If a building does not comply, the building owner may be served with an enforcement notice.’

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Learning Outcome 2

Know the applications of energy sources used in the building services industry
There are five Assessment Criteria in this Learning Outcome:

AC2.1. Identify the types of energy used in properties
AC2.2. Identify the basic operating principles of installations containing environmental energy sources
AC2.3. Identify organisations which give guidance and advice on energy saving and conservation techniques.
AC2.4. Identify how to use energy rating tables and their effect on component selection.
AC2.5. State where to find information on alternative energy sources

Over recent years, there has been and continues to be much debate over the impact of Carbon Dioxide on the environment. Global warming is a phenomenon that is real and here, but it should be remembered that CO₂ is not a pollutant. Neither is it a contaminant. It cannot contaminate nor pollute. It is a naturally occurring gas that is ever present because life on earth is based around carbon and water. However, it can saturate. Too much CO₂, however natural, has a detrimental effect on the climate and its reduction is key to the prevention of continued global warming.

AC2.1 Identify the types of energy used in properties, and AC2.2 Identify the basic operating principles of installations containing environmental energy sources

Energy that is used in properties can be divided into three main categories:

- High carbon energy sources
- Low carbon/carbon neutral energy sources
- Zero carbon energy sources.

Within each of these categories are further sub-divisions and each will be considered in turn.

High carbon energy sources

High carbon energy sources are so called because they contain high concentrations of carbon. Carbon (C) is the building block for all life on planet Earth. Every living plant, animal, insect and human contains carbon. When combusted with hydrogen (H) and oxygen (O₂), it produces carbon dioxide (CO₂), which is well known as a greenhouse gas (GHG) that contributes significantly to global warming. There are four types of high carbon energy sources. Three of these, gas, oil and solid fuel are known as hydro-carbons because they also contain small amounts of hydrogen.
Gas (natural and LPG) (light hydrocarbon)

Natural Gas (CH₄)

Natural gas produces less CO₂ when combusted than any other hydro-carbon fuel. It is primarily a mixture of methane, ethane, butane, propane and hydrogen, with small amounts of hydrogen-sulphide, carbon dioxide, nitrogen and water vapour. It is found in many different locations, such as the North Sea, USA, Russia and Saudi Arabia.

Natural gas occurs below the earth’s surface wherever coal and oil are located but can occur in isolated pockets without other hydro-carbons being present. Shale gas is also a form of natural gas that is found in shale beds. Once extracted using gas and oil wells, it is piped ashore where it is cleaned of impurities and waxy oil deposits called ‘napthas’. Because natural gas has no smell, a chemical known as ‘mercaptan’ is added, which gives the gas its distinctive ‘rotten eggs’ odour, before it is piped along the national grid to homes and industry.

Despite its reputation as a greenhouse gas, natural gas remains one of the cleanest, safest and useful forms of energy, with many industrial and domestic applications. Industry is the largest user of natural gas consuming over 40% of all gas extracted for UK use.

Natural gas is lighter than air, having a specific gravity of between 0.6 and 0.8.

Liquid Petroleum Gas (LPG)

LPG is generally processed from the refining of petroleum spirit and can also be extracted from natural gas. It is stored as a liquid by compressing the gas. This reduces the gas volume by 274 times, meaning that 1 litre of LPG liquid makes 274 litres of LPG gas. There are two types of commercially available LPG types:

- Propane
- Butane

<table>
<thead>
<tr>
<th>Gas</th>
<th>Chemical symbol</th>
<th>Specific gravity</th>
<th>Boiling point</th>
<th>Characteristics and uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propane</td>
<td>C₃H₈</td>
<td>1.5</td>
<td>-45°C</td>
<td>The most widely available of all LPG gases. It is used for cooking, heating equipment including boilers and fires, cars and industrial processes. Propane is 1½ times heavier than air. Propane is available in a range of bottle sizes and can be stored in large bulk tanks for domestic and commercial use.</td>
</tr>
<tr>
<td>Butane</td>
<td>C₄H₁₀</td>
<td>2.0</td>
<td>-15°C</td>
<td>Butane has a higher calorific value than propane but its use is limited because of its relatively high boiling point. Butane is available in a range of bottle sizes. It is twice as heavy as air.</td>
</tr>
</tbody>
</table>

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Like Natural gas, LPG has no smell, so a chemical known as ethanethiol (also known as ethyl mercaptan) is added. LPG has a higher calorific value than natural gas, which means that more heat can be produced from the same volume of gas. Liquid Petroleum Gas has many industrial and domestic applications and can be used in areas where main natural gas is not available, due to its ability to be stored in large LPG storage vessels.

**Fuel oil - kerosene grade C2, 28 second viscosity oil to BS 2869 (medium hydro-carbon)**

There are many different types of fuel oil available. For domestic use, kerosene grade C2, 28 second viscosity oil to BS 2869 is the most widely used. It is a by-product of crude oil that is produced during the refining of petroleum spirit. It is a pale yellow to clear in colour.

Some 95% of domestic oil boilers and cookers use kerosene due to its relatively clean combustion. Most appliances only require a single annual service when used with an atomising or pressure jet-type oil burner and it is the only fuel oil that can be used with both open and balanced type fluing arrangements.

Kerosene has excellent cold weather characteristics and remains fluid to -40°C, although it can appear to ‘thicken’ in extreme cold weather.

**Solid fuels (coal and peat)**

**Coal**

Coal is a fossilised, combustible rock fuel that was formed from plant materials many millions of years ago. It is very carbon rich due to the way it was formed. There are five separate types:

<table>
<thead>
<tr>
<th>Coal type</th>
<th>Heat content kw/kg</th>
<th>Carbon content %</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lignite</td>
<td>2.2 – 5.5</td>
<td>25 – 35</td>
<td>Lignite is crumbly and has high moisture content. It has low carbon content but is known to be a dirty fuel, polluting fuel.</td>
</tr>
<tr>
<td>Sub-bituminous</td>
<td>5.5 – 8.3</td>
<td>35 – 45</td>
<td>Contains less heating value than bituminous coal but has a greater water content.</td>
</tr>
<tr>
<td>Bituminous</td>
<td>7 – 10</td>
<td>45 – 86</td>
<td>Formed by added heat and pressure on lignite, it is made from many tiny layers. It has two to three times the heating value of lignite. Bituminous coal is used primarily in the steel making industry.</td>
</tr>
<tr>
<td>Anthracite</td>
<td>10</td>
<td>86 – 97</td>
<td>Created by additional pressure and extremely high temperatures deep below the earth. It is jet black in colour and looks metallic because of its glossy surface. Very high carbon content</td>
</tr>
</tbody>
</table>
Coke is made by baking coal in ovens at around 1000°C. This releases the methane gas and coal tar, which can be cleaned and re-used. It has a high calorific value and is used in the making of steel. It can also be used in many domestic boilers and room heaters.

Solid fuels are often used for both domestic and industrial central heating systems and also those systems which rely on steam generation. Coal is very seldom used for generating electricity because of the high production of CO₂ and sulphur related pollutants.

Peat

Peat is an organic material formed from rotting vegetation in bog-like conditions in the absence of oxygen over thousands of years. Because of the lack of oxygen, the vegetation does not fully decompose. Instead, the accumulation of the organic material forms in layers, which builds up into a thick, carbon-rich mass.

Once cut and dried out, peat becomes a poor quality fossil fuel with a high carbon content that produces large amounts of fly ash when combusted. It is used in many types of peat burning stoves, room heaters and domestic fires.

Electricity generated from fossil fuels

The chart above shows the fuels that have been used for electricity generation in the UK since January 2006. As can be seen, there are three fossil fuels used (coal, gas and oil), in various quantities, to generate UK electricity.
electricity. The chart illustrates that over the past 10 years, the reliance on coal (the orange line) has dwindled. In fact, in the spring of 2018, no coal-fired power station was operating in the UK. Gas power generation has stayed almost constant. The chart also illustrates how generation from on-shore and off-shore wind has increased just as coal has shown a huge decrease in generating capacity.

By far, the largest fossil fuel generator is natural gas (the thick blue line). This is used because of its low carbon dioxide emissions, when compared to coal and oil. Oil use is virtually non-existent. Most gas-fired power stations use the combined cycle gas turbine (CCGT) to produce steam to drive the generating turbines, while others use Combined Heat and Power (CHP) plants that not only generate electricity but also use the excess steam produced to heat homes and industry. UK CHP plants account for some 6.1 GW of installed electrical capacity.

The remaining coal fired power stations in the UK are due to close by 2025.

Low Carbon/Carbon Neutral Fuels

Low carbon fuels and carbon neutral fuels are those that either produce very little carbon dioxide (CO₂) or those fuels that only release the amount of CO₂ that the plants they once were had taken in during their life time. For example, a 200 year old tree, when converted to biomass, will only release the amount of CO₂ that the plant used during the photosynthesis process over the 200 year period. In this way, the tree is said to be carbon neutral by only releasing what it had used.

There are several, very different low carbon/carbon neutral fuels:

Solar thermal

Solar thermal uses heat from the sun to generate hot water supply. This offsets the use of other fuels such as gas and electricity in hot water demand.

The heat is collected using solar collectors placed on the roof of the property. Inside the collector is a water/glycol (glycol acts as an anti-freeze to prevent damage by freezing) mix that is circulated by a pump to a heat exchanger (coil) inside the hot water storage vessel. The water in the hot water storage vessel is then warmed by the heat exchanger.

During the summer months, the sun will deliver around 1kw of energy per m². So, for a dwelling with 3 occupants, 3m² of solar collectors will deliver enough hot water for the whole household. Over a 12 month period, a solar hot water system will deliver about 60% of the hot water requirement (80% in summer to 20% in winter). A conventional gas boiler or electric immersion heater will be required for those periods when solar hot water is ineffective (at night
The components of solar-thermal hot water systems

The solar collector

There are two different types of solar collector:

1. **Flat plate collectors** – these are tubes that run through a metal box with thick black glass on the front to trap the heat like a greenhouse. The heating glycol/water mix is pumped through the tubes, which is then heated by the sun before being pumped to a double coil hot water storage cylinder. The heat is transferred from the coil to the hot water stored in the hot water storage vessel.

2. **Evacuated tubes** – these are round glass tubes with a vacuum inside. Inside the tube is another tube which contains heat pipe which collects the heat from the sun. The heat is transferred by conduction to a water/glycol filled manifold. From here the water/glycol mix is pumped to the coil of the hot water storage vessel. The tubes are cylindrical. This means that the maximum possible area is presented to the sun at all times, making them much more efficient than flat plate collectors.

Hot water storage cylinder

Unlike most hot water storage cylinders, this has two heat exchange coils. The bottom coil transfers heat from the solar thermal collector. The top coil is connected to a standard gas/oil/electric boiler to be used as back-up when the solar thermal system cannot be used.

Circulating pump

Specifically used to circulate the water/glycol mix from the solar collector to the hot water storage vessel.
Control system

The control system is designed to prevent freezing fluid from being circulated to the hot water storage vessel in winter time or at night when the sun goes down. The control system incorporates a pump, flow meter, pressure gauge, a thermometer and a thermostat.

Solid fuel (biomass)

The phrase ‘biomass’ can be used to describe many plant derived solid and liquid fuels. It can be defined, therefore, as plant matter that is either used directly as a fuel or has been converted into a form that is readily combustible. In solid form it is usually supplied in pellets or wood chips manufactured from felled trees and other plant matter. Other forms of biomass include wood waste, specially cultivated crops and animal wastes.

Biomass is classified as a carbon neutral fuel as it only releases the CO₂ that the biomass contains. It does not produce excess CO₂ like fossil fuels.

Biomass boilers fall into two specific categories:

Batch fuelled

These are usually domestic appliances rated at below 50 kW in the form of room heaters or a stoves. Some appliances can be used for central heating/hot water delivery. They can be fuelled by ‘lump wood’, logs or pellets.

Continuously fired

With these appliances, the fuel is added to the combustion air in the correct proportion to rated output of the appliance. Combustion air is rigidly regulated to match the heating output. Continuously fired units produce less CO₂ than batch fuelled units and can burn wood pellets and wood chips.

<table>
<thead>
<tr>
<th>Building type</th>
<th>Log and pellet stoves</th>
<th>Log boiler</th>
<th>Pellet boiler</th>
<th>Wood chip boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic dwelling:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 bed semi (up to 20kw)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4 bed detached (up to 30kw)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>large farmhouse (up to 50kw)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Working principles of biomass boilers

Fuel, in the form of wood chips or pellets is fed from the fuel store by a worm screw feeding system. This uses a large screw, similar to the Archimedes screw, to continuously feed fuel to the fire bed of the boiler. As the worm screw turns, fuel is automatically fed straight to the fire bed where it burns in the combustion chamber. The hot gases produced by combustion of the fuel heat the water the boiler contains, which is then circulated to the hot water and heating circuits.

Biomass boilers are very controllable, often with the same degree of control as a modern gas or oil boiler.

Hydrogen fuel cells

Hydrogen fuel cells use two elements, Hydrogen and Oxygen and convert them into electricity. During this process, water (H₂O) is formed. The electrical generation process will continue to produce electricity indefinitely while ever the two elements are present. Hydrogen fuel cells have proved incredibly successful. So much so that NASA utilises fuel cells to produce power AND drinking water for the US Space programmes.

Hydrogen fuel cells produce electricity very cleanly, with no emissions other than water.

Heat pumps

Heat pumps use a process called the Vapour Compression Refrigeration Cycle to produce heat. They work in exactly the same way as refrigerators, but in reverse. They are described in detail in Unit J/602/2496 Understand how to apply scientific principles within MES.

Heat pumps are very environmentally friendly, using a low amount of energy for a high return of heat. They are around 300 – 400% efficient. This efficiency is known as the Coefficient of Performance (CoP), which for heat pumps is around CoP 4:1. There are two basic types for domestic heating systems:

Ground Source Heat Pumps – these use a
special coiled heat exchanger, known as a captor or a ‘slinky’, which is buried underground, to extract heat from below the earth.

Ground Source Heat Pump with underfloor heating system

**Air Source Heat Pumps** – ASHPs are much smaller than ground source heat pumps and utilise heat generated by the compression of a refrigerant gas. The compressor compresses the gas, converting it to a liquid. During this process a large amount of heat is generated, which is passed through to a heat exchanger for circulation through to the heating system.
Combined heat and power (CHP)

When electricity is generated by steam, around 70% of the steam generated is wasted to atmosphere. Combined heat and power utilises this excess steam to heat homes and businesses by delivering the heat via a system of underground pipework, known as district heating. With district heating, large numbers of properties can be provided with the heat required to not just heat the building but provide enough energy to heat the hot water supply also. Small scale systems are available for individual domestic properties in the form of micro co-generation boilers that generate electricity via a Stirling engine and heating/hot water via a low water content heat exchanger.

There are several type of CHP Plant:

- **Back pressure power plant**: The electricity and heating are produced in a steam turbine. The steam is generated by burning fossil fuels, such as coal, oil and natural gas.
- **Extraction condensing power plant**: These are used mainly for electricity generation. However, some units have the capacity for the steam to be extracted from the steam turbine for heating purposes.
- **Gas turbine heat recovery power plants**: Here, the heat for the district heating system is generated from the hot flue gases in the turbine via a heat recovery heat exchanger. Often fuelled by natural gas and oil.
- **Gas Combined Cycle power plants**: These units comprise of one or more natural gas-fired turbines with a steam turbine and a heat recovery boiler.
- **Reciprocating Engine power plants**: This unit is a combination of a diesel fuelled reciprocating engine and a heat recovery boiler. Together, these generate steam for electricity generation and heat distribution.

**Combined cooling, heat and power (CCHP)**

These are a variation on a theme. Very similar to combined heat and power except that the steam is also used to generate building cooling by the use of an absorption chiller, which uses the Vapour Absorption Refrigeration Cycle.

**Zero Carbon fuels**

For a fuel to be classified as zero carbon, the net CO₂ emissions from the fuel must be zero. This class of energy is called renewable.

**Electricity generated by wind**

Wind turbines use the wind to drive large, aerodynamic blades connected to a rotating electricity turbine, which generates AC electricity. To be 100% efficient, the wind speed needs to be around 8m/s (or 18mph). Any speeds above or below this, then the efficiency of the turbine is lost.
Wind farms are appearing all over the UK mainland, with very large super windfarms positioned off-shore in the Irish Sea, North Sea and the English channel.

Wind power currently generates around 15 – 20% of all UK electricity.

**Wind turbine types**

**Horizontal axis**

Usually 2/3 blades that face the wind direction. The wind turbine rotates on a vertical axis to face the correct wind direction. Currently, this is the most popular wind turbine design.

**Vertical axis**

These generate electricity by rotating an electricity generator mounted on a vertical axis.

**Electricity generated by tidal movements**

Often called tidal lagoons, tidal generated electricity uses the kinetic energy in the twice daily movement of the tides along sea coasts and tidal rivers. The in/out movement of the tide waters drives underwater turbines in much the same way as wind power drives wind turbines. If carefully positions, it is estimated that tidal generated power could generate more than 20% of the UKs electricity needs.

There are 8 suitable locations across the UK where the tide movement is sufficient to warrant further investigation. These include the rivers Severn, Humber, Avon, Solway and Dee.

**Hydro-electric power**

This method of electricity generation uses the gravity movement of vast quantities of water to drive turbines that generate electricity. Most hydro-electric plants are located in Scotland. There is some impact on the
environment by way of increased noise levels. However, with careful planning, this can be avoided and suppressed.

The principles of hydro-electricity generation

Solar photovoltaic

Solar Photovoltaic Panels or PVs produce direct current electricity from the Sun’s solar radiation that constantly bombards planet Earth. Known as solar arrays, these panels require an inverter to turn the DC power into AC power for use in domestic properties.

Each solar panel is constructed from two layers of semi-conducting material manufactured primarily from silicon. When light from the Sun strikes the panel, some of the light is absorbed by the silicon, and this agitates the electrons within the silicon allowing them to move freely. The electrons, under the influence of an electrical field, flow in one direction generating DC current. This current can be drawn off and used. The current flow and voltage determine the wattage of the panel – the more sunlight, the greater the wattage.

Photovoltaics produce zero CO₂. In domestic properties they can save around 1 tonne of CO₂ every year.

AC2.3 Identify organisations which give guidance and advice on energy saving and conservation techniques

There are many organisations, both governmental and non-governmental, to assist with matters arising from energy conservation and energy saving. The most well-known agencies are listed below:
The Energy Saving Trust is recognised across the UK as an industry leader in the quest to reduce CO₂ emissions. It was formed after the 1992 Earth Summit in Rio De Janeiro, Brazil. Jointly funded by both the British Government and the private sector, its sole purpose is to help fight climate change by the promotion the use of sustainable energy.

http://www.energysavingtrust.org.uk/

The Carbon Trust is an independent, non-profit making organisation. It was originally set up by the UK Government with support from business to promote and encourage the development and use of low carbon technologies. Its primary aim is to reduce carbon emissions through funding, development and technical innovation.

http://www.carbontrust.co.uk

The National Energy Foundation is an independent British Charity formed to promote and encourage the use and generation of sustainable energy

http://www.nef.org.uk

The Department for Energy and Climate Change is the Government department responsible for sustainable energy deployment and for co-ordinating the country’s response to climate change. It was established by the Labour Government of Gordon Brown in 2008 to take over some of the functions related to energy of the Department for Business, Enterprise and Regulatory Reform (DBERR), and those relating to climate change of the Department for Environment, Food and Rural Affairs (DEFRA).

http://www.decc.gov.uk

AC2.4 Identify how to use energy rating tables and their effect on component selection

Almost 30% of the total UK carbon emissions come from domestic properties. Energy Performance Certificates give information of a buildings current energy efficiency rating and its potential energy rating once improvements have been made. All buildings, whether they are rented, bought or sold require an Energy Performance Certificate. They show vital information regarding the building energy usage and CO₂ emissions.
The Energy Efficiency Rating is the overall efficiency of a domestic building in terms of energy use and CO₂ emissions. The higher the rating, the more energy efficient the building is. The Energy Performance Certificate comprises of two main charts. These are shown below:

![Energy Efficiency Rating Chart](image)

The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills will be.

![Environmental Impact Rating Chart](image)

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO₂) emissions. The higher the rating the less impact it has on the environment.

### Band | Rating Points
--- | ---
A | 92-100 SAP points (Most efficient)
B | 81-91 SAP points
C | 69-80 SAP points
D | 55-68 SAP points
E | 39-54 SAP points
F | 21-38 SAP points
G | 1-20 SAP points (Least efficient)

### Improvement | Rating can be improved by | Estimated Savings
--- | --- | ---
Condensing Boiler | 47 SAP points | £225+ per year
Cavity Insulation | 13 SAP points | £100-£125 per year
Roof Insulation | 10 SAP points | £100-£125 per year
Cylinder Stat & Insulation | 8 SAP points | £100-£125 per year
Double Glazing | 4 SAP points | £10-£15 per year
Low Energy Lighting | 2 SAP points | £10-£15 per year

An Energy Performance Certificate or EPC shows the current and potential energy rating of the building. This is known as the buildings SAP rating (SAP – Standard Assessment Procedure). This is the Governments recommended system for producing an energy efficiency rating.

The SAP charts are divided into 7 bands ranging from A to G. Each range has a set amounts of ‘SAP’ points. Each chart has current and potential energy ratings out of a maximum of 100 points (100 being max efficiency). The table left shows some examples of improvements that can make a difference in the energy efficiency rating of a building.

### Estimated energy use, carbon dioxide (CO₂) emissions and fuel costs

EPCs provide a detailed report on the current and potential energy usage and the carbon emissions per year. It also shows the current spending on energy bills on elements such as lighting, heating and hot water and...
Summary of the buildings energy performance related features

The summary will concentrate on the key individual elements that have an impact on the building overall energy performance. Each element is assessed against a simple **very poor/poor/average/good/very good** scale. Key elements assessed are walls, roof, floor, windows, main heating, main heating controls, secondary heating, hot water and lighting.

Recommended measures to improve the building energy performance

The report will contain a section suggesting key measures that can be taken to improve the properties energy efficiency and lower its overall carbon footprint.

AC2.5 State where to find information on alternative energy sources

There are many web sites on the internet that will guide you through the maze of information regarding alternative energy sources. A google search using key words ‘alternative energy sources’ brings 175m results! In AC2.3 Identify organisations which give guidance and advice on energy saving and conservation techniques we looked at both governmental and non-governmental organisations and these too will give good, sound advice on alternative energy and its pros and cons.
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Learning Outcome 3

Know the importance of energy conservation when commissioning building services systems
There are two Assessment Criteria in Learning Outcome 3:

**AC3.1.** State the role of the commissioning process in conserving energy usage.

**AC3.2.** State the actions to be covered during the system handover procedure to the customer that will contribute to conserving energy usage.

### AC3.1 State the role of the commissioning process in conserving energy usage

Energy efficiency starts with the design of the system. The components, appliances and equipment, the size of pipe and the pipework routes all have a bearing on how the finished system will operate. It's not uncommon for good, well designed systems to fail simply because it was installed poorly, or the cheapest components were installed.

However good the system design and installation is, it will not work efficiently if it is not commissioned properly. Improper customer hand over procedures compound the problem further.

To ensure that the system is working to its optimum performance, it must be commissioned correctly. This involves:

- Filling each system i.e. cold water, hot water and heating, and flushing in accordance with the regulations add recommendations.
- Soundness testing and dealing with leaks,
- Setting the shut off levels of any float operated valves and adjusting if necessary,
- Checking flow rates at outlets and taps etc, to ensure they meet the design specification,
- Checking the temperatures at all hot taps,
- Running central heating systems to maximum working temperature, checking flow and return temperatures, and checking the correct operation of controls,
- Balancing central heating systems to give the best possible heating performance,
- Checking CO₂ emissions of space heating appliances,
- Benchmarking all systems in line with manufacturer’s instructions and recommendations.

### AC3.2 State the actions to be covered during the system handover procedure to the customer that will contribute to conserving energy usage

Customer handover is a crucial part of any installation. The customer can do untold damage to the smooth operation of a system simply by not understanding the system or its controls. The Building Regulations recognise customer interaction. Indeed, it is a requirement of Document L1A/B that:
‘The owner of the dwelling should be provided with sufficient information......so that the fixed building services and their maintenance requirements can be operated in such a manner as to use no more fuel and power than is reasonable.’

At the end of the commissioning process, the customer should be given careful and precise instruction on how to operate and maintain the system, so that it continues to give optimum, energy efficient performance. This includes showing the customer:

- The appliance, the controls and the thermostats
- How to make adjustments to the timing and temperature configurations
- What routine maintenance is required by the system, its appliance(s) and components to ensure maximum efficiency performance throughout the life of the system
- Explaining the need for annual routine boiler servicing and system checks.

Give the customer a chance to ask questions and don’t forget to show them where the emergency isolation points – gas, water and electricity – are located and how to operate them.
Learning Outcome 4

Know the methods of reducing waste and conserving energy while working in the building services industry

REUSE
REDUCE
RECYCLE
There are three Assessment Criteria in this Learning Outcome:

AC4.1. Identify the working practices that can be employed to conserve energy and protect the environment.

AC4.2. State the methods used for reducing material wastage

AC4.3. Identify the methods of conserving material usage

AC4.1 Identify the working practices that can be employed to conserve energy and protect the environment

It is a fact that adopting a ‘green’ attitude to plumbing activities can help to protect the environment. The working practices we employ can reduce CO₂ emissions, prevent material wastage and save the customer money. Here are some suggestions:

1. Whenever possible use fittings other than capillary-type fittings. Capillary fittings require a blowtorch, which produces CO₂ emissions when it is used. Using press-fit, push-fit and compression-type fittings also reduces installations time.
2. Introduce a waste reduction regime of working in line with the Waste and Resources Action Plan (WRAPS), initiated by the UK Government to reduce waste materials.
3. Use off-site fabrication techniques when dealing with large or complex installations.
4. Plan the work activities to minimise material wastage. Adopt accurate measurement and cutting techniques for pipes and tubes. Exact measurement and cutting reduces wastage and costs.
5. Avoid over purchasing materials and fittings.
6. Keep a rigid check on material stocks by developing accurate store keeping. This can help reduce wastage, loss and theft.
7. Keep fragile materials in a safe environment to prevent breakage and damage.

AC4.2 State the methods used for reducing material wastage

These are the facts about wastage in the construction industry:

- **400 Million Tonnes** of materials used every year in the construction industry
- **100 Million Tonnes** of waste is produced – more than 1/3 of the UK's annual waste
- **25 Million Tonnes** of construction waste ends up in landfill sites
The economics of these figures are simple. If the materials for a construction project costs £4m, then £1m of that is wasted, and of that £250,000 will be spent filling a landfill site! It was precisely because of figures like these that the UK Government initiated the Waste and Resources Action Plan (WRAPS). Its aim is to reduce wastage in construction to 2008 levels, a reduction of 50% in the level of construction, demolition and excavation waste. This can be achieved by the 3R’s rule:

1. **Reducing** - minimising the amount of waste produced
2. **Reusing** - reusing items as many times as possible
3. **Recycling** - recycling what you can and dispose of what’s left in a responsible way.
4. **Dispose** – disposing of materials as a last resort

Developing an environmentally friendly approach can:

- Generate income from collecting some waste materials, such as scrap metals.
- Reduce costs from purchasing less material.
- Reduce accidents by storing materials carefully.
- Reduce CO2 emissions.
- Help to conserve natural resources.
- Contribute to the compliance of Regulations.

### AC4.3 Identify the methods of conserving material usage

Apart from the obvious financial benefits, good waste management prevents environmental pollution and less contaminated, unusable land. For the Site Management Team good waste management means:

- Lower disposal costs in the form of less skip hire, land fill tax and gate fees.
- Avoidance of waste transportation costs
- Better use of available materials, saving on raw materials purchased.
- Lower levels of waste materials.

To reduce waste materials, construction companies need to consider the following points:

- **When buying and storing materials:**
  - Ordering the correct amount.
  - Arrange ‘on-the-day’ deliveries to reduce storage needs and loss of materials.
  - Consider using recycled materials as a cheaper alternative.
  - Can the packaging used for materials be recycled?
  - Reject damaged and incomplete deliveries.
  - Ensure storage areas are secure, safe and weatherproof.
  - Store fragile and breakable materials, such as WCs and Washbasins in a separate part of the store. Do not stack materials that are fragile.
  - Store liquids away from drains and sewers.
- **Site activities:**
  - Make sure the option to use recycled materials is considered.
- Recycle spoil, hard core and surplus construction materials as this avoids the need for transportation.
- Keep a tidy, safe site.
- Ensure that unused materials are returned to a locked store at the end of each day to prevent loss and theft.

**Awareness Training:**
- Promoting good practice as part of mandatory site inductions and health and safety training

**Waste segregation:**
- Providing separate skips for inert, wood, hardcore, packaging and general waste. This may generate some income
- Using licenced waste management professionals to deal with waste on site.
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http://bpec.org.uk/bpec-interactive-products/
Learning Outcome 5

Know how to safely dispose of materials used in the building services industry
There are five Assessment Criteria in this Learning Outcome:

- **AC5.1.** Identify the statutory legislation for waste management on construction sites
- **AC5.2.** State the methods of safely disposing of waste materials
- **AC5.3.** Specify the approved processes for recycling materials
- **AC5.4.** Identify the disposal requirements of potentially hazardous materials
- **AC5.5.** Identify what action to take if work activities endanger the environment

### AC5.1 Identify the statutory legislation for waste management on construction sites

**Site Waste Management Plans Regulations 2008**

These Regulations are relevant to the client, planners, developers, contractors and buyers and are compulsory for construction projects with an estimated cost greater than £300,000. The Regulations state that construction projects must have a Site Waste Management Plan (SWMP). For projects costing £500,000 SWMPs with greater detail are required. Overall responsibility for the plan lies with the Client or the Main Contractor.

Under SWMPR 2008, the Construction Management Team have to:

- Estimate the amount and type of waste i.e. inert, non-hazardous waste, hazardous waste that is expected to be produced by the project.
- Show how the efficiency of materials used is going to be improved.
- Set out how they intend to recycle, re-use and reduce the amount of waste produced and how they intend to dispose of the rest. This is required under the duty of care and reducing fly-tipping and other unlawful disposal methods.
- Update the SWMP for the duration of the project, recording all receipts and references to waste disposal transactions with authorised waste removal companies. These include waste transfer notes, identity of the remover forms and notification of the waste receiving site the waste was disposed in.

**Site Waste Management Programmes apply to all construction work including:**

- Demolition and excavation
- Civil engineering projects
- Projects involving maintenance, alteration and decoration of existing buildings
- The installation, maintenance or removal of related services i.e. electrical, gas, water, sewage etc.

To comply with the SWMP Regulations, construction companies must:

- Complete waste transfer notes before waste leaves the site
- Ensure all waste carriers have a valid waste carriers registration certificate
- Ensure all wastes are disposed of at a correctly licensed site
AC5.2 State the methods of safely disposing of waste materials

The construction industry, as we have already seen, produces huge quantities of waste every year. Not all of it is disposed thoughtfully or legally. It is a fact that fly tipping and the illegal dumping of waste is on the increase in the UK.

It is illegal in the UK to:
- Mix hazardous and non-hazardous waste
- To give waste materials to persons that are not licenced to carry them.
- To dump waste by the side of the road (fly tipping). This carries a maximum fine of £50,000 and/or 12 months in prison.
- To burn waste that produces toxic fumes such as polystyrene and plastics

So, how should waste be dealt with and what are the legal requirements for those dealing with waste?

Licensed waste disposal

A licenced waste disposal company will conduct a survey of the site to assess whether the waste generated can be segregated. This may involve options for compaction, on-site segregation and container services. The licenced company will often be involved in the instigation of the waste management plans for the site, setting up fully auditable recycling certificates to verify their waste management and recycling performance. The advantages to this are:
- The site has a SWMP that is specifically tailored to the sites needs
- Duty of Care can be proven
- Regular management reports on recycling performance.

Waste carriers license

In the UK, it is law that companies and the self-employed who deal with waste in any form must register with the Environment Agency if they transport or arrange the transport and disposal or recovery of domestic, industrial and commercial waste. This includes Plumbers who transport scrap or waste to registered recycling sites.
A licence is NOT needed if:

- The waste is owned by the person transporting it UNLESS it is building waste or demolition spoil.
- The waste is being transported out of the UK by air or sea.
- Transporting exempt waste which comprises only of animal by-products, only mines or quarries waste or only agricultural waste.

Recycling

A lot of the materials that are wasted or discarded on construction sites can be reused or recycled. Even waste such as hardcore, asphalt and concrete have recycling value and finding a way to recycling them is important to companies who are committed to waste reduction. Recycling also provides some companies with a small but useful income. There are many recycling methods:

- Isolate and segregate – this involves separating the waste into specifically coloured or marked skips for wood, metals, cardboard, plastics and the like, in much the same way as households are expected to do at local council refuse sites. Using this method saves time that would otherwise be spent by the waste management company separating the various waste materials.
- Request that goods be delivered in less packaging and ask that excess packaging be returned to the company.
- Local Salvage – use local salvage companies to recycle such items as reinforced steel joists and wood items.
- Keep recycling skips away from the general rubbish skips to avoid confusion about what goes where.
- Educating the workforce – this can play a key role in getting the ‘green’ message across to the site workforce. Using information such as posters can highlight recycling policies and waste reduction targets.

Plumbers and recycling

Plumbers must:

- Make sure that a waste ticket is produced for every waste collection.
- Keep a record of all waste transfers to a waste carrier for a period of two years.
- Use a hazardous waste ticket when hazardous waste, such as lead and asbestos, is recycled. These must be kept for three years.

Plumbers can help by:

- Using accurate installation techniques to reduce material wastage
- Keeping low stock so as not to over purchase materials
- Design systems that use as little pipework and fittings as possible.
- Using recycled timber when building stillages and platforms for cisterns and components
- Installing water saving appliances and dual flush sanitary fittings
• Recommending environmentally friendly systems, such as solar hot water systems, rainwater and greywater recycling

Specialist disposal – asbestos and other forms of hazardous waste

The Hazardous Waste Regulations 2005

The Hazardous Waste Regulations requires that hazardous waste in all forms be collected from businesses separately from other forms of waste and be treated and disposed of separately by a licenced hazardous waste disposal company. A construction company producing less than 500kg of hazardous waste per site does not have to register with the environment agency. However, separate collection, treatment and disposal is still a mandatory requirement.

Typical materials from construction sites that fall within the Hazardous Waste Regulations include:

• Asbestos
• Treated wood, glass, plastic (alone or in mixtures) containing dangerous substances, such as lead paint
• Bituminous mixtures containing coal tar and tar products
• Metals containing dangerous substances, such as lead.
• Cables containing oil, coal tar and other dangerous substances
• Rubble or hardcore containing dangerous substances
• Soil, stones and dredging spoil containing dangerous substances
• Gypsum materials such as plasterboard
• Un-used or un-set cement
• Paints and varnishes containing organic solvents and lead
• Paint or varnish remover
• Adhesives and sealants containing organic solvents

Empty packaging contaminated with residues of dangerous substances – e.g. paint cans, intermediate bulk containers (IBCs) and drums

AC5.3 Specify the approved processes for recycling materials

Recyclable materials such as cardboard and certain plastics usually carry the international recycling symbol. Materials that can be recycled can be divided into four categories:

• Metals
• Plastics
• Cardboard
• Wood
Metals are sub-divided into two groups:

- **Ferrous** – metals containing iron – iron, steel, cast iron
- **Non-ferrous** – copper, brass, bronze, aluminium, zinc, lead, tin.

Metals should be separated into their various groups before being collected by specialist licenced waste removal companies. The metals are smelted into ingots and then sold to industry. Metals can be recycled indefinitely with no loss of their properties or qualities. Most metals have a monitory value.

Plastics

There are many different categories of plastic with many hundreds of sub-categories. Most, but not all, plastic materials are recyclable. The greatest problem facing plastics recycling is identifying them. There is a standard marking code, developed to assist with identification. Some of these relating to the plumbing industry are shown below:

- **HDPE** – High Density Polyethylene – Used for water pipes below ground
- **PVCu** – Polyvinyl Chloride Unplasticised – waste pipes, guttering, soil and vent pipes, drainage and mains cold water pipes.
- **MDPE** – Medium Density Polyethylene – Often called ‘blue poly’, used mainly for below ground water supply
- **PP** – Poly Propylene – Used for push-fit waste systems
- **PS** - Polystyrene - Usually found in packaging
- **PC** – Poly carbonate – Various uses

Plastics recycling involves either melting, shedding or granulation of the raw material. Plastics are usually sorted by trained staff who separate the plastic by polymer type and colour. Automated separation technology, that uses x-ray, infra-red and electrostatics is also available. After separation, the plastic is either melted down and directly re-moulded or shredded into flakes and reprocessed into granules.

Recycled plastic has many uses in the construction industry, such as window frames, doors, building insulation board, pipes and flooring.

Cardboard

There are over 8 million tonnes of cardboard produced in the UK every year. It is the single largest element of public waste worldwide. It is a fibrous material manufactured from wood pulp. When cardboard is recycled, it is first soaked in water and agitated to release these fibres, which can then be re-pulped. Cardboard and paper, however, can only be recycled 5 times before the fibres become useless.

There are some waste paper companies that will collect cardboard but it is often disregarded as far as recycling is concerned as uneconomical and much of it ends up on landfill sites,
Wood

Around 50 million m$^3$ of timber is used every year in the UK. Two thirds of this are imported. Around half of this is used by the paper making industry.

Although classified as sustainable, recycled and re-claimed timber has a big impact on the environment. Re-using timber ensures that it does not end up in landfill sites, where it will bio-degrade and produce harmful greenhouse gases.

Wood waste from businesses (mainly wooden crates, pallets and demolition) produces around 1.4 million tonnes a year. Wood that cannot be re-used can be recycled into many other products, such as chipboard, blockboard and biomass woodchips and pellets.

Re-using and recycling timber ensures that forests remain intact, saving energy and water that would have otherwise been used in the felling and preparation processes.

AC5.4 Identify the disposal requirements of potentially hazardous materials

There are hazardous materials in the Building Services Industry that will need to be disposed of carefully and safely. These include:

- Asbestos
- Refrigerants
- Electrical and electronic equipment
- Lead

These will often require the assistance of specialised removal companies.

Asbestos

The subject of asbestos was dealt with in Unit J/602/2479 Understand and carry out safe working practices in building services engineering at the beginning of this book. It is vitally important that it is dealt with by specialist asbestos removal companies.

If asbestos is discovered whilst at work:

- Leave the asbestos alone. Provided it is not disturbed, it is reasonably safe.
- Have the property surveyed by a licenced asbestos removal contractor. If necessary, they will take a sample for analysis of the type of asbestos present.
- Never drill, saw or break the asbestos as this releases fibres into the atmosphere.
- DO NOT attempt to remove asbestos lagging, coatings or insulation board. These MUST only be removed by specialist asbestos removal contractors.
If asbestos is discovered in waste skips, seek advice immediately. Do not attempt to remove it.

Ensure that your own health and safety and that of others is protected.

The Health and Safety Executive have a dedicated asbestos telephone number should you require any asbestos related advice. 0845 345 0055.

Refrigerants

Most refrigeration equipment uses the Vapour Compression Refrigeration Cycle (see J/602/2496 Understand how to apply scientific principles within MES. A key part of this is the refrigerant gas, which produces the cold effect during the Refrigeration Cycle. Refrigerators, freezers and chiller cabinets contain refrigerants in both liquid and gas form, some of which contain Chlorofluorocarbon’s or CFCs and hydrochlorofluorocarbons (HCFCs). These are dangerous to the environment as they deplete the ozone layer high in the Earth’s atmosphere. It is the ozone layer that prevents health damaging solar radiation from hitting Earth’s surface. They are known as Ozone Depleting Substances or ODS. Other refrigerants, although they are CFC free, are highly toxic.

On October 1st, 2000, a law was passed that specifically stated that it is the responsibility of the owner of any refrigeration equipment that all ODS be removed at an Environment Agency Approved facility BEFORE the equipment is disposed of.

Identifying equipment containing ODS

The age of the appliance will give a good idea of the refrigerants used:

- Before 1994 almost every refrigeration appliance contained a CFC refrigerant. Generally, this was CFC R12 refrigerant.
- After 1994, these were replaced with a hydrochlorofluorocarbon refrigerant R134a.
- Modern refrigeration equipment is manufactured to use either R134a or a hydrocarbon HC6000a.
- R134a and HC6000a are not harmful ODCs but they are toxic.

The data plate of the appliance will almost certainly give the refrigerant information required, as well as the appliance rating, its serial number and the date of manufacture.

Disposing of Refrigerants

1. Consult the waste collection department of the local council. Although they are not obligated to accept refrigeration equipment, they may be able to give advice on its disposal.

2. Consult a specialist refrigeration disposal company.

3. DO NOT be tempted to dump the equipment as this constitutes an illegal act. Dumped refrigeration equipment also poses a danger to animals, pets and small children.

4. For more information see the Scottish Environment Protection Agency website at:
Lead

The subject of lead was dealt with in Unit J/602/2479 Understand and carry out safe working practices in building services engineering at the beginning of this book.

Lead is highly toxic metal that is still widely used for lead roofing of buildings, both old and new. In the past, lead was mined. Lead can be found in around 60 different minerals, although only three were mined for lead production. Processing the lead ore involves mining, crushing, filtering and smelting the lead ore to extract the virgin metal. This process is very energy intensive. Most lead used today has been recycled as this uses far less energy in the process. It is known as milled sheet lead.

There are 3 ways in which lead can enter the body:

- Through ingestion - eating
- Through inhalation – breathing in fumes
- Through absorption – through the skin, touching

If lead is recycled, it should be handled with great care. It should be disposed of at a licenced waste contractor, where it will be smelted down into ingots of lead. It will then be re-sold back to industry.

Electrical and electronic equipment

It has been estimated that there were 6 million tonnes of electrical and electronic equipment that was not recycled in any way. electrical and electronic equipment is manufactured from plastics, copper, aluminium, glass and steel. It takes huge amounts of energy to produce these materials, as well as copious amounts of water and much environmental damage by mining, transport etc.

The disposal of electrical and electronic equipment in landfill sites creates many highly toxic environmental hazards, such as arsenic, bromide, cadmium, lead and mercury. Incineration also creates cyanide gas, CO₂, CO, NOx and other atmospheric pollutants and saturates.

Electrical and electronic equipment should always be disposed of at a local authority licenced waste recycling site. This includes any batteries and battery packs of the type used by cordless tools. On no account must these be placed in the household waste as they can leak, giving off dangerous acids and chemicals. Many batteries and single cells contain nickel cadmium, a known carcinogenic material.

AC5.5 Identify what action to take if work activities endanger the environment

Construction sites have a significant environmental impact, both locally and nationally. At every stage of a construction project, the construction of a building involves materials that have been manufactured, mined,
packaged and transported to the site. The construction project itself involves the use of machinery and tools that are heavily reliant on fossil fuels and gases that produce CO₂ and other noxious gases and, as the project develops, waste materials are produced from the inert to the toxic that present problems of collection, removal and safe processing. In this respect, it is extremely important that we understand the environmental impact of construction and how we can help prevent further environmental catastrophes from accidental fuel and chemical spills, airborne pollution and water contamination.

Damage to the water supply

By far, the greatest risk to the environment from construction work is through damage to the water supply. Fuel spills and chemical spills, unless treated quickly, will eventually filter down through the geology and into the ground water, causing contamination. In many areas of the UK, groundwater constitutes the only source of water. Contamination puts strain on the purification systems for both the water undertaker and the private water supply user alike. In many instances, ground water contamination is extremely costly in terms of cost to clean and loss of water source.

In plumbing systems, contamination of water mains can occur through incorrect plumbing design, incorrect or poor installation and even flagrant disregard for the regulations in force. Even the actions of the end user can cause significant contamination issues through backflow and back syphonage.

Plumbing systems can be safeguarded from contamination through:

- Correct design of plumbing systems
- Correct installation techniques
- Adhering to the Water Supply (water fittings) Regulations and British Standards
- Following manufacturer’s installation instructions
- Correct filling and commissioning procedures
- Correct handover procedures once the installation is complete

The message is be vigilant when working on new or existing plumbing systems. If a possible contamination issue is discovered, inform the supervisor, manager or end user.

Damage to the atmosphere

A plumber’s work often involves using gas powered blow torches to solder copper capillary fittings and tubes. Gas, in all its forms, produces Carbon Dioxide (CO₂), a known greenhouse gas that is a major cause of global warming and climate change. CO₂ is not a pollutant as such. It is a naturally occurring gas that is already part of the mixture we call ‘air’. In this context, CO₂ cannot pollute. It can however saturate and it is this ‘saturation’ that is causing so much environmental damage to Planet Earth.

There are other alternatives to using capillary fittings, such as compression, push-fit and press-fit types that do not require the use of blow torches and so negate the CO₂ that would have otherwise been produced by the use blow torches and capillary fittings.
Learning Outcome 6

Know the methods of conserving and reducing wastage of water within the building services industry
AC6.1 Identify the statutory legislation for water wastage and misuse

Statutory legislation for wastage of water and contamination

The Water Supply (water fittings) Regulations 1999

The Water Supply (water fittings) Regulations safeguard the water supplied by the water undertakers against contamination, wastage, misuse, undue consumption and erroneous metering. Of these 5 points, contamination and wastage are of vital importance since both of these directly lead to water loss.

Contamination of water

Contamination of the water supply in the UK can occur in many situations. Often, the direct causes of contamination are difficult to pinpoint:

- Through accidental spillage of chemicals and toxic substances that can then filter down into the ground water.
- Flooding, which has become a major issue in some parts of the UK.
- Leakage of raw sewage
- Through the use of nitrates and other fertilisers
Contamination can also occur in the home. Badly installed taps and equipment can lead to back syphonage and back pressure, which directly contaminates the mains cold water supply. Plumbers have a legal obligation under the Water Supply (water fittings) Regulations 1999 to ensure that their actions do not cause contamination of the water supply in any form, whether directly through their plumbing installations or through indirect causes by returning contaminated water back into a water source.

During the course of their work, plumbers may use chemicals for disinfection of cold water systems or through flushing of central heating systems. These chemicals can often be toxic in large quantities. Disinfection of large hot and cold water systems, for instance, involves using sodium hypochlorite, a disinfection agent with a high chlorine content. It is vitally important that chemicals such as these are not simply discharged down the nearest drain. Permission should be sought by contacting the local water undertaker to ensure that they are aware of the potentially harmful concentrations of the solution and that it can be dealt with in the correct manner.

Other ways in which contamination can occur are:

- Improper use of plumbing fittings, such as lead locks. These fittings can cause galvanic action leading to lead contamination of the water system from lead pipes.
- Improper use of penetrating oils and linseed oil-based jointing compounds that leech into the water causing contamination.
- Illegal use of solders that contain lead on potable water supplies
- Incorrect flushing and poor commissioning procedures

Wastage of water

Wasted water through leaking pipes will probably never find its way back into the water supply. That is the stark reality of water wastage. Over 2000 litres of water are wasted in homes across the UK every month and many times more from leaking street mains. Water is wasted through:

- Dripping taps – these can waste over 200 litres of water in a single home every month. If the tap is a hot tap, that leads to wasted energy also.
- Running overflows from WC cisterns and Cold water storage cisterns
- Water main leaks from the water undertaker’s pipework. This accounts for 30% of all water usage in some areas of the UK due to old and defective pipework
- Burst pipes that go unreported
- Excessive use of water in the home. Simple water saving techniques could save 15% of all domestic water usage.

The Water Act 2014

Section 73 of the water act makes it very clear regarding contamination and wastage of water and the end users responsibilities:

‘Offences of contaminating, wasting and misusing water etc

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Author: BPEC Ltd. Editor: BPEC Ltd. Design: BPEC Ltd
(1) If any person who is the owner or occupier of any premises to which a supply of water is provided by a water undertaker intentionally or negligently causes or suffers any water fitting for which he is responsible to be or remain so out of order, so in need of repair or so constructed or adapted, or to be so used—

(a) that water in a water main or other pipe of a water undertaker, or in a pipe connected with such a water main or pipe, is or is likely to be contaminated by the return of any substance from those premises to that main or pipe;

(b) that water that has been supplied by the undertaker to those premises is or is likely to be contaminated before it is used; or

(c) that water so supplied is or is likely to be wasted or, having regard to the purposes for which it is supplied, misused or unduly consumed,

that person shall be guilty of an offence and liable, on summary conviction, to a fine ………

(2) Any person who uses any water supplied to any premises by a water undertaker for a purpose other than one for which it is supplied to those premises shall, unless the other purpose is the extinguishment of a fire, be guilty of an offence and liable, on summary conviction, to a fine……..

(3) Where a person has committed an offence under subsection (2) above, the water undertaker in question shall be entitled to recover from that person such amount as may be reasonable in respect of any water wasted, misused or improperly consumed in consequence of the commission of the offence.

(4) For the purposes of this section the owner or occupier of any premises shall be regarded as responsible for every water fitting on the premises which is not a water fitting which a person other than the owner or, as the case may be, occupier is liable to maintain.’

The Water Act puts the onus for the maintenance and repair of water systems on the owner, occupier or end user. It is their responsibility to ensure that water systems are installed correctly (by employing reputable approved plumbers) and do not waste, contaminate or misuse the water supply.

AC6.2 State the criteria for water efficiency calculations for new dwellings

On April 6\textsuperscript{th} 2010, water efficiency was included as part of the Building Regulations. Document G, Regulation 17K requires that a water efficiency calculation be carried out in respect of the need for stored water in premises. The calculation shows the potential consumption of wholesome water per day and is based on the number and type of water outlets. It also takes into account any grey water installed in the form of rainwater harvesting or grey water recycling. The maximum water allowance per person per day in the UK is currently 150 litres. However, according to the Building Research Establishment (BRE), the sustainable home level 1 standard is 125 litres, a reduction of 25 litres per person per day.
### Performance Target

<table>
<thead>
<tr>
<th>Performance Target</th>
<th>Maximum consumption of potable water (litres/person/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.K Compliance</td>
<td>125</td>
</tr>
<tr>
<td>Code for sustainable homes (level 1/2)</td>
<td>120</td>
</tr>
<tr>
<td>Code for sustainable homes (level 3/4)</td>
<td>105</td>
</tr>
<tr>
<td>Code for sustainable homes (level 5/6)</td>
<td>80</td>
</tr>
</tbody>
</table>

### Water efficiency Calculator for new dwellings

The requirement under G2 of the Building Regulations states that:

**G2. Reasonable provision must be made by the installation of fittings and fixed appliances that use water efficiently for the prevention of undue consumption of water.**

**Water efficiency of new dwellings** (Regulation 17K)

36. (1) The potential consumption of wholesome water by persons occupying a new dwelling must not exceed the requirement in paragraph (2).

(2) The requirement referred to in paragraph (1) is either—

a) 125 litres per person per day; or

b) in a case to which paragraph (3) applies, the optional requirement of 110 litres per person per day,

as measured in either case in accordance with a methodology approved by the Secretary of State.

**Wholesome water consumption calculation** (Regulation 20E)

37.—(1) Where regulation 36 applies, the person carrying out the work must give the local authority a notice which specifies—

a) which of the requirements in regulation 36(2)(a) or (b) applies to the dwelling; and

b) the potential consumption of wholesome water per person per day in relation to the completed dwelling.

Requirement G2 applies only when a dwelling is—

a) erected; or

b) formed by a material change of use of a building

### The methodology of the Water efficiency Calculator

The water efficiency calculator uses the water consumption figures that are provided from manufacturers data. These must be obtained before the assessment can be attempted. The figures are then entered into a series of tables to determine the water consumption per person. Water consumption/flowrate figures are required for:

- WCs
- Washing machines
- Taps
- Showers
- Baths
- Water softeners
- Dishwashers
- External taps.

Bidets are exempt from the calculation due to their minimal water consumption.
## Example of the Water efficiency calculator

<table>
<thead>
<tr>
<th>Installation type</th>
<th>Unit of measure</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Capacity/flow rate</td>
<td></td>
<td>Use factor</td>
<td>Fixed use/ (litres/person/day)</td>
<td>Litres/person/day (= ([1] \times [2]) + [3] )</td>
</tr>
<tr>
<td>WC (single flush)</td>
<td>Flush volume (litres)</td>
<td>4.42</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WC (dual flush)</td>
<td>Full flush volume (litres)</td>
<td>1.46</td>
<td>0.00</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Part flush volume (litres)</td>
<td>2.96</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WC (multiple fittings)</td>
<td>Average effective flushing volume (litres)</td>
<td>4.42</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taps (excluding kitchen/utility room taps)</td>
<td>Flow rate (litres/minute)</td>
<td>1.58</td>
<td>1.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bath (where shower also present)</td>
<td>Capacity to overflow (litres)</td>
<td>0.11</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shower (where bath also present)</td>
<td>Flow rate (litres/minute)</td>
<td>4.37</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bath only</td>
<td>Capacity to overflow (litres)</td>
<td>0.50</td>
<td>0.00</td>
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<td></td>
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<tr>
<td>Shower only</td>
<td>Flow rate (litres/minute)</td>
<td>5.60</td>
<td>0.00</td>
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<td></td>
</tr>
<tr>
<td>Kitchen/utility room sink taps</td>
<td>Flow rate (litres/minute)</td>
<td>0.44</td>
<td>10.36</td>
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<td>Washing machine</td>
<td>Litres/kg dry load</td>
<td>2.1</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dishwasher</td>
<td>Litres/place setting</td>
<td>3.6</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water softener</td>
<td>Litres/person/day</td>
<td>1.00</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(5) Total calculated use = (Sum column 4)

(6) Contribution from greywater (litres/person/day) from Table 4.6 Appendix A, App Doc G

(7) Contribution from rainwater (litres/person/day) from Table 5.5 Appendix A, App Doc G

(8) Normalisation factor 0.91

(9) Total water consumption \(=\) \([\text{(5)} - \text{(6)} - \text{(7)}]\) = (8)

(10) External water use 5.0

(11) Total water consumption = (9) + (10) (litres/person/day)
AC6.3 State the methods for reducing water wastage

A reduction of water consumption must be made if the BRE recommendation of 125 litres/person/day is to be realised. There are several areas where savings can be made:

- Fitting Dual flush WC cisterns
- Fitting flow reducing valves to high consumption terminal fittings
- Repairing dripping taps and running overflows
- Changing taps to low consumption spray type taps
- Changing shower heads to low water consumption heads
- Installing rain water harvesting and grey water recycling systems.

AC6.4 Identify the methods available for capturing surface water and recycling used water, AC6.5 Identify the uses of captured and recycled water in properties

AC6.6 State the basic working principles of captured and recycled water systems

Capturing surface water – Rainwater Harvesting

Rainwater harvesting can save large volumes of water for use in WC flushing, garden irrigation and clothes washing. This would significantly reduce the usage of mains cold water and relieve the strain on the water undertaker’s supplies. A basic rainwater harvesting system can save up to 50% of water consumption.
Rainwater harvesters use a large storage cistern, buried beneath the ground where the rain water pipes from the property rainwater guttering system discharges into. The cistern is sized depending upon the size of the roof capturing the water and the water usage demands of the property.

Inside the cistern is a filter and a submersible pump. The filter first removes sediments and solids. The filtered water is then pumped into a specific storage cistern in the roof space of the property. The water then flows by gravity to WCs and clothes washing machines. This system MUST be marked as grey, non-potable water and must be totally separate from the mains domestic supply. On no account must a cross-connection be made between the rainwater harvesting system and the domestic water supply as this would constitute a contamination risk.

Grey water recycling systems

Waste water from baths, showers and washing machines is often termed ‘grey water’.

In a grey water recycling system, water is collected from baths, showers, washbasins and washing machines into a cistern installed below ground, where it is filtered and disinfected. The water is then pumped to a holding cistern in the roof space before being distributed to the WCs within the property.

Grey water is usually clean enough for only a light disinfection before use. Problems can sometimes arise where bacteria can multiply, making the water smell. It should also be realised that grey recycled water has only a short life span before it becomes unsafe for use. As with rainwater harvesting, grey water recycling systems MUST be kept totally separate from the mains cold water supply to prevent contamination issues. Cross-connections between grey water recycling and mains cold water are strictly forbidden.