



Central heating system
specifications (CHeSS)
Year 2008



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1. Introduction

Home energy use is responsible for over a quarter of UK carbon dioxide (CO₂) emissions which contribute to climate change. To help mitigate the effects of climate change, the Energy Saving Trust has a range of technical solutions to help UK housing professionals build to higher levels of energy efficiency.

This guide gives basic and best practice specifications for the components of domestic wet central heating systems that are critical to energy efficiency. CHeSS (Year 2008) replaces CHeSS (Year 2005) to take account of changes to building regulations and other developments.

Basic means sufficient to comply with building regulations in England and Wales, Scotland and Northern Ireland (Refs [1, 2 and 11]). Building regulations apply to replacement heating systems in existing housing, as well as new ones. Best practice means the adoption of products and technologies that are already established in the market, cost effective, and able to save energy without incurring undue risks: this evolves with emerging technological development.

This publication also includes reference tables to show typical SAP ratings, environmental impact (CO₂) ratings, energy savings and fuel cost savings attributable to CHeSS. SAP 2005 (Ref [6]) has been used to carry out these calculations.

The specifications have been prepared for the Energy Saving Trust at the request of the Heating Strategy Group of the Energy Efficiency Partnership for Homes, with assistance from the trade associations of manufacturers of heating products.

More detailed advice on the selection and installation of domestic wet central heating systems is given in domestic wet central heating systems (see Refs [3], [4], and also Ref [5]).

For notes on the specifications see pages 8 to 10; for references see page 14.

- Purchasers should use the CHeSS specifications to ensure their heating installations will conform to current basic or best practice.
- Installers should use them to quote for systems of defined quality, comparable with their competitors.
- Following the specifications will improve energy efficiency and reduce carbon emissions, and quantified savings are included for reference.

2. Reference points

2.1 Reference tables showing SAP ratings, DER, environmental impact (CO₂), energy consumption, and savings attributable to CHeSS

Tables 1 to 3 show the benefits of domestic wet central heating systems that meet the CHeSS specifications. For different fuels (gas, LPG, oil) and a range of dwelling types, the tables give quantified improvements to the SAP rating, environmental impact (CO₂) rating, dwelling emission rate (DER), energy consumption, and fuel cost savings. Where savings are quoted they are compared with a reference case, explained below.

The basic and best practice calculations are based on boilers that meet the minimum efficiencies specified in CHeSS. Higher savings are possible by purchasing boilers with SEDBUK (Seasonal Efficiency of Domestic Boilers in the UK) above those minimum levels. Boilers can be obtained with approximate efficiencies up to 91% for gas, 93% for LPG, or 95% for oil. Other columns in the tables are explained on the next page.

2.2 SAP (The Government's Standard Assessment Procedure for Energy Rating of Dwellings, 2005 edition, DEFRA)

SAP is the UK Government's procedure for the energy rating of homes (see Ref [6]). The properties of a building, such as the insulation, determine its heat requirements, while the type of heating system and heating fuel determine the energy use, cost and CO₂ emissions under standard occupancy conditions.

In the latest version, SAP 2005, the rating scale is 1 to 100. This is based on the calculated cost of space and water heating, ventilation and lighting, less savings from any energy generated in the building. High numbers represent better energy performance, and a rating of 100 is reached when the net energy consumption (over a whole year) is zero. Ratings above 100 are possible when the dwelling is a net exporter of energy. To comply with building regulations all new homes must have a SAP assessment.

2.3 Dwelling CO₂ emission rate (DER)

SAP also calculates the dwelling emission rate (DER), and the target emission rate (TER) for compliance with building regulations. These take account of energy used for space and water heating, ventilation and lighting. These are given in units of kg CO₂ per square metre of floor area per year.

2.4 Environmental impact (CO₂) rating and band

The environmental impact (EI) rating is a number representing the annual CO₂ emissions, calculated as part of the SAP procedure. Higher numbers represent lower emissions, with 100 representing zero net emissions. Numbers above 100 are possible if the dwelling is a net exporter of energy. The number range is divided into bands labelled A to G, as shown below, for use on energy performance certificates.

Environmental impact (CO ₂) rating	
Rating	Band
92 or more	A
81 to 91	B
69 to 80	C
55 to 68	D
39 to 54	E
21 to 38	F
1 to 20	G

2.5 Energy and costs

The energy in kWh per year for the reference case (described below), and percentage savings for CHeSS basic and best practice, are for heating and hot water energy consumption only.

Cost savings are quoted for CHeSS systems in comparison with the reference case. Energy prices are taken from table 12 of SAP 2005 (see Ref [6]), and standing charges are excluded. Energy prices for SAP are averaged over a period to eliminate short-term fluctuations, and current prices may vary depending on energy suppliers and market movements.

Reference points

2.6 The reference case

Savings are based on comparisons with dwelling characteristics known as the reference case, which have been calculated using the Building Research Establishment Domestic Energy Model (BREDEM). To get realistic savings, the reference case has heating systems and insulation standards typical of the housing stock. Each type of dwelling has the same insulation standard, which is:

- Uninsulated solid floor (U-value varying depending on dimensions).
- 100mm loft insulation (0.4W/m²K).
- Solid walls (U-value 2.1W/m²K) or filled cavity walls (0.5W/m²K).
- Mostly double glazing (average U-value 3.5W/m²K).
- Solid wooden doors (3.0W/m²K).

The main features of the heating system are:

- Gas boiler with SEDBUK efficiency 73% (75% is the stock average and 2% is deducted to represent the proportion of the stock lacking boiler interlock).
- Or LPG boiler with SEDBUK efficiency 75%.
- Or oil boiler with SEDBUK efficiency 82%.
- Cylinder thermostat present (not applicable to combi boiler systems).

- Primary pipe-work uninsulated (not applicable to combi boiler systems).
- Cylinder insulated to the stock average level, equivalent to a 55mm insulating jacket on a 120 litre cylinder (not applicable to combi boiler systems).
- Room thermostat and programmer, but no thermostatic radiator valves (TRVs).

Savings are calculated by changing the heating systems to meet the basic and best practice CHeSS specifications, but leaving the insulation and other characteristics unchanged. It is assumed that each dwelling is heated to 21°C in the living area during the morning and evening on weekdays, and all day at weekends.

Total floor areas are typical for each of the dwelling types as shown below.

Total floor areas	
Dwelling type	Floor area (m ²)
Flat *	61
Detached bungalow	67
Semi-detached bungalow	64
Mid-terraced	79
End-terraced	79
Semi-detached	99
Detached	104

* Top floor flat with two external walls (a top floor flat has an energy consumption intermediate between a ground and mid-floor flat)

3. Central heating system specifications – CHeSS (Year 2008)

Basic (2008)	
Reference	CHeSS – HR7 (2008)
Description	Domestic wet central heating system with regular boiler (natural gas, LPG, or oil) and separate hot water store.
Boiler (see notes 5 and 6)	<ul style="list-style-type: none"> A regular boiler (not a combi) which has a SEDBUK efficiency of at least 86% (bands A and B).
Hot water store	EITHER <ul style="list-style-type: none"> Hot water cylinder, whose heat exchanger and insulation properties both meet or exceed (see note 7) those of the relevant British Standards (see Refs [7],[8]). OR <ul style="list-style-type: none"> Thermal (primary) storage system, whose insulation properties meet or exceed those specified in Ref [9].
Controls (see notes 10, 11 and 12)	<ul style="list-style-type: none"> Full programmer Room thermostat Cylinder thermostat Boiler interlock (see note 13) TRVs on all radiators, except in rooms with a room thermostat Automatic bypass valve (see note 14)
Installation	See notes 1, 2, 3 and 4.

Basic (2008)	
Reference	CHeSS – HC7 (2008)
Description	Domestic wet central heating system with combi or CPSU boiler (natural gas, LPG, or oil).
Boiler (see notes 5 and 6)	<ul style="list-style-type: none"> A combi or CPSU boiler which has a SEDBUK efficiency of at least 86% (bands A and B)
Hot water store	None, unless included within boiler.
Controls (see notes 10, 11 and 12)	<ul style="list-style-type: none"> Time switch Room thermostat Boiler interlock (see note 13) TRVs on all radiators, except in rooms with a room thermostat Automatic bypass valve (see note 14)
Installation	See notes 1, 2, 3 and 4.

Central heating system specifications – CHeSS (Year 2008)

Recommended best practice (2008)	
Reference	CHeSS – HR8 (2008)
Description	Domestic wet central heating system with regular boiler (natural gas, LPG, or oil) and separate hot water store.
Boiler (see notes 5 and 6)	<ul style="list-style-type: none"> A regular boiler (not a combi) which has a SEDBUK efficiency of at least 90% (band A).
Hot water store	EITHER <ul style="list-style-type: none"> High-performance hot water cylinder (see note 8). OR <ul style="list-style-type: none"> High-performance thermal (primary) storage system (see note 9). In suitable buildings, consideration should be given to fitting a cylinder with an additional heat exchanger to allow for solar water heating.
Controls (see notes 10, 11 and 12)	<ul style="list-style-type: none"> Programmable room thermostat, with additional timing capability for hot water Cylinder thermostat Boiler interlock (see note 13) TRVs on all radiators, except in rooms with a room thermostat Automatic bypass valve (see note 14) More advanced controls, such as weather compensation, may be considered, but at present cannot be confirmed as cost effective.
Installation	See notes 1, 2, 3 and 4.

Recommended best practice (2008)	
Reference	CHeSS – HC8 (2008)
Description	Domestic wet central heating system with combi or CPSU boiler (natural gas, LPG, or oil).
Boiler (see notes 5 and 6)	<ul style="list-style-type: none"> A combi or CPSU boiler which has a SEDBUK efficiency of at least 90% (band A).
Hot water store	None, unless included within boiler.
Controls (see notes 10, 11 and 12)	<ul style="list-style-type: none"> Programmable room thermostat Boiler interlock (see note 13) TRVs on all radiators, except in rooms with a room thermostat Automatic bypass valve (see note 14) More advanced controls, such as weather compensation, may be considered, but at present cannot be confirmed as cost effective.
Installation	See notes 1, 2, 3 and 4

4. Notes applicable to CHeSS HR7, HC7, HR8, HC8 (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, using methods such as those described in Ref [5]. They should be installed in accordance with relevant safety regulations, manufacturers' instructions, the Benchmark scheme (see Ref [10]), building regulations (see Refs [1], [2], [11]), the Domestic Heating Compliance Guide (see Ref [16]), and British Standards (see Refs [12], [13], [17], [18]). 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 (see Refs [3] and [4]), and the CIBSE guide (see Ref [5]). 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 (see Ref [14]).

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.

For further definitions of boiler types see Appendix D of Ref [6].

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 below.

Notes applicable to CHeSS HR7, HC7, HR8, HC8 (Year 2008)

SEDBUK	
Efficiency range	Band
90% and above	A
86% – 90%	B
82% – 86%	C
78% – 82%	D
74% – 78%	E
70% – 74%	F
Below 70%	G

7. Hot water cylinder (basic)

Vented cylinders shall comply with the performance requirements of BS 1566:2002 Type P cylinders (see Ref [7]). The performance of unvented cylinders shall comply with BS EN 12897:2006 (see Ref [8]) or be approved by the BBA or other equivalent body. All cylinders must be factory insulated such that the standing heat loss will not exceed:

$1.6 \times (0.2 + 0.051 V^{2/3})$ kWh per 24 hours, where V is the capacity in litres. All cylinders shall be labelled with the standing heat loss in kWh/24hours.

Indirect cylinders shall also be labelled 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 (see Refs [7], [8]). The standing heat loss must not exceed: $1.28 \times (0.2 + 0.051 V^{2/3})$ 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 (see Ref [9]), 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

Definitions of heating controls are given in Ref [4]. The most common are repeated below.

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.

Notes applicable to CHeSS HR7, HC7, HR8, HC8 (Year 2008)

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.

Consequently it is not sufficient for the manufacturer to confirm compliance with the RTTE Directive. The manufacturer should also confirm that the switching range, and preferably alignment range, do not include any frequencies below 430MHz, and that in regard to ETSI EN 300 220-1 v1.3.1 (see Ref [15]) the receiver classification (clause 4.1.1) is either Class 1 or Class 2, and the device is marked in accordance with clause 4.3.4.

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) so as to 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 paths 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 (not a fixed-position 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 paths are closed.

5. Gas heated dwellings

Table 1: Dwellings with gas boilers.

The benefits of domestic gas wet central heating systems that meet the CHeSS specifications

Gas heated dwelling with solid walls and a regular boiler															
Dwelling type	SAP			Environmental impact (CO ₂) rating			DER (kgCO ₂ /m ² /yr)			Energy (kWh/yr) – % saving			Cost saving (£/yr)		
	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	CHeSS Basic	CHeSS Best	
Flat	64	70	71	59	67	68	52.8	43.0	41.2	14,951	20%	24%	50	59	
Detached bungalow	51	59	60	45	53	54	71.7	59.5	56.9	23,261	18%	22%	69	84	
Semi-det. bungalow	54	62	63	48	56	57	68.6	56.5	54.1	20,836	19%	23%	64	77	
Mid-terraced	63	70	71	58	66	67	49.2	39.9	38.2	18,108	21%	25%	62	73	
End terraced	54	62	63	48	56	58	63.0	51.8	49.6	23,721	19%	23%	74	89	
Semi-detached	53	61	62	47	55	57	62.0	51.0	48.8	26,347	19%	23%	82	98	
Detached	45	54	55	40	47	49	69.4	57.8	55.4	34,896	18%	22%	102	123	

Gas heated dwelling with filled cavity walls and a regular boiler															
Dwelling type	SAP			Environmental impact (CO ₂) rating			DER (kgCO ₂ /m ² /yr)			Energy (kWh/yr) – % saving			Cost saving (£/yr)		
	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	CHeSS Basic	CHeSS Best	
Flat	71	76	77	68	74	75	41.9	33.8	32.4	11,532	22%	26%	41	48	
Detached bungalow	63	69	71	57	65	67	53.1	43.0	41.2	16,779	21%	25%	57	67	
Semi-det. bungalow	64	71	72	59	67	69	51.8	41.9	40.1	15,345	21%	25%	53	62	
Mid-terraced	72	77	78	69	75	76	36.7	29.4	28.1	13,056	23%	27%	49	57	
End terraced	68	74	75	64	71	72	42.2	34.0	32.5	15,282	22%	26%	55	64	
Semi-detached	67	72	73	62	69	71	42.7	34.4	32.9	17,512	22%	26%	62	73	
Detached	63	70	71	58	66	68	44.6	36.2	34.7	21,567	21%	25%	73	86	

Gas heated dwelling with solid walls and a combi boiler															
Dwelling type	SAP			Environmental impact (CO ₂) rating			DER (kgCO ₂ /m ² /yr)			Energy (kWh/yr) – % saving			Cost saving (£/yr)		
	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	CHeSS Basic	CHeSS Best	
Flat	65	70	71	60	67	68	51.7	43.2	41.5	14,625	18%	22%	44	52	
Detached bungalow	52	59	60	46	53	54	70.5	59.6	57.1	22,848	17%	20%	62	76	
Semi-det. bungalow	55	61	63	48	56	57	67.2	56.5	54.2	20,406	17%	21%	57	69	
Mid-terraced	64	70	71	59	66	67	48.2	40.0	38.4	17,705	19%	22%	54	65	
End terraced	55	61	63	48	56	57	62.1	52.0	49.9	23,361	18%	21%	67	81	
Semi-detached	54	61	62	47	55	56	61.0	51.1	49.0	25,922	18%	21%	75	90	
Detached	46	53	55	40	47	49	68.8	58.0	55.6	34,543	17%	21%	95	116	

Gas heated dwelling with filled cavity walls and a combi boiler															
Dwelling type	SAP			Environmental impact (CO ₂) rating			DER (kgCO ₂ /m ² /yr)			Energy (kWh/yr) – % saving			Cost saving (£/yr)		
	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	CHeSS Basic	CHeSS Best	
Flat	72	76	77	69	74	75	40.5	33.9	32.6	11,120	19%	22%	34	41	
Detached bungalow	64	69	70	58	65	67	51.7	43.0	41.3	16,306	18%	22%	49	59	
Semi-det. bungalow	65	71	72	60	67	68	50.3	41.8	40.2	14,866	19%	22%	45	54	
Mid-terraced	73	77	78	70	75	76	35.5	29.4	28.3	12,551	20%	23%	40	48	
End terraced	69	74	75	65	71	72	41.1	34.0	32.7	14,814	19%	23%	47	55	
Semi-detached	67	72	73	63	69	71	41.5	34.4	33.0	16,975	19%	23%	53	63	
Detached	64	70	71	59	66	67	43.8	36.3	34.9	21,167	19%	23%	66	79	

6. LPG heated dwellings

Table 2: Dwellings with LPG boilers.

The benefits of domestic LPG wet central heating systems that meet the CHeSS specifications

LPG heated dwelling with solid walls and a regular boiler															
Dwelling type	SAP			Environmental impact (CO ₂) rating			DER (kgCO ₂ /m ² /yr)			Energy (kWh/yr) – % saving			Cost saving (£/yr)		
	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	CHeSS Basic	CHeSS Best	
Flat	31	39	41	53	61	62	61.0	50.8	48.7	14,552	18%	22%	99	119	
Detached bungalow	15	22	24	39	45	47	83.4	70.8	67.7	22,641	16%	20%	134	168	
Semi-det. bungalow	18	26	28	41	49	50	79.6	67.1	64.2	20,282	17%	21%	126	155	
Mid-terraced	30	38	40	52	60	61	56.9	47.2	45.1	17,625	19%	23%	122	147	
End terraced	18	26	28	42	49	51	73.1	61.5	58.9	23,088	17%	21%	145	179	
Semi-detached	17	25	27	40	48	49	72.0	60.6	57.9	25,645	17%	21%	161	198	
Detached	10	17	19	34	40	42	80.8	68.8	65.9	33,966	16%	20%	197	246	

LPG heated dwelling with filled cavity walls and a regular boiler															
Dwelling type	SAP			Environmental impact (CO ₂) rating			DER (kgCO ₂ /m ² /yr)			Energy (kWh/yr) – % saving			Cost saving (£/yr)		
	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	CHeSS Basic	CHeSS Best	
Flat	42	50	52	63	69	71	48.2	39.7	38.0	11,224	20%	24%	82	99	
Detached bungalow	29	37	39	51	59	61	61.5	51.0	48.7	16,331	19%	22%	112	136	
Semi-det. bungalow	31	40	42	53	61	63	59.9	49.5	47.4	14,937	19%	23%	105	127	
Mid-terraced	43	52	54	64	71	72	42.3	34.5	33.0	12,708	21%	25%	98	116	
End terraced	37	46	48	58	66	67	48.8	40.0	38.3	14,874	20%	24%	109	131	
Semi-detached	35	43	45	56	64	65	49.3	40.6	38.8	17,045	20%	23%	123	148	
Detached	30	39	41	52	60	62	51.6	42.8	41.0	20,993	19%	23%	145	175	

LPG heated dwelling with solid walls and a combi boiler															
Dwelling type	SAP			Environmental impact (CO ₂) rating			DER (kgCO ₂ /m ² /yr)			Energy (kWh/yr) – % saving			Cost saving (£/yr)		
	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	CHeSS Basic	CHeSS Best	
Flat	32	39	41	54	61	62	59.8	51.0	49.0	14,236	16%	20%	85	105	
Detached bungalow	16	22	24	39	45	47	82.0	70.9	67.9	22,240	14%	18%	119	150	
Semi-det. bungalow	19	26	28	42	49	50	78.1	67.2	64.4	19,863	15%	19%	110	138	
Mid-terraced	31	38	40	53	60	61	55.8	47.3	45.4	17,232	17%	20%	106	130	
End terraced	19	26	28	42	49	50	72.1	61.7	59.2	22,738	15%	19%	130	161	
Semi-detached	18	25	27	41	48	49	70.9	60.7	58.2	25,230	15%	19%	144	179	
Detached	10	17	19	34	40	42	80.0	69.0	66.1	33,622	15%	18%	181	229	

LPG heated dwelling with filled cavity walls and a combi boiler															
Dwelling type	SAP			Environmental impact (CO ₂) rating			DER (kgCO ₂ /m ² /yr)			Energy (kWh/yr) – % saving			Cost saving (£/yr)		
	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	CHeSS Basic	CHeSS Best	
Flat	43	50	52	64	69	71	46.7	39.8	38.3	10,824	17%	20%	67	82	
Detached bungalow	30	37	39	52	59	61	59.9	50.9	48.9	15,872	16%	20%	95	117	
Semi-det. bungalow	32	40	42	54	61	63	58.2	49.5	47.5	14,470	16%	20%	88	108	
Mid-terraced	45	52	54	65	71	72	40.9	34.5	33.2	12,215	18%	21%	79	96	
End terraced	38	46	47	59	66	67	47.4	40.1	38.5	14,418	17%	21%	91	111	
Semi-detached	36	44	45	57	64	65	48.0	40.5	38.9	16,521	17%	21%	104	127	
Detached	31	39	41	53	60	61	50.7	42.9	41.1	20,602	17%	21%	130	158	

7. Oil heated dwellings

Table 3: Dwellings with oil boilers.

The benefits of domestic oil wet central heating systems that meet the CHeSS specifications

Oil heated dwelling with solid walls and a regular boiler														
Dwelling type	SAP			Environmental impact (CO ₂) rating			DER (kgCO ₂ /m ² /yr)			Energy (kWh/yr) – % saving			Cost saving (£/yr)	
	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	CHeSS Basic	CHeSS Best
Flat	63	66	68	52	56	58	63.2	57.1	54.6	13,257	11%	15%	31	43
Detached bungalow	47	51	53	37	40	42	86.4	79.7	76.2	20,657	8%	13%	37	56
Semi-det. bungalow	50	54	56	40	44	46	82.4	75.5	72.2	18,494	9%	13%	36	53
Mid-terraced	61	65	66	50	55	57	58.9	52.9	50.6	16,072	11%	15%	39	54
End terraced	50	54	56	40	44	46	75.7	69.2	66.2	21,062	9%	14%	42	62
Semi-detached	48	53	55	39	43	45	74.5	68.1	65.2	23,400	9%	13%	46	68
Detached	40	44	46	32	35	37	83.6	77.5	74.1	31,010	8%	12%	52	81

Oil heated dwelling with filled cavity walls and a regular boiler														
Dwelling type	SAP			Environmental impact (CO ₂) rating			DER (kgCO ₂ /m ² /yr)			Energy (kWh/yr) – % saving			Cost saving (£/yr)	
	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	CHeSS Basic	CHeSS Best
Flat	71	74	75	61	66	67	50.0	44.5	42.6	10,222	12%	17%	27	37
Detached bungalow	61	65	66	50	54	56	63.6	57.2	54.7	14,889	11%	15%	35	49
Semi-det. bungalow	63	67	68	52	56	58	62.1	55.6	53.2	13,613	11%	16%	34	46
Mid-terraced	71	74	76	63	67	69	43.8	38.6	36.9	11,581	13%	18%	34	45
End terraced	67	70	72	57	62	63	50.5	44.9	42.9	13,559	12%	17%	36	49
Semi-detached	64	68	70	55	59	61	51.1	45.5	43.5	15,544	12%	16%	41	55
Detached	61	64	66	51	55	57	53.4	48.0	45.9	19,153	11%	15%	46	64

Oil heated dwelling with solid walls and a combi boiler														
Dwelling type	SAP			Environmental impact (CO ₂) rating			DER (kgCO ₂ /m ² /yr)			Energy (kWh/yr) – % saving			Cost saving (£/yr)	
	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	CHeSS Basic	CHeSS Best
Flat	63	66	68	53	56	58	61.9	57.3	55.0	12,966	8%	12%	23	35
Detached bungalow	48	51	53	38	40	42	84.9	79.8	76.5	20,285	6%	11%	28	47
Semi-det. bungalow	51	54	56	41	44	45	80.8	75.6	72.5	18,111	7%	11%	27	44
Mid-terraced	62	65	66	51	55	56	57.7	53.1	50.9	15,708	9%	13%	30	44
End terraced	51	54	56	41	44	45	74.6	69.4	66.5	20,742	8%	12%	34	52
Semi-detached	49	53	55	40	43	44	73.4	68.2	65.4	23,021	8%	12%	38	58
Detached	41	44	46	33	35	37	82.8	77.7	74.4	30,696	7%	11%	44	71

Oil heated dwelling with filled cavity walls and a combi boiler														
Dwelling type	SAP			Environmental impact (CO ₂) rating			DER (kgCO ₂ /m ² /yr)			Energy (kWh/yr) – % saving			Cost saving (£/yr)	
	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	Ref Case	CHeSS Basic	CHeSS Best	CHeSS Basic	CHeSS Best
Flat	72	74	75	63	66	67	48.4	44.6	42.9	9,854	9%	13%	19	28
Detached bungalow	62	65	66	51	54	56	62.0	57.2	54.9	14,463	8%	12%	26	39
Semi-det. bungalow	64	67	68	53	56	58	60.3	55.5	53.3	13,180	9%	13%	25	36
Mid-terraced	72	74	75	64	67	68	42.3	38.6	37.1	11,129	10%	14%	24	33
End terraced	67	70	71	58	62	63	49.1	45.0	43.2	13,141	9%	13%	27	38
Semi-detached	65	68	70	56	59	61	49.6	45.5	43.6	15,064	9%	13%	30	44
Detached	61	64	66	51	55	57	52.5	48.1	46.1	18,790	9%	13%	37	54

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