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BRE Client Report

Ofgem Deemed Scores Methodology

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1 Introduction

This report outlines the methodology employed in the creation of the deemed scores proposed to be used for an extension year to the Energy Company Obligation. The key objectives of the work were to calculate savings by developing categories for which the scores are significantly different and representative of the cost or carbon savings that ECO measures will achieve, whilst at the same time are reasonably unambiguous, to reduce the risk of misidentification, and are easy to verify.

Over 11,000 scores have been calculated for this work, which has required over 22,000 SAP calculations to be performed.

The most appropriate deemed score will be identified by selecting the dwelling type, dwelling size and heating system type for each measure type.

The deemed scores and methodology were produced on behalf of Ofgem by Peter Iles, Jack Hulme, Deborah Morgan, John Henderson and Nicola Schofield at BRE, with additional input from Neil Cutland of Cutland Consulting Ltd.

2 Methodology employed in calculation of deemed scores

2.1 Dwelling types/sizes

To aid clear identification, dwellings were defined by type and number of bedrooms. Dimensions were derived from the English Housing Survey 2013 data. Scottish and Welsh data is available, but differing survey design and conventions make integration difficult. However, previous BRE work[1] allows comparisons to be made in key areas, in particular the key characteristic of dwelling floor area, which indicates that defaults derived from the English Housing Survey are able to represent the stock of these nations reasonably well. Although the climate in different regions is different, SAP assumes a standardised climate. These differences, therefore, are not relevant for these scores.

For flats, there are a large variety of configurations. In all cases, one wall was assumed to be a reduced heat loss wall facing a corridor, while the other walls were assumed to be party or external walls. To simplify use of the scores and prevent errors, other simplifications have been made. Firstly, a top floor flat is used to represent the 'typical' position of all flats on all floors. Previous work has shown that there is not a large difference in savings following the installation of measures between top, mid, and bottom floor flats. There is very little difference for insulation measures and for heating measures: the top floor flat gives savings which are intermediate compared with bottom and mid-floor. Top floor flats are therefore used to represent flats on any floor level. The savings for 3 and 2 external wall flats have been combined into a single saving for 'flats' of each size, using a weighted average of the number of each in the stock. Flats with one and four external walls are relatively rare and were therefore neglected since they made no significant difference to the weighted average which defined the combined savings.

The English Housing Survey collects the number of bedrooms and the dimensions of dwellings. To ensure that the number of archetypes remains manageable to use, while also giving a fair estimation of size, we have controlled the number of typologies defined in a number of ways. For the rarer large and small sizes of dwellings, where there are less than 30 dwellings in the sample the results are unreliable and in these cases data was combined. For larger numbers of bedrooms, data was combined to give x+ bedrooms (for example the data from 5 or more bedrooms for semi-detached houses was combined to give a 5+ bedrooms category). Similarly, for some dwelling types where the 1 bedroom size was rare (for example in detached properties), the data was combined to give a 2- (2 or fewer) bedrooms category. As a result, the deemed scores may be applied to all sizes of the different types of dwellings based on a robust analysis of floor area data relating to houses with the complete range of number of bedrooms, extracted from the English Housing Survey. Following further analysis of wall, floor and window data from the English Housing Survey and standard dwelling dimensions, gross wall areas were calculated from the dwelling perimeters and window areas were calculated using the RdSAP equations.

[1] Housing in the UK: National comparisons in typology, condition and cost of poor housing. Piddington, Garrett and Nowak. BRE Trust 2013.

For each dwelling type and size, average physical characteristics of all dwellings in the stock are used. Whilst it is recognised that on an individual basis some properties will have larger or smaller floor areas or other characteristics, these archetypes should provide reasonable approximations of average savings across all dwellings of each type within the stock as a whole. The average dimensions are based on a median score, rather than mean, were used to avoid small numbers of very large or very small values skewing the result. The floor areas used for each dwelling type are shown in **Table 1** below.

Table 1: Dwelling floor areas used in deemed scores.

Dwelling Type	No. of bedrooms	Median total floor area (m^2)
	1	53.7
1) Mid-terrace House	2	67.6
	3	84.4
2) End-terrace House	4	115.2
	5 +	158.8
3) Semi-detached House	2 -	68.9
	3	85.8
	4	129.0
	5 +	175.1
4) Detached House	2 -	99.7
	3	104.9
	4	145.8
	5	198.1
	6 +	299.0
5) Semi-det. or End-terrace Bungalow	1	45.4
	2	58.2
6) Mid-terrace Bungalow	3 +	85.2
7) Detached Bungalow	2 -	70.7
	3 +	105.8
8) Flats & Maisonettes	1	45.6
	2	63.3
	3 +	84.9

2.1.1 Park Homes

For Park Homes Insulation measures, two types of park home have been specified: single and double width. This is described further in section 2.4.11. When selecting a deemed score for all other improvements to Park Homes (ie any measure that is not a Park Home insulation measure), detached bungalows are to be used as a proxy for a Park Home.

2.2 Base cases – heating systems and typical insulation level

Insulation savings are significantly affected by the primary heating system in a dwelling, its efficiency and its fuel. Calculations for insulation savings were therefore undertaken for a variety of heating systems.

In Table 2, heating systems data from the English Housing Survey are combined into broad categories where they would give similar savings. For example 'gas central heating' includes systems with both regular and combi boilers, and 'electric storage' includes both 7 and 10 hour off-peak tariffs. Typical 'base cases' for the most common heating types were then defined, and savings calculated for these common heating types. In order to maintain a reasonable number of deemed scores, specific scores were not calculated for the rarest heating fuels (e.g. bottled propane, wood etc.).

Table 2: Heating system types in the housing stock.
Those in BOLD are the common heating types used in the deemed scores

	% of housing stock	Number in housing stock (thousands)	Assumed system efficiency (see Table 5)
Central & Storage Heating			
GAS (MAINS)	***83.9%***	***19519***	***83%***
ELECTRIC STORAGE	***6.1%***	***1414***	***100%***
OIL	***3.6%***	***838***	***83%***
BULK LPG	***0.5%***	***113***	***83%***
SOLID FOSSIL	***0.4%***	***82***	***60%***
ELECTRIC	***0.3%***	***77***	***100%***
Bottled Propane	0.2%	35	
Wood	0.12%	27	
Heat pumps & other	0.08%	18	
Room Heating			
ELECTRIC	***2.1%***	***486***	***100%***
GAS	***0.6%***	***150***	***60%***
SOLID FOSSIL	***0.2%***	***45***	***50%***
Bottled Propane	0.04%	8	
Wood	0.02%	4	
Oil	0.01%	2	

Table 3: Details of heating types used in the deemed scores (in BOLD in Table 2)

Central & Storage Heating
Gas (mains) with radiators and hot water cylinder
Electric Storage with electric dual immersion heater
Oil with radiators and hot water cylinder
Bulk LPG with radiators and hot water cylinder
Solid fossil with radiators and hot water cylinder
Electric dry core storage with radiators and hot water cylinder
Room Heating
Electric with electric immersion heater
Gas with electric immersion heater
Solid fossil with electric immersion heater

Taking account of the efficiency, carbon and cost factors, the rare heating types (italics in Table 2) may be represented using the proxy heating systems in Table 4.

Table 4: Proxy heating systems to be used for rare heating types.

Heating type	Carbon savings	Cost savings
Bottled Propane central heating	Bulk LPG	Bulk LPG
Bottled Propane room heating	Bulk LPG	Bulk LPG
Oil room heating	Oil	Oil
Wood central heating	Solid	Solid
Wood room heating	Solid	Solid
Heat pumps central heating	Mains gas	Mains gas

Savings were calculated using an average or typical efficiency and responsiveness for each of the above systems. As a result the deemed score calculated for an insulation measure is unlikely to match the saving for a specific individual dwelling but will be an average or typical saving representative for the stock.

Heating improvement savings will be significantly affected by the level of insulation in the dwelling. An average insulation level is used and as a result the saving calculated for a heating measure is unlikely to match the saving for an individual dwelling. It is an average or typical saving, representative for the stock. The base case parameters were derived from a variety of sources. The following table gives the estimates, with a brief description of its source, for a 'typical dwelling' of the building stock in 2017/18, using a time series of data to give an extrapolated value.

Table 5: Sources of deemed scores data.

Parameter	Value	Data sources[2,3,4,5,6] values extrapolated to year 2017/18
Loft U-value	0.36 W/m^{2}K	EHS 2013 and Domestic Energy Fact File (DEFF) data to 2011
Wall U-value	0.98 W/m^{2}K	Annual data from EHS and 'DECC National Statistics, Domestic Green Deal, ECO and Insulation Levels in GB' report (Sept. 2015)
Window U-value	2.2 W/m^{2}K	EHS 2013 with DEFF data up to 2007 shows nearly all homes have double glazing. This value is between basic double glazing (2.8) and the replacement standard (1.6)
Hot water cylinder insulation	80mm	Depth of insulating jacket equivalent (using adjusted foam insulation depths) from EHS 2013 data
Central heating seasonal efficiency	Gas, LPG & Oil 83% Solid fossil 60%	EHS 2013 and DEFF data to 2011 Estimate from SAP
Room heating efficiency	Gas 60% Solid fossil 50%	Estimate from SAP Estimate from SAP
Heating controls	Timer, Roomstat & TRVs	EHS 2013 and previous EHS data indicates this as the most common controls combination.
Electric storage heating controls	automatic	Estimate using EHS data
Proportion of low energy lighting	40%	Data from EHS 2013, the Energy Follow-Up Survey 2011 and the English Household Electricity Use Study 2010/11

[2] BRE analysis of English Housing Survey data

[3] https://www.gov.uk/government/statistics/united-kingdom-housing-energy-fact-file-2013

[4] https://www.gov.uk/government/statistics/green-deal-energy-company-obligation-eco-and-insulation-levels-in-great-britain-detailed-report-to-june-2015

[5] https://www.gov.uk/government/statistics/energy-follow-up-survey-efus-2011

[6] http://www.energysavingtrust.org.uk/sites/default/files/reports/PoweringthenationreportCO332.pdf

2.3 Carbon emission factors and fuel prices

Carbon emission factors from SAP2012 were used for the various fuels in generating the associated scores. These are CO_2 equivalent factors which include the global warming impact of CH_4 and N_2O as well as CO_2.

Fuel prices current in the PCDB at the time the deemed scores were calculated (March 2016) were used in preference to the values in SAP Table 12. It is not anticipated that these will be changed for the purpose of the 2017/18 ECO and that these prices are fixed.

2.4 Measures, 'before' and 'after' values

This section presents the 'before' and 'after' values used in the calculation of the deemed scores.

2.4.1 Solid wall insulation

Savings were calculated for the improvements in U-value indicated in **Table 6**. These savings may be applied to internal or external wall insulation on either solid or cavity walls. The before and after U-values are taken from Section S5.1 of RdSAP (SAP 2012 v9.92).

Table 6: Assumed U-values for solid wall insulation

	Insulation thickness			
	50mm	**100mm**	150mm	200mm
Starting U-value (W/m^2K)	**End U-values (W/m^2K)**			
2.1	0.6	0.35	0.25	0.18
1.7	0.55	0.35	0.25	0.18
1.0	0.45	0.32	0.21	0.17
0.6	0.35	0.24	0.18	0.15
0.45	0.3	0.21	0.17	0.14

2.4.2 Cavity wall insulation

Savings were calculated for three construction age bands using standard U-value calculation methodology applied to the relevant construction (e.g. brick/brick, brick/block with an average cavity width derived by BRE from installer data, as used for the CERT scheme). These age bands are associated with significant changes in wall U-values due to the introduction of successive new Building Regulations. For cavity wall insulation with a standard thermal conductivity of 0.040 W/mK the U-values are as shown in **Table 7** below.

Table 7: Assumed base U-values for cavity wall dwellings

Year of construction	**Uninsulated U-value (W/m^2K)**	**Insulated U-value (W/m^2K)**	**Weighting**
(1) Pre 1976	1.435	0.478	73%
(2) 1976 - 83	1.003	0.417	13%
(3) post 1983	0.694	0.343	15%

The U-values for the three age bands are combined to give one uninsulated and one insulated U-value regardless of the age band of the wall. This is consistent with latest research which shows wide variation in measured U-values for each age band. The three values are averaged using the weightings in the table, which are derived from the number of uninsulated cavity wall dwellings for each age band in the national stock.

This results in the U-values in **Table 8** below for cavity wall insulation with a thermal conductivity of 0.040 W/mK. Calculations were also undertaken for 0.033 W/mK since this is a common thermal conductivity for cavity wall insulation. The resulting U-values after weighting by age band are also given in Table 8.

Table 8: U-values for Cavity Wall Insulation

Thermal conductivity (W/mK)	Weighted average 'before' U-value (W/m²K)	Weighted average 'after' U-value (W/m²K)
0.040	1.272	0.451
0.033	1.272	0.393

Party wall insulation savings were calculated using the standard SAP U-values. The U-value assumptions are shown in **Table 9** below.

Table 9: U-values for Cavity Wall Insulation of party walls

	'before' U-value (W/m²K)	'after' U-value (W/m²K)
Party wall insulation	0.5	0.2

2.4.3 Loft insulation

During the previous CERT scheme, a case was made that during 'top-up' of loft insulation, the additional savings from correction of the existing insulation was not taken account of. A survey of 200 lofts was commissioned, collecting data on 'disturbances' such as missing or compressed insulation, and also the fraction of wood (the joists), area of loft hatches and water tanks. From this data, modified U-values were derived, resulting in an increase to the scores. These deemed scores are calculated using these modified U-values to take account of these additional savings, resulting in improved scores.

These loft insulation savings may be used for both insulation at roof joist level and rafter-level loft insulation, which is assumed to give similar savings.

After loft insulation is installed, it is recognised that the actual depth before installation is difficult to audit. It was therefore decided to derive a single deemed score using a 'typical' starting U-value. The starting U-value was determined from examination of English Housing Survey data, and assessment of the effect on the final U-value. This is shown in the **Figure 1** and **Figure 2** below.

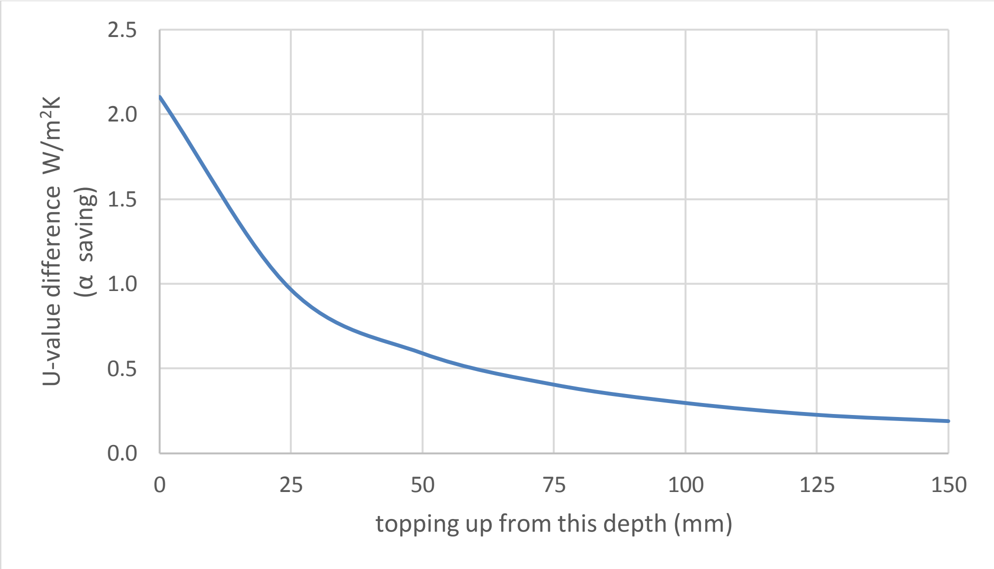

Figure 1: Difference in loft insulation U-value from topping up from different depths.

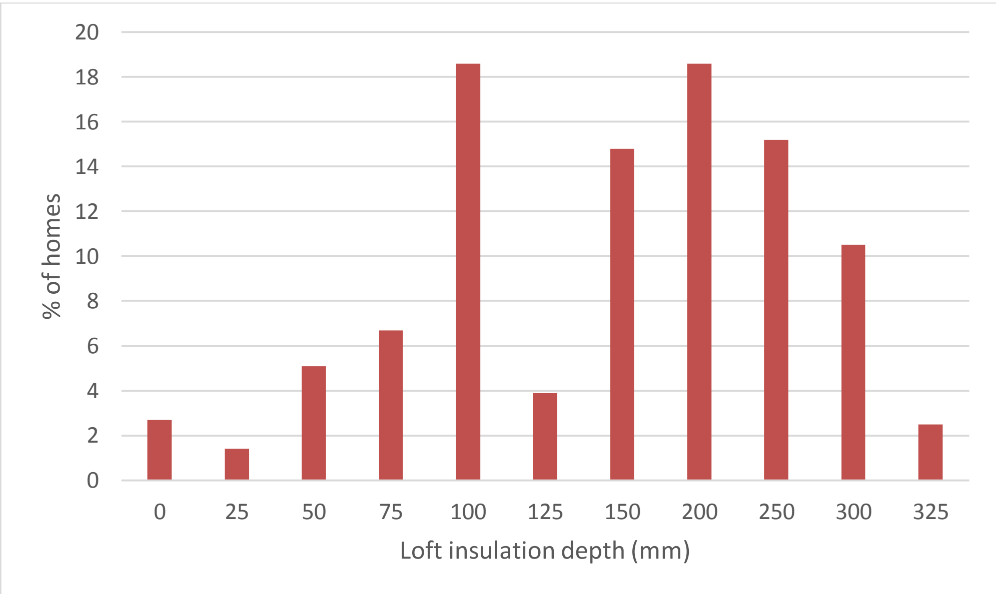

Figure 2: Distribution of loft insulation depths within England.

Figures 1 and 2 show:

a) the reduction in savings with existing depth of insulation. This graph indicates very little increase in savings when insulating from a depth above about 125mm,
b) the percentage of homes with different existing depths. This indicates a significant number with 100mm. This is a common depth, being the normal depth of joists, and so usually the maximum level while still allowing storage on the joists without compressing the insulation.

On the basis of this data, a weighted average U-value of depths in the stock of 125mm and less was chosen as the 'before' starting point. Table 10 shows the U-values used in the calculations. The post-insulation U-value assumes a thickness of 270mm which reflects Building Regulations.

Table 10: U-values for loft insulation

	U-value before (W/m^2K)	**U-value after (W/m^2K)**
Loft insulation	0.696	0.185

2.4.4 Room-in-roof insulation

The size of a 'room in the roof' is constrained by the roof sloping on two, three or four sides. RdSAP requires the room area to be measured, however this is not suitable for 'deemed scores'. Instead, a simple estimate is used, that the room area is half the roof plan area, implying that each of the length and width of the room is around 70% of the length and width of the roof.

Rooms in the roof in existing dwellings will be insulated to a range of standards. The 'before' U-value is that used for loft insulation, for both the ceilings and walls (there being no other known information on which to base the latter). The 'after' U-values are based on Building Regulations PartL1B Table 3, with 270mm depth loft and ceiling U-values (modified to allow for 'disturbances' as described under 'Loft insulation').

Two cases are considered

(a) the roof room ceiling and walls insulated, but not the surrounding residual loft area
(b) the residual loft area insulated in addition to the roof room ceiling and walls

The assumed values are shown in
Table below.

Table 11: U-values for Room in Roof insulation.

(a) residual area uninsulated	**U-value before (W/m^2K)**	**U-value after (W/m^2K)**
Room in roof ceiling	0.696	0.185
Room in roof walls	0.696	0.30
Residual loft area	0.696	0.696
(b) residual area insulated	**U-value before (W/m^2K)**	**U-value after (W/m^2K)**
Room in roof ceiling	0.696	0.185
Room in roof walls	0.696	0.30
Residual loft area	0.696	0.185

2.4.5 Flat roof insulation

Savings were calculated using the standard SAP U-value for an uninsulated roof and insulating to Building Regulations Approved Document Part L1B Table 3 requirements.

Table 10: U-values for flat roof insulation.

U-value before (W/m^2K)	U-value after (W/m^2K)
2.3	0.18

2.4.6 Underfloor insulation

Savings were calculated for insulating a suspended wooded floor. The 'before insulation' U-value for each of the dwelling types/sizes was derived from a standard calculation for wooden timber ground floors (derived from the floor area and perimeter of external walls). For the 'after insulation' case the Building Regulations Part L1B Table 3 requirement of 0.25 W/m^2K was used.

Table 113: U-values for floor insulation.

U-value before (W/m^2K)	U-value after (W/m^2K)
Suspended wooden floor U-value calculation (depends on the area and perimeter so is a different value for each dwelling type and size, varying from 0.46 to 0.79 W/m^2K for a suspended timber floor)	0.25

2.4.7 Draught-proofing

Savings were calculated using a 'before' case of 0%, and an 'after' case of 100% draught-proofing.

2.4.8 Glazing

Savings were calculated for upgrading windows to the standard required in Building Regulations Approved Document Part L1B Table 1, from two cases:

(a) Single glazed windows
(b) Double glazed windows, typical for the existing stock as defined in 'base cases' (table 2 in section 2.2).

Table 124: U-values for glazing upgrades

Before	after
Single glazing U-value: 4.8 W/m^2K 0% draughtsealing	Double or triple glazing U-value: 1.6 W/m^2K 100% draughtsealing
Double glazing U-value: 2.2 W/m^2K 100% draughtsealing	Double or triple glazing U-value: 1.6 W/m^2K 100% draughtsealing

2.4.9 Hot water cylinder insulation

The graph below shows the percentage of homes with different depths of cylinder jacket. A weighted average of the thermal conductance of the different depths below 80mm provides an average depth of 20mm, which was used as the 'before' starting point, with no savings given for adding insulation to an 80mm depth or greater.

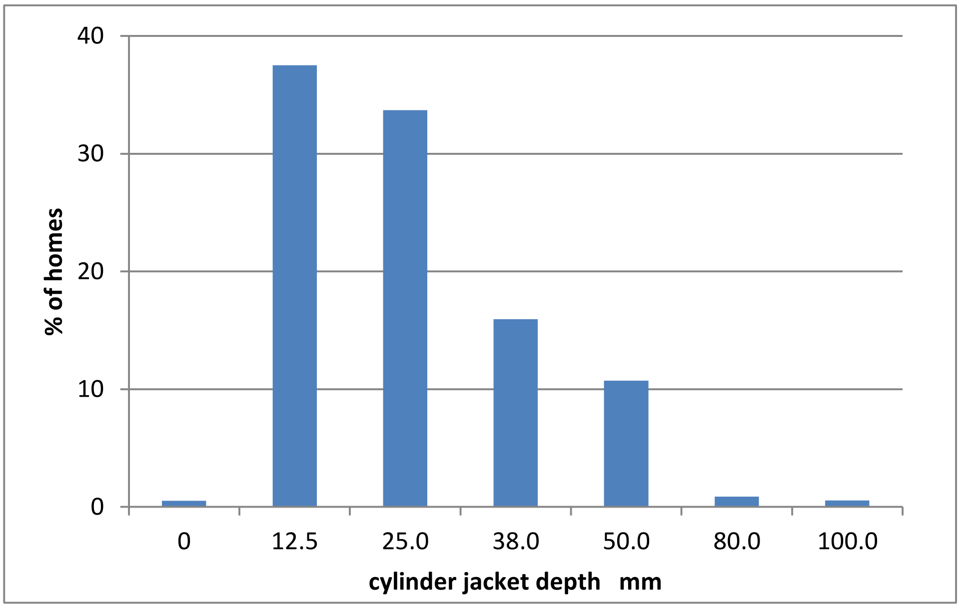

Figure 3: Existing cylinder jacket depth (England)

A standard jacket depth of 80mm applied to this 20mm 'before' case gives an 'after' depth of 100mm.

Table 15: Jacket thickness

before	after
20mm	100mm

2.4.10 High performing doors

Savings were calculated for improving the doors from a standard U-value as given in RdSAP for pre-1976 age bands, to that required by the Building Regulations Approved Document Part L during a refurbishment. This can be applied to doors with areas of glazing since the same Part L minimum requirements apply (n.b. the ECO2 measures table distinguishes doors with greater than 60% glazing, which give the same savings, but with different lifetimes).

Table 136: U-values for door improvements

U-value before (W/m^2K)	U-value after (W/m^2K)
3.0	1.8

2.4.11 Park home insulation

Although many sizes of Park Homes may be found, two common types are found which can be described as either a "single" or "double" types. Both are typically 12 metres long and either 3 or 6 metres wide. Savings have been calculated for these two sizes as shown below:

Table 147: Park Home dimensions

	Size	Floor area (m^2)
Park Homes	single	36
	double	72

The before U-values assume that the Park Home has been constructed to the BS3632:1981 standard. The 'after' standard assumes an upgrade to achieve a thermal resistance of 0.69, a level which internal BRE work considers to be achievable, and which also brings the elemental U-values of the Park Home up to approximately the level of the BS3632:1991 standard.

Table 158: U-values used for Park Home Insulation

	U-value before (W/m^2K)	U-value after (W/m^2K)
Roof	1	0.59
Wall	0.6	0.42
Floor	suspended wooden floor calculated U-value for each dwelling type/size	0.52

2.4.12 Qualifying & non-qualifying boiler replacement and repair

Savings were calculated for changes of heating systems; replacement of a complete heating system, replacement of a boiler by one using a different fuel, or replacement or repair of a boiler using the same fuel. Full heating controls were included in the new heating system where appropriate. Hence, the resulting scores are only appropriate where these controls are in place following installation of the measure. The 'before position' efficiencies, and other parameters, were the same as those in the 'base case'.

A second set of savings were calculated where no heating controls were included in the 'after' case. This second set of scores is intended to be use in the case where a full set of heating controls are not in place following the installation of the measure.

Table 169: Replacement heating system assumptions

before — Efficiencies and other parameters are as in Table 2, except back boilers; these are from SAP

	Controls:	Hot water from:	efficiency
Gas central heating	timer, roomstat, TRVs	boiler	83%
Electric storage heating	automatic	dual immersion	100%
Oil central heating	timer, roomstat, TRVs	boiler	83%
LPG central heating	timer, roomstat, TRVs	boiler	83%
Solid fossil central heating	timer, roomstat, TRVs	boiler	60%
Electric boiler central heating	timer, roomstat, TRVs	boiler	100%
Electric room heating	thermostat	immersion	100%
Gas room heating	thermostat	immersion	60%
Solid fossil room heating	none	immersion	50%
Gas back boiler	appliance thermostat	back boiler	50%
Gas back boiler and radiators	appliance thermostat	back boiler	66/56%*

*winter/summer efficiency

after

Gas central heating	timer, roomstat, TRVs	boiler	88%
Oil central heating	timer, roomstat, TRVs	boiler	88%
LPG central heating	timer, roomstat, TRVs	boiler	88%
Biomass central heating	timer, roomstat, TRVs	boiler	65%
Air source heat pump central heating	timer, bypass, TRVs	system	230%
Electric boiler central heating	timer, roomstat, TRVs	boiler	100%

Table 20: Sources of assumed efficiencies used for 'after' case i.e. new central heating systems.

Gas, LPG and oil central heating	as required by Building Regs. Approved Doc Part L
Biomass central heating	from SAP for HETAS approved appliances
Heat pumps	from recent field trials (see below)

Recent field trial data[7] gives adjusted mean SPF_{H4} values of 2.30 for air source heat pumps. SPF_{H4} values are the most consistent with the SAP values, giving inputs of 230% for air source heat pumps.

[7] www.gov.uk/government/publications/detailed-analysis-of-data-from-heat-pumps-installed-via-the-renewable-heat-premium-payment-scheme

2.4.13 Qualifying electric storage heater replacement

Savings were calculated for a 'before' case of no heating system, represented by electric room heating. There are two 'after' cases, a combined score to cover standard slimline and fan storage heaters with automatic controls and high heat retention storage heating with their associated controls (SAP2012, 9.2.8). In addition, three proportions of the dwelling treated are considered, high (100%), medium (66%) and low (33%).

Table 21: Qualifying electric storage heater replacement assumptions

before	Electric room heating	Responsiveness
after	Electric storage heating, dual immersion (a) standard slimline with automatic controls (b) high heat retention with incorporated controls (c) fan storage with automatic controls	 0.2 0.8 0.4

2.4.14 Non-qualifying electric storage heater installation

Table 172: Non-qualifying electric storage heater replacement assumptions.

<table>
<tr><td>before</td><td>Efficiencies and other parameters are as in Table 2, except back boilers; these are from SAP
<table>
<tr><th></th><th>Controls:</th><th>Hot water from:</th><th></th></tr>
<tr><td>Electric slimline storage</td><td>Automatic</td><td>dual immersion</td><td>100%</td></tr>
<tr><td>Oil central heating</td><td>timer, roomstat, TRVs</td><td>boiler</td><td>83%</td></tr>
<tr><td>LPG central heating</td><td>timer, roomstat, TRVs</td><td>boiler</td><td>83%</td></tr>
<tr><td>Solid fossil central heating</td><td>timer, roomstat, TRVs</td><td>boiler</td><td>60%</td></tr>
<tr><td>Electric boiler central heating</td><td>timer, roomstat, TRVs</td><td>boiler</td><td>100%</td></tr>
<tr><td>Electric room heating</td><td>Thermostat</td><td>immersion</td><td>100%</td></tr>
<tr><td>Gas room heating</td><td>Thermostat</td><td>immersion</td><td>60%</td></tr>
<tr><td>Solid fossil room heating</td><td>None</td><td>immersion</td><td>50%</td></tr>
<tr><td>Gas back boiler</td><td>appliance thermostat</td><td>back boiler</td><td>50%</td></tr>
<tr><td>Gas back boiler and radiators</td><td>appliance thermostat</td><td>back boiler</td><td>66/56%*</td></tr>
</table>
*winter/summer efficiency</td></tr>
<tr><td>after</td><td>Electric storage heating, dual immersion
(a) standard slimline with automatic controls
(b) high heat retention with incorporated controls
(c) fan storage with automatic controls</td></tr>
</table>

2.4.15 Heating controls

The controls that are included in this measure (see table 23) are considered normal good practice when installing a central heating system. The savings calculated therefore assume that all heating controls stated in table 23 are present.

Table 183: Heating control assumptions.

<table>
<tr><td>For:</td><td>(Efficiencies and other parameters as base case typical heating types)
<table><tr><th></th><th>Hot water from:</th></tr><tr><td>Gas central heating</td><td>boiler</td></tr><tr><td>Oil central heating</td><td>boiler</td></tr><tr><td>LPG central heating</td><td>boiler</td></tr><tr><td>Solid fossil central heating</td><td>boiler</td></tr></table></td></tr>
<tr><td>before</td><td>No heating controls</td></tr>
<tr><td>after</td><td>Timer, roomstat & TRVs</td></tr>
</table>

2.4.16 Photovoltaics

Savings were calculated for the configuration defined in SAP Appendix T 'Improvement measures for Energy Performance Certificates'. This identifies a solar panel as 2.5kWp, and located on a south facing roof on an incline of 30°, with modest overshading.