Communities and Local Government

Baseline Key Performance Indicators

Sustainable and Secure Buildings Act: Baseline Key Performance Indicator report on Section 6(2) (e) and 6(3)

February 2007

Department for Communities and Local Government: London

On 5th May 2006 the responsibilities of the Office of the Deputy Prime Minister (ODPM) transferred to the Department for Communities and Local Government

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Executive summary

The Sustainable & Secure Buildings Act 2004 extends the purposes of the Building Act 1984 so as to improve the sustainability of the building stock in England & Wales in respect of energy efficiency, preventing waste, furthering the protection of the environment, facilitating sustainable development and furthering the prevention and detection of crime. Section 6 of the Act requires DCLG to submit a biennial report to Parliament on the effects (or likely effects) of measures that are planned under the SSBA as well as those which have already been introduced in the two-year reporting period. Specifically, Section 6(2)(e) requires the report to cover:

> *"Overall changes during the period in:*
>
> (i) *the efficiency with which energy is used in buildings in England and Wales;*
>
> (ii) *levels of emissions from such buildings that are emissions considered by the Secretary of State to contribute to climate change;*
>
> (iii) *the extent to which such buildings have their own facilities for generating energy;*
>
> (iv) *the extent to which materials used in constructing, or carrying out works in relation to, such buildings are recycled or re-used materials."*

A further related reporting requirement is contained in Section 6(3) of the Act. Specifically this is *"A report under this section must contain an estimate, as at the end of the period, of the number of dwellings in England and Wales".*

DCLG has commissioned BRE to provide support in the production of the biennial report to Parliament.

The focus of this report is the requirements under Section 6(2)(e) and 6(3) – the reporting requirements under Section 6(2)(a) to (d) are addressed in a companion report[1]. As a first step, a set of Key Performance Indicators (KPIs) were proposed to provide initial benchmarks for the building stock in England & Wales in respect of items (i) to (iv) which can then be used to measure changes in performance during each two-year reporting period. The first reporting period covers November 2004 to November 2006.

The report has been structured so that the underlying data sources and methodologies have been explained but the KPIs have been clearly identified so that they can be extracted for reporting purposes.

[1] Hartless, R. "Sustainable and Secure Buildings Act 2004: Biennial Report to Parliament: Impact of policy measures". BRE Output 233926, January 2007.

1 Introduction

The Sustainable & Secure Buildings Act 2004 (Section 1(1)) extends the purposes of the Building Act 1984 to cover:

> *(b) "furthering the conservation of fuel and power,*
>
> *(c) preventing waste arising, undue consumption and the misuse or contamination of water,*
>
> *(d) furthering the protection or enhancement of the environment,*
>
> *(e) facilitating sustainable development, or,*
>
> *(f) furthering the prevention and detection of crime."*

Section 6(1) of the Act requires DCLG to submit a report every two years to Parliament (the first period being November 2004 to November 2006) on the progress of the building stock in England & Wales towards the purposes in Section 1(1)(b) to (e) above. The focus of this biennial report is therefore to document the progress towards sustainability in buildings as opposed to documenting progress in preventing and detecting crime in buildings.

The scope of the biennial report is set out in Section 6(2) of the Act, the text of which is reproduced in Box 1 overleaf.

Box 1. Text of Section 6(2) of the Sustainable and Secure Buildings Act 2004

"A report under this section [i.e. Section 6] *must (in particular) deal with:*

(a) building regulations made during the period for any of these purposes [i.e. Section 1(1)(b) to (e) as listed above]*;*

(b) proposals current at the end of the period to make building regulations for any of these purposes;

(c) effects of likely effects of regulations or proposals dealt with in the report under paragraphs (a) and (b) [i.e. the two paragraphs immediately above]*;*

(d) proposals considered by the Secretary of State during the period for setting of targets for any of these purposes in relation to:

(i) *buildings in England and Wales; or*

(ii) *services, fittings or equipment provided in or in connection with such buildings;*

(e) overall changes during the period in:

(i) *the efficiency with which energy is used in buildings in England and Wales;*

(ii) *levels of emissions from such buildings that are emissions considered by the Secretary of State to contribute to climate change;*

(iii) *the extent to which such buildings have their own facilities for generating energy;*

(iv) *the extent to which materials used in constructing, or carrying out works in relation to, such buildings are recycled or re-used materials."*

The reporting requirements under Section 6(2)(a) to (d) are addressed in a companion report[1] to this and are not discussed further here. The focus of this report is therefore the requirements under Section 6(2)(e). To address these requirements a set of Key Performance Indicators (KPIs) is required to provide initial benchmarks for the building stock in England & Wales in respect of items (i) to (iv) which can then be used to measure changes in performance during each two year reporting period. The first reporting period covers November 2004 to November 2006.

A further related reporting requirement is contained in Section 6(3) of the Act. Specifically this is *"A report under this section must contain an estimate, as at the end of the period, of the number of dwellings in England and Wales"*. Again, this can be addressed through a suitable KPI.

DCLG has commissioned BRE to provide support in the production of the biennial report to Parliament (BRE proposal 116383). As a first step BRE proposed a list of possible KPIs to meet the reporting requirements of Section 6(2)(e) of the Act. These KPIs were then refined and BRE prepared a report outlining the data sources and methodologies required to derive them[2].

[2] Hartless, R. et al "Sustainable and Secure Buildings Act 2004: Biennial Report to Parliament: Data sources and methodologies to generate KPIs". BRE Output 227350, March 2006.

To summarise, the proposed KPIs were:

Section 6(2)(e)(i) – Changes in the efficiency with which energy is used in buildings

Dwellings

K1. Acquisitions of loft insulation

K2. Acquisitions of cavity wall insulation

K3. Acquisitions of double glazing

K4. Acquisitions of hot water tank insulation

K5. Sales of gas boilers by energy efficiency rating (A-rated, B-rated, etc.)

K6. Energy use (kWh) per dwelling (or household) per m^2

Non-Domestic buildings

K7. kWh/m^2 for public, commercial and building-related industrial energy consumption (adjusted to take account of variations in weather and changes in the structure and the demand for energy services)

KPIs K6 and K7 can then be taken together to show how energy use in buildings has changed.

Section 6(2)(e)(ii) – Greenhouse gas emissions from buildings

Greenhouse gas emissions from dwellings and non-domestic buildings stem directly from KPIs K6 and K7 above by using the appropriate NAEI (National Atmospheric Emissions Inventory) factor.

Section 6(2)(e)(iii) – Extent to which buildings have facilities to generate energy

- Number of renewable energy systems installed (broken down by technology)
- Number of renewable energy systems installed as a % of the total technically feasible installations (broken down by technology)

Section 6(2)(e)(iv) – Extent to which materials are recycled or reused in building works

- Recycled content by weight of construction materials/products
- Reuse by weight of construction materials/products

Section 6(3) – Number of dwellings in England & Wales

- Number of new dwellings completed in the period

This report explains the data sources and methodologies used to derive all of the KPIs, but the structure of the report is such that the KPIs are clearly identified for each requirement of Section 6 of the Act and so they can easily be extracted for reporting purposes.

An earlier draft of this report was prepared in October 2006 to accord with the end of the two year reporting period (November 2006). But, given that there is an inevitable time lag for statistical data to be compiled and published, the time period for producing the report was extended to include as much up-to-date information as practically possible. The availability of data for each of the KPIs is discussed throughout this report.

2 Section 6(2)(e)(i) – Energy efficiency changes in buildings

2.1 Dwellings

2.1.1 Insulation measures

Establishing Nov 2004 baseline

In order to provide Government departments with information to assist with various energy-efficiency-related policy issues – such as Building Regulations for England & Wales (Part L), Energy Efficiency Commitment (EEC), Warmfront, the Climate Change Programme etc. – BRE maintains and develops a model of the GB housing stock, called BREHOMES. Insulation ownership data from GfK Marketing Services Ltd. is collected each year and used for developing and maintaining the BREHOMES model. These data refers to the end of December. Although they are for GB they are easily filtered to extract just the numbers that are relevant to England & Wales.

To calculate figures for 16 November 2004 it is necessary to interpolate between the December 2003 and December 2004 data. This has been done by simply assuming that the period between 31 December 2003 and 16 November 2004 represents ten and a half twelfths of the total change between the two data points. The following table therefore contains the figures (all numbers are in thousands) for December 2003, December 2004 and the estimates for 16 November 2004 interpolated as described above.

	Dec-03	Dec-04	16-Nov-04
Loft insulation			
With accessible loft	18195	18366	18345
with loft insulation (any)	16666	16918	16887
Cavity insulation			
With cavity	16396	16801	16750
with cavity insulation	5591	6059	6001
Tank insulation			
With tank	17233	17442	17416
with tank insulation	16301	16492	16468
Double glazing			
Homes	22652	22919	22886
with double glazing (any)	18305	19006	18918

Table 1. Household ownership levels for insulation measures in England & Wales

In what follows, the term “relevant baseline figure” is used. This means the homes existing at 16 Nov 2004 to which that measure could potentially be applied (including those that already have the measure). So for loft insulation it is 18,345 thousand, for cavity insulation 16,750 thousand, for tank insulation 17,416 thousand and for double glazing 22,886 thousand.

Insulation acquisitions since 16 Nov 2004

For the four insulation measures in the table above, figures are also available from GfK Marketing Services Ltd. for the acquisitions that occur in each quarter of the year (i.e. Jan to Mar, Apr to Jun, Jul to Sept and Oct to Dec). Again, these data refer to GB but they are readily filtered to extract figures for England & Wales.

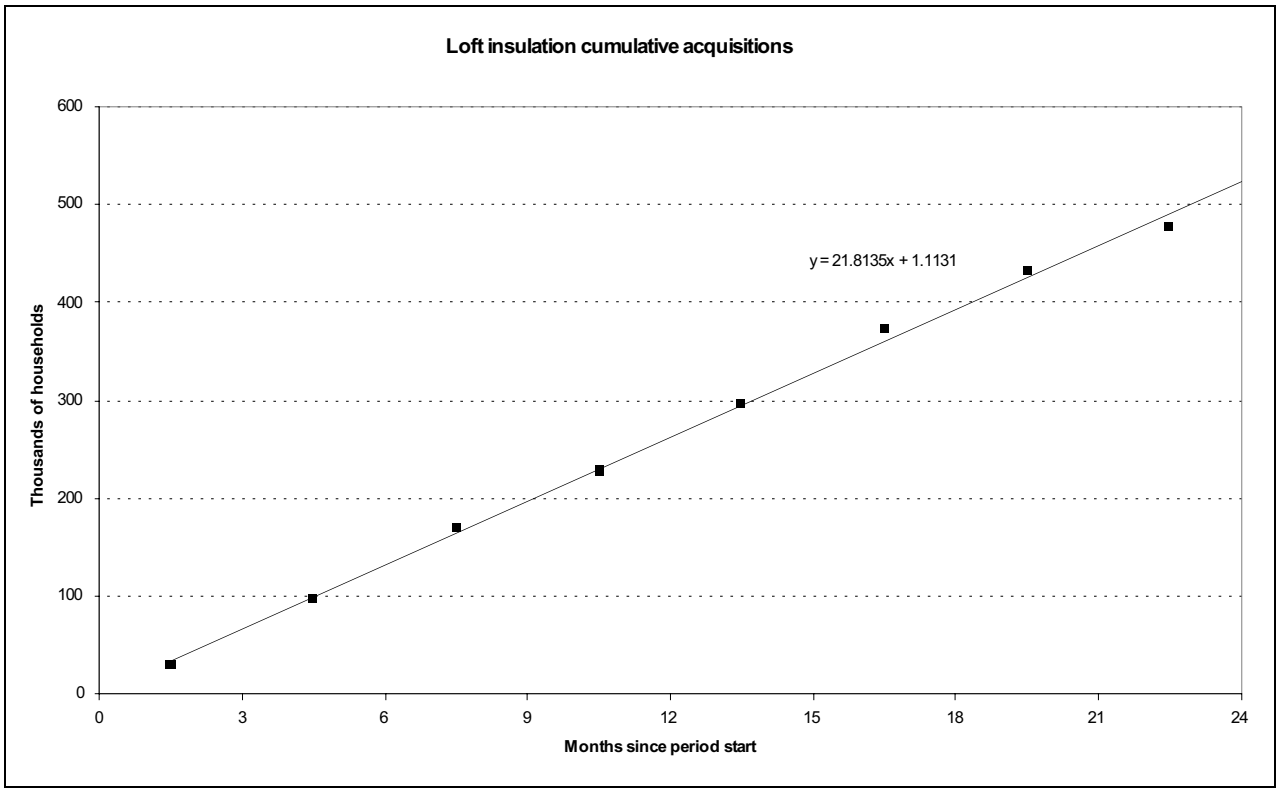
Insulation acquisitions (in thousands) for the eight quarters ending Dec 2004, Mar 2005, Jun 2005, Sept 2005, Dec 2005, Mar 2006, Jun 2006 and Sept 2006 are shown in the table below, together with the estimate “to date” of acquisitions since 16 Nov 2004 (for this, it is assumed that acquisitions in the period 16 Nov 2004 to 31 Dec 2004 are 50% of the acquisitions in the quarter ending Dec 2004). This is also expressed as a percentage of the relevant baseline figure for 16 Nov 2004 (from Table 1), and as a percentage of the total homes figure at 16 Nov 2004.

	Acquisitions of the measure to the end of the quarter											
	Dec-04	Mar-05	Jun-05	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	16 Nov 04 to date	As % of baseline	As % of baseline total households
Loft insulation	58	68	72	59	69	76	60	44		477	2.6%	2.1%
Cavity insulation	51	50	64	60	62	68	74	54		457.5	2.7%	2.0%
Tank insulation	18	17	3	13	1	19	4	12		78	0.4%	0.3%
Double glazing	434	264	373	329	275	365	353	344		2520	11.0%	11.0%

Table 2. Acquisitions of insulation measures (data currently only available to Sept 2006)

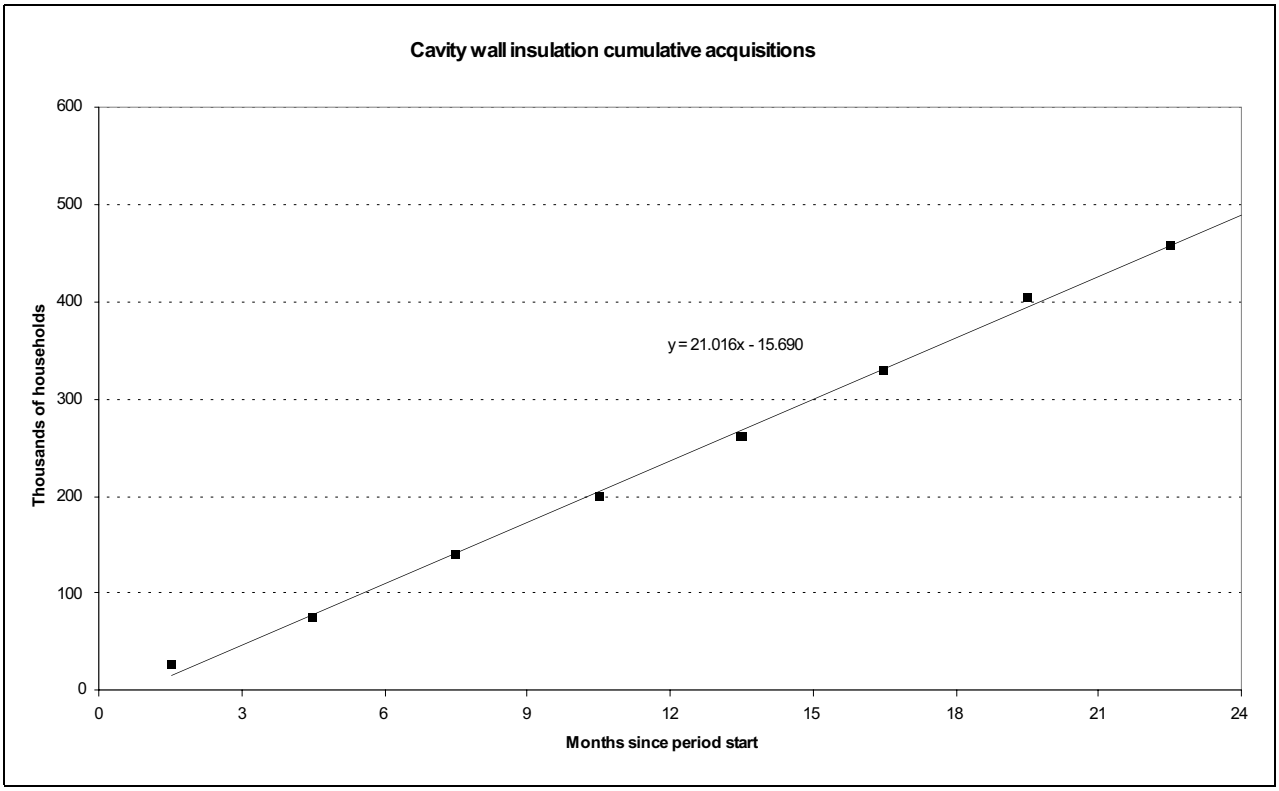
Thus, by calculating cumulative acquisitions, KPIs illustrating the progress being made in improving the existing housing stock can be determined. However, the aim of the work is to provide KPIs for the two year period 16 Nov 2004 to 16 Nov 2006. The complication is that the figures for 16 Nov 2006 need to be reported before the final quarter’s data will be available. This means that projections have to be made based on the data that are available when the final report is produced. Fortunately, as the following will illustrate, the data are very consistent so there is a high level of confidence that the resulting estimates will be very close to the actual figures (which obviously could be established at a later date, if required).

The following charts show plots of cumulative acquisitions for each of the four insulation measures. On the x-axis of these charts 0 represents 16 Nov 2004 and 24 represents 16 Nov 2006 (i.e. the scale represents a period of two years, or 24 months). Doing this allows a simple linear best fit line equation to be derived (shown on each chart) which can be used to predict the cumulative acquisitions at any point, but most closely, providing considerable confidence that the projected figures for Nov 2006 will be very close to the eventual actual figures.

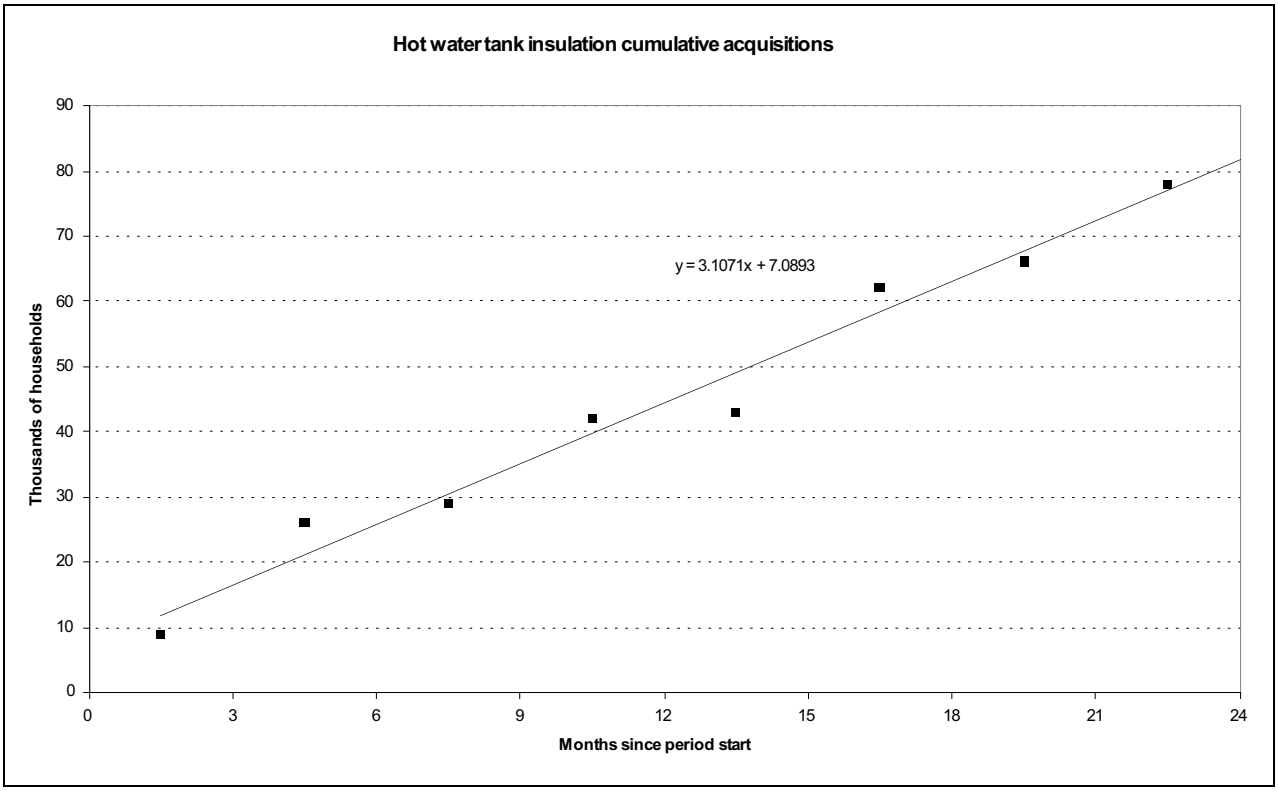


The chart above indicates that between 16 Nov 2004 and 16 Nov 2006 it can be expected that approximately 522 thousand households in England & Wales will acquire **loft insulation**. The best-fit line on the chart suggests that the uncertainty in this estimate is likely to be quite small – the actual value when it is known would be expected to be within about ±20 thousand of this estimate.

The chart overleaf indicates that between 16 Nov 2004 and 16 Nov 2006 we can expect that approximately 489 thousand households in England & Wales will acquire **cavity wall insulation**. Again, the best-fit line suggests that the uncertainty in this estimate is likely to be quite small – the actual value, when it is known, would be expected to be within about ±20 thousand of this estimate. It does need to be noted, however, that cavity wall insulation is a measure that is being heavily promoted at present through schemes such as the EEC. Thus, it is possible that the uptake rate will increase and this estimate could therefore prove to be very slightly low in practice.



The chart overleaf indicates that between 16 Nov 2004 and 16 Nov 2006 it can be expected that approximately 82 thousand households in England & Wales will acquire **hot water tank insulation** (including those that will acquire a factory insulated tank). The uncertainty in this estimate is likely to be about ±10 thousand at most.



The chart below indicates that between 16 Nov 2004 and 16 Nov 2006 it can be expected that approximately 2.6 million households in England & Wales will acquire **double glazed windows**. This estimate will probably be within 100,000 of the actual value when it is known.

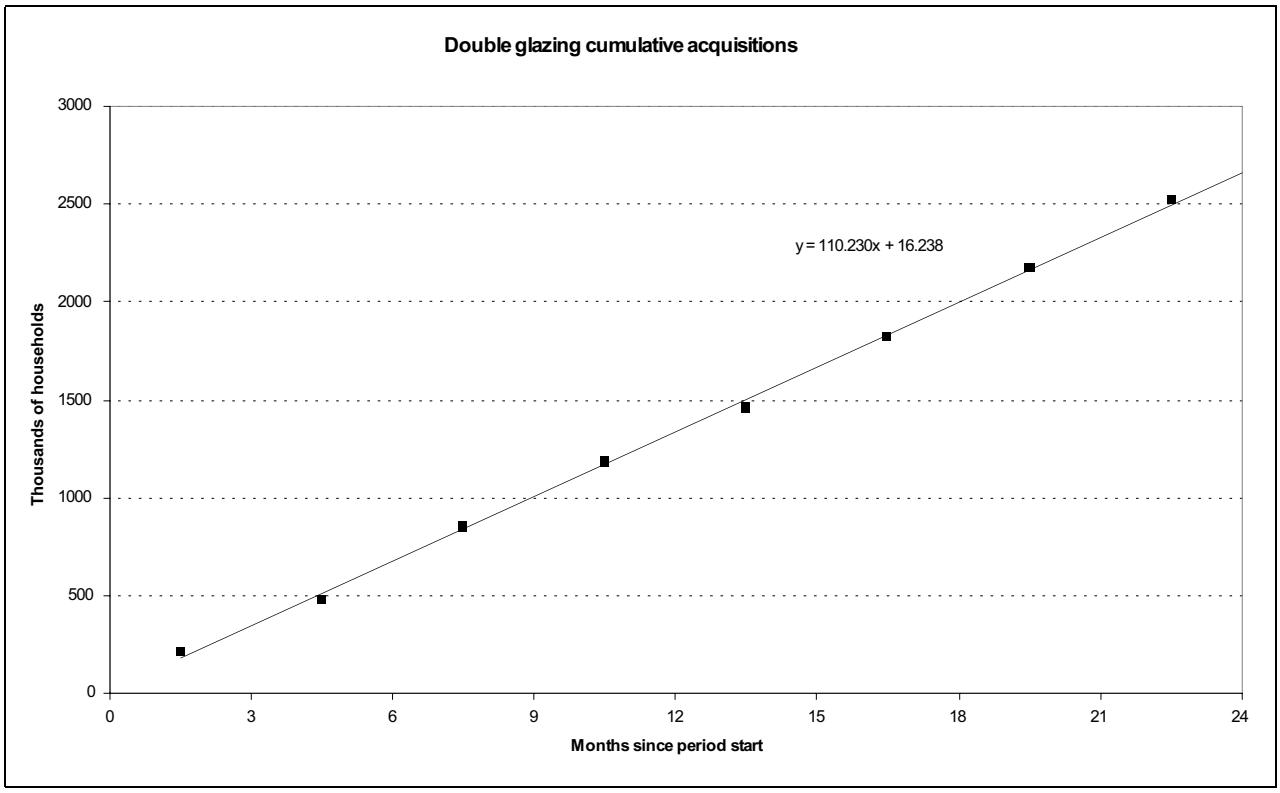


Table 3 below summarises the cumulative acquisitions figures for each measure, including projections beyond Sept 2006 based on the best fit equations shown in the above charts.

	Dec-04	Mar-05	Jun-05	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Nov-06
Loft insulation	29	97	169	228	297	373	433	477	522
Cavity insulation	25.5	75.5	139.5	199.5	261.5	329.5	403.5	457.5	489
Tank insulation	9	26	29	42	43	62	66	78	82
Double glazing	217	481	854	1183	1458	1823	2176	2520	2662

Table 3. Cumulative acquisitions of insulation measures (figures beyond Sept 06 are projections)

The acquisitions to 16 Nov 2006 shown above, expressed as percentages of the relevant baseline figure (from Table 1), are:

- Loft insulation – 2.8%
- Cavity insulation – 2.9%
- Tank insulation – 0.5%
- Double glazing – 11.6%

These percentages, or the numbers themselves, could be used as the KPIs for insulation measures.

Ownership of insulation at 16 Nov 2006

In principle, the ownership of insulation measures at 16 Nov 2006 can be estimated by adding the cumulative acquisitions shown in the final column of Table 3 to the figures in the final column of Table 1. However, for all measures except cavity wall insulation, this is not correct because many acquisitions are either replacements of existing insulation (e.g. a new factory insulated hot water tank replacing an old hot water tank with a loose jacket) or additions to what is already there (e.g. topping up of existing loft insulation). Such acquisitions will not result in a change to the ownership of the measure, although they will still generally result in a somewhat better standard of insulation than what was there previously.

The acquisitions data do contain information on what proportion of acquisitions are “initial”, so it is possible to estimate what the growth in ownership is using such figures together with the cumulative acquisitions that have already been determined. Note that the survey questions about whether insulation is “initial”, “replacement” or “additional” are often not answered by householders so the figures are less robust than the overall acquisitions figures. Nonetheless, applying the proportions that the figures indicate to the overall acquisitions figures provides the best estimate that can be made (short of using actual ownership data for Dec 2005 and Dec 2006, i.e. using the same methodology as discussed above for determining the 16 Nov 2004 figures).

The proportions of acquisitions that are “initial” (based on the data up to Mar 2006) were (rounded to the nearest whole percentage) actually as follows:

- Loft insulation – 36%
- Cavity insulation – 100%
- Tank insulation – 3%
- Double glazing – 32%

Thus, the initial acquisitions in the period 16 Nov 2004 to 16 Nov 2006, and hence the projected ownership level at 16 Nov 2006, can be estimated as:

- Loft insulation – 189 thousand (i.e. projected ownership of 17,076 thousand)
- Cavity insulation – 489 thousand (i.e. projected ownership of 6,489 thousand)

- Tank insulation – 3 thousand (i.e. projected ownership of 16,471 thousand)[3]
- Double glazing – 847 thousand (i.e. projected ownership of 19,766 thousand)

The growth in ownership noted above, expressed as a percentage of the relevant baseline figure (from Table 1) is as follows:

- Loft insulation – 1.0%
- Cavity insulation – 2.9%
- Tank insulation – 0.0%
- Double glazing – 3.7%

These percentages, or the numbers themselves, can also be used as the KPIs for the insulation measures (K1 to K4). For example, we can say:

Available figures indicate that, from 16 Nov 2004 to 16 Nov 2006:

K1. 2.9% of households with lofts (18,345 thousand had lofts at 16 Nov 2004) acquired loft insulation (1.0% of these being initial acquisitions).

K2. 2.9% of households with cavity walls (16,750 thousand had cavity walls at 16 Nov 2004) acquired cavity wall insulation.

K3. 0.5% of households with hot water tanks (17,416 thousand had hot water tanks at 16 Nov 2004) acquired tank insulation (0.0% of these being initial acquisitions).

K4. 11.6% of households (total households 22,886 thousand at 16 Nov 2004) acquired double glazing (3.7% of these being initial acquisitions).

2.1.2 Gas boilers by efficiency band

Information on the sales of gas boilers by energy band (A-rated as the most efficient to G-rated as the least efficient) is provided to BRE (and others) by SBGI on a monthly basis. These data form a key input to a boiler model that has been developed for Defra's Market Transformation Programme (MTP), which is used to consider possible future scenarios for carbon emissions related to domestic boilers. As part of the model, an estimate of the entire stock of boilers by energy band, consistent with the sales data, is determined for the end of each calendar year. Thus, by interpolation, an estimate of the boiler stock by efficiency band as at 16 Nov 2004 can be obtained from the 2003 and 2004 information, in exactly the same manner as for the insulation ownership data. Table 4 shows the relevant figures.

[3] NB Ownership of hot water tanks has been slowly declining in recent years owinge to the popularity of combi boilers, so it is quite possible that the overall ownership of tank insulation will actually have fallen over the period. There is no way of determining if this is the case from the acquisitions data – the ownership data are required in order to make such a judgement. Nonetheless, the small figure obtained from the cumulative acquisitions data clearly indicates that this is not a measure where strong growth can be expected.

				Eng & Wales
	Dec-03	Dec-04	16-Nov-04	16-Nov-04
Band A	402	730	689	634
Band B	265	301	297	273
Band C	74	79	78	72
Band D	4120	5172	5040	4637
Band E	4261	4142	4157	3824
Band F	3219	3028	3052	2808
Band G	6909	6347	6417	5904
Unknown				
All	19250	19800	19731	18153

Table 4. Stock of gas boilers by efficiency band

The sales data, and hence the model, relate to the whole of the UK[4]. England & Wales figures have to be estimated by applying a factor to the UK figures. This factor, which is 0.92, represents the proportion of gas central heating within the UK that is actually within England & Wales. The factor of 0.92 was derived by looking at GfK Marketing Services data on the ownership of gas central heating systems in England & Wales, as compared with the ownership of such systems in GB (the GfK data do not cover Northern Ireland but the ownership of gas central heating in Northern Ireland is still extremely low and so its exclusion from this calculation makes a negligible difference).

Table 5 shows the cumulative sales of gas boilers in England & Wales (estimated as the UK figures multiplied by 0.92) since 16 Nov 2004. These figures show that, as a result of recent legislation there are essentially no boilers being sold that are below D-rated. Furthermore, C-rated gas boilers are so rare that there are essentially no sales of these either. Comparing Table 5 with Table 4 it is also clear that there has been a dramatic change to the boiler market since 16 Nov 2004. In particular, sales of A-rated boilers since 16 Nov 2004 total more than the entire stock of A-rated boilers at 16 Nov 2004. This is due to the Building Regulations (Part L) changes that became effective in April 2005[5].

[4] The sales figures include LPG boilers, although mains gas boilers make up 98.5% of these figures. Sales figures for oil-fired boilers are only available for Jan 06 onwards (i.e. two quarters only so far), but using these data suggests that the boiler market is made up of 94.1% gas, 1.4% LPG and 4.5% oil. This is based on UK figures, which may slightly overstate the oil boiler proportion for England and Wales (given the high proportion of oil boilers in Northern Ireland) but gas-fired boilers are still likely to make up 94% of the boiler market.

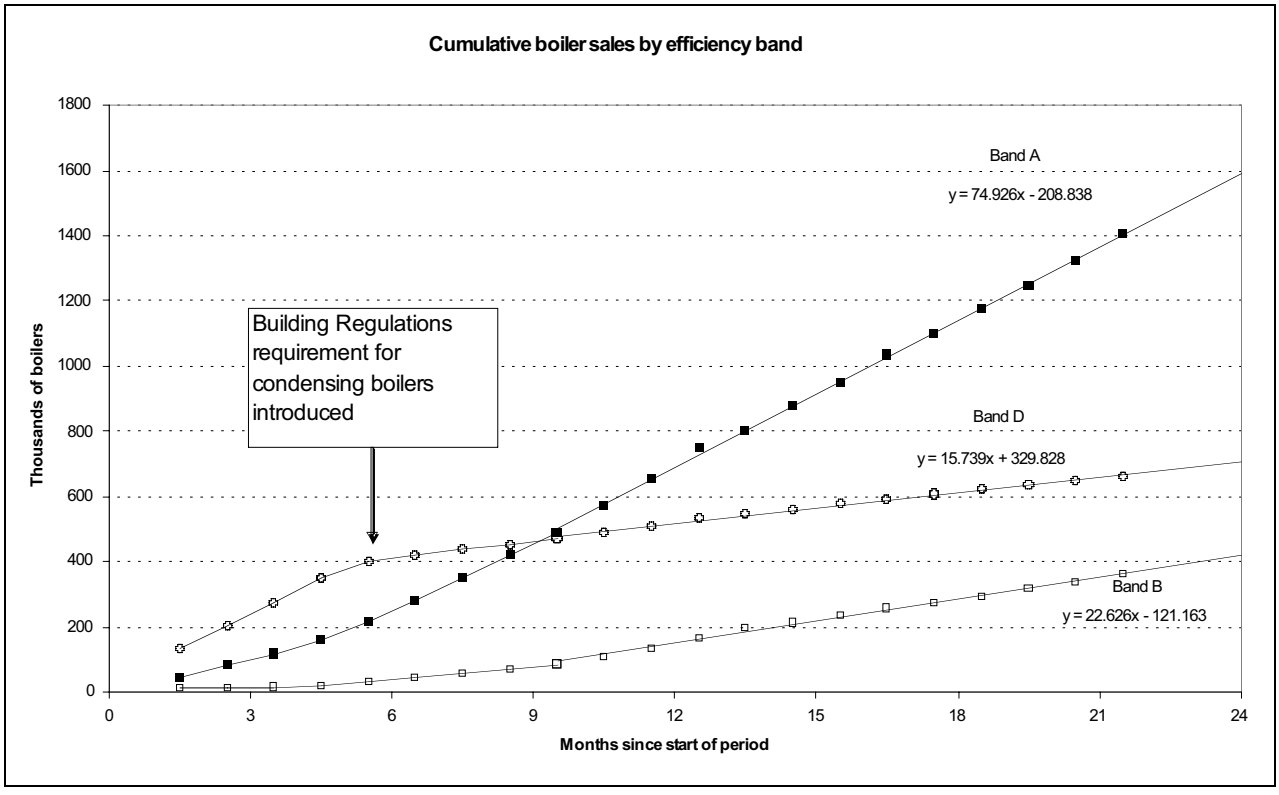
[5] Further discussion of the Part L changes is given in the companion report[1] to this.

	Sales of gas boilers by efficiency band since 16 Nov 2004
Band A	1667
Band B	431
Band C	2
Band D	694
Band E	4
Band F	0
Band G	0
Unknown	0
All	2800

Table 5. Sales of gas boilers by efficiency band

The figures in Table 5 include sales data up to 16 Nov 2006 so projection of trends, as used for the insulation measures, is not required. The chart below shows the cumulative sales data to Nov 2006. As a result of the changes to the Building Regulations (Part L) that came into force in April 2005, the sales trends have changed dramatically, as already noted. Sales of D-rated boilers dropped because of the requirement to fit condensing boilers (i.e. A- and B-rated boilers) unless the boiler exceptions rules would allow a standard (i.e. a non-condensing one) boiler to be fitted. The sales data actually show that the result of this in practice is that condensing boiler sales stabilised at about 85% of all gas boiler sales around July/August 2005, and have since risen slowly to about 90%.

The chart overleaf indicates that between 16 Nov 2004 and 16 Nov 2006 approximately 1,667 thousand A-rated boilers, 431 thousand B-rated boilers and 694 thousand D-rated boilers were sold.



Thus, the KPI (K5) for gas boilers is:

Available figures indicate that, from 16 Nov 2004 to 16 Nov 2006:

- 2,800 thousand gas boilers were installed in homes in England & Wales (representing about 15.4% of the baseline boiler stock at 16 Nov 2004).

Of these:

- 1,667 thousand (59.5%) were the most efficient condensing boilers (A-rated),
- 431 thousand (15.5%) were slightly less efficient (B-rated) condensing boilers, and,
- 694 thousand (25.0%) were regular boilers (D-rated)

The majority of the boiler sales noted above will have been replacements. However, there are some that will have been completely new installations and so the overall stock of gas boilers will have grown between 16 Nov 2004 and 16 Nov 2006. Table 6 overleaf indicates the growth that was expected as estimated using the boiler model. It shows a large growth in A- and B-rated boilers, a modest growth in D-rated boilers (due to the sales before April 2005) and a decline in the other efficiency bands. These figures could form the basis of further KPIs for gas boilers, although if this were to be pursued it would be useful to update the boiler model with the actual 2006 sales data first to produce improved estimates of the stock figures. This can only be done if the model is being updated anyway as part of the MTP activity.

	Eng & Wales	Eng & Wales	% in each band		Growth relative to
	16-Nov-04	16-Nov-06	16-Nov-04	16-Nov-06	16-Nov-04
Band A	634	1804	3.5%	9.4%	184%
Band B	273	897	1.5%	4.7%	229%
Band C	72	70	0.4%	0.4%	-3%
Band D	4637	5235	25.5%	27.4%	13%
Band E	3824	3584	21.1%	18.7%	-6%
Band F	2808	2486	15.5%	13.0%	-11%
Band G	5904	5048	32.5%	26.4%	-15%
Unknown					
All	18153	19125	100.0%	100.0%	5%

Table 6. Growth in the gas boiler stock between 16 Nov 2004 and 16 Nov 2006

2.1.3 Energy use per m^2 of floor area

Figures derived from the BREHOMES model of the energy use of the GB housing stock indicate that in 2004 the average dwelling energy use in England & Wales was 22,165 kWh. This is the total energy use (i.e. space heating, water heating, cooking as well as lights and appliances), and it has not been weather corrected.

A robust figure for the year to 16 Nov 2004 cannot readily be derived from available statistics but it is clear that the figure for the calendar year 2004 will be sufficiently representative of this given the minor time difference of just six weeks.

Figures from the English House Condition Survey (EHCS) in 2001 indicate an average dwelling floor area of 87m^2, so this implies an energy use per m^2 of floor area of 255 kWh/m^2 (±5 kWh/m^2 taking account of uncertainties in the underlying figures).

Thus, the KPI (K6) for the energy use per m^2 of floor area is:

Available figures indicate that at 16 Nov 2004:

- Average annual dwelling energy use per m^2 of floor area was 255 kWh/m^2

Providing equivalent figures for 16 Nov 2006 is more problematical because the energy use figures for 2006 will not be available until mid-2007. Thus, a projection will be required, which will inevitably be uncertain because energy use is, at least partially, dependent on the weather, and there is no way of knowing what the weather will be like several months in advance. All that can be done is to monitor the quarterly energy use figures for the UK domestic sector from the DTI's Energy Trends publication (and the annual figures in the Digest of UK Energy Statistics, DUKES) and use the most recent "year-to-date" figures as an indication of any changes relative to the calendar year 2004. These changes, in the absence of actual energy use figures, can then be used (taking account of growth in the stock) to indicate likely figures for 2006.

Current figures (from Energy Trends) indicate that total domestic sector energy use in the year to the end of Jun 2006 was 2.05% less than in 2004. However, the housing stock had grown by 1.37% in that time (changes to the size of the housing stock are discussed in more detail in Section 6 below) so the average annual dwelling energy use per m^2 of floor area in the year to Jun 2006 was approximately 3.4% less than in 2004. Correcting for the difference in external temperatures between the two years, however, the energy use in the year to Jun 2006 (which we take as approximating to the year to 16 Nov 2006) was 0.9% more than that in 2004.

So the above energy use KPI can be expanded slightly to read:

Available figures indicate that at 16 Nov 2004:

- Average annual dwelling energy use per m^2 of floor area was 255 kWh/m^2

And at 16 Nov 2006 (allowing for temperature correction):

- Average annual dwelling energy use per m^2 of floor area was 257 kWh/m^2 which represents an increase of 0.9%.

Note that by taking account of the uncertainty of about ±5 kWh/m^2, it is not possible to be absolutely sure that there has been any significant change in this KPI between 16 Nov 2004 and 16 Nov 2006.

2.2 Non-domestic buildings

2.2.1 Introduction

As noted above in Section 1, this report derives and presents the 2004 and 2006 energy KPI for non-domestic buildings. In general terms the non-domestic sector does not have as robust sources as the domestic sector so a number of assumptions have to be made. The kWh/m^2 KPIs are derived firstly by determining the total floor area of the non-domestic stock in England & Wales in 2004 and 2006, and then establishing the stock's total energy consumption in these periods.

2.2.2 Floor area of non-domestic buildings in 2004

The main source of data on the floor area of the current stock of non-domestic buildings in England & Wales can be obtained from DCLG (formerly ODPM) planning statistics[6]. Although some data are collected on all rateable premises[7], the published floor area data only cover the most common building types, known as bulk classes, which are factories, warehouses, offices and retail. Also, the floor areas published relate to the rateable floor area which can be significantly less than the internal treated area, which is most appropriate for measuring changes in energy efficiency. Hence the rateable floor areas need to be adjusted

[6] *Commercial and Industrial Floorspace and Rateable Value Statistics 2005 (2005 Revaluation)*, ODPM, February 2006.

[7] The main categories that are excluded are Crown premises, which includes the Government estate buildings, and also churches and religious buildings. In addition, premises within enterprise areas may also be excluded.

to take account of these differences, and factors for making such adjustments have been derived based on comparing the rateable and net internal treated floor areas for a sample of buildings for each bulk class[8].

Whilst the published floor area statistics can account for a significant proportion of the total non-domestic floor area, data from other sources must be used to provide coverage of the whole stock. In addition to the published floor area data for the bulk classes, for many other building types the Rating Valuation Office Agency (RVOA) also has some records on the rateable floor area. The rateable value of a premises is determined, at least in part, by its floor area, although other factors such as building condition and other amenities also play a role. Hence, where a significant and reasonably representative proportion of building types have their rateable floor area recorded, it is possible to establish the relationship between floor area and rateable value and use this to infer the floor area for premises where the floor area has not been recorded.

Apart from the incomplete coverage of the non-domestic building stock, a further issue with the ratings data is there can be a significant delay in obtaining new and/or extended premises ratings and the statistics are typically published at least a year behind the year to which they relate. However, as there is frequently a period of several months between completion and occupancy (particularly for commercial premises which are built on a speculative basis) which is commensurate with the time lag between completion and rating, no attempt has been made to adjust the rateable floor area data to account for this.

Clearly, for non-rateable premises and for those building types where the rateable floor areas are rarely recorded (and hence it is not possible to reliably infer floor area from the rateable values) other data sources must be used to supplement the information that can be generated from the ratings data. This mainly affects public sector buildings, and fortunately the floor area information is collected for other purposes, for example, for the Government estate data on the floor area (and fuel consumption data) is already collected as part of the sustainable development in Government reporting process. Similarly, for schools and hospitals such information is gathered by DfES and the NHS respectively for the purpose of monitoring energy performance. For some other building types, there are not comprehensive details of the floor area in England & Wales, and here the floor area has been estimated based on the number of rateable premises (where this is available) and their typical floor area gleaned from in-the-field measurements and/or based on other data that can be related to floor area, e.g. number of employees and typical values for employees per m^2.

[8] The factors used to estimate net internal area from rateable area are: commercial offices 1.1; retail 1.3; warehouses 1.0 and factories 1.0.

Table 7 below summarises the floor area estimates for non-domestic buildings for 2004.

Building type	Stock 2004
Commercial Offices	89,037
Communications and Transport	39,849
Education	104,177
Government	24,715
Health	26,726
Hotel	73,342
Retail	144,092
Sport and Leisure	54,087
Warehouses	151,339
Other Services	81,213
Industrial	224,398
All Non-Domestic	**1,012,975**

Table 7. Floor area (thousand m^2) by non-domestic building type for 2004

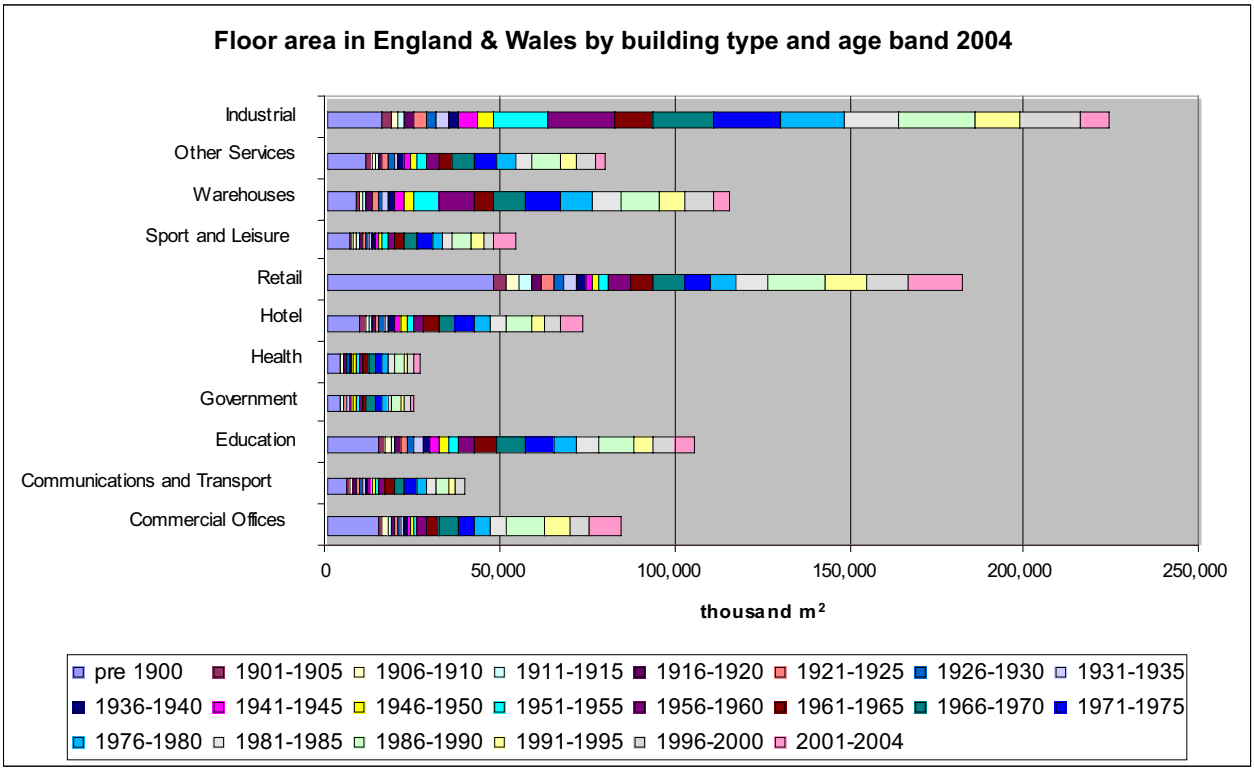
Although this data relates to the calendar year 2004 it is proposed that this should be used without adjustment to represent the floor area standing in November 2004. The reasons for not adjusting the floor area are that:

- comprehensive data is only available on calendar year basis,
- uncertainty regarding the time lag between rating a premises and occupying it, and,
- the low turnover rate for the stock.

The age of a building is important as it can be related to the thermal performance of the building envelope, and more recently the minimum efficiency of the heating, lighting and cooling systems, based on the Building Regulations in force at the time. Building Regulations relating to energy efficiency were only introduced for non-domestic buildings in 1985, and from 2002 they extended to some aspects of existing buildings. Determining the age breakdown of the non-domestic building stock in the baseline year will allow the impact of improvements in the overall efficiency of the building stock due to improvements in the regulations to be measured.

The age of a building is collected for the rating valuation process, and for more recent years has been obtained based on ABI planning application and contract data.

The age profile of the building stock of England & Wales is show in the chart below.



2.2.3 Floor area of non-domestic buildings in 2006

The most recent RVOA statistics published are for 2005 and data for 2006 will not be available until 2007. However, 2005 was a revaluation year and there were significant changes in the classification of properties resulting from the revaluation that came into effect on 1st April 2005, which means that the 2005 data are not consistent with the 2004 data. For these reasons it was necessary to determine the amount of new floor area that is expected to be constructed up to November 2006. ABI planning application data give information relating to all construction projects that require planning permission (the data are collected at several stages during the planning application process) and this is supplemented by information on projects at the tender and contract stages. For this report, non-domestic new-build and extension projects that had reached contract stage were considered for the 12-month period running from April 2005. These data do not always include floor area information for projects at the contract stage, however, the project value is provided in all but a few instances. To overcome this shortfall, the relationship between contract value and floor area was used to estimate the amount of new floor area constructed for each building type. The resultant new-build floor area for the year to March 2006 is shown below.

Building Type	ABI 2005-2006
Care residential	897
Civic & Public	397
Commercial & Retail	3,674
Education	2,481
Hotel & Catering	1,127
Industrial	6,130
Leisure facilities	277
Medical & Healthcare	1,323
Sports facilities	410
Transport	796
All Non-Domestic	17,514

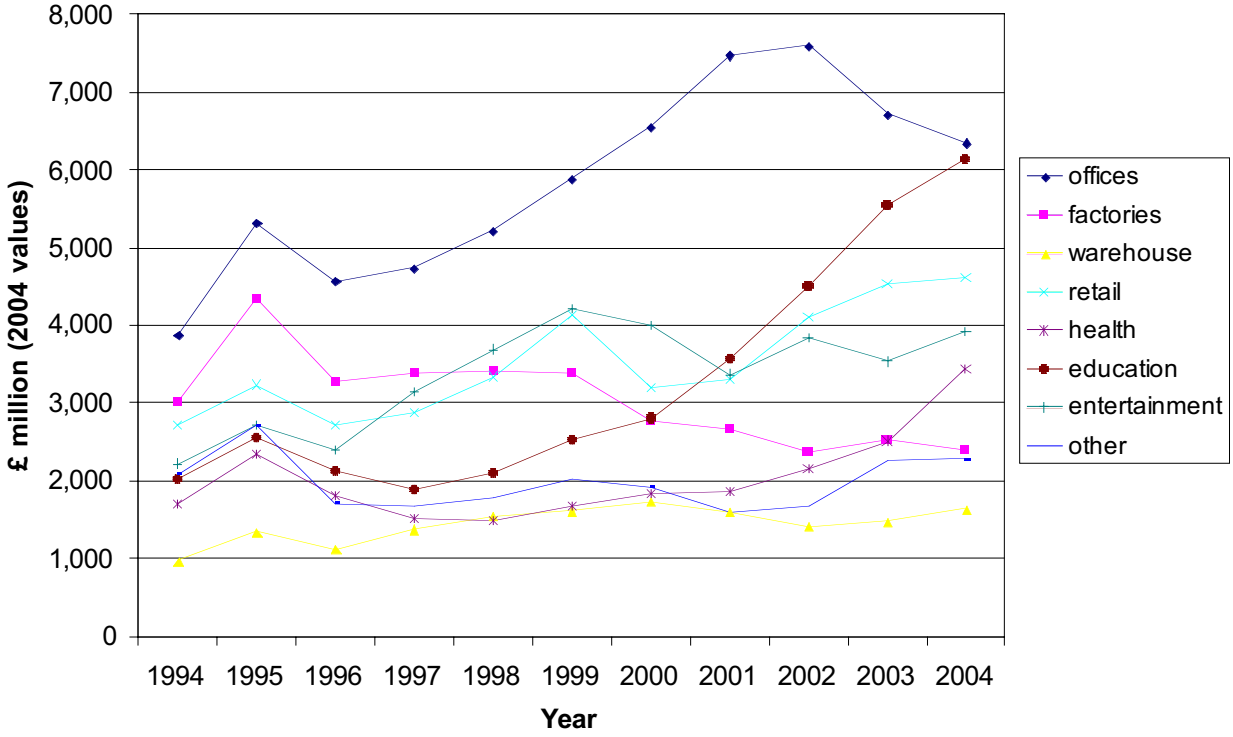
Table 8. Estimated new-build floor area (thousand m^2) for England & Wales (1/04/05 to 31/03/06)

For the purpose of this exercise it was assumed that these new-build rates will prevail across the period November 2004 to November 2006.

The construction industry is extremely volatile, particularly with respect to non-domestic buildings. This is illustrated by the following two graphs. Graph 1 is based on Rating Valuation Office Agency data for the major commercial building sectors, whilst Graph 2 shows construction output for all non-domestic buildings[9].

Graph 1. Total new-build floor area in UK based on Valuation Office data

9 *Construction Statistics Annual 2005*, DTI, October 2005.



Graph 2. Value of new-build from construction statistics

These observations serve to indicate the level of uncertainty which are contained in the new-build projections made here.

Another factor that is particularly relevant for non-domestic buildings is the demolition rate, which is known to be significant as the net annual increase in floor area is significantly lower than the new-build rate alone would suggest. Comprehensive information on the demolition rate for non-domestic buildings is not available, although anecdotal evidence from local authorities indicates that the demolition rate for non-domestic buildings can be as high as half the new-build rate in some areas. This accords with the observation that most non-domestic new-build activity is not on greenfield sites and they are often built as replacement for existing buildings that have come to the end of their useful life, e.g. schools and hospitals. For this study we have used Rating Valuation Office Agency statistics for the four major commercial building sectors to determine the ratio of new-build to demolition for non-domestic buildings in England & Wales. This shows that in recent years the ratio of demolitions to new-build floor area is 29%. In the absence of other information this ratio was used to estimate the total floor area in England & Wales in November 2006. See Table 9 opposite.

Building type	Stock 2004	New-build 2004-2006	% new-build	Estimated demolitions	Stock 2006	% net increase
Commercial Offices	89,037	3,674	4%	2,226	90,485	1.6%
Communications and Transport	39,849	1,592	4%	996	40,445	1.5%
Education	104,177	4,963	5%	3,125	106,015	1.8%
Government	24,715	794	3%	618	24,891	0.7%
Health	26,726	2,646	10%	1,336	28,036	4.9%
Hotel	73,342	2,254	3%	1,834	73,762	0.6%
Retail	144,092	3,674	3%	2,882	144,884	0.6%
Sport and Leisure	54,087	821	2%	270	54,638	1.0%
Warehouses	151,339	6,130	4%	3,783	153,686	1.6%
Other Services	81,213	1,794	2%	812	82,195	1.2%
Industrial	224,398	6,130	3%	5,610	224,918	0.2%
All Non-Domestic	**1,012,975**	**34,472**	**3%**	**23,492**	**1,023,955**	**1.1%**

Table 9. Change in total non-domestic floor area (thousand m^2) for England and Wales 2004 to 2006

2.2.4 Fuel consumption in non-domestic buildings

Fuel consumption data for non-domestic buildings for the baseline year, 2004, and for 2006 have been generated from DTI energy statistics. The fuel consumption is the annual energy use in the 12 calendar months to the middle of November 2004, and 2006 in accordance with the biennial reporting period. This approach differs from that used for housing fuel consumption, which considers the calendar years 2004 and 2006. This is because both the rate of new-build and refurbishment rates within the non-domestic sector are much higher than for housing and hence approximation to the calendar year used for housing is not justified here.

Electricity consumption

Electricity consumption data are available monthly, broken down by country (Scotland, Northern Ireland, England and Wales)[10] and also by main sector (Domestic, Industrial and Other) for public supply electricity, which accounts for the vast majority of electricity consumption in the UK. Data from own generation electricity is not broken down by country, so we have had to estimate consumption of own generation electricity in England & Wales based pro rata on the public supply data. In the monthly data, electricity consumed by public and commercial buildings is only a proportion of the emissions arising from energy use in the "Other" category, so annual UK consumption data[11] (which give a more disaggregated sectoral breakdown[12]) were used to estimate the monthly electricity consumption for public and commercial buildings.

For the industrial sector we need to exclude electricity consumption for process applications. We have not been able to locate any recent studies which specifically identify the proportion of electricity used for process applications and for building-related applications. There is a 1980s ETSU report but there have

[10] TABLE 5.5 Availability and consumption of electricity, available from www.dti.gov.uk/energy

[11] Table 1.1 in the *Digest of UK Energy Statistics* (DUKES) 2005, DTI.

[12] The public and commercial sectors comprise the public administration, commercial and miscellaneous categories in DUKES.

been such significant changes within industry that the report's findings are no longer relevant. Instead we have assumed that the building-related energy consumption per m^2 in industrial buildings is equivalent to that for warehouses[13] because they are likely to be of similar construction(s) and have similar requirements regarding heating and lighting levels.

In January 2007, monthly electricity consumption data were only available to October 2006, so annual consumption to October 2006 instead of to mid-November was used to estimate electricity use for 2006.

The public, commercial and industrial building related electricity consumption for 2004 and 2006 are summarised in Tables 10 and 11 below.

November 2004	**UK**	**England & Wales**				
TWh pa	Total final users	Total final users	Industry	Building-related industry	Service	**Non-Domestic Buildings**
Publc Supply	326	289	92	27	94	**121**
Own Generation	26	23	7	2	7	**10**
Total	352	312	99	29	101	**130**

Table 10. Electricity consumption in public, commercial and industrial buildings 2004

November 2006	**UK**	**England & Wales**				
TWh pa	Total final users	Total final users	Industry	Building-related industry	Service	**Non-Domestic Buildings**
Public Supply	330	279	118	31	94	**124**
Own Generation				2	7	**10**
Total				33	101	**134**

Table 11. Electricity consumption in public, commercial and industrial buildings 2006

Owing to the fact that only a small proportion of electricity consumption in non-domestic buildings is for heating, the electricity consumption value for 2006 has not been temperature corrected.

Gas consumption

Monthly gas data are only available for gas supplied, and gas consumption is only available at the quarterly intervals. Here, to estimate consumption in the two half quarters (mid-November 2004 to end December 2004, and beginning of October 2005 to mid-November 2005) the ratio of gas consumption within the relevant quarters was allocated based on the monthly gas supply data. Unlike electricity, gas consumption in England & Wales is not available from DTI statistics, but NETCEN has produced regional statistics on carbon emissions from fuels which were used to adjust the DTI UK statistics to England & Wales[14]. Data are currently only available for 2003, but it is expected that more up-to-date data will be published in the future.

[13] Based on most recent N-DEEM (Non-Domestic Energy and Emissions Model) estimates.

[14] *Local and Regional CO_2 Emissions Estimates for 2003*, produced by NETCEN for Defra http://www.defra.gov.uk/environment/statistics/globatmos/galocalghg.htm

As gas is used primarily as a heating fuel, it is necessary to take account of the effect of the weather on gas consumption in order both to project future demand and to provide estimated consumption compared to the base year. This was achieved here by correlating annual gas consumption in the service and industrial sectors against temperatures for England & Wales[15] in much the same way as was done for the domestic sector in Section 2.1.3. Other weather effects will also impact on heating energy use (e.g. solar gains and wind chill effects) but these impacts are much more variable across the non-domestic building stock and hence are harder to assess, and in any case are likely to show a strong correlation with average monthly temperatures, so other aspects of weather correction were not considered here.

In all other respects, the public, commercial and industrial building related gas consumption was calculated as for electricity for the base year and is summarised in Table 12 below.

TWh pa	**UK**	**England & Wales**				
Natural gas	Total final users	Total final users	Industry	Building-related Industry	Service	**Non-Domestic Buildings**
2004	674	622	143	50.8	101	**152**
2006	643	593	137	48.7	93	**142**
2006 weather corrected				48.9	94	**143**

Table 12. Gas consumption in public, commercial and industrial buildings (2004 and 2006)

Oil consumption

Monthly oil consumption data are available from DTI statistics but only from January 2005 onwards, so monthly consumption from earlier months has been inferred from annual consumption based on the monthly consumption pattern for 2005. Otherwise, the public, commercial and industrial buildings related oil consumption was calculated as for natural gas for both the base year and the 2006 actual and 2006 weather corrected oil consumptions which are summarised in Table 13 below.

TWh pa	**UK**	**England & Wales**				
Oil	Total final users	Total final users	Industry	Building-related Industry	Service	**Non-Domestic Buildings**
2004	808	745	74	0.1	13	**13**
2006			76	0.1	12	**12**
2006 weather corrected				0.1	12	**12**

Table 13. Oil consumption in public, commercial and industrial buildings (2004 and 2006)

Coal and renewable solid fuel

Coal and renewable solid fuels (e.g. municipal waste, hospital waste etc.) are the only solid fuels with significant usage in non-domestic buildings. Data availability for coal are similar to those for oil, and so 2004 data had to be inferred from the 2005 monthly consumption data.

[15] Average quarterly temperatures for England & Wales were used to determine the correlation between energy consumption and external temperature. A temperature correction based on degree day data for the two periods was also explored and this gave a slightly larger correction factor. The reasons for the difference are unclear so it is suggested that this is investigated more thoroughly.

Renewable energy consumption data are only available annually in DUKES, and currently 2004 is the most recent year of published data. So here, 2005 consumption has been inferred based on the annual trend in consumption. It was assumed that the monthly consumption pattern for renewable energy was the same as for coal.

Public, commercial and industrial buildings related fossil and renewable solid fuel consumption figures are summarised in Tables 14 and 15 below.

TWh pa	**UK**	**England & Wales**				
Solid fossil fuel	Total final users	Total final users	Industry	Building-related Industry	Service	**Non-Domestic Buildings**
2004	35	32	23	0.02	0.1	**0.1**
2006			21	0.02	0.2	**0.2**
2006 weather corrected				0.02	0.2	**0.2**

Table 14. Solid fossil fuel consumption in public, commercial and industrial buildings

TWh pa	**UK**	**England & Wales**				
Renewable	Total final users	Total final users	Industry	Building-related Industry	Service	**Non-Domestic Buildings**
2004	7	6	3	0.002	1.4	**1.4**
2006			2	0.001	1.5	**1.5**
2006 weather corrected				0.001	1.5	**1.5**

Table 15. Renewable solid fuel consumption in public, commercial and industrial buildings

2.2.5 Energy use per m^2 of floor area

Based on the floor areas for 2004 and 2006 derived in Sections 2.2.2 and 2.2.3 above and the delivered fuel consumption data derived in Section 2.2.4, the following energy consumption indicators are obtained for the non-domestic buildings stock in England & Wales:

Non-Domestic Buildings in England & Wales 2004		
Total Delivered Energy	TWh pa	297
Total Floor Area	1,000m^2	1,012,976
Energy Efficiency	**kWh/m^2**	**294**

Non-Domestic Buildings in England & Wales 2006		
Total Delivered Energy	TWh pa	290
Total Floor Area	1,000m^2	1,023,955
Energy Efficiency	**kWh/m^2**	**283**

Non-Domestic Buildings in England & Wales 2006 (Temperature corrected)		
Total Delivered Energy	TWh pa	291
Total Floor Area	1,000m^2	1,023,955
Energy Efficiency	**kWh/m^2**	**284**

Available figures indicate that at 16 Nov 2004:

- Average annual non-domestic building energy use per m^2 of floor area was 294 kWh/m^2

And at 16 Nov 2006 (allowing for temperature correction):

- Average annual non-domestic building energy use per m^2 of floor area was 284 kWh/m^2 which represents a decrease of 3.3%.

As discussed above, the analysis for the non-domestic stock is not as robust as that for the domestic stock primarily because of the limitations with the data sources, and experience suggests that the errors in the above KPIs are therefore likely to be twice those for the equivalent domestic KPIs, i.e. the errors are probably about ±5%. Therefore, given that the size of the change in the reporting period is comparable to that of the error it is not possible to say whether the change is significant.

2.3All buildings: Energy use per m^2 of floor area

We can combine the two KPIs in Sections 2.1.3 and 2.2.5 to produce a further KPI which represents the annual energy use per m^2 for all buildings in England & Wales:

Available figures indicate that at 16 Nov 2004:

- Average annual energy use in buildings per m^2 of floor area was 268 kWh/m^2

And at 16 Nov 2006 (allowing for temperature correction):

- Average annual energy use in buildings per m^2 of floor area was 266 kWh/m^2 which represents a decrease of 0.7%.

In other words, the energy efficiency (in terms of delivered energy) of the building stock in England & Wales has improved by about 0.9% within the two-year reporting period. However, as discussed above, given the sizes of the errors, we cannot be sure that this represents a significant change.

As an aside, we can see that the energy use per m^2 of non-domestic buildings is slightly larger than that of dwellings (about 10-15% larger). Dwellings are responsible for nearly two-thirds of the total energy consumed by buildings although this is simply because they occupy a larger area, again nearly two-thirds of the total.

3 Section 6(2)(e)(ii) – Greenhouse gas emissions from buildings

3.1 Dwellings

As discussed above, KPIs for greenhouse gas emissions stem directly from the energy use KPI. Following on from Section 2.1.3, the BREHOMES figures for 2004 indicate that the average dwelling carbon emission (including emissions from the use of electricity which actually occur at the power station rather than at the dwelling) was 1.58 tonnes (i.e. 1,580 kg). Thus, an equivalent KPI for the carbon[16] emission per m^2 of floor area is:

Available figures indicate that at 16 Nov 2004:

- Average annual dwelling carbon emission per m^2 of floor area was 18.2 kgC/m^2

Again, as discussed in Section 2.1.3, we need to use DTI's *Energy Trends* and *Digest of UK Energy* publications to see how emissions have changed. Since the total domestic sector energy use in the year to Jun 2006 was 2.05% lower than in 2004, the carbon emissions would also have been about 2.05% lower. Allowing for the growth in the housing stock (see Section 6 below), and correcting for temperature differences, we can currently say that this KPI has increased by about 0.9% (to 18.4 kgC/m^2) between 16 Nov 2004 and 16 Nov 2006, but the uncertainty in the figures is such that it is not possible to be absolutely sure that there has been any significant change in this KPI.

3.2 Non-domestic buildings

As for the domestic sector, the KPIs for greenhouse gas emissions stem directly from the energy use KPI. The emission factors used here relate to delivered energy and thus include emissions from the generation of electricity and the extraction, production and distribution of other fuels. The emission factors used for the non-domestic sector are show below:

Fuel	kgC/kWh
Electricity 2004	0.148
Electricity 2006 (projected)	0.152
Natural Gas	0.052
Oil	0.074
Coal	0.081
Renewable Fuels	–

[16] To obtain the equivalent KPI for the emission of carbon dioxide (CO_2) simply multiply the carbon KPI by 44/12.

Using these emission factors, the total carbon emissions from the non-domestic building stock in 2004 therefore become 28.2 Mtonnes. The KPI therefore becomes 27.9 kgC/m^2. Similarly, carbon emissions for 2006 (temperature corrected) are 28.7 Mtonnes, and the KPI becomes 28.1 kgC/m^2.

Non-Domestic Buildings in England & Wales 2004		
Total Carbon Emissions	MtC pa	28.2
Total Floor Area	1,000m^2	1,012,976
Carbon Efficiency	**kgC/m^2**	**27.9**

Non-Domestic Buildings in England & Wales 2006		
Total Carbon Emissions	MtC pa	28.7
Total Floor Area	1,000m^2	1,023,955
Carbon Efficiency	**kgC/m^2**	**28.0**

Non-Domestic Buildings in England & Wales 2006 (Temperature corrected)		
Total Carbon Emissions	MtC pa	28.7
Total Floor Area	1,000m^2	1,023,955
Carbon Efficiency	**kgC/m^2**	**28.1**

Available figures indicate that at 16 Nov 2004:

- Average annual non-domestic building carbon emission per m^2 of floor area was 27.9 kgC/m^2

And at 16 Nov 2006 (allowing for temperature correction):

- Average annual non-domestic building carbon emission per m^2 of floor area was 28.1 kgC/m^2 which represents an increase of 0.9%.

The reason for the small increase in the carbon KPI compared to the 3.3% decrease for the energy efficiency KPI is because the proportion of electricity – which has a higher emission factor than the other fuels – used in non-domestic buildings has increased. The increase in the carbon emission factor for electricity will also have contributed to the difference between the carbon and energy KPIs.

3.3 All buildings

As with energy use, we can combine the two carbon KPIs:

Available figures indicate that at 16 Nov 2004:

- Average annual carbon emission from buildings per m^2 of floor area was 21.4 kgC/m^2

And at 16 Nov 2006 (allowing for temperature correction):

- Average annual carbon emission from buildings per m^2 of floor area was 21.6 kgC/m^2 which represents an increase of 1.1%.

In other words, the carbon efficiency of the building stock in England & Wales has decreased by just over 1% within the two-year reporting period. However, given the errors involved in deriving these KPIs it is not possible to say whether the change is significant.

3.4 Other greenhouse gases

Energy use in buildings also results, both directly and indirectly, in the release of other greenhouse gases. Of the basket of six gases which are included under the Kyoto Protocol and are therefore appropriate to consider here, methane and NOx are relevant for energy consumption. However, unlike carbon dioxide, there is not a fixed relationship between energy consumption and emissions for methane and NOx. For example, methane emissions from coal mining occur over a long period, and the rate of gas emissions is largely independent of the amount of coal extracted, and could continue for many years after active mining has ceased.

4 Section 6(2)(e)(iii) – Facilities for buildings to generate energy

4.1 Introduction

This reporting requirement is taken to be the development of microgeneration in England & Wales during the reporting period. In other words, it is not concerned with reporting on large-scale utility generation of renewable energy which is addressed through AEAT's RESTATS (Renewable Energy STATisticS) database. Microgeneration is the production of heat and/or electricity on a small-scale (this refers to homes and small commercial developments/public sector buildings) from a low carbon source. Low carbon refers to renewable energy generators or technologies with better fuel efficiency than conventional technologies. The technologies considered are therefore:

- Electricity generation technologies:
  - Solar photovoltaics (PV)
  - Wind turbines
  - Small hydro
- Heat generation technologies:
  - Solar thermal hot water
  - Ground source heat pumps (GSHP)
  - Bio-energy
- Co-generation technologies:
  - Small and micro Combined Heat and Power (CHP)
  - Hydrogen energy and fuel cells

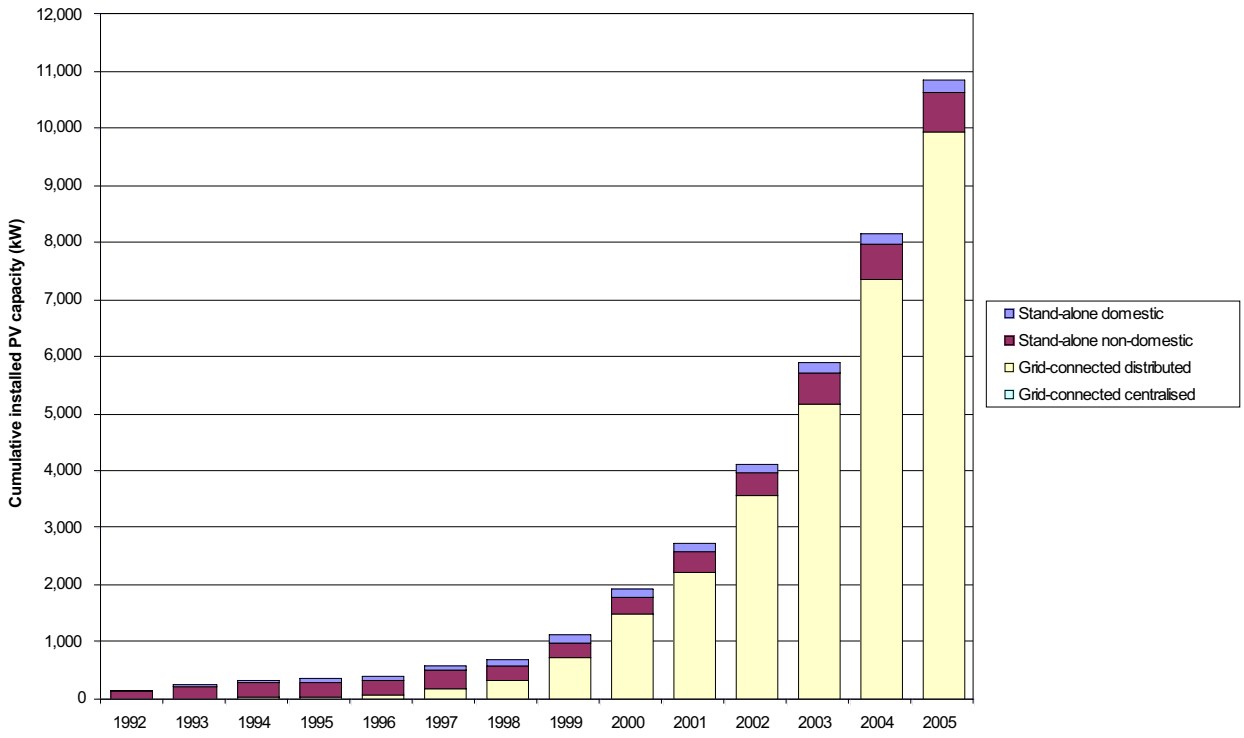
Microgeneration is defined as any technology, connected to the distribution network (if electric) and with a capacity <50-100 kW. Most domestic installations will be below 3 kWe, though thermal systems could be larger. Further details on these technologies can be found in the DTI's *Microgeneration Strategy and Low Carbon Buildings Programme* consultation document.

Much of the information on the uptake of these technologies is derived from the DTI-funded grant programmes Clear Skies (covered wind turbines, small hydro, solar thermal hot water, GSHP and biomass) and Major PV Demonstration Programme (MDP). Clear Skies commenced in January 2003 and the MDP in 2002, but both finished in March 2006 and have now been replaced by the Low Carbon Buildings Programme (LCBP). Both Clear Skies and MDP primarily addressed dwellings but a substantial number of grants were also made available to larger buildings, principally public ones. In addition to these grant programmes, there are the domestic and large-scale PV field trials which are also DTI- funded. Overall, information on microgeneration, particularly on renewable energy activity outside of the DTI-funded programmes, is not as robust and as comprehensive as that used to produce other KPIs, such as the domestic energy KPIs.

Further information, particularly on the likely growth of microgeneration in the UK from 2005-2050, can be obtained in the DTI-sponsored report, *Potential for Microgeneration: Study and Analysis*.

4.2 Solar photovoltaics

Most statistical reports refer to photovoltaics in the form of installed capacity quoted as a multiple of Wp (i.e. power output under ideal conditions). Each year, a report is produced for the International Energy Agency's Photovoltaic Power Systems Programme (IEA-PVPS)[17]. The latest published report goes up to the end of the 2005 calendar year and gives the total cumulative installed capacity in the UK as 10.9 MWp, an increase of 33% on the previous year[18]. The growth in PV is shown in Graph 3 below.



Graph 3. Growth in PV capacity in UK (1992-2005)

This figure of installed capacity includes a wide range in terms of the size of each installation, and the number of installations is not given. In order to estimate the number of installations, reference was made to data from the MDP which reports the following in terms of actual installations from March 2002 (the start of the Programme) to the end of the calendar year 2005:

- Stream 1 (0.5 to 5 kWp) – 923 installations with a capacity of 2,071 kWp (equivalent to an average capacity per installation of 2.2 kWp and which is primarily aimed at domestic installations),

[17] Further details can be found at: http://www.iea-pvpsuk.org.uk/index.shtml

[18] *National Survey Report of PV Power Applications in the UK 2005*. Report prepared for DTI, July 2006.

- Stream 2 (5 to 100 kWp) – 95 installations with a capacity of 2,834 kWp (equivalent to an average capacity per installation of 29.8 kWp and which is primarily aimed at businesses including public sector buildings, i.e. generally non-domestic installations).

There are invariably more grant offers than actual installations, allowing for the time taken to install a system and the fact that some approved installations do not proceed; for example, during this time period there were 204 Stream 2 approved grant applications compared to the 95 actual installations.

Therefore, the total capacity installed under the MDP to the end of 2005 is 4,905 kWp with Stream 1 applications amounting to 42% of this, and Stream 2 applications amounting to 58%. We can see the growing importance of the MDP to the overall growth in PV in the UK. This is shown in Table 16 below.

	2002	2003	2004	2005
Total installed capacity	4,136	5,903	8,164	10,877
Total MDP installed capacity	66	906	2,724	4,905
MDP as % of total	1.6%	15.3%	33.4%	45.1%

Table 16. Cumulative PV installed capacity in UK and contribution from MDP

Specifically, 80% of the capacity installed in both 2004 and 2005 was funded through the MDP.

The reporting period of the Act is Nov 2004 to Nov 2006 so installation data for 2006 ares required. However, these are not yet available, but grant data for up to the end of July (which includes LCBP) show that 656 grant offers were made (599 under Stream 1 and 57 under Stream 2) with a total capacity of 3,148 kW. It is difficult to translate these figures into actual installed capacity so it is proposed that the current trend in PV growth (as illustrated in Graph 3) be extrapolated to calculate the installed capacity for 2006. Analysis shows that an exponential curve models the growth of PV extremely well[19] and, accordingly, the UK's total installed capacity at the end of 2006 is estimated to be 13,666 kW. Certainly, the number of grant offers to date in 2006 tends to support this estimate, and obviously it should be reviewed at the time of the next biennial report when the actual number of installations will be known. Therefore, using this estimate, the figures in Table 17 and applying the Stream 1 and 2 proportions and average capacity per installation above give:

[19] This is perhaps not surprising given that such an approach has been used to model the uptake of energy efficiency measures in the domestic stock. Initial exponential growth of a measure becomes linear after a few years before reducing in an exponential fashion as the measure reaches saturation point, to produce a characteristic S-curve.

	2004		2005		2006	
	Capacity (kW)	**No.**	**Capacity (kW)**	**No.**	**Capacity (kW)**	**No.**
Installations <5 kWp	3,447	1,536	4,593	2,047	5,770	2,572
Installations >5 kWp	4,717	158	6,284	211	7,896	265
Totals	**8,164**	**1,694**	**10,877**	**2,258**	**13,666**	**2,837**

Table 17. Capacity and number of PV installations in UK

The figures in Table 17 are for the UK and the Act is only concerned with England & Wales so a correction factor is required. The most straightforward approach is to use a population-based one so, given that the population of England & Wales makes up 88.7% of the UK population[20], the correction factor is 0.887.

Therefore, at the beginning of the reporting period (Nov 2004) it is estimated that there were:

- 1,500 PV installations of which 1,360 were in dwellings and 140 were in non-domestic buildings

And at the end of the reporting period (Nov 2006) it is estimated that there were:

- 2,515 PV installations of which 2,280 were in dwellings and 235 were in non-domestic buildings which represents an increase of 67%.

Given that these figures were derived from the total installed PV capacity in the UK they also includs those systems installed under the domestic and large-scale PV field trials. Specifically though, PV systems installed in England & Wales from 2001 to 2004 as part of the domestic field trial serve nearly 474 individual dwellings at 28 sites, amounting to a total installed capacity of 741 kW, and there are 12 projects in the UK covered by the large-scale field trial with a total installed capacity of 639 kW[18].

To determine the number of PV systems as a percentage of those technically feasible is difficult. Both roof and façade-mounted systems are installed so, in theory, every dwelling (flats as well as houses, as shown by the domestic field trial) and non-domestic building could accommodate a PV system. However, this ignores many other practical considerations as well as economic ones, not the least of which is a favourable roof/building orientation, but these factors are difficult to quantify on a national scale. Nevertheless, as part of its review of the sustainability of existing buildings, DCLG undertook an initial analysis of the energy efficiency of dwellings[21] which included an assessment of the number of potential homes that could reasonably incorporate microgeneration technologies. Specifically, it estimated that potentially some 9.9 million homes (i.e. 43% of the total dwelling stock of 22.9 million, see Table 1) could have PV systems installed.

[20] Based on ONS mid-2005 estimate of UK population.

[21] *The Energy Efficiency of Dwellings – Initial Analysis* (November 2006). Available on the DCLG website at http://www.communities.gov.uk/index.asp?id=1504372

The equivalent figure for non-domestic buildings is harder to determine, not least because of the difficulty in establishing the total number of non-domestic buildings. This is because of the wide variety of building types (hence this requires numerous data sources, as discussed in Ssection 2.2.2) and also the difficulty of defining what is meant by a 'building'. The RVOA database contains hereditaments (i.e. rateable area) of many building sectors but it does not always uniquely specify a building, for example, there can be a number of premises in a building such as a shopping mall. Nevertheless, although not providing an exact number of buildings, the database does provide a reasonable estimate. Based on this information, together with the other building stock data, it is estimated that there are some 1.35 million non-domestic buildings in England & Wales. It is not possible to say what proportion of these could reasonably have a PV system installed so, for simplicity, we shall assume that the total number of systems that could be installed equates to the total number of non-domestic buildings.

Therefore, at the beginning of the reporting period (Nov 2004) it is estimated that:

- 0.014% of potential dwellings and 0.01% of all non-domestic buildings had PV installations

And at the end of the reporting period (Nov 2006) it is estimated that:

- 0.023% of potential dwellings and 0.017% of all non-domestic buildings had PV installations

However, for the reasons outlined above, the figures for non-domestic buildings are likely to be an underestimate of the proportion of those buildings where PV systems are technically feasible.

4.3 Solar thermal

Whereas statistics for PV are normally quoted in terms of installed capacity, solar thermal systems are normally quoted in terms of total collector surface area in square metres. However, on average. a typical domestic installation for domestic hot water (DHW) is in the region of 3.2 m^2 and for a swimming pool it is about 20 m^2 (as derived from the Clear Skies database).

Two studies have been undertaken, although the figures conflict as follows:

(1) Market report for the Soltherm project, data provided by the Solar Trade Association (STA) detailed the total installed capacity in the UK as at the end of 2001 as:

Solar thermal system	Total area (m^2)	Application
Flat plate	92,950	Typically used for DHW
Evacuated tube	26,470	
Unglazed	89,000	Typically used for swimming pool

The above figures equate to 37,318 DHW systems and 4,450 swimming pool systems, giving a total of 41,768 systems.

(2) ETSU (now AEAT) report for DTI *New and Renewable Energy: Prospects in the UK for the 21st Century, Supporting Analysis* (March 1999) provided an estimated total UK capacity at the end of 1997 as:

(a) 169,256 m^2 for DHW

(b) 106,884 m^2 for swimming pools

Using the above Clear Skies assumptions, these equate to 52,892 DHW systems and 5,344 swimming pool systems for a period four years before the data in (1) above. However, the report stated that the total of ~270,000 m^2 equates to a total number of 47,658 systems. It is not clear how this figure was derived as the report uses the assumption of a DHW system being 3-4 m^2 in size and a swimming pool system being 20 m^2 in size (i.e. almost identical to the data from Clear Skies).

The data collated by the STA were based upon a questionnaire issued to 39 installation companies which we feel may have been under-representative of the industry as a whole. In addition to that, some of them did not respond and some clearly responded with dubious data (the STA study attempted to rectify this). It is also worth noting that there are companies that sell and install solar thermal systems in high volume which have never belonged to the STA. Even though they might have been included in the 39 (the available data was anonymised), it may well be that they did not respond. We therefore feel that this information is probably too low.

We do not have access to the methodology employed for the ETSU study but assume some form of discussion took place with the industry. However, it does include an assessment of the total installed capacity for each of the five years from 1992 to 1997. It is therefore judged that the methodology may be more robust than that used by the STA (there may have been a greater budget available for the study).

The data within the ETSU study for these five years are presented in the table below, along with an assessment of the number of systems represented (based on 3.2 m^2 and 20 m^2) and the year-on-year increase.

Year	DHW			Swimming pools		
	Total area (m^2)	No. systems	Annual increase	Total area (m^2)	No. systems	Annual increase
1992	136,187	42,558	-	89,180	4,459	-
1993	142,234	44,448	1,890	92,220	4,611	152
1994	148,654	46,454	2,006	94,660	4,733	122
1995	154,814	48,379	1,925	98,860	4,943	210
1996	162,035	50,636	2,257	102,872	5,144	201
1997*	169,256	52,893	2,257	106,884	5,344	201

* Figures for 1997 are an estimate based upon the previous year.

Table 18. ETSU data on solar thermal systems in the UK (1992-97)

Now, Clear Skies – which started in 2003 – covers England, Wales and Northern Ireland – a separate programme, the Scottish Community and Householder Renewables Initiative (SCHRI), covers Scotland so will not be considered here – and provides grants for solar thermal installations. Clear Skies data for 2004 and 2005 show that there were 3,513 and 1,988 grant applications respectively from private householders for these two years, but about 7% of these were for Northern Ireland which is not within the scope of the Act. Further, experience shows that around 15% of applications do not proceed. Therefore, allowing for these two factors means that in 2004 and 2005 the number of solar thermal systems installed under Clear Skies in England & Wales was 2,777 and 1,571 respectively.

In addition to these figures, however, we need to add the following:

(i) Systems grant funded under the Clear Skies community stream. This grant stream addressed both social housing applications (primarily from local authorities and housing associations) as well as those for public buildings (e.g. schools, community centres, sports centres, council offices etc.). Reviewing the data shows the number of solar thermal systems installed in England & Wales were:

	2004	**2005**
Social housing	465	368
Public buildings	64	37
Total	**529**	**405**

(ii) Other large-scale installations not grant funded, estimated at 100 per year.

(iii) Professionally installed systems not grant funded for various reasons (e.g. by installers not registered with the Clear Skies scheme). Based on the size and turnover of these installers, this is estimated to amount to 500 schemes per year.

(iv) DIY and systems installed in new housing developments, estimated at around 500 systems per year.

(iv) DIY and systems installed in new housing developments, estimated at around 500 systems per year.

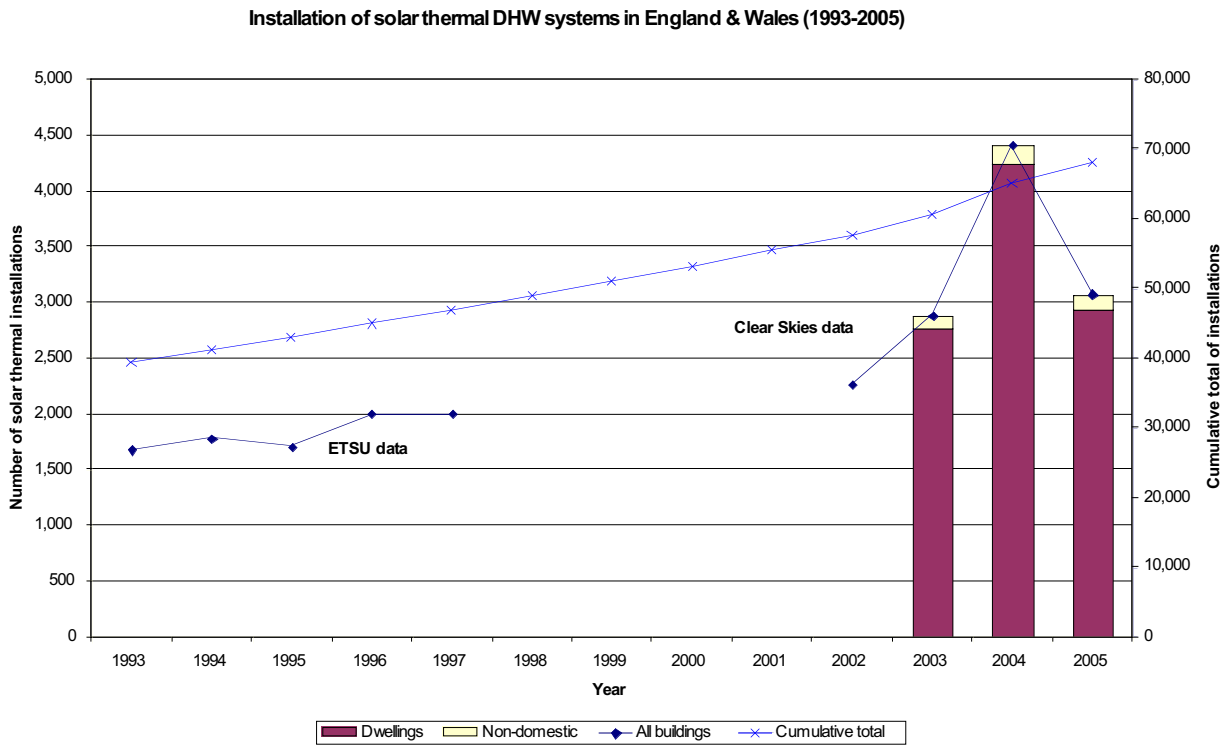
Experience indicates that around 40% of the Clear Skies-funded installations would have proceeded without the grant and so using the data above, we can estimate the number of installations in the year before Clear Skies (i.e. 2002) as follows:

Source	**Number**
Based on 2004 figure for private householders for Clear Skies grants corrected with observation that 40% would have occurred in the absence of the grant	2,777 x 40% = 1,111
Based on 2004 figure for applications for Clear Skies community grants. Community-based installations are very grant-dependent so assume that only 10% would have gone ahead without grant	529 x 10% = 53
Large-scale installations	100
Professionally installed systems	500
DIY and systems in new houses	500
Total	**2,264**

Similarly, for 2003 when Clear Skies operated only part of the way through the year:

Source	**Number**
No. applications from private householders for Clear Skies grants in 2003 corrected for factor that only 85% proceed	1,339 x 85% = 1,138
No. applications for Clear Skies community grants in 2003	147
Large-scale installations	100
Professionally installed systems	1,000
DIY and systems in new houses	500
Total	**2,885**

We can therefore plot the ETSU data for solar thermal DHW installations in Table 7 (corrected to England & Wales) together with the Clear Skies data. This is done on the chart below.



The chart shows that a rise in installations from the 1993-97 period to the 2002-2005 period. Also plotted is the cumulative total – the period between the ETSU and the Clear Skies data has been derived on the basis of a simple linear rise. Reviewing the Clear Skies data for 2003-05 suggests that the vast majority (96%) of solar thermal installations are in dwellings.

Therefore, at the beginning of the reporting period (Nov 2004) it is estimated that there were:

- 65,000 solar thermal DHW installations, of which 62,400 were in dwellings and 2,600 were in non-domestic buildings.

For the last year of the reporting period (2006) there is a transition between the end of Clear Skies and the start of the LCBP, but indications from grant applications in 2006 suggest that the level of activity is comparable to that seen in 2005 so a simple linear extrapolation will be used to derive the 2006 KPI.

Therefore, at the end of the reporting period (Nov 2006) it is estimated that there were:

- 71,100 solar thermal DHW installations, of which 68,300 were in dwellings and 2,800 were in non-domestic buildings which represents an increase of 9.5%.

As with PV, it is difficult to determine the proportion of buildings where installation of solar thermal systems is technically feasible. Like PV, a range of factors needs to be considered including favourable roof orientations, but such information is not readily available nationally. The aforementioned DCLG report[21] did

estimate the potential for solar thermal systems in dwellings however, and suggested that this was 19.3 million (i.e. 84% of the total dwelling stock). As noted above, it is difficult to estimate the potential in non-domestic buildings so, as with PV, we shall assume that the total number of systems that could be installed equates to the total number of non-domestic buildings.

Therefore, at the beginning of the reporting period (Nov 2004) it is estimated that:

- 0.32% of potential dwellings and 0.19% of all non-domestic buildings had solar thermal DHW installations

And at the end of the reporting period (Nov 2006) it is estimated that:

- 0.35% of potential dwellings and 0.21% of all non-domestic buildings had solar thermal DHW installations.

However, for the reasons outlined above, the figures for non-domestic buildings are likely to be an underestimate of the proportion of those buildings where solar thermal DHW systems are technically feasible.

4.4 Small wind

For the purposes of this report, micro wind turbines used for marine and leisure purposes (boats and caravans) or those for telecommunications equipment are ignored as, although the numbers may be very large – the British Wind Energy Association (BWEA) is aware of 24,000 small machines manufactured by one company alone – the contribution to carbon reduction targets is likely to be small in the future.

No previous studies detailing the number of small-scale wind installations in the UK could be found (this has been confirmed with BWEA). Most studies have concentrated on the larger utility scale and so do not fall into the definition of microgeneration. Therefore, the only data that could be obtained are from Clear Skies, although these data only cover the period from the start of the programme (Jan 2003) until now. These data show that to the end of 2004 there were 112 small wind turbine installations (including the community stream) in England & Wales, of which 88 were in dwellings and 25 were in the non-domestic sector. However, the data also show that one supplier's machines account for around 70% of all the machines installed under the programme. It is therefore a reasonable assumption that these machines account for around 70% of the total number of small wind turbines installed in the UK.

Discussions with the company suggest that as of 2005 it believes there to be in the region of 450 to 500 of its machines operating in the UK. This therefore indicates that the total number of machines in the UK is in the region of 650 to 700.

Therefore, at the beginning of the reporting period (Nov 2004) it is estimated that there were:

- 570 to 630 small wind turbines.

Accepted Clear Skies grant applications in 2005 for wind turbines were more than double those in 2004, and data for 2006 from LCBP show an order of magnitude increase in applications compared to 2005. However, there can be a considerable time lag before turbines are installed because planning permission is

usually required. Specifically, at the end of 2006, there was a commitment to provide grants for nearly 1,300 wind turbines though only a very small proportion of grants had been paid, although the likelihood is that more turbines have actually been installed. The data for 2006 will need to be reviewed at a later date to confirm the number of turbines actually installed.

Therefore, at the end of the reporting period (Nov 2006) it is estimated that there were:

- 720 to 780 small wind turbines which represents an increase of 23-26%.

As with PV and solar thermal, to estimate the technically feasible building population for small wind turbines is very difficult. The factors affecting installation are, if anything, even more extensive and include wind environment around the building, roof structure and local planning requirements. An extensive discussion of these can be found in the report, *The Feasibility of Building-mounted/Integrated Wind Turbines (BUWTs): Achieving their potential for carbon emission reductions* (May 2005). The DCLG report[21] was not able to estimate the potential number of dwellings where small turbines could be installed so, for simplicity, the whole building stock is considered.

Therefore, at the beginning of the reporting period (Nov 2004) it is estimated that:

- 0.0024-0.0026% of all buildings had small wind turbine installations

And at the end of the reporting period (Nov 2006) it is estimated that:

- 0.0030-0.0032% of all buildings had small wind turbine installations.

However, for the reasons outlined above, these figures are likely to be an underestimate of the proportion of buildings where small wind turbines are technically feasible.

4.5 Small hydro

The ETSU study referred to in Section 4.2 does consider small-scale hydro but defined it as <5 MW and so will include many installations larger than the definition of microgeneration given in Section 4.1. In addition to this, the Clear Skies database is lacking a useful quantity of data as there have been only 14 accepted grant applications in total to the end of 2005.

In order to establish a national figure, therefore, two sources were consulted: Ofgem's list of accredited generators for the Renewables Obligation and the British Hydropower Association (BHA). Unfortunately, Ofgem's list detailed only 20 sites of <50 kW with a total capacity of 329 kW. The BHA contains details of 20 UK sites <50 kW on its website (http://www.british-hydro.org/index.asp) but estimates that there are between 90 to 100 sites overall in the UK.

Therefore, at the beginning of the reporting period (Nov 2004) it is estimated that there were:

- 80 to 90 small hydro schemes.

The number of Clear Skies grant applications for hydro schemes during 2003-2005 was very low (average of five per year) and the situation was much the same with LCBP in 2006.

Therefore, at the end of the reporting period (Nov 2006) it is estimated that there were:

- 100 to 110 small hydro schemes which represents an increase of 21-24%.

Given that the scope for installing small hydro schemes in buildings is much narrower in comparison to the other technologies so far considered – and is very difficult to establish – it does not make sense to express the above figures as a percentage of the total building stock, so it is suggested that a KPI for this is not derived.

4.6 Ground source heat pumps

A study by FES (*Renewable Heat and Heat from Combined Heat and Power Plants – Study and Analysis*, April 2005) for DTI (and mentioned in DTI's microgeneration and LCBP consultation documents) refers to a recent survey which indicated around 600 to 700 installations in the UK. Unfortunately, this study is not referenced so we were not able to establish how that figure was derived. It is therefore not known what proportion would fall into or outside the microgeneration definition. As far as BRE is aware (and BRE manages the Heat Pump network and partners in the newly formed Ground Source Heat Pump club) no detailed studies have been undertaken.

However, discussions with colleagues who coordinate BRE's work with the Heat Pump network and GSHP club suggest that they would consider that there was in the region of 150 GSHP installations in the UK prior to the launch of Clear Skies (i.e. about 130 in England & Wales). It is further likely that the majority of subsequent domestic installations will have been grant funded. Commercial installations are ignored as they are likely to be >45 kW.

As at the end of 2004 in England & Wales, there had been 221 accepted Clear Skies grant applications for dwellings (both private and social housing) and a further 28 community stream grants (i.e. 11%) in the non-domestic sector.

Therefore, at the beginning of the reporting period (Nov 2004) it is estimated that there were:

- 380 GSHPs with 340 in dwellings and 40 in the non-domestic sector.

Accepted Clear Skies applications in 2005 were nearly 50% higher than in 2004, and applications through LCBP show that in 2006 they have maintained this level. But, because of time lag arising from the installation of boilers and processing of grants, only a small proportion of grants had been paid.

Therefore, at the end of the reporting period (Nov 2006) it is estimated that there were:

- 940 GSHPs with 860 in dwellings and 80 in the non-domestic sector which represents an increase of nearly 150%.

As with small wind turbine it is recommended that the grant data for 2006 be reviewed at a later date to confirm that number of GSHPs actually installed.

The DCLG report[21] estimated the potential number of dwellings where GSHP could be installed as 17 million (i.e. 74% of the total dwelling stock). This figure is based purely on the number of dwellings with gardens (i.e. having some ground for installing the required pipework) so is likely to be an overestimate, as it does not consider other relevant factors such as the geological and environmental conditions of a site. For these reasons, the scope for GSHP in non-domestic buildings is likely to be much lower but it cannot be estimated nationally here.

Therefore, at the beginning of the reporting period (Nov 2004) it is estimated that:

- 0.002% of potential dwellings had ground source heat pumps

And at the end of the reporting period (Nov 2006) it is estimated that:

- 0.006% of potential dwellings had ground source heat pumps.

However, for the reasons outlined above, these figures are likely to be an underestimate of the proportion of dwellings where ground source heat pumps are technically feasible. It is not possible to produce equivalent figures for non-domestic buildings.

4.7 Biomass

Of all the technologies this is probably the hardest to assess because the Clear Skies dataset is relatively small and there is a wide range of technologies that could be included, some of which would not normally be considered as new renewable energy technologies, e.g. multi-fuel range boiler/cookers that can burn coal, peat and wood or small log burning stoves. However, the technologies with the greatest potential to contribute to the UK's efforts to reduce carbon emissions will be those acceptable to the widest possible audience. To be acceptable they must be convenient and so only the automated modern appliances burning wood pellet or wood chip have been considered.

Up to the end of 2004 in England & Wales, Clear Skies accepted 60 domestic grants for wood-fuelled boilers and pellet stoves together with 44 community stream grants in the non-domestic sector. Previous studies undertaken by BRE have established that these appliances only started to appear in the UK around the year 2000. Assuming grant funding has had a significant effect on the annual installation rate, it is probable that the rate of installation in 2000, 2001, 2002 and 2003 would have been no more than 20.

Therefore, at the beginning of the reporting period (Nov 2004) it is estimated that there were:

- 180 biomass installations (wood-fuelled boilers and pellet stoves) of which 100 were in dwellings and 80 were in the non-domestic sector.

Accepted Clear Skies grant applications in 2005 were just over double those in 2004 and indications from LCBP are that they have increased further still.

Therefore, at the end of the reporting period (Nov 2006) it is estimated that there were:

- 440 biomass installations (wood-fuelled boilers and pellet stoves) of which 340 were in dwellings and 100 were in the non-domestic sector which represents an increase of about 140%.

As with the other technologies, the 2006 grant data should be reviewed at a later date to confirm the actual number of biomass installations.

Again, it is very difficult to assess the size of the building population where installation of biomass is technically feasible and so a KPI for this has not been derived.

4.8 Combined Heat and Power

CHP is a highly fuel efficient energy technology which puts to use waste heat produced as a by-product of the electricity generation process. Most new CHP schemes use natural gas, but some burn alternative, including renewable (e.g. biomass), fuels. CHP units are often used in community heating schemes and if the installation is >100 kWe then it is often CHPQA registered[22]. Further information on schemes can be obtained directly from the Community Energy programme which is managed by the Energy Saving Trust (EST) as well as CHPQA, but current installed capacity is estimated to be about 5 GW.

Most CHP is likely to fall outside the definition of microgeneration and so should not be included within the reporting requirements of the Act, but there are field trials on 40 small-scale CHP (i.e. <25 kW) and micro-CHP (i.e. around 1 kW) units which are being managed by the Carbon Trust[23]. The purpose of these trials is to see how these units perform and whether they can deliver the expected carbon savings.

4.9 Hydrogen energy and fuel cells

Hydrogen and fuel cells are intermediate technologies, not renewable sources, so they cannot contribute to national renewable energy targets. However, the production of hydrogen from renewable energy sources offers the potential to create an almost zero emission energy chain, and hydrogen and fuel cells can be used to provide both heat and power to domestic households. The technologies are at the pre-commercial stage, however, so existing installations are demonstration projects. As such, there is very little that can be reported upon.

[22] CHPQA registration is used to certify that CHP is good quality, i.e. energy efficient and well-matched to the load where CHP is installed. CHPQA certification allows access to certain financial benefits, e.g. ECAs (Enhanced Capital Allowances) and CCL (Climate Change Levy) exemptions.

[23] *The Carbon Trust's Micro and Small-scale CHP Field Trial Update Report* (November 2005).

5 Section 6(2)(e)(iv) – Recycled and reused materials

5.1 Introduction

The terminology to describe materials that have been discarded and are going to be used again in some form or another may be termed 'reused' or 'recycled' material. ISO definitions for these terms are available but in simple terms, to avoid confusion, they are:

- *Reused material/product* – material or product used again in the same form and/or application without the need for extensive additional processing.
- *Recycled material* – material, pre or post-consumer material that has been discarded, and changed from its original form for incorporation into another material or product using a mechanical process.

In order to ensure the KPIs developed for construction products/materials can be calculated on a consistent basis, the data sources used must be readily available and also collected in a reliable manner. Government statistics on material and product sales, and published literature on recycled content of generic building materials/products have been used to derive the KPIs, additional indicators have also been derived to provide context.

Since sales figures are well-established and available, the KPI and the proportion of the building materials market that this takes into account have been calculated using sales data.

5.2 Data sources

5.2.1 Sales and tonnage data

The routine and extensive collation of product and sales statistics by the Office of National Statistics (ONS) has provided the foundation for the KPIs developed. The availability and consistency of the data collected now and in the future were principal factors in choosing the information source. The two Government sources used were:

- ONS Products and Sales statistics (2004 figures)
- DTI statistics on Monthly Statistics of Building Materials and Components (2004 figures).

The following information, which is most readily available for the widest range of materials, was extracted from these published sources:

- Total UK manufacturer sales (£000s)
- Quantities of products being sold in the UK in units of volume, weight or items.

Where total UK manufacturer sales values were available, these figures were used to establish the baseline for the performance indicator. In cases where only product quantities were available, these were converted where possible into an equivalent sales value using average figures for material density and/or qualitative

information. The assumptions and method used to derive some of the data used in the KPI tables are given in Section 5.2.3.

The scope of construction materials and products in the KPI was determined by the availability of recycled content data, as described in the next section (Section 5.2.2).

Currently, the materials and products included in the KPI (using Government sales statistics and BRE recycled content values only) accounted for 57% of the total construction products market by monetary value in 2004. The remaining 43% comprised those materials/products for which reliable factual sales and/or recycled content data were not available. Use of additional reference sources could increase the coverage from 57% to 67%. This increase would, however, be subject to the limitations of the additional data which include its availability and transparency. Appendix B has a list of materials/products that are not included.

To give an indication of the relative amount of data that was available for products/materials in terms of tonnage or volume information, the UK manufacturer sales values of those products/materials were added together. In this case, the percentage of the construction products market covered was reduced from 57% to 47%. With the additional reference sources, the coverage could increase from 47% to 60%.

Note, all data reported here cover the UK, but the derived KPIs apply equally to England & Wales.

5.2.2 Recycled content data

Comprehensive information on the levels of recycled content in different building materials is not available. Some information is available through the WRAP[24] reference guide published in September 2004[25]. The technical information used in this reference guide was provided by BRE.

Additional information on the recycled content of building materials and products was potentially also available in a report prepared for WRAP by AMA Research in March 2006[26]. The information in that report has not been used to calculate the main KPI due to limitations on data availability. The report contains information that is not openly available as it relies on consultations with industrial companies and trade associations as well as previous market research studies. The AMA report outcomes will be updated only if WRAP commissions subsequent work using a similar methodology. Information from this report has, however, been incorporated into another KPI as a basis for comparison and to illustrate the opportunities to broaden the construction products/materials coverage that exist, although these are subject to the limitations detailed above.

A consistent set of recycled content percentage figures is being used within BRE in the toolkits *Green Guide to Specification*, EcoHomes and BREEAM[27] that assist in the determination of the environmental performance of different building constructions, and are the key sources of information contained within the WRAP reference guide publication. These recycled content figures have been used as the basis for the KPIs developed in this report.

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[24] Waste & Resources Action Programme – see http://www.wrap.org.uk/

[25] *Opportunities to Use Recycled Materials in House Building*. Reference Guide published in September 2004 by WRAP.

[26] Analysis of data on market share of recycled content in construction – WRAP, March 2006.

[27] BRE Environmental Assessment Method. For further details on these toolkits see http://www.breeam.org/

The availability of recycled content figures for the various construction materials has, in conjunction with ONS sales figures, determined which materials can be included in the KPI calculation. The proportion of the market this represents has been calculated to assess whether less reliable sources of information (such as using more data from the AMA report) needed to be used to ensure coverage of a reasonable proportion of the total building materials market. KPIs presented in this report have used different levels of input from sources other than Government statistics and the BRE recycled content figures.

5.2.3 Derivation of data for KPI calculation

As mentioned earlier, it was necessary to calculate the market size or tonnage quantities of some construction materials and products using different assumptions and methods. Information for the following products was adjusted for use for the KPIs developed.

For concrete blocks, the volume sales of each type of block: dense, lightweight and aerated, were available from the *Monthly Statistics of Building Materials and Components*[28]. Densities for these block types (1,750, 1,250 and 600 kg/m^3 respectively) were used to calculate these volumes in terms of mass. The total value and equivalent mass of the wall market, which includes brick and block, was obtained from PRODCOM PRA26610. A proportion of the wall market by value was attributed to the concrete blocks by calculating the mass of the three types of block as a percentage of the total mass of the building blocks market.

For clay bricks, the total sales value was obtained from PRODCOM PRA26400 PCC26401110, however, the tonnage amount was calculated by AMA[26] using an average weight of 2 kg for a clay brick.

Cases where the published statistics were modified using other information are:

- For timber board products PRA20200, the statement made in the WRAP report[26] that 40% of production is used for construction purposes has been used to reduce the total sales figure by 60%.
- Primary, secondary and recycled aggregate sales have been derived through information supplied by the Quarrying Products Association (routine surveys are conducted by the organisation) and WRAP.
- For plasterboard, volumes of product sold were converted to units of weight based on the assumption that the average density of plasterboard is 9 kg/m^2.
- For fibre cement, volumes of product sold were converted to units of weight based on the assumption that the average density of fibre cement is 1,500 kg/m^2.

Tonnage figures were not calculated for ceramic tiles and flags and roofing felt, for which there was volume information but a suitable conversion factor was not available. These material groups comprise a number of products of varying density values and were thus difficult to convert with any degree of certainty.

It should also be noted that more recent data weres not available for some materials and historical data have been used. These include:

- PCC27422350 Aluminium extrusion – Al wire (2003 data only)
- PCC27432550 Zinc (2002 data only)
- PRA26650 Product Sales and Trade: Fibre Cement (2003 data).

[28] Monthly Statistics of Building Materials and Components. January 2005. No.359.

All other PRODCOM sales figures are taken directly from the 2004 data sheets. The full list of PRODCOM data is given in Appendix A.

5.3 Calculation of KPI

In the WRAP reference guide[25] a table identifying the recycled content of generic building materials and products is presented along with three levels of recycled content. These levels referred to as 'standard', 'good' and 'best' practice represent the readily achievable level of recycled content (standard) for a material or product through to the best level that could be met but which is potentially difficult to achieve at present. Some recycled content values are easily verified whilst other have been derived through consultation with industry and experts. As such, the values given for recycled percentage are for guidance.

An extract from the reference guide is presented below:

Materials	Product	Recycled % of mass		
		Standard	Good	Best
	Steel section	60		
	Steel coil	12		
	Lead	80		
	Zinc	31		
	Aluminium extrusion	44		
	Aluminium sheet	73		
Board materials	Chipboard	65	70	90
	Fibre boards			
	Hardboard	60		
	Medium density fibreboard (MDF)	60		90
Brick & block	**Walls**			
	Dense block	0	10	20
	Lightweight block	50	60	80

Table 19. Example of recycled content in building products and materials (Standard, Good and Best practice)

Calculation of the KPI for building materials and products for this report is based on the **Standard** recycled content percentage. It was decided that materials and products at this level of recycled content are more likely to form the majority of the market share, i.e. it is better to potentially underestimate rather than overestimate the recycled content of the building materials.

The total UK manufacturer sales for as many as possible of the building products and materials listed in the recycled content table were extracted or deduced from the relevant PRODCOM data sheets. Assuming the **Standard** Recycled Content (SRC) was applicable to all the UK manufactured products sold, a value of recycled content was calculated by multiplying the standard recycled content by the manufacturer's sales in pounds, i.e.

- *Value of recycled content = SRC (%) x Total UK manufacturer sales (£)*

The result is illustrated below for metallic products.

	Product	Recycled % of mass [Standard]	Total UK manufacturer sales (£000s)	Value of recycled content (£000s)
	Steel section	60	3,553,152	2,131,891
	Steel coil	12	711,789	85,415
	Stainless steel	75	322,954	242,216
	Copper sheet	60	58,912	35,347
	Copper cable and pipe	15	171,194	25,679
	Lead	80	106,729	85,383
	Zinc	31	1,946	603
	Aluminium extrusion	44	1,260	554
	Aluminium sheet	73	73,819	53,888

Table 20. Calculation of the value of recycled content for metallic products

If manufacturers increase the amount of recycled materials as feedstock to their manufacturing processes, the recycled percentage of mass and values will change. The value of recycled content calculation will reflect that change and thus provide a useful indicator of improving recycled content.

As already stated, this calculation was carried out for construction materials and products where both a recycled content figure and ONS sales statistics (PRODCOM) were available, and then related to the total construction products markets as estimated in the AMA report[26]. AMA has calculated the value of the total construction products market from the sales figures it has assembled for its market share report to WRAP:

- *Total construction products market (2004/2005) =£14,722,000,000*

To calculate the recycled content KPI for each group of construction products, both the UK manufacturer sales and the SRC figures are required. When these two datasets were compared (i.e. relevant PRODCOM statistics alongside materials with recycled content information), UK manufacturer sales of £8,416,253k had adequate data. This equates to 57% of the total construction products market. When this share of the market was multiplied by the respective SRC percentages, a total value of recycled content of £3,095,616k resulted. This equates to 21% of the total construction products market. This percentage calculation is the basis for the main KPI, given in bold, in the box below.

Available figures indicate that for Nov 2004:

Value

K_{Va} 21% by value of the total construction products market is recycled material – based on data for 57%* of the total construction products market (i.e. £8,416m of £14,722m)

K_{Vb} 23% by value of the total construction products market is recycled material – based on data for 67%** of the total construction products market (i.e. £9,912m of £14,722m)

Mass

K_{Ma} 20% by mass of the total construction products market is recycled material – based on weight and volume data for 47% by value of the total construction products market (i.e. £6,916m of £14,722m)

K_{Mb} 22% by mass of the total construction products market is recycled material – based on weight and volume data for 60% by value of the total construction products market (i.e. £8,766m of £14,722m)**

* The remaining 43% of products did not have sufficient data (either sales and/or recycled content figures) or comprised information on materials/products that came from a limited source (individually sourced from industry). Also, whole building components or structures such as windows, doors and pre-fabricated structural items that constitute a large proportion of the value of the construction market have not been included due to the reasons stated above and also because of the complexity of materials used. Appendix B has a list of materials/products that are not included.

** Although more of the market is represented, the additional dataset is not updated.

There is currently a shortage of reliable and updated information needed to calculate the KPI. The information used to derive this KPI was deemed to be the best and most appropriate as presented in Section 5.2.

Data have not been included for material that may have been recycled on-site and subsequently used in the construction process. This could be in the form of keeping materials on-site from demolition and using them for new build, excavation materials and other site-won material. This material is most likely to be aggregates and used in low-value applications such as for fill and temporary roads. However, some organic materials could be recycled in this way, e.g. composting for mulching purposes. There is a complete lack of consistent data in terms of the amounts of materials that are recycled in this way – as there is no standard requirement to collect this information. It is also difficult to ascertain the value of such materials on-site which will be dependent upon the type of the material, the location and the application in which it is used. In addition, some of this material may be double-counted within the statistics for construction and demolition waste which have been included as part of the recycled aggregates dataset.

The data used to develop and calculate the KPIs for 2004 are not as yet available for 2006. To show how K_{Va} and K_{Vb} could change as a result of increased recycling and recycled content of construction products, the products were assumed to achieve the levels of **Good** and **Best** for recycled content. The results of this calculation are summarised in Table 21 below.

KPI	Level of recycled content		
	Standard practice	Good practice	Best practice
K_{Va}	21%	25%	30%
K_{Vb}	23%	28%	36%

Table 21. Percentage by value of the total construction products market is recycled material for different levels for three levels of recycled content

Tables complete with all the data used to calculate the above KPIs are given in Appendix C. Specific data references (indicated in the tables) that will enable the calculation to be repeated for successive years or different time periods, are included in the references.

It is envisaged that, although there is a shortage of accurate quality information at present, as the situation improves, the KPI developed will provide a valuable measure of changing practice.

5.4 Reused material/product indicator

The reused material/product indicator has been derived from the BigRec survey which was carried out by BRE and SALVO[29]. This represents the only survey of its kind of the reclamation industry and was completed in 1998. The data presented below are therefore based on 1998; a future forecast has not been completed in terms of the indicator for 2004 and 2006 as there are no data to use.

Available figures indicate that for Nov 2004 (based on 1998 data):

Value

- **2.6% by value of the total construction products market is a reclaimed product (based on a total construction products market of £14,722m)**

Mass

- 1% based on weight data (3,324 ktonnes of 322 Mtonnes) for 60% by value of the total construction products market

[29] BRE & SALVO *Reclamation and recycling of building materials: industry position report*. BRE Information Paper IP 7/00 (2000). SALVO is an information provider/network for the reclamation industry. Further details can be found at: http://www.salvoweb.com/.

There may be other areas in the build process whereby reuse is being carried out but data are unavailable, e.g. the salvage of materials on-site which are not passed onto a reclamation dealer.

5.5 Improving the data

The KPI of 21% recycled content by value represents only 57% of the construction products market by value, and the KPI of 20% recycled content by mass represents only 47% of construction products. These can be improved upon using other data sources but there is little to suggest the other data sources will be updated on an annual or biennial basis. Therefore, the focus for improving this KPI must be to have a fully represented construction products dataset.

The basis of achieving this is through the PRODCOM reports. If these datasets are improved so that all product groupings have data for value (£), weight (t) and/or volume (m^3), it would be possible to have a KPI that represented 100% of construction products.

This has been recognised as a major data gap which makes target-setting and KPIs difficult to define with much confidence. As such, the Defra-funded project *Developing a Strategic Approach to Construction Waste* has commissioned a project to investigate the methodology behind the PRODCOM reports and make recommendations for improving it to the point of having a complete annual dataset for UK construction product use. Findings from this project are expected in March 2007.

Having achieved total coverage of construction products, it would still be necessary to have standard recycled content percentages for every product grouping. It is expected that WRAP and BRE's *Green Guide to Specification* will continue to provide these data.

To include data on site-won material that is recycled within the construction process, a system would have to be set up to collect these data in a systematic and consistent fashion for volume/tonnage. A current opportunity is to use the proposed legislation for Site Waste Management Plans (SWMPs) – led by Defra – which will require sites over a certain value threshold to identify and manage their waste appropriately. The aforementioned Defra-funded project has commissioned a project to identify how data generated from the SWMP process can be used effectively and provide evidence for policy.

In terms of the reuse product indicator, the only available statistics are those collected through the BigRec survey process (as identified above). A BigRec 2 survey has been recently commissioned (again through the aforementioned Defra project) as this is considered a major evidence gap. This will be completed by the end of January 2007 and a comparison will be made with the original survey. The BigRec 2 survey will have data for 2005.

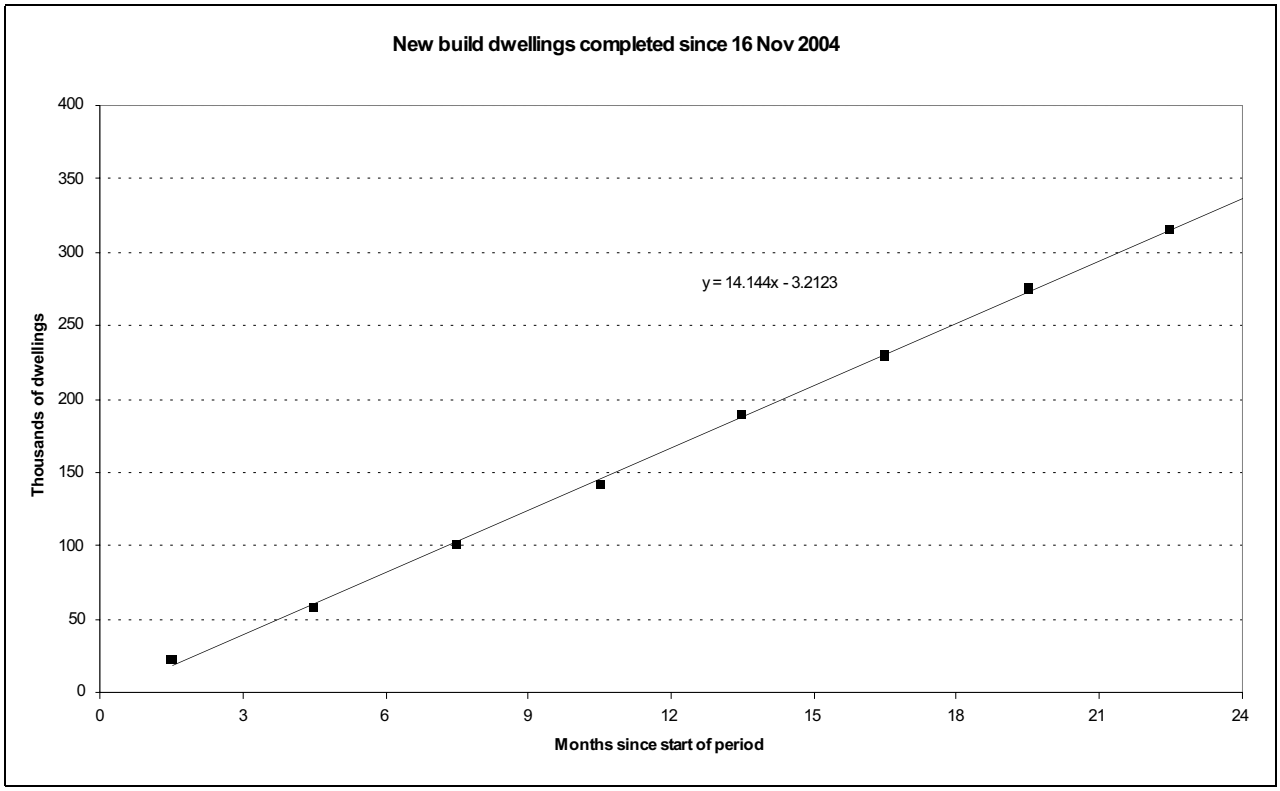
6 Section 6(3) – Number of dwellings in England & Wales

As noted above in Section 1, there is also a reporting requirement for the number of dwellings in England & Wales at the end of the reporting period. In other words, there is a need to report on changes in the size of the housing stock which mainly arise through the construction of new dwellings. But this also has an impact on the overall energy efficiency of the housing stock.

Now, the insulation acquisitions data discussed in Section 2.1.1 above relats only to the existing housing stock and thus they do not reflect the improvements that are occurring because of the addition of new homes that are being constructed to high standards. Such dwellings will have well-insulated walls (often, but not always, of cavity construction), roofs, windows and floors, following the Building Regulations (Part L) requirements of the day.

Quarterly housing completions statistics are published by DCLG (in the “live tables” that may be downloaded from the DCLG website) but, like the insulation acquisitions data, there is an inherent delay in the collected data being processed and reported so it is necessary to project available figures in order to estimate the number of new homes added to the stock in the period 16 Nov 2004 to 16 Nov 2006. Also, the timing of data becoming available differs between England and Wales. Wales lags behind, so it is often necessary to estimate a figure for Wales to obtain a figure for England & Wales. Given that Wales represents just 5.5% or so of the combined England & Wales (in terms of dwelling stock), it is clear that the effect of any uncertainties in such estimates is unlikely to be significant. Furthermore, the statistics on completions show that the figures from one quarter to the next tend to remain relatively constant, so any estimates that are made are unlikely to be significantly in error anyway.

Following the same sort of approach as for the insulation data, the chart below shows the cumulative new-build completions from 16 Nov 2004 to the end of Sept 2006 (the Sept 2006 figure for Wales is an estimate), and projected forward to 16 Nov 2006. This chart indicates that between 16 Nov 2004 and 16 Nov 2006 we can expect that approximately 335 (±10 roughly) thousand new dwellings will be completed (actually 336 thousand, using the equation of the best fit line shown on the chart). This represents a growth, relative to the baseline stock figure at 16 Nov 2004 (22,886 thousand) from Table 1, of 1.47% (i.e. 0.73% per year), all of which should have been fully insulated homes (i.e. Building Regulations compliant).



The KPI for new build-dwellings could be:

Available figures indicate that from 16 Nov 2004 to 16 Nov 2006:

- 336 thousand new dwellings (i.e. incorporating all relevant energy efficiency measures required by the Building Regulations) were completed. This represents 1.47% extra energy efficient homes relative to the baseline stock as at 16 Nov 2004 (22,886 thousand)

By way of further clarification, there are both gains and losses in the housing stock each year. Gains are mostly through the construction of new dwellings, but there are also some gains through conversions and changes of use. Losses to the housing stock are generally attributable to demolitions (mostly of old, unfit and energy inefficient housing) but there are also some losses through changes of use. Specifically, EHCS data (obtained from the DCLG website and dated June 2005) show that in the English housing stock over the five-year period 1999/00 to 2003/04:

- the gains averaged just over 157,000 dwellings per year of which 87% were new-build dwellings – annually these gains equate to 0.65% of the total stock; and,
- the losses averaged nearly 23,000 dwellings per year of which 94% is attributable to demolition – annually these losses equate to 0.10% of the total stock.

Overall, these figures equate to a net gain of 134,500 dwellings per year on average over the five years considered. However, more recent (but less comprehensive) data (dated October 2006) obtained from the DCLG website show that the net gains have been revised upwards by about 5% for the 2001/02 to 2003/04

period. The construction rate for new housing has not altered, so this revision suggests that gains through conversions and changes of use are slightly larger and/or that demolitions are slightly smaller than first thought. Whatever the exact situation, these data show that the rate of replacement of the housing stock is very low.

Figures for the size of the non-domestic building stock as well as demolition and new-build construction rates (all in terms of floor area) are derived in Sections 2.2.2 and 2.2.3. Comparison of the above data with that presented in Table 9 shows that the rates of demolition and new-build construction appear to be much greater in the non-domestic stock compared to the domestic stock. However, although these figures are needed for the derivation of the non-domestic energy and carbon KPIs, the Act does not appear to require them to be reported on separately.

Acknowledgements

Many thanks to Chris Roberts, Monica Munzinger and Kate Perry for their help in compiling the information on microgeneration.

Appendix A – PRODCOM data used

PRA20200 Product Sales and Trade: Veneer Sheets, Plywood, Laminboard, Particle Board, Fibre Board & Others

PCC20201333, 20201335, 20201337, 20201339 Chipboard

PCC20201415, 20201435, 20201455 Medium density fibreboard

PRA26300 Product Sales and Trade: Ceramic Tiles & Flags

PRA26400 Product Sales and Trade: Bricks, Tiles & Construction Products in Baked Clay

PCC26401110 Clay bricks

PRA26610 Product Sales and Trade: Concrete Products for Construction Purposes

PRA26620 Product Sales and Trade: Plaster Products for Construction Purposes

PRA26640 Product Sales and Trade: Mortars

PRA26650 Product Sales and Trade: Fibre Cement

PRA26820 Product Sales and Trade: Other Non-Metallic Mineral Products nec

PCC26521253 Roofing felt (bitumen based)

PRA27220 Product Sales and Trade: Steel tubes

PCC27221010, 27221070, 27222010, 27222030, 27222073, 27222075 Stainless steel tube

PRA27420Product Sales and Trade: Aluminium Production

PCC27422350 Aluminium extrusion – Al wire (2003 data only)

PCC27422670 Aluminium extrusion – tube or pipe fittings

PCC27422430 Aluminium sheet

PRA27430 Product Sales and Trade: Lead, Zinc and Tin Production

PCC27432200 Lead

PCC27432550 Zinc (2002 data only)

PRA27440 Product Sales and Trade: Copper Production

PCC27442400 Copper plates, sheet and strips

PCC27442630 Copper tubes and pipes including refined and alloys

PRA28110 Product Sales and Trade: Metal Structures & Parts of Structures

PCC28110001, 28110002, 28111030, 28112100, 28112200 Steel section

PCC28112350, 28112340 Sheet steel

PRA36639 Product Sales and Trade: Other Manufacturing

PCC36634000: Linoleum

Some additional facts and assumptions that have been taken into account when generating the KPI:

- Board manufacturing figures have been reduced by 60% to take into account the AMA statement that 40% of board materials are used for construction.
- Aggregate manufacturing data have been derived from the Quarrying Products Association survey data (2003) and assumes 100% recycled content for both secondary and recycled aggregates.
- The KPI calculation uses the AMA estimated value for the total construction products market in 2004/5 of £14,722m.

Appendix B – Products/materials not included in the recycling KPIs

	UK Market 2004	
Product	**£m**	**Vol 000T**
Growing media	26	1,190
Ready-mix concrete	1,015	36,741
Bulk fill	n/a	172,575
Cement	790	11,405
Non-refractory roof tiles	48	131
Non-refractory clay building prods.	52	163,811
Non-refractory clay pipes	17	44,119
Natural slate	76	37
Reconstituted slate	36	n/a
Slate cladding/architectural use	n/a	21
Slate powder/granules	n/a	31
Insulation - glasswool	160	175
Insulation -rock (mineral) wool	119	167
Foam/polymer insulation	220	170
Cellulose-based insulation	1	3-4
Membranes inc. damp proof	200	35
PVC profiles (windows, doors, conservatories)	640	400
Plastic pipes/ducting	1,000	320
Timber windows	378	85
Timber doors	804	814
Fencing	85	304
Pre-fab timber structures	730	n/a
Decking	39	101
Roof trusses	114	231
Wood flooring	361	2,300
Total	**6,910**	**435,216**

Dataset used in the calculation of K_{Va} (without WRAP data[26]).

Materials	Product	Recycled % as % of mass	Total UK manufacturer sales	Value of recycled content	Reference source
		Standard	£000s	£000s	
Metals	Steel section	60	3,553,152	2,131,891	PRA28110 Metal Structures & Parts of Structures PCC 28110001, 28110002, 28111030, 28112100, 28112200 Steel section
	Steel coil	12	711,789	85,415	PRA28110 Metal Structures & Parts of Structures PCC 28112350, 28112340 Sheet steel
	Stainless steel	75	322,954	242,216	PRA27220 Steel tubes PCC 27221010, 27221070, 27222010, 27222030, 27222073, 27222075 Stainless steel tube
	Copper sheet	60	58,912	35,347	PRA27440 Copper plates, sheets and strips PCC27442400
	Copper cable and pipe	15	171,194	25,679	PRA27440 Copper tubes and pipe incl. refined and alloys PCC27442630
	Lead	80	106,729	85,383	PRA27430 Lead, Zinc and Tin Production PCC 27432200 Lead
	Zinc	31	1,946	603	PRA27430 Lead, Zinc and Tin Production PCC 27432550 Zinc- 2002 data only
	Aluminium extrusion	44	1,260	554	PRA27420 Aluminium production PCC27422350 extrusion Al wire 2003 data only
	Aluminium sheet	73	73,819	53,888	PRA27420 Aluminium production - PCC27422430 Al plates, sheets & strips >0.2mm thick
Board materials	Chipboard & hardboard (60% recycled mass)	65	202,764	131,796	PRA20200 Timber board products PCC 20201333, 20201335, 20201337, 20201339-Chipboard, AMA- 40% of production used for construction
	Fibre boards	60	88,590	53,154	PRA20200 Timber board products - excl.OSB and MDF and chipboard AMA= 40% of production is used in construction
	Medium density fibreboard (MDF)	60	41,214	24,729	AMA- 40% of production used for construction
	Other boards			0	
	Plasterboard, plaster panels/tiles	36	491,641	176,991	PRA26620 Plaster products for construction purposes
Brick & block	**Walls**		400,399	0	PRA26610 - Building blocks & bricks of cement, concrete or artificial stone
	Dense block	0	271,464	0	Monthly Statistics of Building Materials and Components
	Lightweight block	50	131	66	Monthly Statistics of Building Materials and Components
	Aerated block	7	82	6	Monthly Statistics of Building Materials and Components
	Clay brick	0	523235	0	PRA26400 Bricks, Tiles & construction products in baked clay. Clay bricks -PCC26401110
Floor covering	Linoleum	24	65,755	15,781	PRA36639 Other manufacturing PCC36634000 Linoleum
	Ceramic tiles and flags	0	97,527	0	PRA26300 Ceramic tiles and flags
Roof materials	Fibre cement	0	97,039	0	PRA26650 Fibre cement
	Roofing felt	0	82,000	0	PRA26820 Other non-metallic mineral products -PCC26521253 Roofing felt
Aggregate	Primary aggregate (crushed rock, sand & gravel)	0	1,680	0	QPA surveys and WRAP estimates for primary, secondary and recycled aggregates.
	Secondary aggregates	100	105	105	QPA surveys and WRAP estimates for primary, secondary and recycled aggregates.
	Recycled aggregates	100	451	451	QPA surveys and WRAP estimates for primary, secondary and recycled aggregates.
Mortar	Standard mortar mix (includes binder and aggregate contents)	3	143,029	4,291	PRA26640 Mortars
Landscaping materials	Concrete kerb stones	3	907,392	27,222	PRA26610- Tiles, flagstones of cement, concrete & artificial stone PCC26611150
	Total for each category		£8,416,253	£3,095,567	
	Total construction products market		£14,722,000		WRAP report by AMA 'Analysis of data on market share of recycled content in construction'
	Proportion of total market as %		**57.2**	**21.0**	

Dataset used in the calculation of K_{Vb} (without WRAP data[26]).

Materials	Product	Recycled % as % of mass	Total UK manufacturer sales	Value of recycled content	Reference source
		Standard	£000s	£000s	
Metals	Steel section	60	3,553,152	2,131,891	PRA 28110 Metal Structures & Parts of Structures PCC 28110001, 28110002, 28111030, 28112100, 28112200 Steel section
	Steel coil	12	711,789	85,415	PRA 28110 Metal Structures & Parts of Structures PCC 28112350, 28112340 Sheet steel
	Stainless steel	75	322,954	242,216	PRA 27220 Steel tubes PCC 27221010, 27221070, 27222010, 27222030, 27222073, 27222075 Stainless steel tube
	Copper sheet	60	58,912	35,347	PRA 27440 Copper plates, sheets and strips PCC27442400
	Copper cable and pipe	15	171,194	25,679	PRA 27440 Copper tubes and pipe incl. refined and alloys PCC27442630
	Lead	80	106,729	85,383	PRA 27430 Lead, Zinc and Tin Production PCC 27432200 Lead
	Zinc	31	1,946	603	PRA 27430 Lead, Zinc and Tin Production PCC 27432550 Zinc - 2002 data only
	Aluminium extrusion	44	1,260	554	PRA 27420 Aluminium production PCC27422350 extrusion Al wire 2003 data only
	Aluminium sheet	73	73,819	53,888	PRA 27420 Aluminium production - PCC27422430 Al plates, sheets & strips >0.2mm thick
Board materials	Chipboard & hardboard (60% recycled mass)	65	202,764	131,796	PRA 20200 Timber board products PCC 20201333, 20201335, 20201337, 20201339- Chipboard, AMA - 40% of production used for construction
	Fibre boards	60	88,590	53,154	PRA 20200 Timber board products - excl. OSB and MDF and chipboard AMA = 40% of production is used in construction
	Medium density fibre board (MDF)	60	41,214	24,729	AMA - 40% of production used for construction
	Other boards			0	
	Plasterboard, plaster panels/tiles	36	491,641	176,991	PRA 26620 Plaster products for construction purposes
Brick & block	**Walls**		400,399	0	PRA 26610 - Building blocks & bricks of cement, concrete or artificial stone
	Dense block	0	271,464	0	Monthly Statistics of Building Materials and Components
	Lightweight block	50	131	66	Monthly Statistics of Building Materials and Components
	Aerated block	7	82	6	Monthly Statistics of Building Materials and Components
	Clay brick	0	523235	0	PRA 26400 Bricks, Tiles & construction products in baked clay. Clay bricks - PCC26401110
Thermal & acoustic insulation	Mineral wool	25	119000	29,750	Analysis of data on market share of recycled content in construction – WRAP March 2006
	Glass wool	30	160000	48,000	Analysis of data on market share of recycled content in construction – WRAP March 2006
	Foamed glass	66	220000	145,200	Analysis of data on market share of recycled content in construction – WRAP March 2006
	Cellulose fibres	80	1000	800	Analysis of data on market share of recycled content in construction – WRAP March 2006
Floor covering materials	Linoleum	24	65,755	15,781	PRA 36639 Other manufacturing PCC36634000 Linoleum
	Ceramic tiles and flags	0	97,527	0	PRA 26300 Ceramic tiles and flags
Roof materials	Reconstituted (resin bonded) slates	43	36000	15,480	Analysis of data on market share of recycled content in construction – WRAP March 2006
	Fibre cement	0	97,039	0	PRA 26650 Fibre cement
	Roofing felt	0	82,000	0	PRA 26820 Other non-metallic mineral products - PCC26521253 Roofing felt
Aggregate	Primary aggregate (crushed rock, sand & gravel)	0	1,680	0	QPA surveys and WRAP estimates for primary, secondary and recycled aggregates.
	Secondary aggregates	100	105	105	QPA surveys and WRAP estimates for primary, secondary and recycled aggregates.
	Recycled aggregates	100	451	451	QPA surveys and WRAP estimates for primary, secondary and recycled aggregates.
Mortar	Standard mortar mix (includes binder and aggregate contents)	3	143,029	4,291	PRA 26640 Mortars
Pipes	HDPE land pipe	20	252000	50,400	Analysis of data on market share of recycled content in construction – WRAP March 2006
	PVC soil & waste pipes	0	315000	0	Analysis of data on market share of recycled content in construction – WRAP March 2006
	PVC road drainage and land drainage pipe	0	105000	0	Analysis of data on market share of recycled content in construction – WRAP March 2006
Plaster	Lime based	0	132782	0	PRA 26530 Plaster for use in buildings and other uses eg dentistry
Electrical systems	Cable management/ trunking & ducting		155000	0	Analysis of data on market share of recycled content in construction – WRAP March 2006
Landscaping materials	Concrete kerb stones	3	907,392	27,222	PRA 26610 - Tiles, flagstones of cement, concrete & artificial stone PCC26611150
	Total for each category		£9,912,035	£3,385,197	
	Total construction products market		£14,722,000		
	Proportion of total market as %		**67.3**	**23.0**	

Dataset used in the calculation of K_{Ma} (with WRAP data

Materials	Product	Recycled % of mass	Total UK manufacturer sales	Sales/Production volume	Units	Value of recycled content
						£
		Standard	£000s			#VALUE!
Metals	Reinforcing steel	100		420	ktonnes	0
	Steel section	60	3553152	1231	ktonnes	2,131,891
	Coated steel coil	3		254	ktonnes	0
	Stainless steel	75	322954	205.4	ktonnes	242,216
	Copper sheet	60	58912	24.616	ktonnes	35,347
	Copper cable and pipe	15	171194	69.195	ktonnes	25,679
	Lead	80	106729	157.853	ktonnes	85,383
	Zinc	31	1946	2.207	ktonnes	603
	Aluminium extrusion	44	1,260	1.260	ktonnes	554
	Aluminium sheet	73	73819	20.699	ktonnes	53,888
Board materials	Plasterboard	36	491641	2.843	ktonnes	176,991
Brick & block	**Walls**		400,399	9,724.432	ktonnes	0
	Dense block	0	271,464	6,593	ktonnes	0
	Lightweight block	50	131	3.182	ktonnes	66
	Aerated block	7	82	1.986	ktonnes	6
	Clay brick	0	523235	5414	ktonnes	0
Floor covering materials	Ceramic tiles and flags	0	97527	10,236	ksqm	0
	Fibre cement	0	97039	57.2	ktonnes	0
Roof materials	Roofing felt	0	82000	85481	ksqm	0
Aggregate	Primary aggregate (crushed rock, sand & gravel)	0	1680	210	Mtonnes	0
	Secondary aggregates	100	104.8	13.1	Mtonnes	105
	Recycled aggregates	100	451.2	56.4	Mtonnes	451
Mortar	Standard mortar mix (includes binder and aggregate contents)	3	143029	2621	ktonnes	4,291
Thermal & acoustic insulation	Mineral wool	25	119000	167	ktonnes	29,750
	Glass wool	30	160000	175	ktonnes	48,000
	Foamed glass	66	220000	170	ktonnes	145,200
	Cellulose fibres	80	1000	3.5	ktonnes	800
Pipes	HDPE land pipe	20	252000	84	ktonnes	50,400
	PVC soil & waste pipes	0	315000	97.5	ktonnes	0
	PVC road drainage and land drainage pipe	0	105000	63	ktonnes	0
Plaster	Lime based	0	132782	1118.5	ktonnes	0
Landscaping materials	Concrete kerb stones	3	907392	13625.8	ktonnes	27,222
Electrical systems	**Cable management / trunking & ducting**		155000	41	ktonnes	0
	Total for each category		8,765,923			£3,058,842
	Total construction products market		14722000			
	Proportion of total market		59.5			20.8

Dataset used in the calculation of K_{Mb} (with WRAP data[26]).

Materials	Product	Recycled % of mass	Total UK manufacturer sales	Sales/Production volume	Units	Value of recycled content
						£
		Standard	£000s			
	Steel section	60	3553152	1231	ktonnes	2,131,891
	Stainless steel	75	322954	205.4	ktonnes	242,216
	Copper sheet	60	58912	24.616	ktonnes	35,347
	Copper cable and pipe	15	171194	69.195	ktonnes	25,679
	Lead	80	106729	157.853	ktonnes	85,383
	Zinc	31	1946	2.207	ktonnes	603
	Aluminium extrusion	44	1,260	1.260	ktonnes	554
Metals	Aluminium sheet	73	73819	20.699	ktonnes	53,888
Board materials	Plasterboard	36	491641	2.843	ktonnes	176,991
	Walls		400,399	9,724.432	ktonnes	0
	Dense block	0	271,464	6,593	ktonnes	0
	Lightweight block	50	131	3.182	ktonnes	66
Brick & block	Aerated block	7	82	1.986	ktonnes	6
Floor covering materials	Ceramic tiles and flags	0	97527	10,236	ksqm	0
	Fibre cement	0	97039	57.2	ktonnes	0
Roof materials	Roofing felt	0	82000	85481	ksqm	0
	Primary aggregate (crushed rock, sand & gravel)	0	1680	210	Mtonnes	0
	Secondary aggregates	100	104.8	13.1	Mtonnes	105
Aggregate	Recycled aggregates	100	451.2	56.4	Mtonnes	451
Mortar	Standard mortar mix (includes binder and aggregate contents)	3	143029	2621	ktonnes	4,291
Plaster	Lime based	0	132782	1118.5	ktonnes	0
Landscaping materials	Concrete kerb stones	3	907392	13625.8	ktonnes	27,222
	Total for each category		6,915,688			2,784,692
	Total construction products market		14722000			
	Proportion of total market		47.0			18.9

Dataset used in the calculation of K_{Va} **Good** practice (without WRAP data[26]).

Materials	Product	Recycled % as % of mass	Total UK manufacturer sales	Value of recycled content
		Good	£000s	£000s
Metals	Steel section	60	3,553,152	2,131,891
	Steel coil	12	711,789	85,415
	Stainless steel	75	322,954	242,216
	Copper sheet	60	58,912	35,347
	Copper cable and pipe	15	171,194	25,679
	Lead	80	106,729	85,383
	Zinc	31	1,946	603
	Aluminium extrusion	44	1,260	554
	Aluminium sheet	73	73,819	53,888
Board materials	Chipboard & hardboard (60% recycled mass)	70	202,764	141,935
	Fibre boards	60	88,590	53,154
	Medium density fibreboard (MDF)	60	41,214	24,729
	Plasterboard, plaster panels/tiles	84	491,641	412,978
Brick & block	**Walls**		400,399	0
	Dense block	10	271,464	27,146
	Lightweight block	60	131	79
	Aerated block	50	82	41
	Clay brick	5	523235	26,162
Floor covering materials	Linoleum	37	65,755	24,329
	Ceramic tiles and flags	9	97,527	8,777
Roof materials	Fibre cement	5	97,039	4,852
	Roofing felt	75	82,000	61,500
Aggregate	Primary aggregate (crushed rock, sand & gravel)	0	1,680	0
	Secondary aggregates	100	105	105
	Recycled aggregates	100	451	451
Mortar	contents)	10	143,029	14,303
Landscaping materials	Concrete kerb stones	20	907,392	181,478
	Total for each category		£8,416,253	£3,642,996
	Total construction products market		£14,722,000	
	Proportion of total market as %		**57.2**	**24.7**

Dataset used in the calculation of K_{Va} **Best** practice (without WRAP data[26]).

Materials	Product	Recycled % as % of mass	Total UK manufacturer sales	Value of recycled content
		Best	£000s	£000s
	Steel section	60	3,553,152	2,131,891
	Steel coil	12	711,789	85,415
	Stainless steel	75	322,954	242,216
	Copper sheet	60	58,912	35,347
	Copper cable and pipe	15	171,194	25,679
	Lead	80	106,729	85,383
	Zinc	31	1,946	603
	Aluminium extrusion	44	1,260	554
Metals	Aluminium sheet	73	73,819	53,888
	Chipboard & hardboard (60% recycled mass)	90	202,764	182,487
	Fibre boards	60	88,590	53,154
	Medium density fibreboard (MDF)	90	41,214	37,093
Board materials	Plasterboard, plaster panels/tiles	98	491,641	481,808
	Walls		400,399	0
	Dense block	20	271,464	54,293
	Lightweight block	80	131	105
	Aerated block	65	82	53
Brick & block	Clay brick	9	523235	47,091
Floor covering materials	Linoleum	37	65,755	24,329
	Ceramic tiles and flags	20	97,527	19,505
	Fibre cement	10	97,039	9,704
Roof materials	Roofing felt	90	82,000	73,800
	Primary aggregate (crushed rock, sand & gravel)	0	1,680	0
	Secondary aggregates	100	105	105
Aggregate	Recycled aggregates	100	451	451
Mortar	contents)	80	143,029	114,423
Landscaping materials	Concrete kerb stones	75	907,392	680,544
	Total for each category		£8,416,253	£4,439,923
	Total construction products market		£14,722,000	
	Proportion of total market as %		**57.2**	**30.2**

Dataset used in the calculation of K_{Vb} **Best** practice (with WRAP data[26]).

Materials	Product	Recycled % as % of mass	Total UK manufacturer sales	Value of recycled content
		Best	£000s	£000s
	Steel section	60	3,553,152	2,131,891
	Steel coil	12	711,789	85,415
	Stainless steel	75	322,954	242,216
	Copper sheet	60	58,912	35,347
	Copper cable and pipe	15	171,194	25,679
	Lead	80	106,729	85,383
	Zinc	31	1,946	603
	Aluminium extrusion	44	1,260	554
Metals	Aluminium sheet	73	73,819	53,888
	Chipboard & hardboard (60% recycled mass)	90	202,764	182,487
	Fibre boards	60	88,590	53,154
	Medium density fibreboard (MDF)	90	41,214	37,093
Board materials	Plasterboard, plaster panels/tiles	98	491,641	481,808
	Walls		400,399	0
	Dense block	20	271,464	54,293
	Lightweight block	80	131	105
	Aerated block	65	82	53
Brick & block	Clay brick	9	523235	47,091
	Mineral wool	50	119000	44,030
	Glass wool	70	160000	32,000
	Foamed glass	66	220000	145,200
Thermal & acoustic insulation	Cellulose fibres	90	1000	900
	Linoleum	37	65,755	24,329
Floor covering materials	Ceramic tiles and flags	20	97,527	19,505
	Reconstituted (resin bonded) slates	95	36000	34,200
	Fibre cement	10	97,039	9,704
Roof materials	Roofing felt	90	82,000	73,800
	Primary aggregate (crushed rock, sand & gravel)	0	1,680	0
	Secondary aggregates	100	105	105
Aggregate	Recycled aggregates	100	451	451
Mortar	Standard mortar mix (includes binder and aggregate contents)	80	143,029	114,423
	HDPE land pipe	75	252000	189,000
	PVC soil & waste pipes	10	315000	31,500
Pipes	PVC road drainage and land drainage pipe	100	105000	105,000
Plaster	Lime based	70	132782	92,947
Electrical systems	Cable management / trunking & ducting	75	155000	116,250
Landscaping materials	Concrete kerb stones	75	907,392	680,544
	Total for each category		£9,912,035	£5,230,950
	Total construction products market		£14,722,000	
	Proportion of total market as %		**67.3**	**35.5**