DEPARTMENT OF ENERGY & CLIMATE CHANGE

National Energy Efficiency Data-Framework

Summary of analysis using the National Energy Efficiency Data-Framework

November 2012

Contents

1. Executive summary

The National Energy Efficiency Data-Framework (NEED) was set up to provide a better understanding of energy use and energy efficiency in domestic and non-domestic buildings in Great Britain. This report covers:

- how the framework was developed;
- energy consumption by property attributes and household characteristics;
- estimates of the saving from installation of key energy efficiency measures and a summary of which households have received measures; and
- an initial assessment of the quality of non-domestic data in NEED.

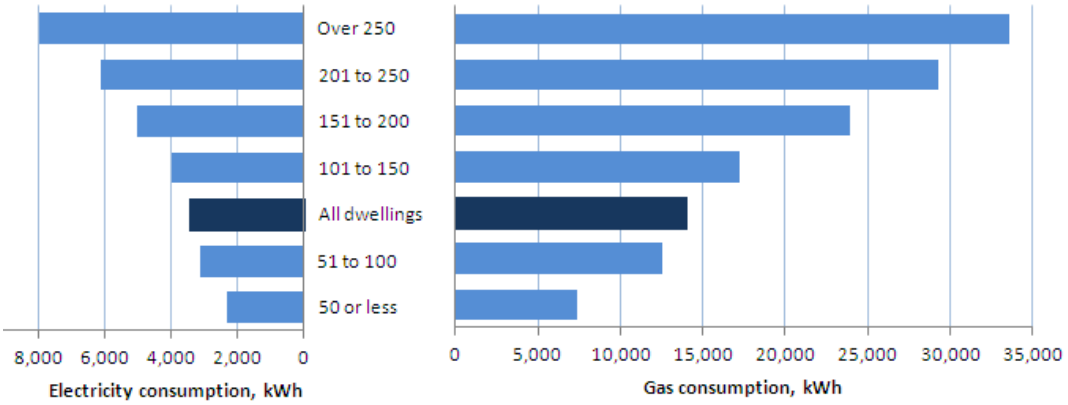
Improving the evidence base on energy efficiency is a major aim for the Department of Energy Climate Change (DECC). It benefits energy consumers and providers to understand how energy can be saved and the value of energy efficiency investments. It is also helpful to understand more about energy use to help change individuals' behaviour.

All results presented for domestic analysis in this report are based on a sample of data for England. Non-domestic results cover England and Wales.

Domestic energy consumption

The analysis shows that while the property attributes and household characteristics considered in NEED influence electricity and gas consumption they alone do not explain all the variation between properties. Of the variables within NEED, property size has the greatest influence – more significantly on gas consumption than electricity, see Figure 1.1.

Figure 1.1: Median gas and electricity consumption in 2010, by area of property, m^2



However, there is a significant amount of variation which has not been explained. This echoes other work undertaken on behalf of DECC to model gas consumption[1], which shows that only approximately 30 to 40 per cent of the variation in gas consumption seen in different households can be explained using the variables available in NEED[2]. In addition to these,

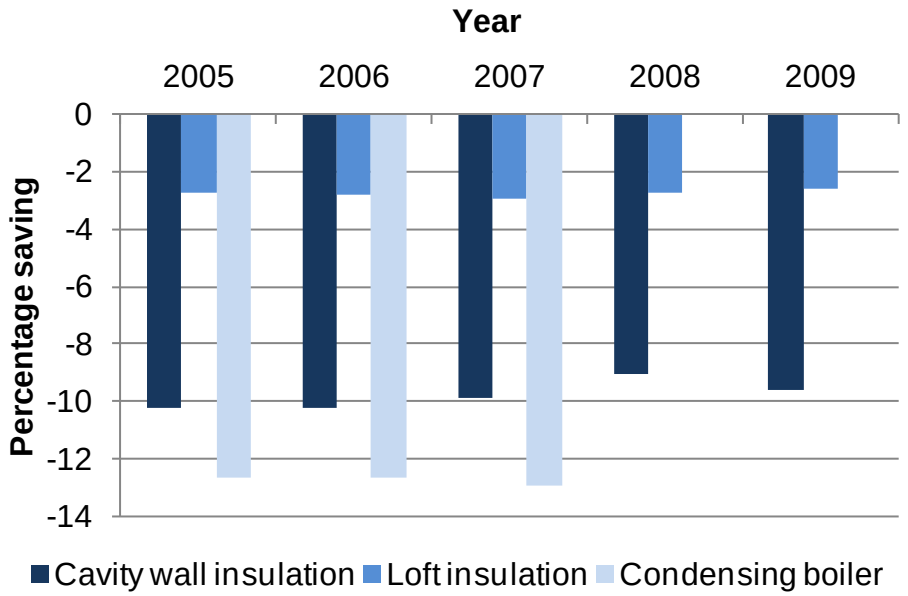
[1] Work undertaken by NERA and Katalysis set out in Annexes E and F of this report.
[2] DECC's local area gas model also draws a similar conclusion (See the special feature 'Identifying local areas with higher than expected domestic gas use' in Energy Trends, March 2012 available at:

there will also be some variation resulting from differences in the materials and methods used in building construction, and differences in performance of heating systems and appliances. However, a substantial component of the unexplained variance will stem from the behaviours of the individuals within the household, and how they express their preferences on heating and other energy use. The possibility of these behaviours and preferences changing over time in response to price and other drivers reinforces the importance of NEED as a useful supplement to physics based estimates of energy use.

Impact of energy efficiency measures

The analysis shows that considerable savings can be made by installing energy efficiency measures in homes. Savings based on data in NEED reflect observed savings, giving the saving after comfort taking (where a household takes the benefit of the insulation through increased warmth) and an average for all properties irrespective of whether the measure has been installed fully throughout the property. As a result there will be differences between the savings estimates reported in NEED and more technical physics based estimates. These savings estimates reflect what occurs in practise. Figure 1.2 shows the typical savings for households which use gas as the primary heating fuel for the three main measures considered in this report.

Figure 1.2: Summary of observed savings for energy efficiency measures (median)



The percentage saving for each of these measures is consistent across all the years considered. However, the typical kWh savings have decreased over time as typical gas consumption has decreased[3].

The report also highlights the variation in the observed savings for different types of properties and occupants.

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http://www.decc.gov.uk/assets/decc/11/stats/publications/energy-trends/4779-energy-trends-mar12.pdf).

[3] It should be noted that the data used for this analysis are weather corrected. This is important to ensure comparability between years but masks the variation in savings occurring as a result of different temperatures during the heating season. For example, in a year with a cold winter households will experience a greater absolute saving than they would in a warmer year.

Due to data availability, similar robust analysis of solid wall insulation was not possible. However, a preliminary assessment reflecting the savings for the types of properties that have received solid wall insulation through Government schemes between 2005 and 2008 is included. Due to the policy under which most of these measures have been installed, a high proportion of these households are in the Priority Group and are therefore not typical of the population as a whole. There are not enough observations to be able to draw reliable conclusions about the typical saving for all solid wall properties. However, it is estimated that for the types of properties which have received solid wall insulation (mainly smaller, council or housing association properties) the typical saving in annual gas consumption was 12.1 per cent. For a number of reasons (described further in Section 5.4), this is likely to be an underestimate of the typical saving for all solid wall properties in the population as whole.

The analysis from NEED will help support the development of key DECC policies, including the Green Deal, and will be used alongside other evidence to help understand observed savings and how and why these differ from physics based estimates. The work will be extended to cover Wales, and if possible Scotland, in future. Further work will also be undertaken on the non-domestic data in NEED to see whether robust analysis can be produced in order to inform energy policy in the non-domestic sector.

2. Introduction

The National Energy Efficiency Data-Framework (NEED) project was set up by DECC with support from the Energy Saving Trust (EST) and gas and electricity suppliers. Its purpose is to assist DECC in its business plan priority to "save energy with the Green Deal and support vulnerable consumers".

It is a key element of DECC's evidence base supporting DECC to:

- develop, monitor and evaluate key policies (including the Green Deal);
- identify energy efficiency potential which sits outside the current policy framework;
- develop a greater understanding of the drivers of energy consumption; and
- gain a deeper understanding of the impacts of energy efficiency measures for households and businesses.

The data framework provides the largest source of data available for analysis of consumption and the impacts of energy efficiency measures. The first results from the framework were published in June 2011, as a pilot to test the framework approach worked. It demonstrated the value of NEED and its importance to DECC and a wider group of stakeholders, and as result, further work has been undertaken enabling DECC to update and expand on results published in June 2011.

This report provides results which have been produced as part of a longer term plan to make best use of the potential of NEED. Results covered in this report are helping DECC reduce its dependence on survey data and small monitoring trials. It provides estimates based on observed energy use which can be used to help validate and improve theoretical estimates.

This report builds on the initial pilot findings and also provides results at a lower level of geography (local authority) for the domestic sector. It includes the first assessment of non-domestic data in NEED. The report covers four main areas:

- Section 3: Development of the framework – a brief overview of what NEED is and how it was developed;
- Section 4: Domestic energy consumption – analysis of energy consumption by property attributes and household characteristics;
- Section 5: Energy efficiency measures in homes – including estimates of the saving from energy efficiency measures and which households have received measures; and
- Section 6: Non-domestic consumption – an initial assessment of the quality of non-domestic data in NEED.

More detailed information, as well as further information on the quality of the data (Annex B) and methodology for estimating the impact of energy efficiency measures (Annex D), is included in the annexes to this report. A review of work undertaken by DECC contractors and how it compares with the results published by DECC is also included (Annexes E and F).

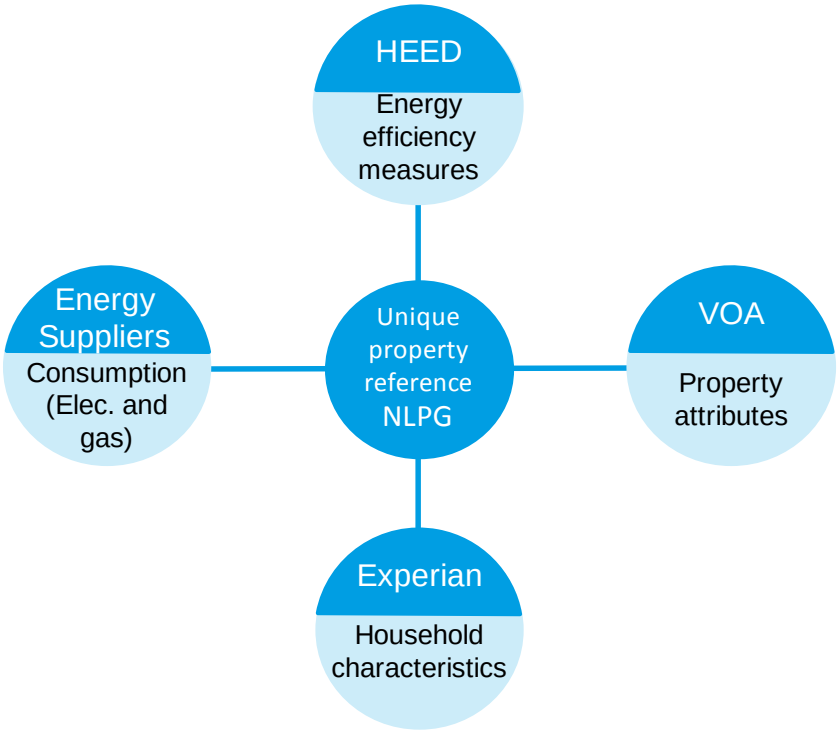
3. Development of the Framework

NEED is a framework for combining data from existing sources (administrative and commercial) to provide insights into how energy is used and what the impact of energy efficiency measures are on gas and electricity consumption, for different types of properties and households.

3.1 Overview

At the core of NEED is the National Land and Property Gazetteer (NLPG), the national standard for all buildings and addresses in England and Wales[4]. Datasets are combined within the framework using the NLPG unique property reference number (UPRN) as a spine. Address data from each of the datasets included in NEED is used to assign a UPRN to each record within that dataset. The UPRN is then used to link records from one dataset to the corresponding record in each of the other datasets. The diagram below shows how this works for the core data used for domestic analysis. The principle is the same for both the domestic and non-domestic sectors, though different data are used.

Figure 3.1: Residential data in NEED



Data in NEED covers the domestic and non-domestic sectors across the whole of Great Britain. The previous publication covered data in the domestic sector in England only. This publication again primarily covers only the domestic sector in England but also includes an initial assessment of the non-domestic data for England and Wales (Section 6). Table 3.1 shows the scope of data in NEED.

[4] The One Scotland Gazetteer is the equivalent in Scotland.

Table 3.1: Scope of NEED

In Scope	Out of Scope
Domestic and non-domestic properties	Very large consumers e.g. power stations
Great Britain[5]	Northern Ireland
Metered gas and electricity	Non-metered fuels e.g. oil, coal
Energy Efficiency Measures in HEED	DIY measures and others not recorded on HEED

The rest of this section provides further information on the data relating to households in NEED (domestic NEED) which underpins the majority of analysis in this report.

3.2 Data in NEED

Data in NEED are gathered from a variety of sources including publically available data and data through commercial licences, voluntary agreements and service level agreements with dataset owners. Four key data sources have been used in the domestic analysis: meter point gas and electricity consumption data; the Homes Energy Efficiency Database (HEED) which includes information on energy efficiency measures installed; Valuation Office Agency (VOA) property attribute data; and Experian modelled data on household characteristics.

Gas and electricity consumption data

Gas and electricity meter consumption data used in NEED are provided by suppliers and cover 2004 to 2010. These data are provided primarily in order to allow DECC to publish consumption data for small geographic areas[6]. Data are obtained from the billing data held on existing administrative systems of the energy companies. Data are annual with gas data covering the period from 1 October to 30 September and adjusted to reflect a weather correction factor. Electricity data cover the year up to the end of January.

Although these data come from the same source as the data used in DECC's published sub-national estimates of consumption, there are some differences between the data analysed. These are due to the cleansing and validation process carried out in NEED. The differences are summarised below.

Table 3.2: Differences in consumption data

NEED data	DECC's sub-national consumption estimates
• The property must be included as a domestic property on the Valuation	• Domestic properties classified based on consumption for gas (less

[5] Only England is included within the scope of analysis of the domestic sector in this report (England and Wales for the non-domestic sector) though data for all of Great Britain are available for a number of variables.

[6] More detailed information about how these data are collected and compiled for DECC's sub-national publication is available on the DECC website: http://www.decc.gov.uk/assets/decc/Statistics/regional/1087-guidance-note-regional-energy-data.pdf.

Office Agency property attribute dataset to be included in domestic NEED analysis.	than 73,200 kWh) and profile class for electricity (profiles 1 and 2 are domestic).
• Gas consumption between 100 kWh and 50,000 kWh.	• Gas consumption below 73,200 kWh.
• Electricity consumption between 100 kWh and 25,000 kWh.	• Electricity consumption below 100,000 kWh and profile class 1 or 2[7].
• Data matched to other sources via the NLPG UPRN at property level.	• Data assigned to Lower Level Super Output Area[8].
• Suspected estimated readings removed.	

These differences mean there are small differences in the mean consumption for the two dataset. Additional information on the rationale for and impact of these differences, as well as further information on the quality of all the data used in domestic NEED are included in Annex B.

Homes Energy Efficiency Database (HEED)

HEED is a national database developed by the Energy Saving Trust. It was set up to help monitor and target carbon reduction and fuel poverty work. It contains details of energy efficiency and micro-generation installations such as cavity wall insulation and solar hot water, including the date of installation. Data have been recorded in HEED since 1995 including activity reported from Government programmes, such as the Energy Efficiency Commitment (EEC) and Carbon Emissions Reduction Target (CERT), and some activity reported by trade associations. Approximately 50 per cent of UK homes have a record in HEED[9].

Valuations Office Agency (VOA)

The VOA are responsible for allocating homes in England and Wales to the appropriate Council Tax band. In order to do this it maintains a property database covering all properties in England and Wales. It includes information on the age of dwelling, dwelling type, number of bedrooms and floor area.

Experian

Experian is a commercial organisation which produces modelled data of household characteristics at address level. Variables include income group, number of adults, age of household reference person and length of residence. DECC purchased a sample of these data for England.

[7] Electricity consumption of between 50,000 and 100,000 kWh is reviewed and is it has a likely non-domestic address then it is also excluded from the sub-national domestic estimates.

[8] This means that for the sub-national consumption statistics some properties can be assigned accurately if the street is identified even if the exact property is not known.

[9] There are records for approximately 50 per cent of homes in the UK, however there is not full information for each of these records. More details on the number of records populated for each variable is given in Annex B. Data include activity delivered through Government schemes and activity reported from trade associations including, Gas Safe (formally CORGI) and FENSA. There is no information on measures that a household have installed themselves (DIY).

3.3 Creating an analytical dataset

In order to help increase processing speed and reduce cost it was decided that a sample would be used for analysis. A representative random sample of approximately 3.5 million records were selected from the VOA data. Due to legal restrictions, VOA data had to be analysed at VOA, so once all the other domestic datasets had been match, the matched sample dataset was taken to VOA and linked with their data. Analysis was then carried out at VOA with only aggregate outputs returned to DECC.

Data matching statistics

The table below shows the match rates for England and Wales for each of the datasets.

Table 3.3: Matching statistics at building level (sub-building[10] match rates in brackets)

Data source	Match rate
Electricity consumption[11]	94% (87%)
Gas consumption[12]	97% (93%)
HEED	99% (98%)
Experian	82% (69%)
VOA property attribute data[13]	100%

The match rates set out in the table are calculated based on the number of records for each relevant source; not the number of UPRNs in England and Wales. The figure quoted for HEED excludes flats which were excluded from the analysis of impacts of energy efficiency measures due to difficulties with matching.

More detailed information on NEED, including how it was developed and the data included in NEED is available in Annex A. Additional information on the quality of data in NEED is available in Annex B.

[10] A sub-building is a separate property within the same building. Such as a flat within a converted property or an individual shop within a shopping centre.
[11] Note that the match rate quoted for electricity and gas consumption include domestic and non-domestic properties.
[12] Note that the match rate quoted for electricity and gas consumption include domestic and non-domestic properties.
[13] The match rate for VOA data is 100 per cent as only VOA records that could be matched to the NLPG were included in the sample.

4. Domestic Energy Consumption

4.1 Introduction

A key purpose of NEED is to understand more about how much energy is used in different properties and by different households. This section presents consumption by various property attributes and household characteristics available in NEED. Gas and electricity consumption for 2010 is presented as well as trends in consumption from 2005 to 2010. The analysis is presented at national level for England. Similar information at local authority level is available in the supplementary data tables[14]. More detailed results including distributional analysis of consumption are available in Annex C.

The consumption data used in NEED are based on administrative billing data held by energy suppliers and published by DECC as sub-national consumption statistics[15]. There are some differences between the data published in the sub-national statistics and the data in NEED. Most significantly, the data used for analysis in this report are based on a sample of the data for England (as described in Section 3) and further cleansing is undertaken before data are used in NEED, including restricting valid consumption and removing suspected estimated readings. More information about this, including a comparison of national estimates with other published sources is available in Annex B. Table 4.1 gives summary statistics for gas and electricity consumption data used in NEED for 2010. Note that all consumption figures presented are based on valid domestic gas and electricity consumption for NEED (as defined above) and that all gas consumption data are on a weather corrected basis[16].

Table 4.1: Summary annual consumption statistics for 2010[17], kWh

	Mean	Standard deviation	Lower quartile	Median	Upper quartile
Gas	15,100	8,000	9,700	14,000	19,200
Electricity	4,200	3,100	2,200	3,500	5,300

The median gas consumption is 14,000 kWh and median electricity consumption is 3,500 kWh[18]. However, within the distribution, there is a range of consumption which can also be seen from the lower and upper quartiles[19] shown in the table. Due to the distribution of consumption data, mean consumption is larger than median consumption, by 8 per cent for gas and 22 per cent for electricity. The mean is influenced by a relatively small proportion of the sample with high

[14] Note that the NEED sample was not designed to be representative at geography lower than region. However, comparisons have been made with Valuation Office Agency property attributes data and all local authorities are adequately represented.
[15] http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/regional/regional.aspx
[16] This means that the consumption for each household has been adjusted to account for differences in temperature and wind in different years.
[17] Based on valid NEED sample.
[18] Consumption estimates throughout this report are rounded to the nearest 100 kWh.
[19] Quartiles (along with the median) divide the consumption values into four parts containing the same number of households. The lower quartile is the consumption value where 25 per cent of households have lower consumption and 75 per cent have a higher one. The upper quartile is the consumption value where 25 per cent of households have higher consumption and 75 per cent have a lower one.

consumption and hence the median is a better indication of typical consumption and is used throughout the rest of this section to represent typical consumption.

Supplementary data tables showing results for both the mean and median are available at: http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/en_effic_stats/need/need.aspx.

4.2 Property attributes

This section presents summary statistics for gas and electricity consumption in 2010 by property attributes. Information about the property attributes for each record was obtained from the Valuation Office Agency (VOA) property attributes database. The results show what the typical consumption is for different types of properties, this is an observed figure and therefore differs from the theoretical consumption derived from physics models.

While the typical consumption (median) is quoted throughout this section, in all cases there is a range of consumption observed for each attribute. More information on these ranges is provided in Annex C and the upper and lower quartiles for each category for each of the attributes considered are provided alongside the mean and median in the tables linked above.

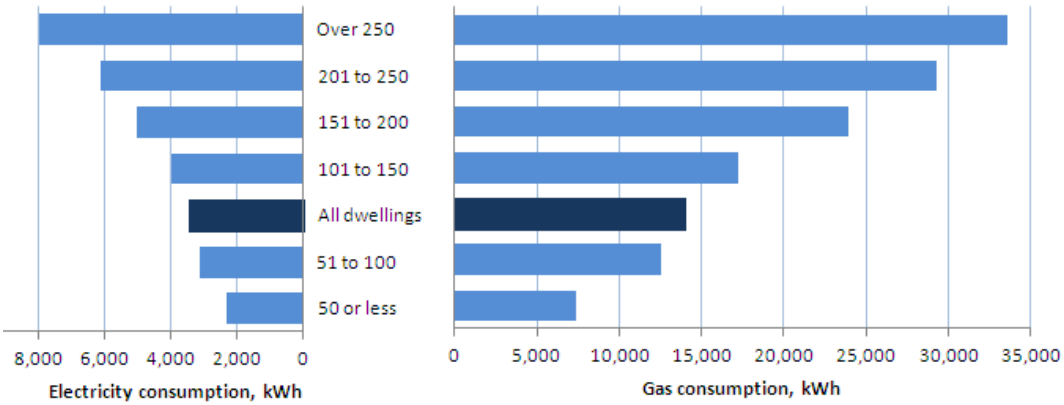
Property size

Property size can be characterised by the floor area of a property. In addition, the number of bedrooms in a property has a strong correlation with property size, so this is also considered below.

The average property has a total usable floor area of 92 square meters[20]. Over half of the properties in the NEED sample have a floor area of between 51 and 100 square meters and only about three per cent have a floor area greater than 200 square meters. Figure 4.1 shows median gas and electricity consumption by floor area band[21]. However, note that the floor area variable available from VOA is defined differently for houses and flats[22].

[20] Source: English Housing Survey (EHS) Homes Report 2010 published by the Department of Communities and Local Government available at http://www.communities.gov.uk/publications/corporate/statistics/ehs2010homesreport.
[21] Note the different scale used for gas and electricity consumption in this and following charts.
[22] For houses the “Reduced Covered Area” is used while the “Effective Floor Area” is used for flats. The floor area being captured for houses is measured externally and is effectively the building’s footprint. For flats, it is the internal floor area excluding some internal spaces such as bathrooms/showers and WCs which are not excluded for houses.

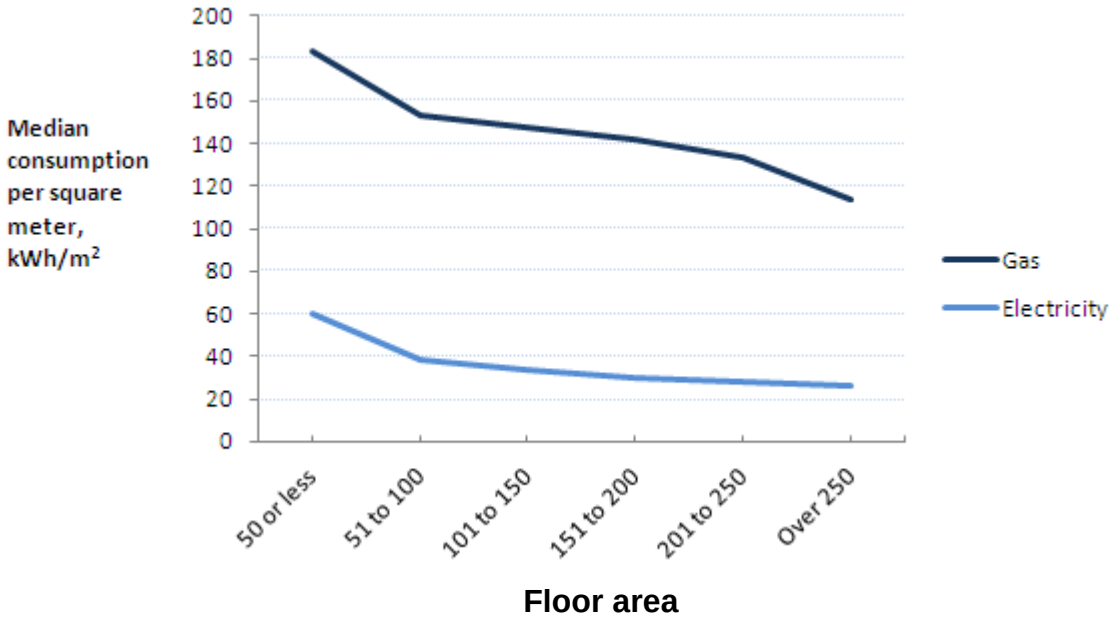
Figure 4.1: Median gas and electricity consumption in 2010, by area of property, m^2



The figure shows that typical consumption is higher for properties with a greater floor area for both electricity and gas. For example, properties with a floor area between 101 and 150 square meters use 23 per cent more than the typical gas consumption for all properties in England. They also use 15 per cent more electricity than typical for all dwellings. Properties in the higher size band (between 151 and 200 square meters) used more energy. Their median gas consumption was 71 per cent more than typical and their electricity 46 per cent more.

The increased consumption for larger homes reflects the fact that in general, more energy is required to heat a larger home and that larger homes are likely to have more appliances. However, the data suggests that the consumption per square meter decreases as property size increases. This is shown in Figure 4.2 below.

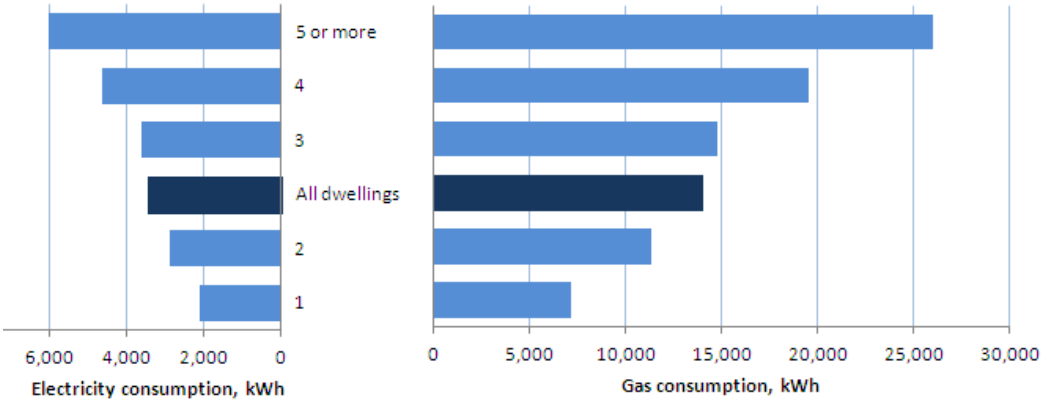
Figure 4.2: Median consumption per square meter, by floor area, m^2



For both gas and electricity, the smallest properties (with floor area of 50 square meters or less) use more energy per square meter than any other property size, while the largest properties have the lowest energy use per square meter. This suggests there is a minimum energy requirement that all properties have, such as refridgeration and cooking, or heating main living areas, and then an additional amount which is more closely linked to property size.

As described above, the number of bedrooms in a home can also be used as an indicator of its size[23]. The relationship between number of bedrooms and energy consumption is shown in Figure 4.3.

Figure 4.3: Median gas and electricity consumption in 2010, by number of bedrooms



There is a clear link between the number of bedrooms in a property and the amount of electricity and gas consumed. About half of the properties (47 per cent) in the sample have three bedrooms. Median consumption for these properties was 14,800 kWh for gas and 3,600 kWh for electricity. This was only slightly larger than the median consumption for all properties in England (about five per cent higher in both cases). Consistent with the findings for floor area, the consumption per bedroom decreases as the number of bedrooms increases up to three bedrooms (see Figure 2.7 in Annex B for further details). Beyond three bedrooms, consumption per bedroom remains approximately the same.

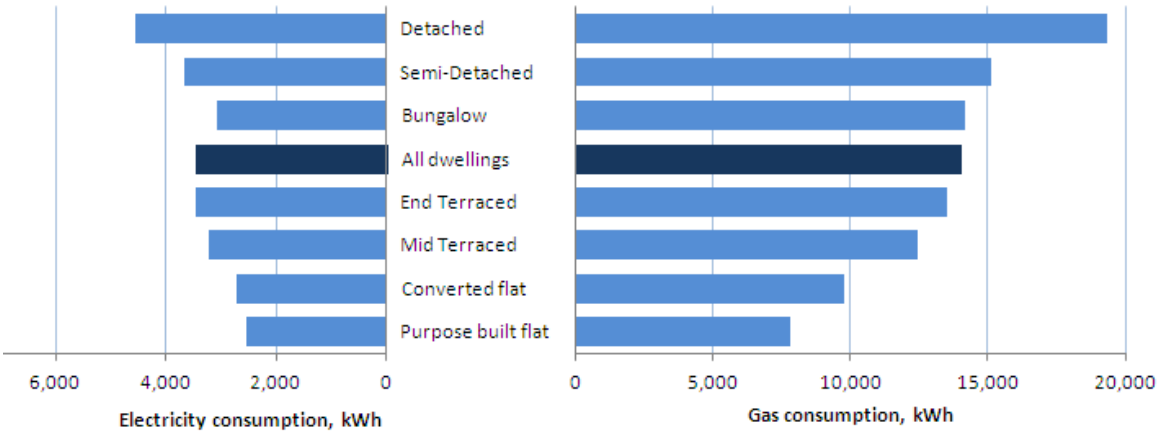
From the above it is clear that on average, larger properties have higher energy consumption. The typical consumption by other property attributes is set out below. The results below do not control for the size of property. This means that where there are correlations between property size and other categories (which in many cases there are, such as income) the size of property will be a factor in the observed typical consumption. For example, higher income households generally have larger properties. Annexes E and F provide more detail on models of consumption which attempt to consider the influence of a number of factors on gas consumption. The annexes show that, of all the variables considered, property size has the greatest influence on gas consumption. However, it only explains a small amount of the observed differences. Other physical attributes and household characteristics (as set out in the rest of this section) help explain variation but there remains a significant amount of variation which has not been explained. This is a results of different behaviours and differences between occupants which cannot be measured using data in NEED.

Property type

Figure 4.4 shows how typical gas and electricity consumption varies for different types of property.

[23] Note that the number of bedrooms includes rooms built as bedrooms even if they are currently used as bedrooms, but excludes rooms incapable of comfortably holding a single bed.

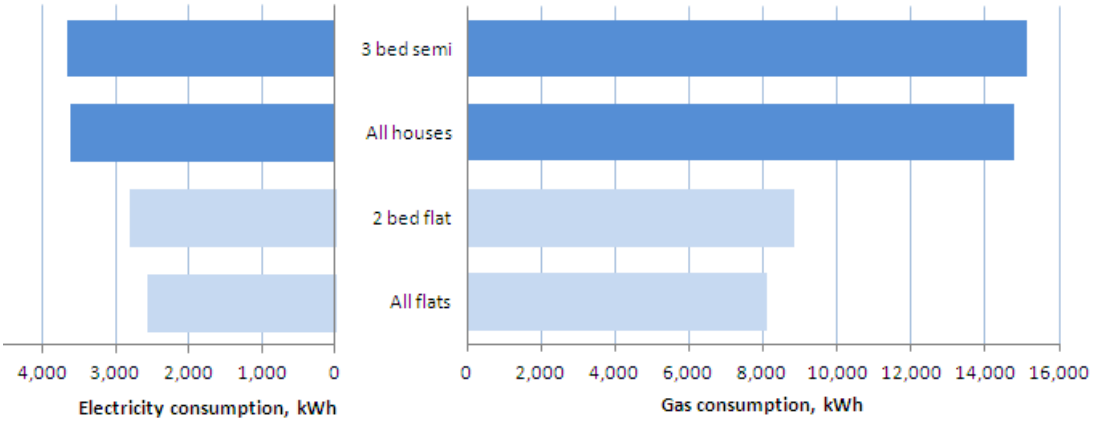
Figure 4.4: Median gas and electricity consumption in 2010, by property type



For different types of property, median consumption ranges from 7,800 to 19,300 kWh for gas and 2,500 to 4,600 kWh for electricity. Detached homes use the most gas, consuming about two and a half times more gas than purpose built flats –which are the lowest gas consumers.

The most common property in England is the three bedroom semi detached house[24]. Around 18 per cent of all properties in England fall into this house type (and 22 per cent of all houses). The most common flat is a two bedroom flat, with nine per cent of properties and 46 per cent of flats making up this property type. Figure 4.5 shows how the consumption of these common property types compares with the consumption for houses and flats in general.

Figure 4.5: Median gas and electricity consumption in 2010 for common property types



Three bed semis use comparable but slightly more energy than typical consumption for all houses (two per cent more gas and one per cent more electricity). Two bed flats on the other hand have higher consumption than that in the typical flat (nine per cent more gas and ten per cent more electricity).

Property age

Two in five properties in England were built prior to the end of World War Two (pre-1945). A similar proportion were built within 40 years of the end of the war (1945 to 1982) with only one in

[24] Source: English Housing Survey Homes Report, published by the Department of Communities and Local Government and available at: http://www.communities.gov.uk/publications/corporate/statistics/ehs2010homesreport.

five houses having been built since 1983[25]. Figure 4.6 shows how consumption varies by dwelling age.

Figure 4.6: Median gas and electricity consumption in 2010, by dwelling age

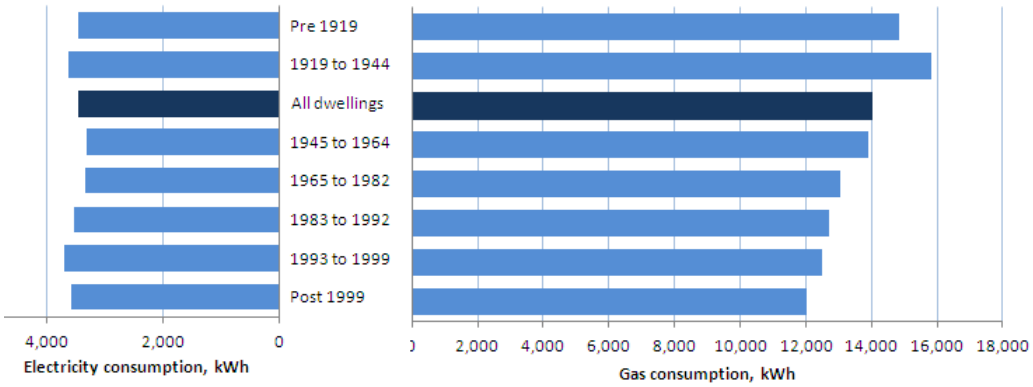


Figure 4.6 shows that in general, older properties have a higher gas consumption than newer ones. This is largely due to improved building regulations regarding energy efficiency since the 1980s[26]. However, there are some exceptions; the very oldest properties (pre 1919) have a lower median gas (and electricity) consumption than those built between 1919 and 1944. In addition, properties built between 1983 and 1992 have a lower median gas consumption than those built later, between 1993 and 1999.

Any link between property age and electricity consumption is not clear. The highest electricity consumption is seen in properties built between 1993 and 1999, but this is only seven per cent more than the median for all properties and 11 per cent more than the median for the lowest group (1945 to 1964).

4.3 Household characteristics

This section sets out median gas and electricity consumption in 2010 for household characteristics, covering tenure and household income.

The data for household characteristics are based on modelled data from Experian. DECC leased this information for approximately 3 million records representing about ten per cent of households in England (about three quarters of the analysis sample). The results below are based on all records in the sample which have an Experian record and valid consumption. As the data from Experian are modelled, estimates are indicative of characteristics of the household rather than actual data for the household and therefore results should be interpreted in this context. Annex B provides more details of quality including accuracy of Experian data.

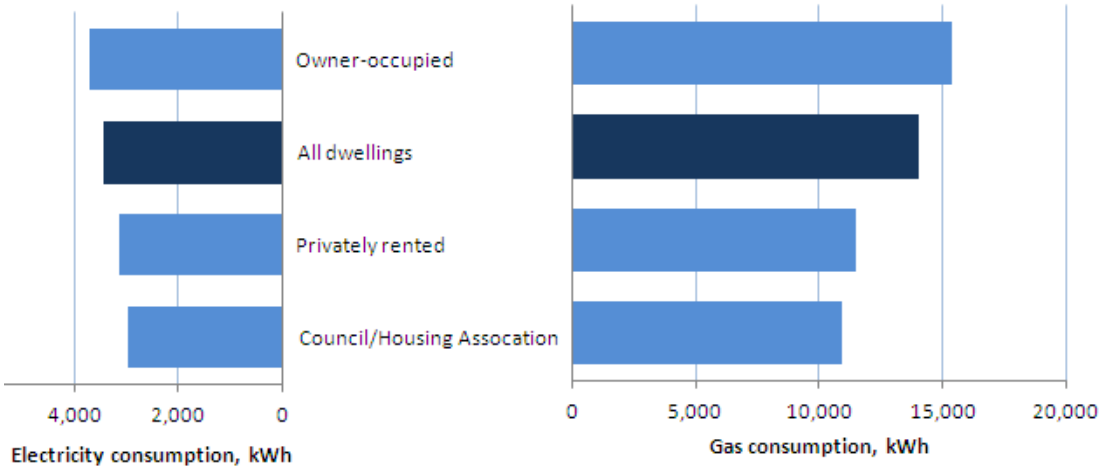
Tenure

The relationship between tenure and energy consumption is similar for gas and electricity, Figure 4.7. Owner occupiers have a higher typical gas and electricity consumption than households living in privately rented properties. Council/housing association occupants have the lowest gas and electricity consumption. Some of this difference is likely to be explained by the fact that social

[25] Source: English Housing Survey Homes Report, published by the Department of Communities and Local Government and available at: http://www.communities.gov.uk/publications/corporate/statistics/ehs2010homesreport
[26] Building Regulations Part L (Conservation of fuel and power).

housing is generally more energy efficient than other properties, as indicated by their higher SAP rating[27]. The lower gas consumption in rented properties compared with owner occupiers may also be related to the size of property as rented properties are generally smaller.

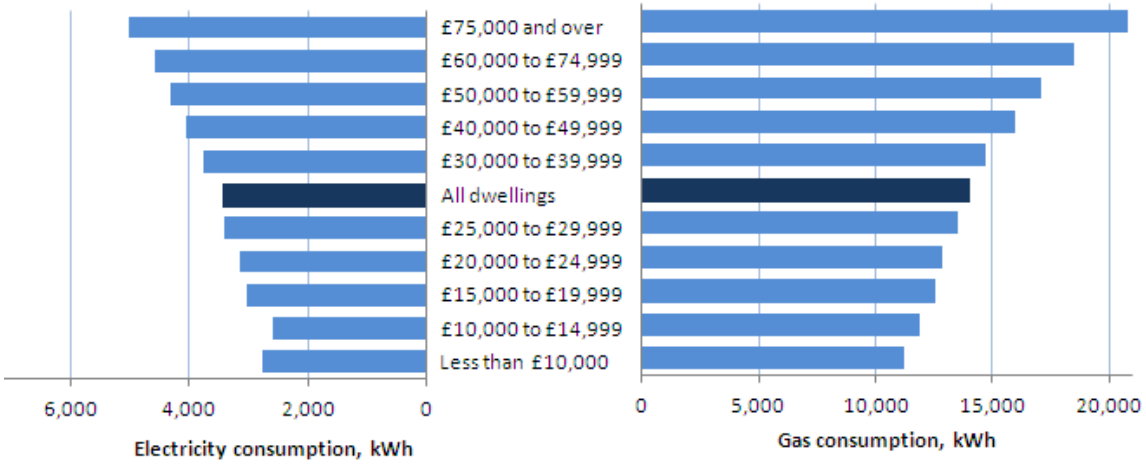
Figure 4.7: Median gas and electricity consumption in 2010, by tenure



Household Income

Figure 4.8 shows median gas and electricity consumption with the higher earners at the top and the lowest earners at the bottom.

Figure 4.8: Median gas and electricity consumption in 2010, by household income



The figure shows that households with higher incomes typically consume more gas. The increase in gas consumption is most apparent for households on incomes of £30,000 and above. For these households, gas consumption increases steadily in the region of eight per cent for each subsequent band.

[27] Source: English Housing Survey Homes Report, published by the Department of Communities and Local Government and available at: http://www.communities.gov.uk/publications/corporate/statistics/ehs2010homesreport. The SAP rating is a measure of the overall energy efficiency of the dwelling.

The relationship between income and electricity consumption follows a similar pattern to that of gas. The only exception is for households on between £10,000 and £14,999 which had a median electricity consumption less than those in the lowest income band (less than £10,000). However, this may be a factor of the quality of the income data which is known to be least reliable for the lowest income bands.

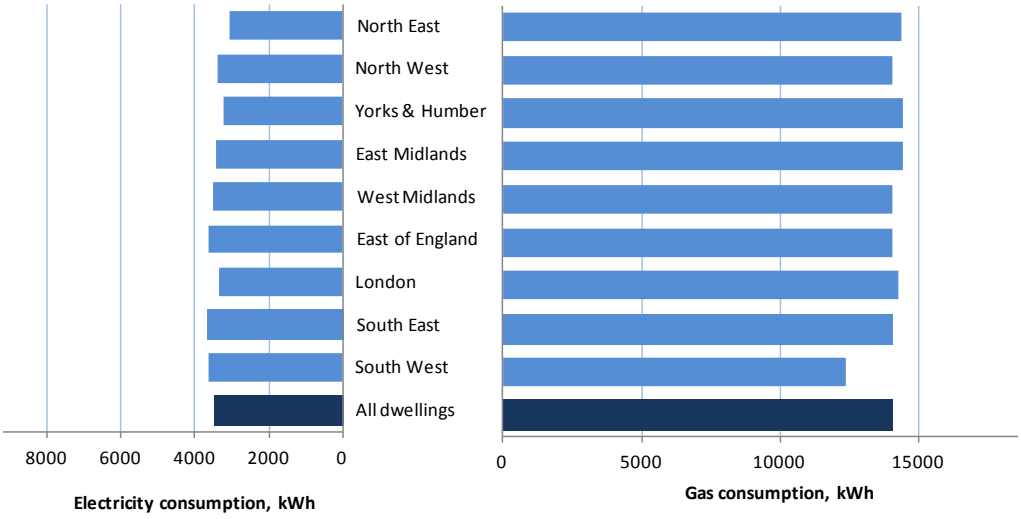
4.4 Geography and area classification

This section provides information about median gas and electricity consumption in 2010 by geography and output area classification. Geographic and area classification information is derived from the address information.

Region

There is very little variation in consumption between regions, particularly for gas, except for the South West which has a typical consumption 12 per cent lower than that for England. This is seen in all years considered (see Annex C) and could be due to a number of factors, such as different types of properties.

Figure 4.9: Median gas and electricity consumption in 2010, by region



Electricity consumption shows more variation by region than gas consumption, but again there is no clear pattern. Median consumption in the South East is the highest (seven per cent higher than the median for all properties), while the North East has the lowest median consumption (11 per cent lower than the median for all properties). Some of the variation between regions may be due to the proportion of properties using electricity to heat their homes or because of differences in the behaviours of occupants.

Output area classification

Output area classification is a neighbourhood classification from the Office for National Statistics based on socio-economic data. It can be used to make comparisons of energy consumption by type of neighbourhood. Figure 4.10 shows consumption for the seven super groups[28].

[28] Output Area Classifications split neighborhoods into seven super groups and 21 groups. More information on Output Area Classifications is available in Annex B and results for the 21 groups are provided in the accompanying tables.

Figure 4.10: Median gas and electricity consumption in 2010, by Output Area Classification

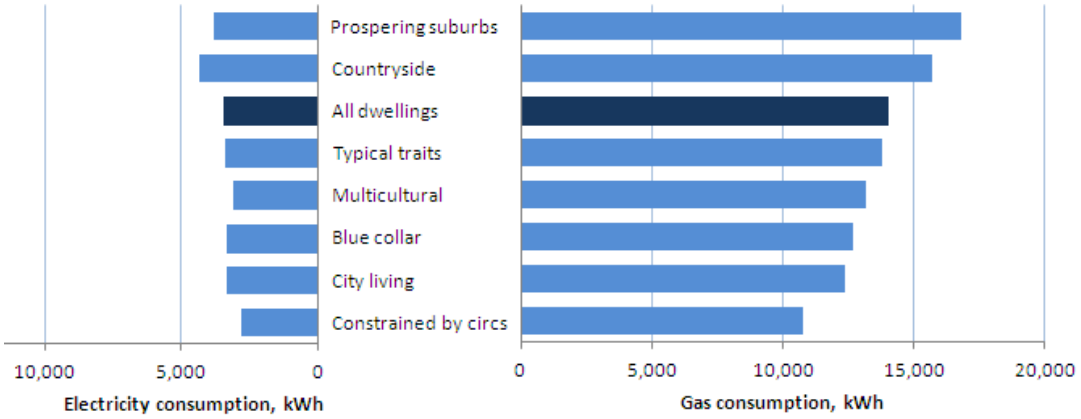


Figure 4.10 shows that the group with the highest median gas consumption is the more affluent 'prospering suburbs'. This group has a median gas consumption a fifth higher than typical and close to three-fifths (56 per cent) more than the group with the lowest median, those 'constrained by circumstances'. Gas consumption is also low for city living communities, which may partly be due to the size and type of property common in such areas.

There is no clear relationship between gas and electricity consumption for households in each type of area, except that communities constrained by circumstances also use the least amount of electricity. The main difference is that areas in the countryside have a higher median electricity consumption than any other neighbourhood type.

4.5 Trends in consumption

This sections provides an overview of the trends in median gas and electricity consumption between 2005 and 2010, a summary of median consumption for variables not included in this section is included in Annex C with data provided in the accompanying tables. For context, Table 4.2 shows the median consumption for all households with valid consumption in the NEED sample between 2005 to 2010.

Table 4.2: Median gas and electricity consumption 2005 to 2010, kWh[29]

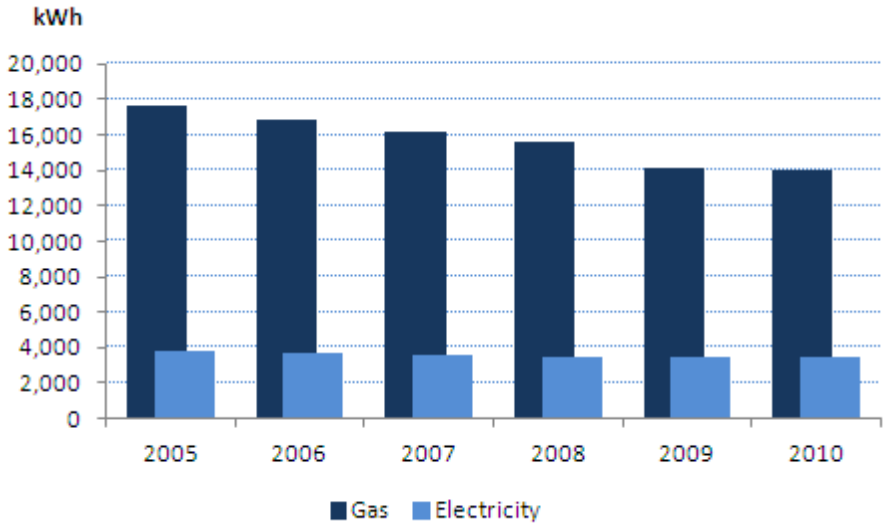
	2005	2006	2007	2008	2009	2010
Gas	17,700	16,800	16,200	15,600	14,100	14,000
Electricity	3,800	3,700	3,600	3,500	3,400	3,500

The data used in NEED are weather corrected, which means that the consumption for each household has been adjusted to account for differences in temperature in different years. This allows a more consistent comparison for analysis as it eliminates the fluctuation which would be observed as a result of warmer or cooler weather in each year. The table shows that both gas and electricity consumption have been generally declining over the period. Gas consumption decreased steadily each year by about four per cent, until 2009 where is decreased sharply by nine per cent. This was followed by a slight decrease of one per cent in 2010. This resulted in the average annual decrease over the period being maintained at about four per cent.

[29] Based on valid NEED sample.

Median electricity has seen a steady year on year decrease, between two and four per cent in electricity consumption until 2008; since then it has remained fairly constant.

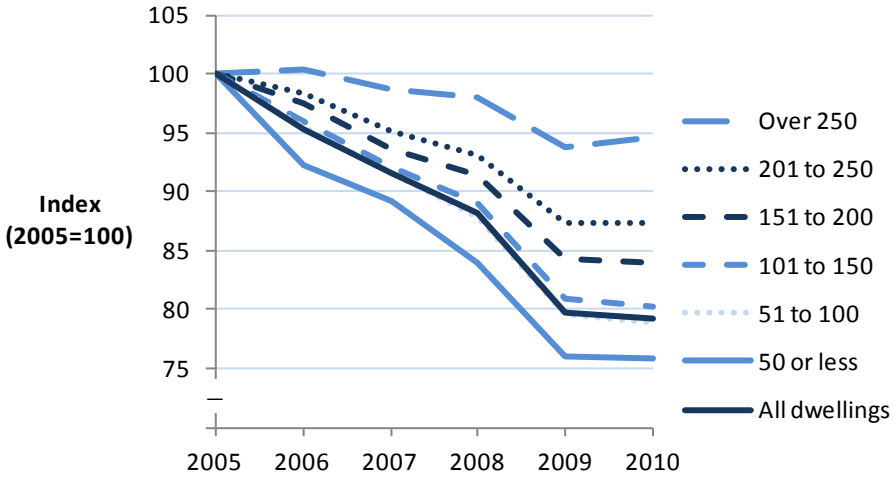
Figure 4.11: Median gas and electricity consumption 2005 to 2010, kWh



The reduction in median consumption for different types of properties and occupants follows a similar pattern as that for all dwellings. Although the general trend is the same, gas consumption shows more variation in the magnitude of the decrease than electricity.

Figure 4.12 shows the trend in valid gas consumption for properties by floor area band. In the following charts, changes in consumption are shown relative to a baseline of 2005 (2005=100)[30].

Figure 4.12: Annual gas consumption by floor area (m^2), 2005 to 2010 (2005 = 100)



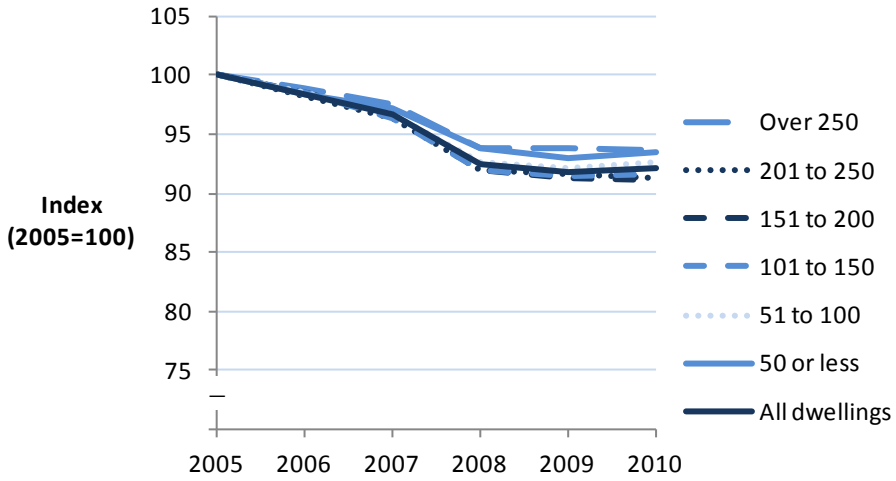
The figure shows that between 2005 and 2010 median gas consumption for properties in different floor area bands follows a similar trend to the national trend. It shows that median consumption has reduced between 2005 and 2010 for all bands. Generally, the smaller properties showed a greater percentage decrease in consumption over the period than larger properties. For example the reduction in median consumption for properties with a floor area of 201 to 250 square metres

[30] Note that the y axis for these charts does not start at zero in order to allow differences between groups to be seen more clearly.

was 13 per cent and the reduction for properties with a floor area of less than 50 square metres or less was 24 per cent. The largest properties (greater than 250 square metres) had a decrease in median consumption of only five per cent but this group form only one per cent of the sample.

Figure 4.13 shows the equivalent information for the trend in valid electricity consumption.

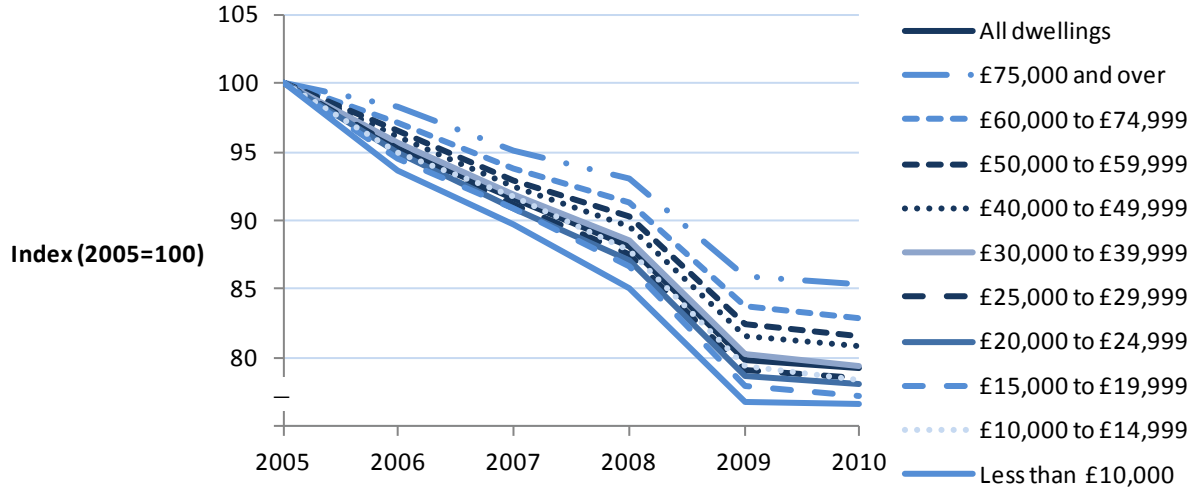
Figure 4.13: Electricity consumption by floor area (m^2), 2005 to 2010 (2005 = 100)



This demonstrates that there is a lot less variation in the median electricity consumption trend for different floor area bands. The figure shows there is a smaller decrease in electricity consumption over the period compared to that of gas. For all bands, median consumption in 2010 was between six and nine per cent less than 2005. Unlike gas consumption, there is no obvious link between reduction in median electricity consumption and floor area band.

Figure 4.14 shows the trend in valid gas consumption for households by income band.

Figure 4.14: Trend in gas consumption by household income relative to 2005 consumption, 2005 to 2010



The figure shows that median consumption for households in the higher income bands generally reduced by less than that for households in the lower income bands. Those in the highest band

reduced median consumption by 15 per cent compared with 23 per cent for the lowest income band[31].

As with floor area, less variation was seen in the trend for median electricity consumption by income band. Across all income bands, median electricity consumption in 2010 was between seven and nine per cent below 2005.

4.6 Conclusion

The findings show that there is considerable variation in median gas and electricity consumption for different property attributes and household characteristics. It shows that property size appears to be the strongest driver of gas consumption, as this variable shows the most variation between group medians. The link between household characteristics and electricity consumption is similar to that for gas, although there is no clear link between property age and electricity consumption, unlike for gas.

For the results shown in this section there is no attempt to control for other variables, therefore it is likely that some of the variation seen in some results is due to correlation with other variables (e.g. median consumption by property type is partly due to the typical size of properties in each group). There is also a lot of variation in consumption which is not seen by solely considering the median consumptions. The distribution for each of the property attributes and characteristics is shown in Annex C and the accompanying tables. This distribution shows that there is a lot of variation in consumption which cannot be explained purely by a single property attribute or household characteristic. This result is confirmed by further work undertaken by and on behalf of DECC to model gas consumption[32], which shows that only approximately 30 to 40 per cent of the variation in gas consumption seen in different households can be explained using the variables available in NEED or similar data. The work shows that, of all the variables considered, property size has the greatest influence on gas consumption. Other physical attributes and household characteristics help explain variation but there remains a significant amount of variation which has not been explained. This is a result of different behaviours and differences between occupants which cannot be measured using other currently available data.

[31] Note that the quality of income data is least accurate for the lowest and highest income groups so this comparison should be treated with caution – however the general finding that median consumption for households in the higher income bands reduced by less than that for households in the lower income bands is more reliable.

[32] Including work undertaken by NERA and Katalysis set out in Annexes E and F respectively and DECC's local area gas model (See the special feature 'Identifying local areas with higher than expected domestic gas use' in Energy Trends, March 2012 available at: http://www.decc.gov.uk/assets/decc/11/stats/publications/energy-trends/4779-energy-trends-mar12.pdf).

5. Energy Efficiency Measures in Homes

5.1 Introduction

The uptake of energy efficiency measures has been encouraged over recent years through Government schemes such as the Energy Efficiency Commitments (EEC), the Carbon Emissions Reduction Target[33] (CERT), the Community Energy Saving Programme[34] (CESP) and Warm Front[35]. The current Government schemes are due to end in December 2012, and new schemes such as the Green Deal and the Energy Company Obligation (ECO) will replace them, aiming to continue to improve the energy efficiency of the housing stock. It therefore remains important to understand the types of properties that have received measures and how these measures affect households gas consumption to help understand the impact of past policy and help with effective delivery of future policy.

This section of the report covers:

- take up rates of energy efficiency measures;
- the impact on gas consumption of having energy efficiency measures installed; and
- initial assessment of impact of measures on gas consumption over time.

This analysis is based on observed savings and therefore takes into account factors such as comfort taking (where some households take the benefit of the insulation measure through increased warmth rather than entirely through energy saving), and the fact that not all measures can be installed in every part of a home. As a result there will be differences between the savings estimates reported in NEED and more technical physics based estimates. The estimates set out in this report are a reflection of what occurs in practise.

The energy efficiency measures included in this analysis are: cavity wall insulation, professionally installed loft insulation, condensing boilers and solid wall insulation. Data on measures installed in homes is taken from the Homes Energy Efficiency Database (HEED). HEED picks up many of the energy efficiency measures installed through Government schemes, but cannot pick up measures installed in properties when they are built or other measures installed outside Government schemes, such as loft insulation installed by the homeowner themselves. More information on the data in HEED including an assessment of its quality is included in Annex B of this report.

5.2 Rates of take up

NEED can be used to look at the take up of different energy efficiency measures by property attributes and household characteristics, specifically, property age, property type, number of bedrooms, floor area, income and tenure. The dataset used in this section of analysis covers records in NEED where HEED data could be matched to the Valuations Office Agency (VOA) property attribute data. Property attribute breakdowns for installations of solid wall insulation

[33] http://www.decc.gov.uk/en/content/cms/funding/funding_ops/cert/cert.aspx
[34] http://www.decc.gov.uk/en/content/cms/funding/funding_ops/cesp/cesp.aspx
[35] http://www.decc.gov.uk/en/content/cms/funding/warm_front/warm_front.aspx

have been included for the first time, however, it should be noted that only 13,000 homes included in this section of analysis have had solid wall insulation installed (0.2 per cent of solid wall properties in England[36]). It should also be noted that properties using different types of heating fuel have been included when looking at take up of measures while the savings estimates covered in later parts of this report only refer to measures installed in properties which use gas. Also, flats are included in this section of analysis, however they are not included in the impact of measures analysis. This is because the analysis is carried out at a property level and in a large number of cases insufficient address details were available to identify which flat within a building received the energy efficiency measures and therefore the measure could not be accurately match to the appropriate consumption.

The analysis in this section is based on HEED. This has good coverage of energy efficiency measures installed under CERT, but progressively less coverage of early policies aimed at improving the energy efficiency of the housing stock. It also has no coverage of measures installed by the home owners themselves and the measures installed in a property when it was built. The analysis of the take up of measures is included to provide an understanding of the distributional differences in rates of take up, it is not intended to be an accurate reflection of the total proportion of properties that have had each measure installed.

For a more complete picture of the total number of homes in Great Britain with cavity wall, loft and solid wall insulation users should refer to 'Estimates of Home Insulation Levels in Great Britain'[37]. This is based on national housing surveys from April 2008 and measures installed through Government schemes since April 2008, including DIY loft insulation. It also takes into account new builds and other changes to the housing stock such as demolitions and change in building use.

Property age

Properties built between 1945 and 1982 were most likely to have received retro-fit cavity wall insulation (CWI), with 29 per cent of properties built between 1945 and 1964 having CWI installed and 26 per cent of properties built between 1965 and 1982 receiving the measure. A similar amount of loft insulation has been installed in properties of all ages up to 1992, with proportions ranging from 13 to 18 per cent. Newer properties have lower proportions of both cavity wall and loft insulation since properties have begun to have their walls and lofts insulated when built[38]. Condensing boilers have been installed in less than ten per cent of properties in each age group, with the proportion in each property age group ranging from three to eight per cent. However it should be noted that information on condensing boilers installed is only available up to 2008. The proportion of properties with solid wall insulation installed is very low across all age categories, only one per cent of homes built between 1945 and 1982 have had solid wall insulation installed with fewer than one per cent having had the measure installed for all other age categories.

Property type

Bungalows are most likely to have had an energy efficiency measures installed, with 28 per cent of them having had cavity wall insulation installed, a quarter having had loft insulation and eight per cent having had a replacement condensing boiler installed. This is likely to be due to the fact that the people in these properties are more likely to be eligible for assistance from

[36] This is based on the number of solid wall properties reported in the English Housing Survey: Home Report 2010 http://www.communities.gov.uk/publications/corporate/statistics/ehs2010homesreport.
[37] http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/en_effic_stats/home_ins_est/home_ins_est.aspx
[38] See Annex G for a summary of building regulations since 1985.

energy efficiency schemes. Energy efficiency measures are next most likely in semi detached properties – a quarter have had cavity wall insulation installed and 18 per cent have had loft insulation.

Number of bedrooms

Properties with three bedrooms are the most likely to have had cavity wall and loft insulation installed – 22 and 18 per cent respectively. The installation of condensing boilers shows less differentiation between properties with different numbers of bedrooms, with approximately six per cent having had a condensing boiler installed in all cases.

Floor area

Around 20 per cent of properties with a floor area of between 51 to 100, and 101 to 150 square metres have had cavity wall insulation installed. Similarly, 17 per cent of properties with the same floor areas have had loft insulation installed. Properties with a floor area of between one and 50, and greater than 250 square metres have the lowest proportion of energy efficiency measures installed.

Tenure

A similar proportion of owner occupied properties have had cavity wall insulation and loft insulation installed, 20 and 17 per cent respectively. Similarly, 20 per cent of council or housing association properties have had retro-fit cavity wall insulation, and 15 per cent have had loft insulation. Privately rented properties are least likely to have any of the three energy efficiency measures considered, with only 10 per cent having cavity wall insulation, 11 per cent with loft insulation and six per cent with a condensing boiler. Privately rented properties could be less likely to have cavity wall and loft insulation since the owner of the property would not see the benefit from having the measure installed as they are renting their property out.

Income

Properties with a household income of between £10,000 and £14,999 are most likely to have had cavity wall and loft insulation installed, with just under a quarter having cavity wall insulation and 22 per cent having loft insulation. After the income group of between £10,000 and £14,999 the proportion of properties with loft insulation decreases as household income increases. This may be due to the fact that Government schemes delivering such measures have specific targets aimed at low income households. The installation of condensing boilers shows little differentiation between household income groups, with approximately seven per cent having had a condensing boiler installed in all cases.

5.3 Methodology – Impact of energy efficiency measures

This section summarises the methodology for estimating the impact of the installation of energy efficiency measures on the amount of gas required to heat a home. A more detailed account of the methodology, including changes to the methodology since the last NEED publication in June 2011, can be found in Annex D Section 4.

The impact of installing energy efficiency measures on a household's gas consumption is estimated by comparing the gas consumption of properties before and after installation of a specific energy efficiency measure, with the gas consumption of similar properties which have not had a measure installed over the same period. To do this, intervention and comparator groups were created – with the intervention group containing properties which have received

the energy efficiency measure being considered (and no other measure), and the comparator group containing similar properties that have not had an energy efficiency measure installed[39]. Headline savings in the report are based on the percentage savings observed. The kWh saving estimates are calculated by applying the percentage saving to the typical gas consumption of a three bedroom semi detached house – except for solid wall insulation which is calculated slightly differently due to the nature of the properties receiving this measure to date (this is explained in more detail in the results section below).

The benefit of the approach used in NEED is that it allows for a better understanding of the observed savings from energy efficiency measures and compliments DECC's understanding of the technical potential of such measures. Savings estimated based on this approach are expected to be lower than the technical potential of a measure because of factors such as comfort taking[40] or incomplete installations (such as not all walls being insulated when a property received cavity or solid wall insulation). It also means the saving estimate is based on the amount of energy the households receiving the measure are using rather than the modelled consumption which is assumed when calculating the technical potential[41].

The rest of this section provides details of how the intervention and comparator groups were formed and compared.

Intervention group

A separate intervention group was created for each of the energy efficiency measures considered and for each year being investigated. To be included in the intervention group properties must have had the measure under consideration installed in the stated year, and meet the following conditions:

- Properties must have had no other significant energy efficiency measure recorded as being installed in the period.
- Records have to have a valid gas consumption (between 2,500 and 50,000 kWh) in the year the energy efficiency measure was installed, and the year before and after installation.
- Estimated gas consumption readings are excluded.
- Properties with an increase in gas consumption of 50 per cent or more, or a decrease of 80 per cent or more are excluded since it is likely something other than the installation of an energy efficiency measure is causing this change in consumption, such as change in occupants or their circumstances.
- Flats are excluded from the analysis as address information in HEED did not allow a reliable match for individual flats within a building.

[39] This group has no energy efficiency measure recorded as being installed in HEED. These properties may have had a measure installed which has not been recorded in HEED, such as DIY loft insulation.
[40] Comfort taking is a rebound effect where some households take the benefit of the insulation measure through increased warmth rather than entirely through energy saving (or reduced bills).
[41] Some pilot work has been done to look at the difference between modeled and observed consumption. More information about this work can be found in Section 6.1 of the Annual Report on Fuel Poverty Statistics 2012 here: http://www.decc.gov.uk/assets/decc/11/stats/fuel-poverty/5270-annual-report-fuel-poverty-stats-2012.pdf.

Comparator group

As the analysis was carried out retrospectively it was not possible to create a control group in advance of measures being installed. Therefore a comparator group was created retrospectively. A separate comparator group was created for each measure for each intervention year – this is made up of properties with no record of ever having had the following energy efficiency measures installed as recorded in HEED: cavity wall insulation, loft insulation, heating measures, solid wall insulation, double glazing and draught proofing. In addition, as outlined in the intervention group section above, the gas consumption has to be valid and flats were excluded. All the conditions applied to the intervention group were also applied to the comparator group.

A specific comparator group was then created for each intervention group using random stratified sampling. This involves creating a comparator which has the same characteristics as the intervention group by selecting a sample which has the same proportion of properties with given characteristics. The comparator group was stratified by region, gas consumption bands, property age, property type and number of bedrooms.

Changes to previous methodology

There have been a number of changes to the methodology used for the impact of measures analysis in the last NEED publication[42], full details of these can be found in Annex D – a summary is presented below:

- A stratified comparator group is now created for each intervention and year, rather than just one comparator group for all measures as used in the previous publication.
- Specific gas consumption readings that are suspected to be estimated values are excluded.
- Properties with extreme changes in gas consumption over the period considered are now excluded.
- There is no longer an adjustment made for measures which are installed but not recorded in HEED (such as unrecorded boilers). The uncertainty surrounding any attempt to quantify the impact of hidden measures alongside other improvements made to the methodology mean that any estimate of this impact would be within the range of uncertainty of the estimates presented.

5.4 Results – Impact of energy efficiency measures

The impact of measures analysis covers the following energy efficiency measures:

- cavity wall insulation – installed in 2005 to 2009;
- loft insulation – installed in 2005 to 2009;
- condensing boilers – installed in 2005 to 2007; and
- solid wall insulation – installed between 2005 and 2008.

Estimates of savings from the installation of solid wall insulation in 2009 are not included as there were not sufficient records to allow robust analysis. Information about boilers installed

[42] http://www.decc.gov.uk/media/viewfile.ashx?filetype=4&filepath=11/stats/energy/energy-efficiency/2078-need-data-framework-report.pdf&minwidth=true

between mid 2008 and the end of 2009 was not available, as a result an assessment of the impact of replacement boilers for this period is also not included in this report.

All analysis looks at the saving in gas consumption for households which use gas as their main heating fuel.

When interpreting the results presented in this section, it should be noted that there is a degree of uncertainty around all the results presented. While there is no value put on this uncertainty in this report, it should be noted that the savings experienced by any specific household are dependent on a number of factors. The median and mean savings provide a headline estimate for typical or average saving for the dwelling stock as a whole while the information on the range and on the savings for specific property types provide a better indication of what a specific household might expect to save.

As described above, these estimates are based on observed savings and therefore show the savings after comfort taking and are an average for all properties irrespective of whether the measure has been installed fully throughout the property[43]. This means that individual households have the potential to make a greater saving than the results set out in this report, but there are also circumstances when a household may save less. As seen in the energy consumption section, household behaviours which cannot be measured using data in NEED have a significant impact on a household's consumption and would therefore also have an impact on the amount of gas a household could expect to save from the installation of a particular energy efficiency measure.

The headline results for each energy efficiency measure for each available year are presented below. A more detailed breakdown of results is presented in the accompanying annex, Annex D. Further tables for all available property attributes and household characteristics by year have been published alongside this report[44].

Cavity wall insulation

Table 5.1 shows the mean saving for properties receiving retro-fit cavity wall insulation in each year between 2005 and 2009. Properties receiving cavity wall insulation in 2009 had a mean annual gas consumption saving of 18.9 per cent while the comparator group experienced a mean saving of 10.3 per cent – a difference of 8.6 percentage points. Based on average gas consumption for a three bedroom semi detached property[45] in 2008 (i.e. the year before the intervention), this gives a mean saving of 1,600 kWh for cavity wall insulation installed in 2009. Table 5.2 shows the median saving for properties receiving cavity wall insulation over the same period. The median saving represents the saving for a typical house. The median saving for properties receiving cavity wall insulation was 9.6 percentage points for 2009. Typical gas consumption in 2008 for a three bedroom semi detached property was 17,900 kWh, which gives a typical annual saving of 1,700 kWh for insulation installed in 2009.

The percentage difference between properties receiving cavity wall insulation and the comparator group is consistent across all five years, with mean savings ranging from 8.2 to 8.9 per cent, and median savings ranging from 9.0 to 10.2 per cent. However, the kWh typical

[43] For example, cavity wall insulation may not have been installed in all walls due to a garage or conservatory on one or more walls.
[44] http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/en_effic_stats/need/need.aspx
[45] A three bedroom semi detached property represents the typical house in England, it is the most common property category making up 18 per cent of the housing stock.

savings have decreased over time as typical gas consumption for all properties has decreased in all years between 2004 and 2010. It should be noted that the data used for this analysis are weather corrected. This is important to ensure it is possible to compare gas consumption over time, but masks the variation in savings which will be seen as a result of the temperature during the heating season. For example, in a year with a cold winter households will experience a greater absolute saving than they would in a warmer year.

Table 5.1: Summary of observed savings (mean)

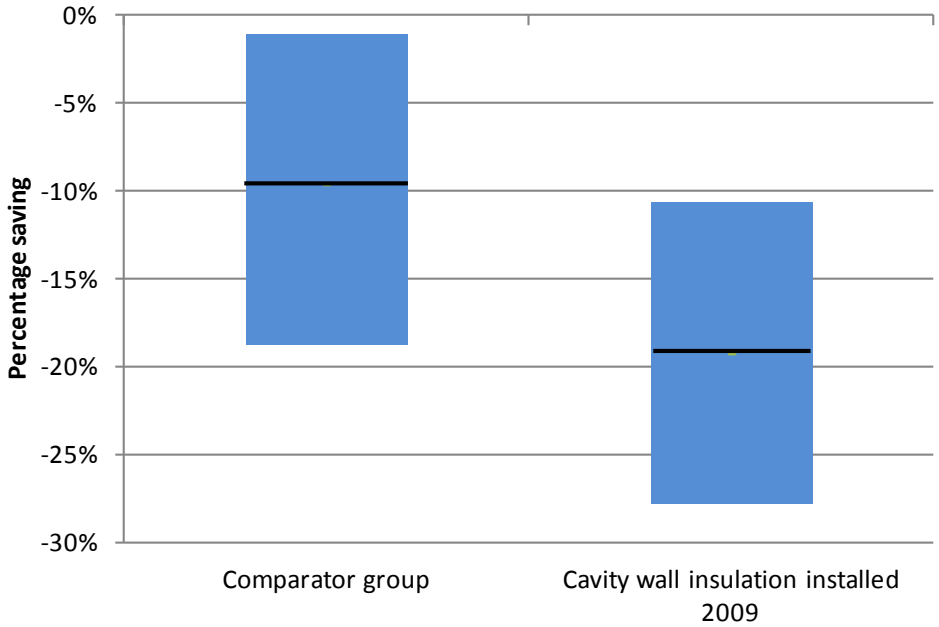
	2005	2006	2007	2008	2009
Percentage saving	-8.9	-8.9	-8.4	-8.2	-8.6
Saving (kWh)	-1,900	-1,800	-1,700	-1,600	-1,600

Table 5.2: Summary of observed savings (median)

	2005	2006	2007	2008	2009
Percentage saving	-10.2	-10.2	-9.9	-9.0	-9.6
Saving (kWh)	-2,100	-2,000	-1,900	-1,700	-1,700

Figure 5.1 below gives an indication of the range of the change in consumption between 2008 and 2010 for properties receiving cavity wall insulation in 2009 and for the comparator group. It shows a 9.6 percentage point difference in the medians, and a very similar inter-quartile range for the two groups.

Figure 5.1: Percentage saving, median and inter-quartile range, 2009



Loft insulation

Data on loft insulation covers professional installations of loft insulation only, as HEED does not capture home owners installing insulation into their own properties. HEED covers both installation of insulation into lofts with no insulation and top up insulation, that is insulation of lofts which may already have some existing insulation, but are not fully insulated. This reflects the lofts which are being insulated in any given year, but means that households with very little or no insulation already in lofts can expect to save more than the savings estimates set out

below. Properties which already have a reasonable amount of insulation are likely to have smaller savings.

The savings set out below are also likely to be an underestimate of the savings a household will experience because some of the properties in the comparator group may have installed DIY loft insulation. Therefore they will have experienced some savings as a result of insulation which is not independent of the measure being considered and not equally experienced in the intervention group. Given the prevalence of DIY insulation in the population, this would lead to an underestimate of the savings of less than 100 kWh. Given the scale of the potential issue and the accuracy of reported estimates no adjustment has been made to the results to account for this, but users should be aware of such issues when interpreting results.

Table 5.3 shows that in 2009 the difference in the mean saving for properties receiving loft insulation and the comparator group was 2.4 percentage points. Based on average gas consumption for a three bedroom semi detached property in the year before the measure was installed (2008) this gives a typical saving of approximately 500 kWh. Table 5.4 shows that the difference in the median saving in 2009 was 2.6 percentage points, also 500 kWh for a typical property receiving loft insulation.

The percentage difference between properties receiving loft insulation and the comparator group is consistent across all five years, with savings based on the mean ranging from 2.1 to 2.8 per cent, and median savings between 2.6 and 2.9 per cent.

Table 5.3: Summary of observed savings (mean)

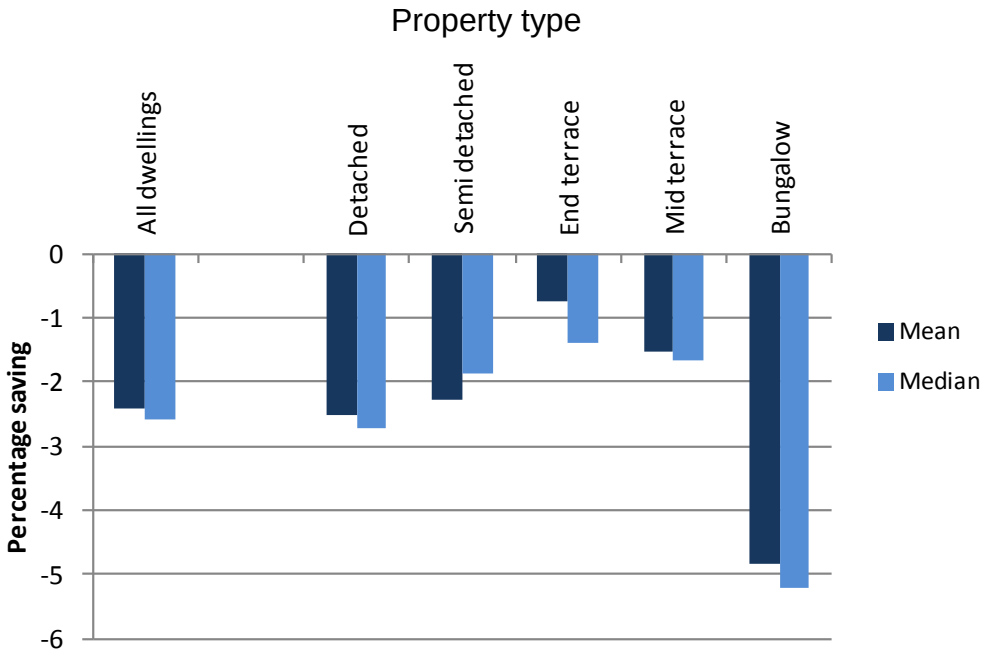
	2005	2006	2007	2008	2009
Percentage saving	-2.1	-2.5	-2.8	-2.3	-2.4
Saving (kWh)	-400	-500	-500	-500	-500

Table 5.4: Summary of observed savings (median)

	2005	2006	2007	2008	2009
Percentage saving	-2.7	-2.8	-2.9	-2.7	-2.6
Saving (kWh)	-600	-500	-600	-500	-500

Figure 5.2 demonstrates how the savings vary for different types of property. It shows that the savings from having loft insulation installed are highest for bungalows, with a typical bungalow saving 5.2 per cent. This is likely to be because bungalows have the largest roof area relative to the size of the property and therefore benefit the most from loft insulation. Detached properties had the next largest saving, and typically save 2.7 per cent, with typical semi detached, end of terrace and mid terrace properties saving between 1.4 and 1.9 per cent. As noted in the consumption section, some of the observed variation may be due to the difference in property size or other correlated attributes and household characteristics, not solely due to the difference in the way these different property types behave.

Figure 5.2: Observed savings from loft insulation, by property type, 2009



Condensing boilers

Data for condensing boilers comes from a variety of sources including Gas Safe, the trade body responsible for registering approved installers. This is important as more boilers are installed outside Government schemes than is the case for the other measures considered in this report. It also means that properties receiving measures are less influenced by the focus of Government schemes, and as observed in the take up of measures section, there is a much more consistent take up of condensing boilers among different households. Data for boilers are only available up to mid 2008, and therefore the analysis in this section only covers the impact of condensing boilers up to 2007; the last full year for which data are available.

Table 5.5 shows that the difference in the mean saving for homes receiving a condensing boiler was 10.3 percentage points for 2007, this gives a typical saving of 2,000 kWh for a three bedroom semi detached property. Table 5.6 shows that the difference in the median saving for homes receiving a condensing boiler was 12.9 percentage points for 2007, a typical saving of 2,500 kWh for a three bedroom semi detached property.

The percentage saving for properties which had a condensing boiler installed is consistent across all three years considered, with mean savings ranging from 9.8 to 10.3 per cent, and median savings ranging from 12.6 to 12.9 per cent.

Table 5.5: Summary of observed savings (mean)

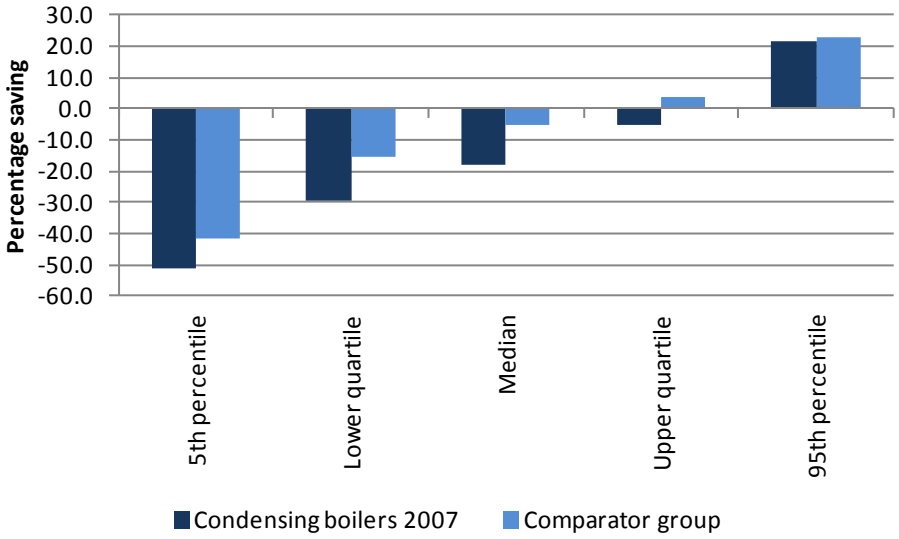
	2005	2006	2007
Percentage saving	-9.8	-10.1	-10.3
Saving (kWh)	-2,100	-2,100	-2,000

Table 5.6: Summary of observed savings (median)

	2005	2006	2007
Percentage saving	-12.6	-12.6	-12.9
Saving (kWh)	-2,500	-2,500	-2,500

Figure 5.3 below shows the distribution of percentage savings for properties having condensing boilers installed in 2007 and the comparator group. It shows that at all points in the distribution the properties that had condensing boilers installed in 2007 had a greater percentage reduction in consumption than the comparator group.

Figure 5.3: Distribution of percentage savings for condensing boilers installed in 2007 and the comparator group



Solid wall insulation

All figures on solid wall insulation should be treated with caution since they are based on a much smaller number of records than other measures considered. Because of the unreliable installation dates for solid wall insulation installed between 2005 and 2008 these installations were considered in one group rather than assessing the saving for each year separately as was done for each of the other measures. Analysis for solid wall insulation installed in 2009 (where the date information is more reliable) was undertaken, but due to the very small sample size (260 properties) it is not considered robust enough to include in this report. The small samples are in part due to the high proportion of solid wall insulation installed in flats and in properties which do not have gas as their main heating fuel and therefore could not be included in this analysis. It is intended that further work will be done to look at the savings from solid wall insulation once more data becomes available in HEED. This is expected following the end of CESP when measures installed through this Government scheme will be incorporated into HEED.

One of the benefits of the approach used in NEED is that estimates are observed, rather than theoretical, so for example the estimates should take in to account people's behaviour and any rebound effects – although we cannot assign values to these different components.

The solid wall estimates shown are based on the percentage saving observed in the sample applied to the consumption for a three bedroom semi detached property. However, unlike the other measures considered in this report, the three bedroom semi detached figure is based on the intervention comparator group, rather than the figure for the whole dwelling stock. This is because, due to the policy under which most of these measures have been installed, a high proportion of these households are in the Priority Group and are therefore not typical of the population as a whole. There are not enough observations to be able to draw reliable conclusions about the typical saving for all solid wall properties.

In particular, it is estimated[46] that the Super Priority Group have a comfort taking factor of more than two times that of the population as a whole, meaning they are likely to take more benefit of the insulation measure through increased warmth rather than as an energy saving. While the Super Priority Group was only created after the measures in this analysis had been installed, it is likely that the Priority Group (who received the majority of solid wall insulation measures included in HEED) also have a higher comfort taking factor than the typical household. This means that the estimates given are likely to be an under estimate of the saving for a typical house.

The savings are also likely to be lower than average for the population as a whole because of the high proportion of mid terraced properties which have received solid wall insulation in this sample. The majority of properties in this analysis were terraced or semi detached with less than one per cent of properties receiving solid wall insulation being detached; the property type which showed the largest percentage saving for cavity wall insulation.

These estimates also have increased variability compared with estimates for the other measures considered. This is in part because of the small sample compared with other measures, but also because of the period of time considered – as installations between 2005 and 2008 were grouped together, meaning any differences between the comparator group and intervention group would be exacerbated.

Table 5.7 shows that the difference in the mean saving for homes receiving solid wall insulation was 11 percentage points for 2005-08. Average consumption in 2004 was 18,800 kWh for three bedroom semi detached properties in the comparator group, this gives a typical saving of 2,100 kWh for these types of properties having solid wall insulation installed. The table also shows the difference in the median saving for homes receiving solid wall insulation which was 12.1 percentage points. Giving a typical saving of 2,200 kWh for these types of properties having solid wall insulation installed.

Table 5.7: Summary of observed savings for solid wall insulation installed between 2005 and 2008

	Mean	Median
Percentage saving	-11.0	-12.1
Saving (kWh)	-2,100	-2,200

Savings for specific property attributes and household characteristics have not been included for solid wall insulation due to the small sample sizes and the resulting uncertainty in results.

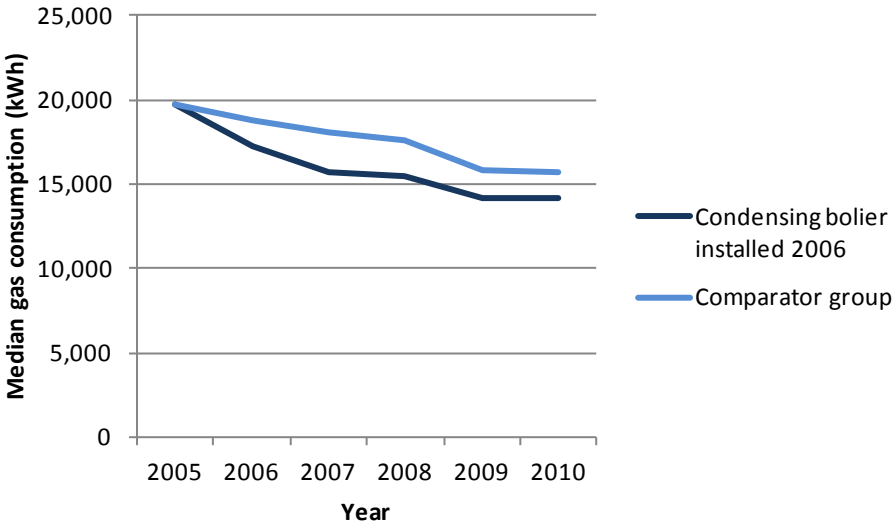
5.5 Comparison of median gas consumption over time

The impact of measures analysis compares gas consumption in the year before and after installation of an energy efficiency measure. Longer term gas consumption can be looked at for cavity wall insulation, loft insulation and condensing boilers installed in 2006 to see whether the savings observed in the year immediately after installation of an energy efficiency measure continue in the longer term. It should be noted that these are presented as initial findings, and will be built on in future analysis.

[46] Green Deal Impact Assessment: http://www.decc.gov.uk/assets/decc/11/consultation/green-deal/5533-final-stage-impact-assessment-for-the-green-deal-a.pdf

For each of the three measures the biggest difference in median gas consumption was seen in the year immediately after the installation of the measure. In all cases there was then a continued saving for all the years for which data are available although at a slightly lower. Figure 5.4 below shows the median gas consumption for properties having a condensing boiler installed in 2006 and for the comparator group. It shows the biggest difference in 2007, and that the median consumption for the group with the measure installed remains below the median consumption for the comparator group in all years. Equivalent charts for cavity wall and loft insulation can be found in Annex D.

Figure 5.4: Condensing boiler installed in 2006 – long term gas consumption



5.6 Conclusion

The analysis shows that significant savings in gas consumption can be made by installing energy efficiency measures in homes. It also provides an insight into the differences in the savings that different properties are likely to gain.

The impact of measures analysis shows that there are significant savings from installation of all the measures considered in this report and provides further support for the value of installing energy efficiency measures. It is also provides a better understanding of the observed saving for households receiving measures and how this varies for different types of properties and households.

6. Non-Domestic Consumption

Introduction

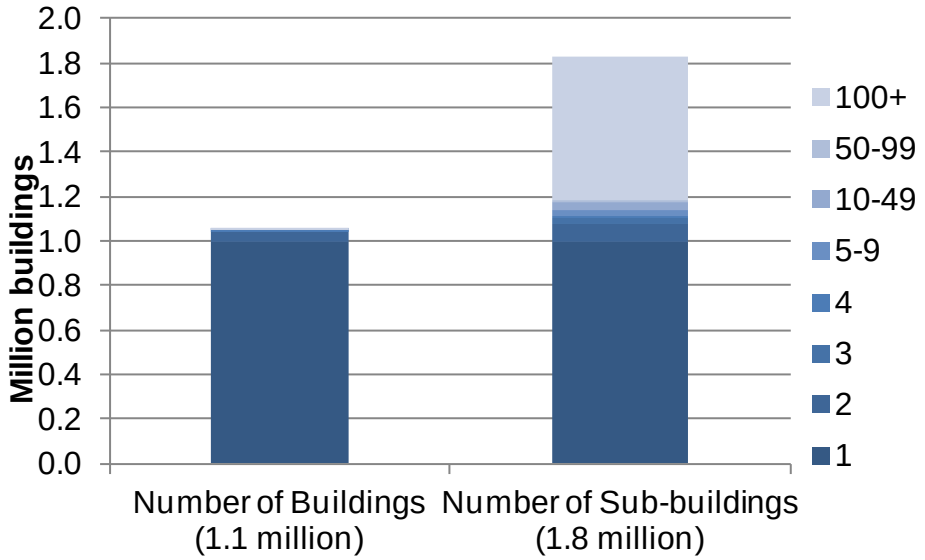
The concept of the NEED framework in the non-domestic sector is similar to the domestic sector, structured around address matching of the energy consumption data and building / occupant attributes but the issues are quite different.

Initial analysis has been done to identify the feasibility of using non-domestic NEED as an analytical framework to support energy efficiency analysis for policy development and evaluation. The analysis has been centred around the 1.1 million buildings captured in the Valuation Office Agency's Non-Domestic ratings File (NDR). These buildings together account for 1.8 million rateable sub-buildings.

Data matching

The address matching of non-domestic buildings is more complicated than in the domestic sector for two reasons. Firstly the building is less likely to be primarily addressed by a number as is the case with homes. The building could be known by a variety of names in the different data sets making matching harder in general and specifically as the occupying business changes. An additional complexity is where several businesses occupy the same buildings. Figure 6.1 shows that while 95 per cent of non-domestic buildings have a single occupier the remaining five per cent account for 46 per cent of sub buildings. These will include, for example some shopping centres and large offices with sections leased by different tenants.

Figure 6.1: Summary of non-domestic buildings



As a result the data matching rates for energy consumption for the non-domestic sector are much lower than for the overall matching rates for NEED shown in Table 3.3, Section 3 and again in Table 6.1.

Table 6.1: Matching statistics at building level (sub-building level match rates in brackets)

Data source	Overall	Non-domestic
Electricity consumption	94% (87%)	74% (34%)
Gas consumption	97% (93%)	77% (54%)

The lower data matching rates make it vital to assess what biases this matching loss may introduce before analysing energy consumption data in this sector. From other data sources, including the Digest of UK Energy Statistics[47] and sub-national energy consumption data[48] we estimate that the matched non-domestic NEED file captures about 20 per cent of metered energy consumption. If it is possible to understand the extent of bias then it may be possible to make analytical use of the matched data in future.

Bias analysis

Analysis is underway to look at where there is bias in the records found in NEED for electricity consumption. Even after considering the data matching rates there is less electricity consumption in the matched file than would be expected if matched records are representative of all businesses.

Figure 6.2: Box-plot of electricity consumption in 2008

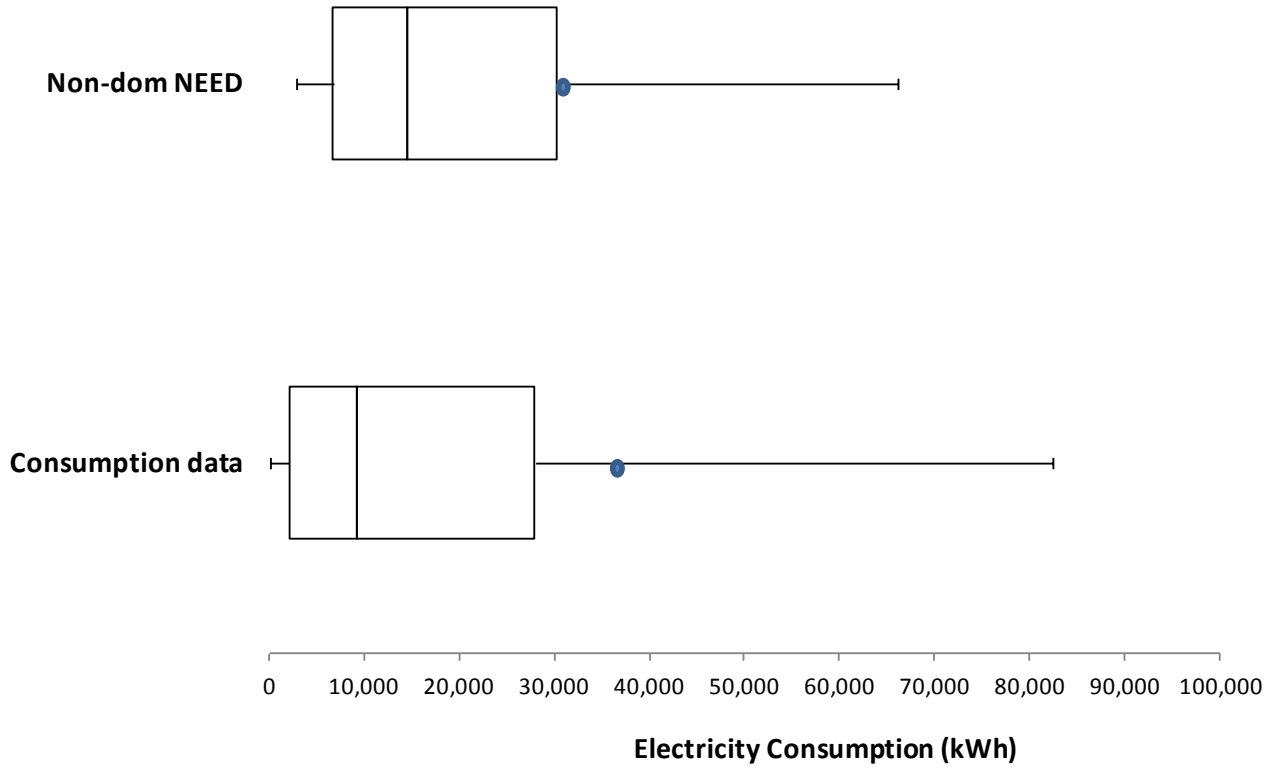


Figure 6.2 compares the electricity consumption data of accurately matched non-domestic consumption with the total electricity consumption in the sub-national energy consumption

[47] http://www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx
[48] http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/regional/regional.aspx

data. Overall the mean consumption[49] (marked with a blue dot) is 17 per cent lower in the matched NEED non-domestic data yet the median is 57 per cent higher. The box plot shows the distribution of this marking the 10th, 25th, 50th, 75th and 90th percentiles. This suggests that consumption bias has been introduced and that the effect of this is to compress the spread of the distribution. Further analysis has shown that the highest energy users with half hourly meters are less likely to be included in NEED. These account for five per cent of all users but only three per cent of the matched NEED records.

Next steps

Further work will be done to investigate the loss of records and see what can be done to improved the data matching rates.

There are a number of additional datasets becoming available that are based on representative samples, for example Display Energy Certificate (DECs)[50] and the Green Deal Business Survey[51] and these will help quantify the bias to enable robust analysis to be performed using NEED datasets.

[49] The mean used is a trimmed mean with the highest one per cent of recorded consumption removed to avoid influence of extreme recorded energy consumption.
[50] http://www.communities.gov.uk/publications/planningandbuilding/displayenergycertificates
[51] http://www.decc.gov.uk/assets/decc/11/tackling-climate-change/green-deal/5509-response-to-the-green-deal-research-among-the-bu.pdf

7. Conclusion

7.1 Summary

The results from this work have provided important evidence to enable DECC to further develop its understanding of how energy is used in homes and what the real impacts are of key energy efficiency measures. It has built on the previous NEED report published in June 2011 including developing the methodology underpinning the analysis and providing more detailed results which can now be used by local as well as central Government to inform policy delivery.

It provides evidence of the significant savings which can be achieved through the installation of energy efficiency measures and presents valuable information on the variation of electricity and gas consumption and variation in savings from installation of energy efficiency measures for different households.

This report also includes initial estimates of the savings from solid wall insulation and preliminary analysis of the non-domestic data in NEED. These non-domestic data are currently unsuitable for robust analysis, but further work may enable this additional resource to be used effectively to fill a crucial gap in DECC's evidence base.

7.2 Future plans

The value of analysis of data held in NEED is clear from the findings in this report and the detailed analysis which has been possible using such a rich source of data. However, there are still a number of areas for further development. DECC will continue to work to expand the analysis undertaken with data from NEED and continue to publish results as analysis is completed.

Over the coming year there are a number of areas where the framework will be developed. These include further developments to the methodology and expansion of the data analysed, such as:

- inclusion of consumption data for 2011;
- refreshing the analysis sample to ensure there is no bias in the sample and enable analysis of data for Wales;
- inclusion of data for measures installed to the end of CERT and CESP. This should increase DECC's ability to produce reliable results for the impact of solid wall insulation;
- work to further understand the impact of the bias resulting from analysis of the impacts of measures which have predominantly been installed through Government schemes;
- further analysis of the impact of installing a combination of measures (such as cavity wall insulation and loft insulation at the same time);
- integration of EPC data into NEED including records for Green Deal and ECO as they become available;
- replacing the NLPG UPRN with the AddressBase UPRN; this should allow better analysis of the impact of measures for flats and increase confidence in the address information and
- setting out plans for data in this publication to be assessed as National Statistics.

In the longer term DECC will also look to expand the analysis to cover additional energy efficiency and heating measures as they become more popular. It will also continue to develop a model of energy consumption carrying out further work to understand the key drivers of consumption.

As already referenced, further work will also be undertaken on the non-domestic data in NEED including investigating the loss of records in data matching in order to see whether robust analysis can be undertaken. DECC will also continue to investigate the possibility of getting access to robust property attribute data for Scotland so this can also be included in future domestic analysis.

Finally, DECC continues to work towards making an anonymised dataset available to allow approved researchers to undertake analysis of data in NEED; subject to meeting all the data privacy obligations required. Prior to producing such an output views will be sought on the most important variables for inclusion in this dataset.

8. Acknowledgements

DECC would like to thank all those who helped establish the data-framework and made analysis possible, as well as organisations which carried out analysis of the framework on behalf of DECC. Including:

- Stakeholders for their input into priorities for analysis of data in NEED.
- Energy suppliers for agreeing for the energy consumption data to be used in NEED.
- Gemserv and xoserve for collating the energy consumption data with addresses for the meters.
- The Energy Saving Trust for access to the Homes Energy Efficiency Database (HEED) and provision of hosting IT infrastructure for NEED.
- The Valuation Office Agency (VOA) for facilitating secondments to VOA and allowing analysis of data from their extensive property attribute data.
- GB Group for their work on matching the datasets.
- Katalysis Ltd for their work on modelling gas consumption.
- NERA for their analysis of the data in NEED.

Glossary

CERT	Carbon Emissions Reduction Target
CESP	Community Energy Saving Programme
DECC	Department of Energy and Climate Change
ECO	Energy Company Obligation
EEC	Energy Efficiency Commitment
EHS	English Housing Survey
EPC	Energy Performance Certificate
EST	Energy Saving Trust
FENSA	Fenestration Self-Assessment Scheme
HEED	Homes Energy Efficiency Database
LLSOA	Lower Layer Super Output Area
MPAN	Meter Point Administration Number (Electricity)
MPRN	Meter Point Reference Number (Gas)
NDR	Non-Domestic Rates
NEED	National Energy Efficiency Data-Framework
NLPG	National Land and Property Gazetteer
OAC	Output Area Classification
ONSPD	Office for National Statistics Postcode Directory
PAF	Postcode Address File
UPRN	Unique Property Reference Number (NLPG)
UARN	Unique Address Reference Number (VOA)
VOA	Valuation Office Agency

Annexes

Annex A – What is NEED?

Annex B – Quality Assurance of NEED Data

Annex C – Domestic Consumption

Annex D – Energy Efficiency Measures in Homes

Annex E – Summary of NERA Analysis

Annex F – Summary of Katalysis Analysis

Annex G – Summary of Building Regulations

All annexes and accompanying data tables can be found as separate downloadable documents here:
http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/en_effic_stats/need/need.aspx

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URN 12D/405