Energy consumption in new domestic buildings 2015 – 2017 (England and Wales)

19th December 2019   **Experimental Statistics**

This document gives an overview of energy consumption per square meter of new builds in England and Wales. Energy consumption is counted as the first year of metered gas and electricity consumption. Consumption of other fuels isn't included due to a lack of data. The appendix at the end of this document sets out the method used. Summary statistics are available here.

In this document "consumption" is shorthand for "annual energy consumption per square meter of floor area". All mention of "properties" refer to new builds only. Consumption data tends to lag build year by one year, so consumption in 2015 – 2017 is used for new builds with EPCs in 2014 – 2016.

Key points

- The first full year of metered energy consumption per square meter of floor area can be used as a proxy for the efficiency of new buildings.

- Data from Energy Performance Certificates are linked to the National Energy Efficiency Data-Framework (NEED) to find metered annual gas and electricity consumption for new build properties. Properties which couldn't be linked or had communal heating were excluded. Gas and electricity are summed to get annual energy consumption.

- The average consumption of properties built between 2014 and 2016 fell by 4.3% (6 kWh/m^2) (weighted by property type, floor area band and whether the property is using gas).

- Average consumption is different for each property type. For properties built in 2017, flats use the least (120 kWh/m^2), and bungalows used the most (143 kWh/m^2). Energy consumption per m^2 tends to decrease with property size.

- On average, properties not using gas used less energy overall than properties using gas (88 kW/m2 and 125 kWh/m2 respectively in 2017). This in part is due to properties not using gas being more likely to use other fuels (e.g.: solid-fuel burners) which are not captured in the data. At end use gas is less efficient for heating than electricity, as the efficiency losses for electric heating come at the point of generation rather than in the home.

- Properties with EPC ratings A and D had the lowest consumption in 2017 (lower than B and C). This is likely to be because a much higher proportion of D rated properties don't use gas (94% in 2017, compared to 5% for B rated properties).

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Background

The Energy Performance Certificate (EPC) data published online gives energy efficiency information for over half the domestic properties in England and Wales[1]. This includes all properties built since 2008. The EPC energy efficiency rating is based on how much energy a dwelling will consume, when delivering a defined level of comfort and service provision, using standardised assumptions for occupancy and behaviour. This enables a like-for-like comparison of dwelling performance.

However, the EPC rating doesn't account for individual resident's behaviour (e.g.: whether the resident spends time away from home, is more or less strict with their energy use, has a preference for a higher temperature, etc). This document presents new figures for understanding the efficiency of new builds, which account for such effects.

Domestic energy consumption is affected by many factors, including property type, length of residency and household income[2]. Metered energy consumption captures the impact of all of these through a figure based on actual consumption rather than modelled values.

The metered gas and electricity consumption held in the National Energy Efficiency Data-Framework (NEED) is linked with EPC data. This is used to find the gas and electricity consumption per square meter. The inspection date of the EPC is used to determine the date the property was built, with the first year of electricity consumption being looked for after this "build year". Table 1 below shows the data sources used.

Table 1: Data sources

Data	Source
Metered energy consumption	NEED
Build year	EPC
EPC rating	EPC
Property type	EPC
Identify converted properties	Valuation Office Agency (VOA)
Floor area band	EPC

Trends in annual energy consumption fluctuate greatly at the household level. The large sample used sees these effects average out, giving a reliable metric.

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[1] Calculated comparing the EPC dataset released in July 2019, which has certificates for 14.8 million domestic properties, against the 25.9 million properties in England and Wales as published by the Valuation Office Agency in September 2019.
[2] An in-depth analysis of the determinants of household gas use is published here.

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The gas and electricity consumption data are adjusted[4] to remove the impact of weather from on year-on-year trends.

The method used is described in detail in Appendix 1 of this document.

Limitations of the data

The energy consumption data only includes metered gas and electricity. Energy used from other sources isn't accounted for, including solid fuel burning, gas from cannisters and electricity generated from solar panels on site.

If it is assumed that the uses of energy remain the same for properties over time (e.g.: heating, cooking, lighting, etc) the changes between years can be viewed as a metric for changes in building efficiency. If energy uses changed (e.g.: if electric cars become more prevalent and are charged at home) then this assumption would no longer be valid under the current methodology.

Some new builds are excluded from the analysis where the EPC data can't be linked to NEED or electricity consumption isn't recorded. Data is linked more successfully for some property types than others, in large part because of how the addresses are formatted. Flats have the lowest match rate. A weighting process is used to reduce the bias this introduces, with the property type accounted for. While the weighting reduces the bias, properties in Inner London are underrepresented in this analysis (see Appendix 1 for further detail).

> **Shared meters**
> A total of 168,000 new builds in January 2014 – July 2019 are heated by gas logged with a shared meter (also known as communal heating). This means that a single meter logs the gas consumption of multiple properties. Gas consumption from these shared meters can't be reliably linked to the properties served by the meters. For this reason, new builds with shared meters are excluded from this analysis. A weighting process is used to reduce the bias this introduces to the sample.

Results

Once the EPCs are linked to NEED and the filters applied, the numbers of properties are 90,000 (2015), 107,000 (2016) and 113,000 (2017) (this is the first year of electricity consumption). The weighted and unweighted headline results are shown in Table 2 below. For year on year comparisons the weighted results should be used.

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[4] Gas consumption is weather corrected by Xoserve, who provide BEIS with gas consumption data. Electricity consumption is weather corrected using correction factors calculated from BEIS' UK Supply and use of fuels (ET 1.3) table.

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Table 2: Weighted and unweighted results

	First year of consumption	Average energy consumption per square meter (kWh/m2)	Number of properties
Unweighted	2015	127.2	89,547
Unweighted	2016	123.5	107,278
Unweighted	2017	121.7	113,209
Weighted	2015	127.6	89,547
Weighted	2016	124.1	107,278
Weighted	2017	122.1	113,209

Weighting: making sure results represent all new builds
Not all newly built domestic properties are included in the analysis: properties not matched to a meter or sharing a gas meter are not used. To reduce bias that may be introduced by this, and so that the results can be compared year on year, weights are calculated for various factors:
(i) property type
(ii) floor area band (other than bungalows)
(iii) whether gas is being used
(iv) year

Weights are calculated using all new builds in 2015 (with EPC data) compared to the number of properties after processing in the year in question. Using 2015 as a baseline makes year on year comparisons possible, with changes due to the make-up of the population in a given year removed.

While all other figures in this report are unweighted, the weighted statistics in Table 2 can be used for overall year on year trends.

Consumption by property type

Figure 1 below shows trends in average energy consumption by property type. Bungalows consistently have the highest consumption, and flats the lowest.
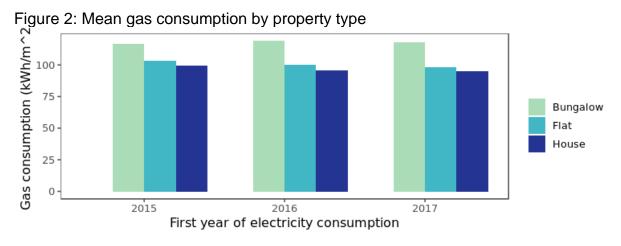
Figure 1: Mean energy consumption, by property type and year

The change in energy consumption between 2015 and 2017 varied from a 3% decrease (bungalows) to a 5% decrease (houses).

Figure 2 below shows trends in average gas consumption for properties using gas. As with energy consumption, bungalows consistently have the highest gas consumption.

Figure 2: Mean gas consumption by property type

The change in gas consumption between 2015 and 2017 varied from a 1% increase (flats) to a 4% decrease (houses).

Figures 3 and 4 below present the energy and electricity consumption of properties built in 2017, both using and not using gas, broken down by property type. In all four charts houses have the lowest consumption (this is in part due to houses being larger and the residents being more likely to use alternative fuels, such as gas from cannisters).

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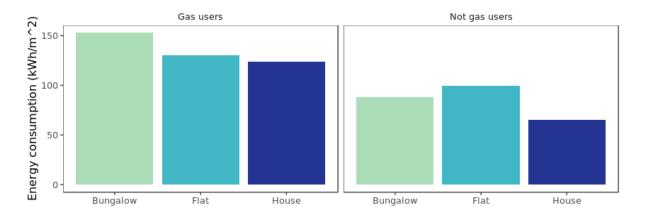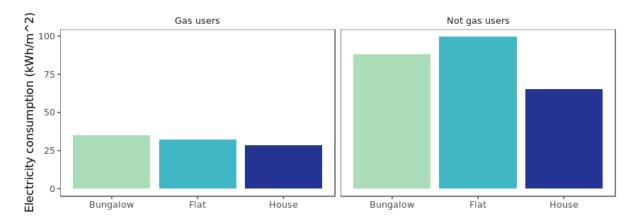Figure 3: Mean energy consumption in 2017, by gas use status and property type

Figure 4: Mean electricity consumption in 2017, by gas use status and property type

How does consumption vary by property size?

Figures 5 and 6 below show that larger properties tend to consume less energy per m^2. Bungalows tend to use the most for a given floor area band and flats use the least. The longer trend shown in figure 7 shows that consumption per m^2 decreases as total floor area increases.

Figure 5: Relationship between banded floor area and mean energy consumption per m^2, by property type
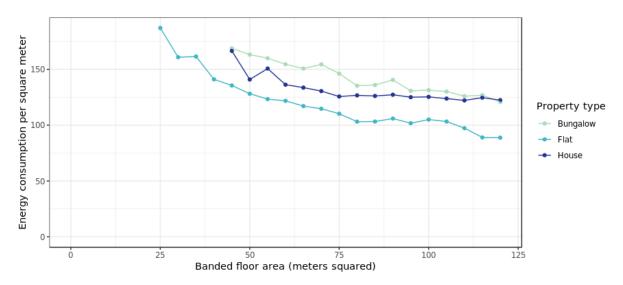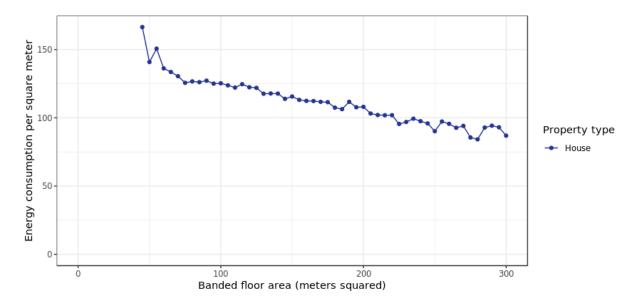

Figure 6: Relationship between banded floor area and mean energy consumption per m^2 (houses only)

The tendency for houses to be larger means they tend to have a lower consumption per m^2. To control for this floor area is included in the weighting.

To compare consumption for different property types of similar sizes, figure 7 below shows consumption by year and property type only for properties with a floor area between 70 and 80m^2. This shows that flats have lower consumption than similarly sized houses or bungalows. In figure 3 the difference between flats and house is greater than figure 1 (where all floor areas are included).

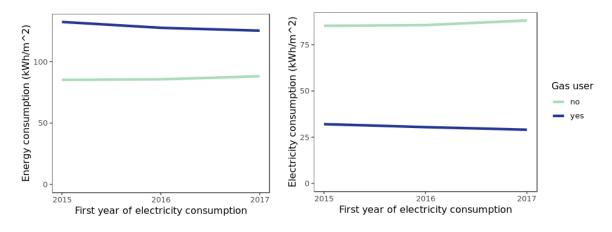Energy consumption in new domestic buildings 2015 – 2017 (England and Wales)

Figure 7: Mean consumption by property type for properties with a floor area between 70 and 80 m^2

Trends of properties using and not using gas

Figure 8 below shows the trends in electricity and energy consumption, with lines representing properties using and not using gas. In 2017, gas users consumed 42% more energy than properties not using gas. This in part due to properties not using gas being more likely to use other fuels (e.g.: solid fuel burners) which aren't recorded in NEED. It may also be partly due to gas appearing less efficient for heating than electricity, as the efficiency losses for electric heating come at the point of generation rather than in the home. For these reason properties not using gas in this analysis appear to be more efficient than they are.

In the same year properties not using gas consumed just over triple the electricity than those using gas.

Figure 8: Trends in mean energy and electricity consumption, by whether the property is using gas or not

Between 2015 and 2017 new builds' energy consumption decreased by 5% for new builds using gas and increased by 3% for new builds not using gas. During the same period electricity consumption decreased by 10% for new builds using gas.

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Electricity consumption increased by 3% for new builds not using gas; electricity being the only source of energy consumption considered for new builds not using gas.

Consumption by EPC rating

Properties with EPC ratings A and D had the lowest consumption in 2017 (lower than B and C). This is likely to be because a much higher proportion of D rated properties don't use gas (94% in 2017, compared to 5% for B rated properties). Properties with EPC ratings E – G are excluded due to small sample sizes. Table 3 below shows consumption by first year of consumption and EPC rating.
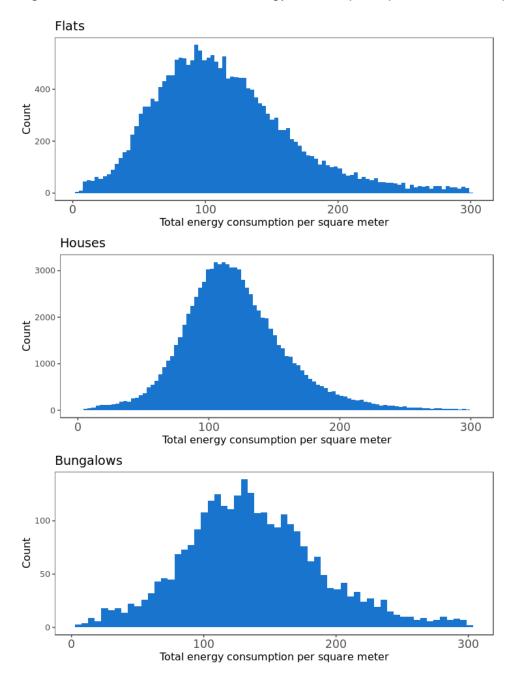
Table 3: Consumption per m^2 area by build year and EPC rating

EPC rating	First year of consumption	Average energy consumption per square meter (kWh/m2)	Average electricity consumption per square meter (kWh/m2)	Average gas consumption per square meter (kWh/m2)	Number of properties
A	2015	117	34	83	1,225
A	2016	113	32	81	1,710
A	2017	113	29	84	1,453
B	2015	127	35	92	69,066
B	2016	124	33	91	89,915
B	2017	122	31	90	98,584
C	2015	132	46	85	17,747
C	2016	124	49	75	14,430
C	2017	121	53	68	11,589
D	2015	117	88	29	1,067
D	2016	117	104	13	1,019
D	2017	114	102	12	1,155

Distribution of consumption by property type

Figure 9 below shows that the variation in consumption is lowest for houses (the shape plotted is "thinner"). While the majority of large new builds (floor area over 200m^2) are houses, most houses have a floor area between 80 and 200m^2.

Figure 9: Distributions of mean energy consumption per m^2 for each property type

Appendix 1: Method

This section sets out the steps taken to create the results. The sample sizes at each step are given immediately below, with the detail of each step set out further below.

Step	Remaining sample size
All EPCs for new builds lodged between January 2014 and July 2019	1,100,000
Linked to NEED, with unmatched EPCs removed	891,000
Converted flats removed	851,000
Duplicate properties removed	830,000
Only include properties where first full year of electricity consumption (the year after build year) is in 2015, 2016 or 2017, and electricity consumption is recorded	432,000
Remove properties heated by community heating schemes	370,000
(splits into properties using and not using gas)	
Properties using gas	
Select properties marked in the EPC data as using gas	337,000
Select properties where first gas year is within one year of first electricity year	315,000
Filter to only include properties with gas consumption between 1,000 and 50,000 kWh	286,000
Filter to only include properties with electricity consumption between 500 and 25,000 kWh	279,000
Properties not using gas	
Select properties marked in the EPC data as not using gas	33,000
Remove properties where any gas consumption is recorded	32,000
Filter to only include properties with electricity consumption between 500 and 25,000 kWh	31,000
Combine tables of properties using and not using gas	310,000

1) New builds are identified by selecting all EPC records which are lodged as a "new build" and the inspection date is after 31st December 2013. The 'new build' category on EPCs includes conversions and change of use – these dwelling types are partially removed (see step 3). For properties with multiple EPCs, the oldest EPC is selected. Using the EPC dataset published in July 2019 this returns 1.1 million records.

2) These are linked to NEED data using each records' Unique Property Reference Number (UPRN). Linking these datasets relies in the data in both NEED and EPCs being assigned the same UPRN by BEIS' address matching process. In doing this a higher proportion of flats are lost than other property types. Records for flats are more difficult to link due to the formatting of their addresses. Not all properties at this stage are lost due to poor matching; some of the properties have been built too recently to have had consumption recorded in NEED at the time of the analysis. This returns 891,000 records linked to NEED.

3) Properties are removed which the Valuation Office Agency data (a component of NEED) classifies as a "converted flat". This removes 40,000 properties, leaving 851,000. There are also 170,000 matched properties which have no property type recorded in the NEED data, some of which will be converted flats.

   There are estimated to be (170,000 * 40,000) / 891,000 = 8,000 converted flats in the dataset which are not removed.

4) Duplicate properties are removed.

5) The first full gas and electricity years immediately after the inspection date is found for each record[7].

6) Starting with the first full electricity year for that property, the first year of recorded electricity consumption is found for each record. For example, if the first full electricity year is 2015, electricity consumption in 2015 will be used if recorded. If it's unavailable then electricity consumption 2016 will be used if recorded, and so on.

7) A filter is applied to only include properties where the first year of electricity consumption is 2015, 2016 or 2017. This returns 432,000 records.

8) Properties which are heated under a "Community scheme" in the EPC are removed, as these properties share a gas meter which isn't included in NEED. This returns 370,000 records (removing 62,000).

9) A "gas users" table is made from the data, only including records where both gas and electricity are recorded. This table only includes records where the first gas and electricity records are within one year of each other. Outliers are removed by only including properties with gas consumption between 1,000 and 50,000 kWh, and electricity consumption between 500 and 25,000 kWh. This returns 279,000 records

10) A "properties not using gas" table is made where electricity is recorded and no gas has been recorded for any years for that property and the EPC doesn't describe the main heating system as using mains gas. Outliers are removed

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[7] More information on the dates covered by gas years can be found in the 2017 Sub-national consumption report

by only including properties with electricity consumption between 500 and 25,000 kWh. This returns 31,000 records.

11) The two tables described above are appended to make an "all consumption" table with 310,000 records.

To ensure that the results represent all new builds and comparisons can be made between years, weights are calculated.

The weights use the ratio of all new builds in 2015 to the number properties included in the analysis in the year in question, for each combination of the features weighted on. Combinations with few records relative to all new builds in 2015 are weighted more highly. The features weighted on depend on the property type:

- For flats and houses, weights are calculated and applied for each year, floor area band and whether the property uses gas.

- For bungalows, weights are calculated and applied for each year and whether the property uses gas. Bungalow weighting uses fewer features due to a smaller sample size.

The weights are chosen to account for the features which most account for changes in consumption. The aim is to weight by as many features as possible, while preserving an adequate sample size for each combination of features. Table 4 below gives some example weights for certain combinations of features (to save space only a sample is shown).

Table 4: Sample of weights for combinations of features

Combination of features	Weight
Flat, under 51m^2, first electricity consumption year: 2015, using gas	2.02
House, 94 – 120m^2, first electricity consumption year: 2017, not using gas	0.84
Bungalow, first electricity consumption year: 2015, using gas	0.76

Tying the weighting to the 2015 new builds means that combinations which become less common in the future would be more heavily weighted if this analysis were repeated. The alternative is to weight the results to another year (e.g.: the most recent year). However this would invert the weighting problem rather than solving it (e.g.: old results get underweighted rather than new results getting overweighed). Therefore either approach is as good as the other, so the less complex option was chosen.

Figure 10 below shows the proportion of new builds included in the final sample against all new builds in the period considered. Figure 11 shows the

contribution from each region once weighting is applied. London is particularly underrepresented prior to weighting, and the weighting only partially corrects this. This is due to the type of property in London: there are more flats which are more likely to be excluded from the analysis following address matching.
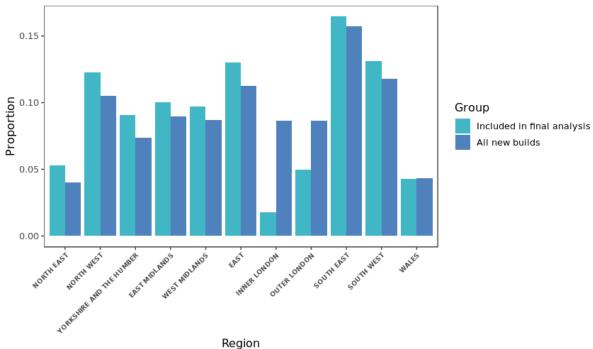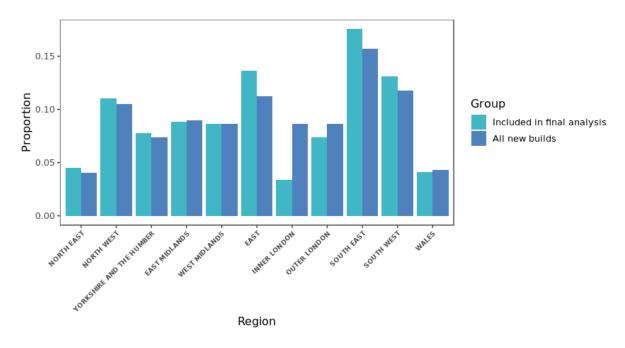
Figure 10: Proportion of new builds in final sample versus all new builds

Figure 11: Proportion of new builds in final sample versus all new builds, after weighting

12) Energy consumption is calculated as the sum of gas and electricity. Though the gas and electricity years don't line up exactly, the first readings for both are in the same "years" for the majority of new builds (e.g.: if the first

electricity year is 2015 for a property, it's first gas year will very likely be 2015 too). All gas and electricity consumption readings cover a typical 12 month period regardless of the time of year the reading took place. Because of this gas and electricity can be summed despite the discrepancy between gas and electricity years.

Energy consumption is divided by the floor area[8] (included in the EPC) to find the total energy consumption per square meter.

Appendix 2: Comparison to NEED consumption tables

The annual NEED report includes figures on the average consumption of properties by build year[9]. This includes the average consumption by banded property age, with the most recent property age being after 1999.

In 2017 gas consumption for properties built after 1999 had a mean of 11,100 kWh. For new builds with the first year of consumption in 2017, the mean gas consumption in 2017 was 9,300 kWh. This is lower and shows that the newest builds are using less gas on average.

In 2017 electricity consumption for properties built after 1999 had a mean of 3,900 kWh. For new builds with the first year of consumption in 2017, the mean electricity consumption in 2017 was 3,100 kWh. As with gas, this is lower and shows that the newest builds are using less electricity on average.

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[8] Floor area includes all heated space within the walls of a property. A detailed definition is available from: https://www.bregroup.com/sap/standard-assessment-procedure-sap-2012/.
[9] See Headline consumption tables England and Wales 2017 on https://www.gov.uk/government/statistics/national-energy-efficiency-data-framework-need-consumption-data-tables-2019

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