Scotland's Non-Domestic Energy Efficiency Baseline

December 2018

Introduction

The Scottish Government's Energy Efficient Scotland programme aims to improve energy efficiency and promote low carbon heating in Scotland's homes and non-domestic buildings. The Energy Efficient Scotland Route Map[1], published in May 2018, sets out that Scotland's non-domestic buildings will be assessed and significantly improved to the extent this is technically feasible and cost effective by 2040.

The Route Map also acknowledges that given the diverse nature of non-domestic buildings there is less known about their current energy performance compared with those in the domestic sector. Historical data on the profile of the non-domestic building stock, and its energy use, is currently limited. However, an increasing amount of data concerning the energy use and energy efficiency of non-domestic buildings has become available since data collected to generate energy performance certificates (EPCs) was first recorded in 2013.

Establishing an energy efficiency baseline for Scotland's non-domestic buildings is therefore essential to enable subsequent monitoring of improvements in energy efficiency and to support the further development of policies targeted at the non-domestic sector.

This report provides an estimate of the baseline energy efficiency performance of Scotland's non-domestic buildings. It is based on almost 30,000 non-domestic EPCs issued between January 2013 and July 2017. The size and typology of Scotland's non-domestic building stock is estimated with the help of non-domestic rates data from Scottish Assessors. Mean EPC ratings across the whole stock are extrapolated from the 30,000 EPCs as outlined in the methodology annex.

Background information on non-domestic EPCs and details on the methodology are provided in the Annex.
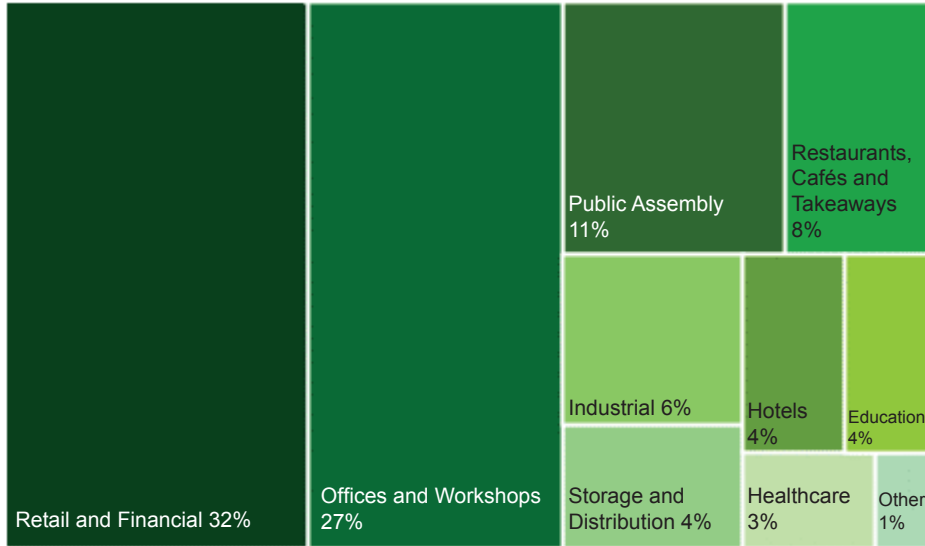
Data tables and charts are available alongside this document.

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[1] https://www.gov.scot/publications/energy-efficient-scotland-route-map/

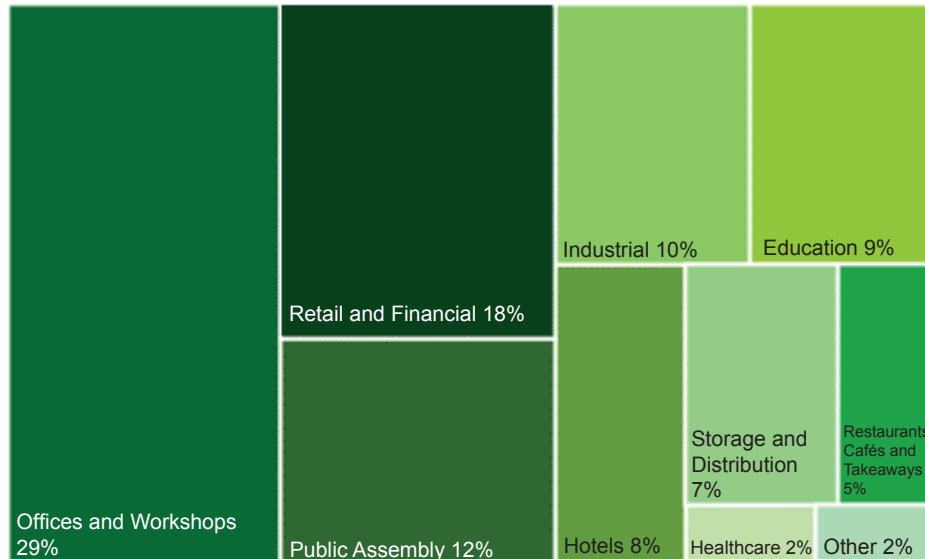# Number and internal area of non-domestic premises

There are an estimated 196,000 non-domestic heat controlled premises in Scotland excluding military and agricultural buildings. Retail and financial premises account for 32 per cent of this total while offices and workshops account for 27 per cent as illustrated in Figure 1.

Figure 1: Share of non-domestic premises count

		Public Assembly 11%	Restaurants, Cafés and Takeaways 8%
		Industrial 6%	Hotels 4% — Education 4%
Retail and Financial 32%	Offices and Workshops 27%	Storage and Distribution 4%	Healthcare 3% — Other 1%

However, the picture changes when the floor area of buildings is considered.

Figure 2: Share of total non-domestic internal area

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	Retail and Financial 18%	Industrial 10%	Education 9%
			Storage and Distribution 7% — Restaurants, Cafés and Takeaways 5%
Offices and Workshops 29%	Public Assembly 12%	Hotels 8%	Healthcare 2% — Other 2%

The mean internal area of non-domestic premises in Scotland is estimated to be 390m^2. Retail and financial premises are the smallest on average, with only an 18 per cent share of the total internal area of non-domestic premises, whereas offices and workshops account for 29 per cent of the total area. Educational premises are the largest on average, representing over 9 per cent of the total internal area of all non-domestic premises, but make up just less than 4 per cent of premises.

area of all non-domestic premises, but make up just less than 4 per cent of premises.

Current EPC banding

Figure 3 shows that it is estimated almost three in four of all non-domestic premises have a current EPC band of E or worse with 5 percent banded B or better.
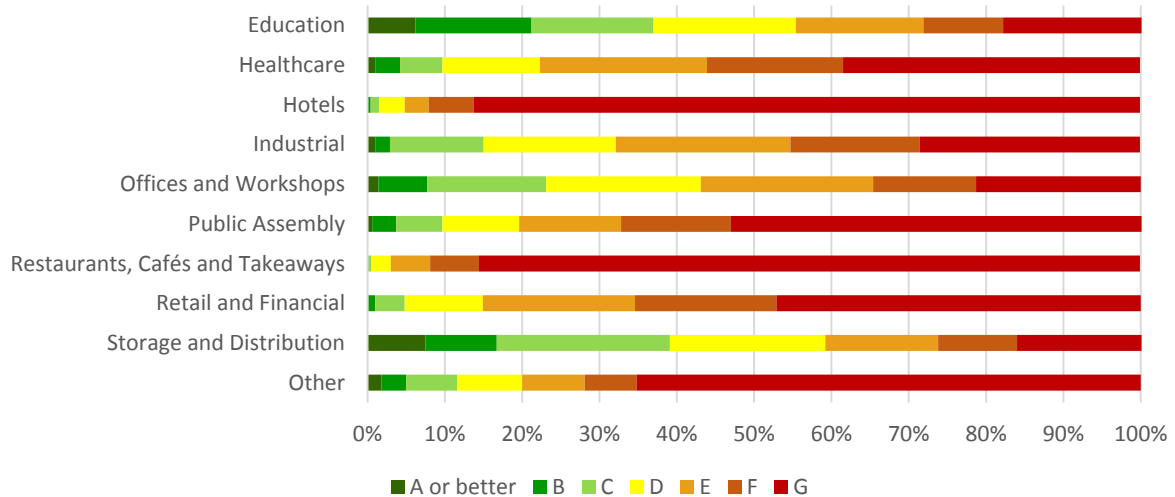
Figure 3: Non-domestic premises by current EPC band
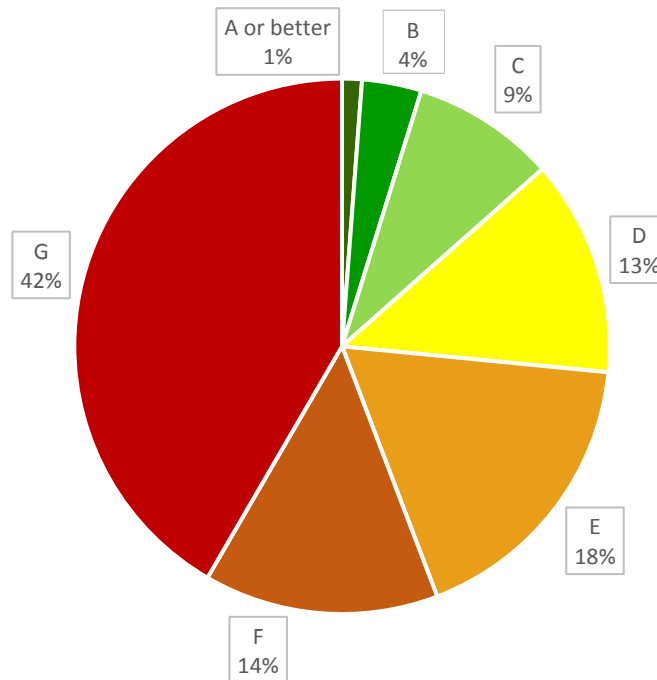
EPC bands present the calculated greenhouse gas emissions for a building on a scale from A to G. The underlying rating therefore reflects the energy efficiency of building elements (e.g. building fabric), the types of fuel used and heating, lighting and ventilation demand standardised by a combination of building type and activity. It can therefore vary considerably both within and between building types. This results in potential issues with using the current EPC band to monitor improvements in non-domestic energy efficiency over time. For example, even if the physical characteristics of a building do not change, the building's current EPC band can shift due to changes in the building's assumed use.

Figure 4 shows 86 per cent of hotels and 85 per cent of restaurants, cafés and takeaways are classed as band G, likely because the EPC model assigns a greater level of energy use to the activities associated with those building types. This is likely to reflect such buildings being in use throughout the day and being heated to comparatively high temperatures. Only 16 per cent of storage and distribution premises and 18 per cent of educational premises lie in the same band. This may result from assumptions that unlike hotels and restaurants, schools are not used for a full working day, at the weekend or during holidays and similarly that warehouses and stores are less energy intensive and are heated to a lower temperature than other buildings.

17 per cent of storage and distribution premises and 21 per cent of educational premises are banded B or better compared to just 3.5 per cent across all other non-domestic building types.

Figure 4: Non-domestic building types by current EPC band

Current EPC ratings

The mean building emissions rate across Scottish non-domestic premises is estimated to be 111 kg of CO_2 emissions per square metre per year. A building with this modelled emissions intensity would fall into band G, the poorest performance band including all premises with modelled emissions exceeding 100 $kgCO_2/m^2/yr$. A building with median (midpoint of numerically ordered values) modelled emissions would lie within band F, equivalent to between 81 and 100 $kgCO_2/m^2/yr$. This difference between the mean and median reflects the mean being skewed by buildings with extremely high ratings, some in excess of 1000 $kgCO_2/m^2/yr$.

In line with the bandings above, education has the lowest mean emissions intensity at 67 $kgCO_2/m^2/yr$ and storage and distribution has a similar mean rating. The mean rating for these properties falls in the middle of band E.

The hotel and restaurant, café and takeaway categories perform particularly poorly with mean ratings of 179 $kgCO_2/m^2/yr$ and 177 $kgCO_2/m^2/yr$ respectively.

The current EPC rating approach is more useful as an indicator of overall emissions than as an indicator of how a building performs compared to other buildings of a different building type. This is discussed further in the next section.

Figure 5: Mean current EPC rating
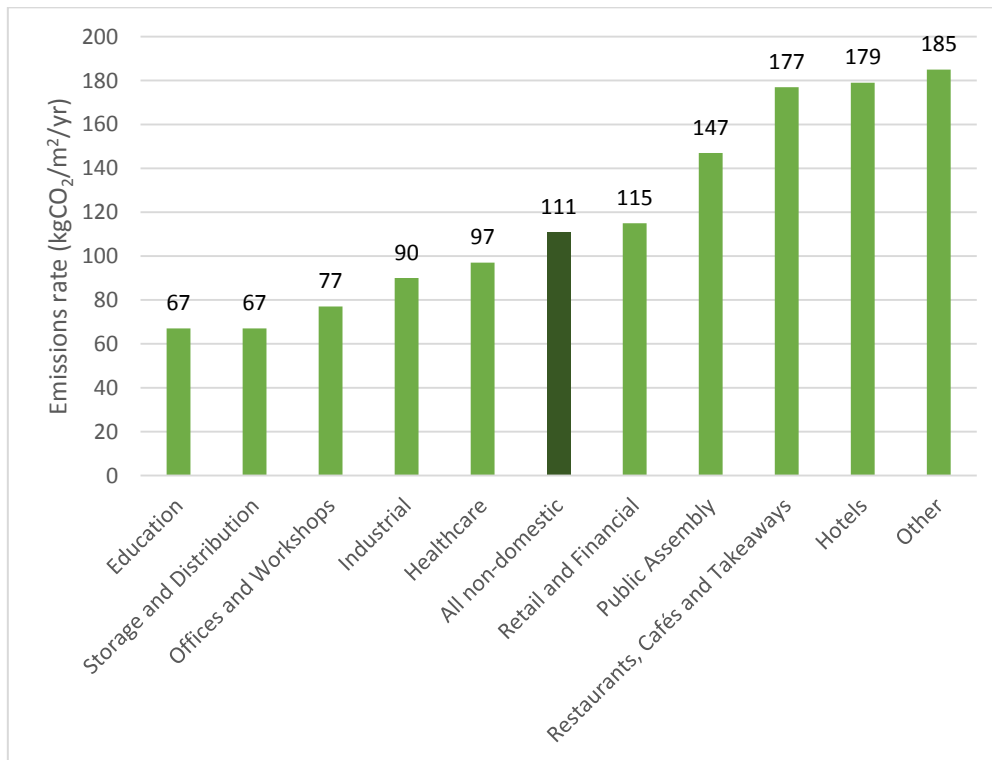
Impact of assigning comparative ratings to building performance

A 'comparative rating'[2] is calculated as part of the assessment process but appears in the Recommendations Report rather than on the face of the non-domestic EPC[3].

This compares the emissions from the actual building to that of a 'reference building' of the same type. The reference building has the same dimensions, location and orientation as the actual building and houses the same activities. However, the performance of the fabric, lighting, heating and hot water service of the reference building are standardised, reflecting a high level of efficiency. Although natural gas is assumed to fuel heating and hot water regardless of the fuel type used in the actual building, this approach does allow for a rating independent of building use assumptions. Buildings within comparative rating bands A and B have lower emissions than the reference building for buildings of their type, while those banded C or worse have higher emissions.

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[2] This is defined in the text box below. Further information on defining the reference building and deriving ratings can be found in the National Calculation Methodology modelling guide.
[3] This is the Asset Rating calculated and displayed on the EPC in England & Wales.

The comparative rating

This was introduced to inform an aspect of the UK government 'Feed-in Tariff' policy which specified a minimum energy efficiency requirement based upon the Asset Rating used in England and Wales and to enable direct comparison of ratings of buildings between Scotland and the rest of the UK.

This rating is derived by a formula which compares the calculated CO_2 emissions for the building against those derived for a 'reference building' of the same type. The comparative rating is the ratio of the CO_2 emissions from the actual building to the reference building, multiplied by 50. Accordingly, a building with calculated emissions equal to those of the reference building will have a comparative rating of 50, placing it on the threshold between bands B and C.

Figure 6 shows that more of the comparative rating bandings are distributed within the higher bands in comparison to the current EPC bandings, with over half of non-domestic premises rated C or D. This implies that emissions from these buildings range between those of the relevant reference building and double those of the relevant reference building. Only 11 per cent of buildings are predicted to have lower emissions than their corresponding reference building, i.e. band A or B.

*Figure 6: Non-domestic premises by comparative rating band*
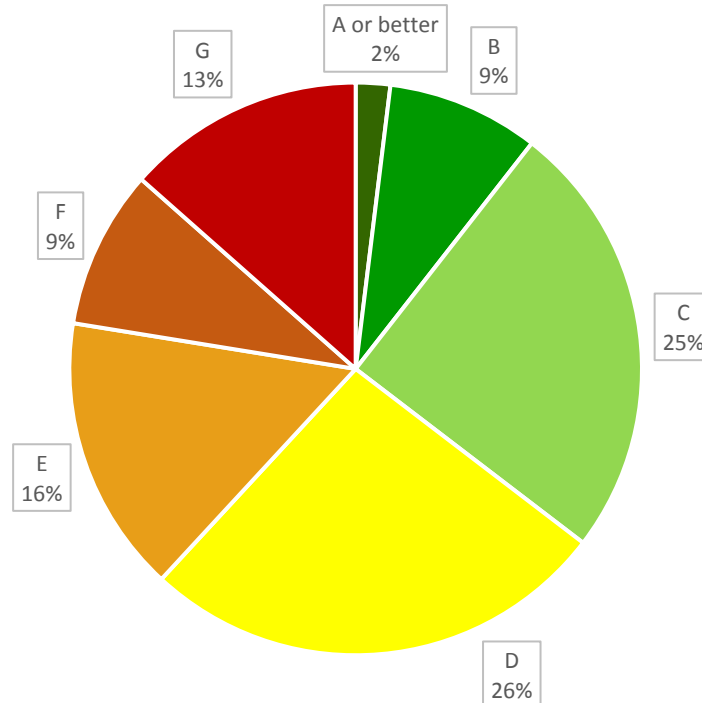
78 per cent of hotels and 69 per cent of restaurants, cafés and takeaways have a comparative banding of D or better despite only five per cent of hotels and three per cent of restaurants, cafés and takeaways achieving a current banding of D or better. Some disparity between current and comparative ratings exists for all categories, but

this is smallest for offices and workshops with 49 per cent having a comparative rating of D or better and 43 per cent achieving a current D or better.

Figure 7: Non-domestic building types by comparative rating band
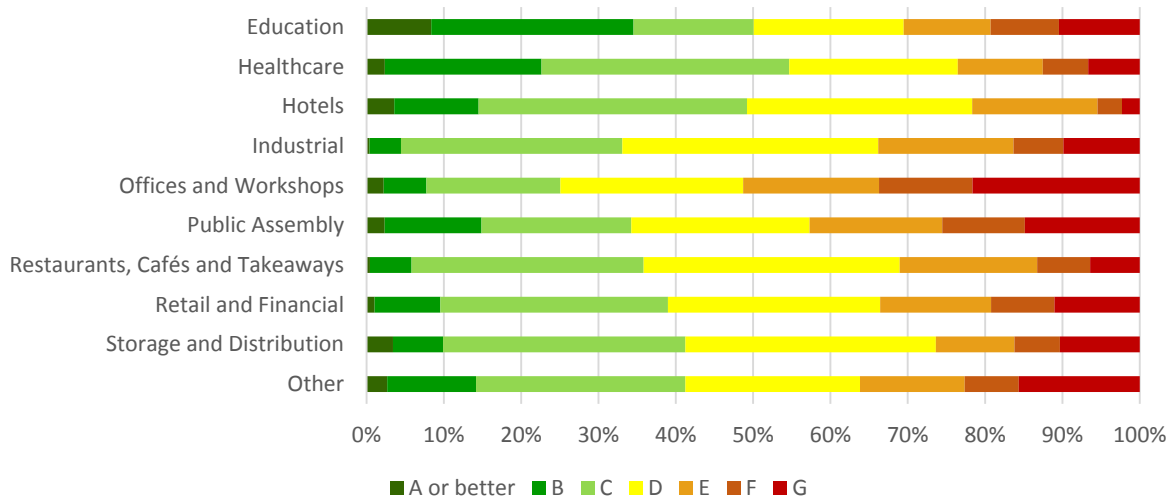
Developing a 'Comparative Asset Rating' for Scotland

The mean comparative rating across the non-domestic building stock is 100. This figure does not indicate a particular emissions intensity, but adopts the benchmarking approach described above. Introduction of such a metric, a Comparative Asset Rating (CAR), could serve as a strong indicator of improvements in the fabric and heating and cooling systems of the non-domestic stock.

Figure 8: Non-domestic building types by comparative rating
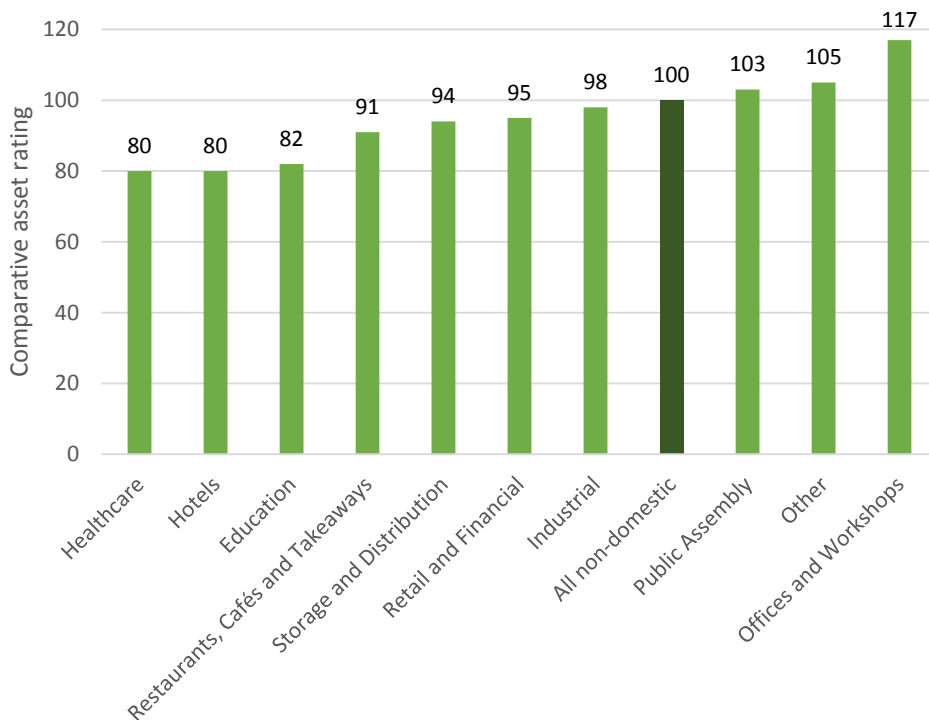
The Scottish current EPC rating and comparative rating report very different results when comparing categories. Table 1 shows that although offices and workshops generally have much lower calculated emissions than both hotels and restaurants, cafés and takeaways, they tend to perform much worse relative to their reference building. This highlights the potential issues with using the current EPC rating as an indicator of how a building performs compared to other buildings of a different building type.

Table 1: Examples comparing comparative and current EPC ratings

Building type	Mean comparative rating	Mean EPC rating ($kgCO_2/m^2/yr$)
Hotels	80	179
Offices and Workshops	117	77
Restaurants, Cafés and Takeaways	91	177

It is clear that the current reference building approach for any given building type, with a comparative rating of 50[4], represents a challenging standard for most non-domestic buildings to match. However, for such a comparative approach to have specific meaning for Scotland beyond comparison with England, Wales and Northern Ireland[5], how the reference building represents an exemplar must be clearly defined.

The Energy Efficient Scotland Route Map proposed research into the setting of future improvement targets for non-domestic buildings, with the development of a notional building specification that illustrates 'what good looks like'. Accordingly, a Scotland-specific indicator of this type is likely to be considered as part of change proposed from 2021.

Public sector occupied buildings

Using available data, there is no statistically significant difference in the distribution of EPC bands for private and public sector occupied buildings. However, we will be working with public sector partners to improve public sector data in order to establish a baseline of the energy efficiency of public sector buildings.

Main heating fuel

EPCs indicate that half of non-domestic premises use electricity as their main heating fuel. Approximately 17,000 more non-domestic premises rely on electricity as their main heating fuel than rely on natural gas. However, the choice of heating fuel can vary depending on building type. For example, the retail and financial category contains around 32,000 more premises reliant on electricity than on natural gas. The most common heating fuel in all other categories except for storage and distribution and restaurants, cafés and takeaways is natural gas.

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[4] A building with calculated emissions equal to those of the reference building will have a comparative rating of 50, placing it on the threshold between bands B and C.
[5] See box on p.6.

Table 2: Proportion of non-domestic premises by main heating fuel

Main heating fuel	Percentage of premises
Natural gas	42%
Grid supplied electricity	50%
LPG/Oil	5%
Biomass	1%
Other	2%

Summary

This report has provided an estimate of the baseline energy efficiency performance of Scotland's non-domestic buildings. The analysis has shown that there is considerable variation between the emissions intensity of different building types predicted by current EPC ratings. It is also clear that there are potential issues with using the current EPC band to monitor improvements in energy efficiency over time.

Adopting a building type benchmarking approach similar to that underpinning the comparative rating and creating a Scottish 'Comparative Asset Rating' may provide a clearer picture of changes in the energy efficiency of non-domestic buildings. This supports the approach advocated in the Energy Efficient Scotland Route Map on which the Scottish Government has recently consulted[6].

The analysis has also highlighted that further work will need to be undertaken with public sector partners to establish a specific baseline for public sector buildings.

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[6] An analysis of consultation responses is available at: https://www.gov.scot/publications/consultation-analysis-energy-efficient-scotland-making-homes-buildings-warmer-greener-more-efficient/

Annex - Methodology

Non-Domestic Energy Performance Certificates

With limited exceptions[7], all buildings that are constructed, sold, or rented to a new tenant require an EPC. There is also a requirement to display EPCs in larger buildings visited by the public. An EPC, required under Scottish regulations which implement Directive 2010/31/EU on the Energy Performance of Buildings, provides information on the energy and emissions performance of a building, calculated using an agreed UK methodology. EPCs enable people to compare the performance of buildings and also illustrate the potential for better performance through building improvement work.[8]

An EPC is not designed to account for energy use beyond heating, cooling, hot water ventilation, lighting and auxiliary systems such as pumps and circulators. The EPC model uses information on building type, fabric, lighting and HVAC systems submitted by an EPC assessor to calculate ratings.

Figure 9: A non-domestic EPC chart
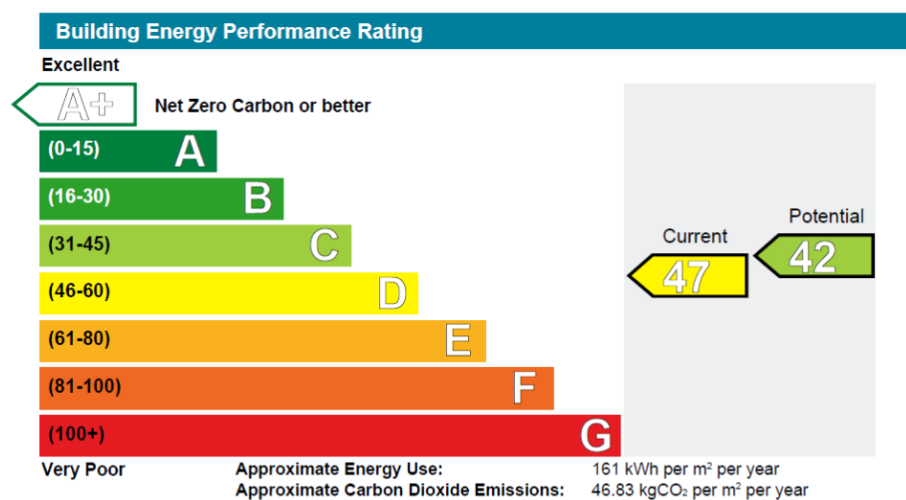
While EPCs for homes in Scotland present a current and potential rating based on predicted consumer cost and a further rating of current environmental impact based on predicted greenhouse gas emissions, non-domestic EPCs present current and potential ratings based purely upon predicted greenhouse gas emissions arising from energy use.

The current rating shown in both the yellow arrow and the text at the bottom of Figure 9 is a modelled estimate of annual carbon emissions per square metre for a particular non-domestic building.[9]

For domestic EPCs, all ratings are indexed, ranging from 0 to 100 with higher numbers indicating better performance. In contrast, a lower numerical rating is preferable for non-domestic EPCs. Buildings generating more energy from

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[7] Exceptions are stand alone buildings with floor area below 50m^2, temporary buildings with planned use of under two years, buildings with low energy demand and buildings sold for demolition.
[8] Further information on EPCs and the EU Directive can be found at http://www.gov.scot/epc. Individual EPCs can be sought by building address, postcode or unique report reference number at https://www.scottishepcregister.org.uk.
[9] Non-domestic EPCs are generated using the Simplified Building Energy Model (SBEM). Information concerning the model can be found at http://www.uk-ncm.org.uk.

renewable sources than they consume are able to achieve a negative rating and there is no maximum rating for inefficient buildings. These differences mean domestic and non-domestic current ratings are not directly comparable. The process used to calculate the current rating applies a standard usage pattern to every building of a particular type.

Within the EPC Recommendations Report, a comparative rating is also reported. This is an alternative metric, used elsewhere in the UK, which compares the energy efficiency of a building to that of a reference building of the same type. It is therefore expressed as a unitless factor. A rating of 50 indicates parity with the reference building while a lower number indicates lower emissions.

All EPC ratings are independent of actual usage of the building as standard assumptions are always applied for each building of a particular type.

Overview of data

The analysis in *Scotland's non-domestic energy efficiency baseline* is based on 29,956 non-domestic EPCs issued between 29 January 2013 and 31 July 2017. Where multiple EPCs were issued for a particular premises during this period, only the most recent was used.

Five outlying EPCs were rejected on the grounds that they contained palpably implausible energy efficiency data.

Due to missing data, the sample size was reduced from 29,951 to 20,232 for comparative rating calculations. Where current EPC ratings are compared to comparative ratings there is at most 0.6 per cent difference between the mean current rating from the full sample and that from the reduced sample.

How has the non-domestic energy efficiency baseline been calculated?

Non-domestic rates (NDR) data from the Scottish Assessors Association Portal was used to help ascertain the overall number of buildings of each type.

Step 1: Data matching 16,782 of the EPCs were linked to non-domestic rates entries by matching unique property reference numbers (UPRNs).

Large data files were stitched together to form a unified data set containing all available address, building type and internal area information. Address information within both the EPC data set and the combined NDR data set was used to seed all entries with UPRNs. Some entries in each data set then had both an original UPRN and a seeded one. Often these differed. UPRNs were often designated to multiple properties in either data set despite their supposed uniqueness.

An algorithm was developed to determine whether to accept matches between UPRNs in the EPC data and UPRNs in the NDR data. For UPRNs appearing for only one property in each data set, it accepted all matches where the UPRN appeared at all four opportunities (original and seeded in both data sets) and some matches

where a UPRN appeared three out of four possible times. A UPRN appearing for more than one property in either data set usually resulted in rejection of matches based on that UPRN.

Step 2: Matching building typologies Different building typologies have been adopted for EPC and NDR purposes. A non-domestic building is assigned one of 22 building types by its EPC assessor. Some of the less common building types have been combined to produce the wider building categories in this report[10]. Non-domestic rates assessors divide properties into 20 classes and also into 200 core descriptions. A table was created showing how many of the above matches fell under each combination of EPC building type and NDR class.

Step 3: Calculating building numbers Each of the 200 core descriptions was deemed typically heat controlled, typically non-heat controlled or mostly heat controlled. Non-heat controlled premises were excluded from building number totals as were a fixed proportion of premises with mostly heat controlled core descriptions. The resulting elimination of approximately 40,000 NDR entries enabled estimation of a total number of heat controlled buildings in each NDR class.

The number of matches between a specific EPC type and a specific NDR class was then multiplied by the estimated total number of heat controlled buildings in that NDR class divided by the total number of matched buildings in that NDR class. A projected total number of buildings of an EPC type was then calculated by summing the results for that EPC type across all 20 NDR classes.

Step 4: Weighting mean ratings and banding distributions Mean ratings across the whole non-domestic stock were calculated using the mean rating for each building type from the whole EPC data set (excluding outliers as noted above) and the projected total number of buildings of each EPC type found in step 3.

The number of buildings of a specific EPC type in a specific band was multiplied by the projected number of buildings of that type divided by the total number of EPCs for buildings of that type. The projected total number of non-domestic buildings falling in each band was then found by summing across all EPC types.

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[10] The public assembly category includes community centres, day centres, places of worship, leisure and entertainment venues, libraries, museums and galleries. Public houses usually fall into the restaurant, café and takeaway category. Emergency service buildings constitute nearly half of the other category.