

Community Carbon Audit Methodology

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The Green Valleys are a Powys-based Community Interest Company that inspire and support community led action on carbon reduction and environmental enhancements. This audit was funded by the UK Community Renewal Fund

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1.0 Introduction

This report provides a detailed explanation of the process for developing the *Community Carbon Audits*. The following key principles were applied to the collection, analysis and correction of data:

- a) The data is provided from a trusted source - preferably UK Government figures
- b) The methodology for creating the data is known and any estimates or inaccuracies within the data are established
- c) The data used is the most recent, suitable dataset available
- d) The data is available at a suitable scale – prioritizing the most local scale

Carbon auditing is a complex process and it can be difficult to produce accurate figures for small geographic areas like communities. Where data is available at a local scale, it has been used. Where data is only available at UK or Wales level, total figures have been scaled to the level of the local population. This has created a hierarchy whereby the datasets used are selected at the most local scale available.

Scale	Data
Local - LSOA	Electricity; Gas; population; households
Regional - County	Road Fuel
Country - Wales	Spending power
National - UK	Consumption; population

It should also be noted that this audit methodology does not aim to produce scientifically precise figures on carbon emissions. It is beyond the scope of the project, expertise of those producing the work or the datasets available to do so. The audit is not intended for use in reporting precise emissions to a particular authority, used for key strategic decisions by local authorities, for use in detailed research or other function where precision and verification of data would be required.

Instead, the audit aims to engage communities with understanding carbon emissions, their emissions sources, relative volumes of use, impact on Co2 emissions and scale these to their community. This is to create a relative and understandable measure to carbon emissions at values the individuals can understand. Carbon emissions are often based on a simple

calculation of UK emissions total proportioned evenly to each citizen. This provide no context as to the source of those emissions and whether it is a households' car travel, heating system or dietary choices that result in the most emissions. This audit aims to provide that greater context and to do so in a way that can be understood without great technical knowledge of the datasets and audit methodology.

The audit methodology is limited to those datasets that are readily available. It is also limited by the necessity to make broad assumptions, use averaged figures and other processes to account for the vast number of variables that will ultimately determine a particular households carbon emissions.

1.1 Sources of carbon emissions

Domestic carbon emissions can be broadly grouped into three sources:

- Domestic energy: Direct carbon emissions from private transport and from homes due to heating, lighting and appliance use
- Consumption: Indirect carbon emissions from the production of goods and services that are consumed. These are effectively non-domestic emissions as the emissions are produced by extraction, manufacturing, supply chain and consumption of goods and services
- Public Services: Indirect carbon emissions from public services including government, NHS, police and other tax-payer funded services

1.2 Annual datasets used

All of the data used is based on annual figures. Energy consumption varies with the seasons and so it is essential that a full years' dataset is used.

However, figures have been significantly impacted by the covid-19 pandemic. The mass closures of schools and businesses along with the shift to home working, reduced road and air travel have resulted in atypical figures for 2020 and 2021 in terms of energy use and consumption. Therefore the 2019 energy datasets used were used as they are considered more typical. The longer term impacts of the pandemic are yet to be realized and so it is accepted that consumption patterns may never return to pre-pandemic patterns.

There would be logic in using 2019 figures for every part of the audit. However, prices in particular have changed significantly and to use older datasets, when more accurate and up to date datasets are available, would result in audits that unsuitable for use in the short-term future. Also, some datasets are only available some time after the period to which they cover. Therefore, the most recent datasets were used for those aspects likely to be unaffected (at least to any significant level) by the pandemic.

Datasets used corresponded to the following years:

Consumption and energy use:	2019 (BEIS)
Population:	2020, mid-year estimate (ONS)
Spending power:	2018-2020 average (ONS)
Emission factors:	2021 (BEIS)
Energy prices:	June 2022 observed averages
Consumption:	2018 (University of Leeds)

2.0 Geographical data

Geographical data produced by the UK's Office for National Statistics ONS divides the UK into Output Areas, based upon Census data. These are further divided into Medium Super Output Areas MSOAs and Lower-layer Super Output Areas LSOAs. Each of these is intended to have a broadly similar population and is used for a variety of statistical and planning functions. UK energy use data is provided at LSOA for domestic and MSOA for non-domestic.

LSOAs and MSOAs do not necessarily conform to political divisions such as electoral ward or community council areas. Each LSOA has been given a recognized name, which has been used throughout the audits, but care should be taken to recognize that this does not necessarily share identical boundaries with a ward or community council area that shares a similar name.

While MSOAs and LSOAs do not cross County boundaries, the community may wish to define its boundaries differently than the LSOA data. If the community wants to expand its area, the LSOA data figures are increased proportionally. For example, if an LSOA area includes 1000 households, but the audit is to include a wider geographic area defined by the community that includes an additional 200 households, the LSOA data is simply increased by 20%.

3.0 Population data

ONS produce mid-year population estimates for the years following a Census and these have been used to provide more up to date population data. The figures used are the mid-year 2020 estimate for the LSOA level and also for the total UK population.

4.0 Number of Households

As with population, this data is only accurately obtained via the Census. The number of households for each LSOA has the potential to change significantly through:

- New buildings – in particular larger developments
- Conversion of redundant and farm buildings to dwellings
- Change of use from commercial premises
- Division of larger dwellings into smaller units
- There are significant number of rented holiday homes and it is unclear how many of these may be registered as households during the Census due to transient occupation.

For this audit, the number of Households in each LSOA is based on the recorded number of electricity meters in each LSOA. As it is assumed that every dwelling will have an electricity supply, the number of meters can provide an indication of the number of households. However, the number of meters usually exceeds the number of households due to the presence of more than one meter in a house. This is most common where buildings are divided into smaller units such as a block of flats, where common areas (lobbies, stairways, landings and external lighting) are likely to be supplied via a dedicated meter.

The number of extra meters is likely to be low enough that it doesn't impact on the figures. Accepting that there may be a slight difference, the number of electricity meters recorded in the LSOA are used to estimate the number of households. As the average energy consumption is derived from the total, divided by the number of meters, this ensures some consistency in how the datasets are applied.

5.0 Domestic Energy consumption

5.1 Datasets and scale

Domestic Energy consumption figures are produced annually by the UK Governments' Department for Business, Energy and Industrial Strategy BEIS. These are known as the *Sub-National Consumption Statistics* and comprise the following datasets with figures provided at one of LSOA, MSOA or County level:

Domestic Energy Consumption

- Gas - LSOA
- Electricity - LSOA
- Road transport fuels - County
- Residual (non-electricity, no-gas and non-road transport) fuels –County

A *Methodology and Guidance booklet* (December 2018) produced by BEIS is available which provides details on the production of these figures.

5.2 Grid Electricity - Domestic

This dataset is considered an estimate but as it is produced from the data used for billing by energy suppliers there is confidence in its accuracy. Some points to note are:

- a) It includes data from both Half-Hour (HH) and non-Half Hour (NHH) meters. Smart meters continue to be rolled out and record the time of energy use in Half Hour segments. Regular “dumb” meters only record actual consumption and no record of time of use it made. However, the type of meter doesn’t change the annual use figures, other than accepting some figures might be derived from meter estimates.
- b) The figures for HH and NHH meters cover a slightly different calendar period.
- c) Electricity figures are not weather corrected (see Gas below).
- d) It is accepted that some meters may be incorrectly located within a particular LSOA.

5.3 Mains Gas - Domestic

This dataset is considered an estimate but as it is produced from the data used for billing by energy suppliers there is confidence in its accuracy. Some points to note are:

- a) Gas figures are weather corrected. This allows for better year-on-year comparison of consumption data that is influenced by climate variances. As gas is primarily used for heating, colder years result in higher consumption.
- b) It is accepted that some meters may be incorrectly located within a particular LSOA.

5.4 Road Transport fuels - Domestic

Road Transport fuels are provided as estimates for consumed energy at the County scale only. To allocate an amount of this figure to each LSOA two factors were applied:

- a) A direct proportion of the LSOA population to the County population. i.e., a LSOA with 1% of the County population is allocated 1% of the County fuel use.
- b) A multiplier has been applied to this direct percentage to account for the LSOAs distance to services. More isolated and rural LSOAs can reasonably be expected to have a higher transport use and therefore a greater proportion of the energy use than the population alone would indicate. Factors of 90% (close to services) 100% (average distance to services) and 110% (further from services) have been used.

The Road Fuels figures are divided into different vehicle types. For the purposes of this audit, the following method was applied:

- a) Total consumption by vehicle type was used throughout.
- b) Domestic diesel use is for private cars
- c) Domestic petrol use includes motorcycles and cars

- d) The Sub-National figures are provided in Tonnes of Oil Equivalent “toe” which is a unit of energy rather than mass. 1toe is equal to 11630kWh. For comparison, the fuels have been converted to kWh figures.

5.5 Residual fuels - Domestic

While gas, electricity and vehicle fuel dominate domestic energy consumption, a number of other fuels are still used. Data on these is provided at the County level and estimates for some fuel types have been aggregated together. After examination, the Residual Fuels dataset has not been used for the audit as it does not provide data at a necessary scale or fuel type to be useful for the localized energy auditing required.

Instead, an estimate of the likely fuels used in off-gas domestic dwellings has been produced based upon the following:

- a) Estimated number of homes using residual fuels: The Sub–National figures for electricity and gas provide a figure for the number of meters in each LSOA. Assuming every property has an electricity meter, but not necessarily a gas meter, the number of gas meters is subtracted from the number of electricity meters, producing a figure for the number of properties that do not use mains gas.
- b) Likely energy demand: For homes within an LSOA with some mains gas, the same figure for the mean consumption of gas in kWh has been used. In practice, modern gas boilers are likely more efficient than boilers using other fuels, resulting in a higher kWh consumption of other fuel types to produce the same heat energy. However, the range of boilers and fuel types makes this difficult to account for in any consistent manner. For LSOA areas without any main gas from which to derive a gas consumption based figure, the mean figure from a neighbouring LSOA has been used.
- c) Likely fuel type: Four fuels are typically used in off-gas households: Heating oil; Liquefied Petroleum Gas LPG; Wood pellets; Wood logs. A fixed percentage has been applied based upon an estimate of the likely scale of use of each fuel type. Figures for electrically heated homes do not need to be included as this use is already recording in the electricity data.

Residual fuels are difficult to estimate. However, it is important that a figure is included to ensure that these fuel types are recognized as part of the local energy mix. While residual fuels form a small overall percentage of energy use in Powys, for non-gas areas they can be locally significant. The residual fuels figures give an indication of what fuels may be used in a LSOA and the likely scale of use but should not be considered an accurate assessment of actual energy use.

6.0 Carbon emissions from consumption

A detailed breakdown on the emissions from consumption is produced for the UK Government for the University of Leeds between 1990 and 2018. This results in a total UK figure for the consumption emissions. This total can then be divided by the UK population of 67.081 Million to create a per-person figure that can then be scaled to the local population figure.

However, this figure would assume that consumption volume is even across the UK when it clearly isn't. A local factor is needed to change the per-person average with a local indicator of consumption volumes.

The ONS produce figures for the weekly average spending power per household. The average for the UK as a whole can be compared to the regional average figure for Wales, which shows people in Wales on average spend less on consumer products and services than the national average. UK Average: £585/week; Wales Average £513/week

Wales's spending indicates that it is only 87% of the UK average and so only 87% of the consumption figure is used. This results in a figure of 3.79 tonnes Co2e per head of Wales' population.

It is very difficult to create a consumption figure through any other method, given the huge range of spending habits across individual households. While households with a higher disposable income can reasonably be assumed to consume more, it doesn't necessarily mean that this is being spent on higher carbon emission products.

The carbon emissions from consumption are derived from the non-domestic sources of emissions i.e., the production of goods and services that are consumed at a household level. This doesn't however provide a figure for the local direct non-domestic emissions from businesses located within a particular LSOA.

The complete dataset for UK consumption is broken down into 34 categories and includes domestic energy use and private transport. As a better dataset is available at the LSOA level, figures for these elements were removed from the UK data before calculating the per person average. The number of categories also created some difficulties in presenting the data for community use. Logical grouping was made to reduce the consumption totals to 14 categories.

7.0 Non-Domestic consumption figures

It is beneficial if communities can also produce a carbon emissions figures produced by local businesses. This is however much less straightforward to undertake than the domestic audit.

Domestic energy use is relatively uniform. While the largest houses use more energy, this is only perhaps up to 2-3 times more than the smallest houses. When averaged across the community scale, this variation produces a figure that will generally be appropriate.

However, non-domestic use is hugely varied. An office might use 1000kWh of electricity annually, whereas a pub serving food might use 10 000kWh and a factory use 100 000kWh or more. This makes it much more difficult to use any sort of average figure.

There is also a question of how the emissions are equitably shared. A large factory will be located within a specific community but if it supplies communities across Wales, how should the emissions be shared? There is value in identifying the sources of emissions, as these can then be targeted for local carbon emission reduction efforts. However, this may be seen as unfair to allocate emissions from a particular source to the community that happens to live near the factory but might actually consume very little of the local productivity. Conversely a particular community might consume much of the production from elsewhere.

There is also some uncertainty in the source of some emissions considered non-domestic. Electricity meters are considered either domestic or non-domestic and this is part of the meter registration. People that work from home and the consumption in a farm business would be difficult to allocate to non-domestic purposes as they are recorded on a domestic meter. A small B&B or a pub where the owners live on site may not have separate business and domestic meters.

For gas, non-domestic is considered to be any meter that records usage over a fixed value of 70 000kWh per year. Numerous small businesses might have gas consumption lower than this figure and so would be considered a domestic user in the datasets.

Finally, this data would only cover the direct emissions from energy consumption. It would not include the emissions from the supply chain, primary production, distribution or other activity that would be considered part of a particular business' carbon emissions.

7.1 Suitability of the Non-Domestic datasets: Gas, Electricity, Road Fuels & Residual fuels

Non-Domestic energy consumption figures are produced annually by BEIS. These are known as the *Sub-National Consumption Statistics* and comprise of the following datasets with figures provided at one of MSOA or County level:

- Gas – MSOA
- Electricity – MSOA
- Road Transport – County
- Residual Fuels - County

This data is provided at the MSOA level only and the emission sources are unevenly distributed across the LSOAs due to individual high-use sites such as a factory being located in a particular LSOA. In addition, the MSOA figures for electricity do not include those businesses on Half-Hour metering. Data for HH meters is only provided at County level. This makes it impossible to allocate any part of the HH data to a specific community.

For most communities, this dataset cannot be accurately proportioned down to the LSOA level. Should a defined community happen to be the entirety of an MSOA, then these figures can be used, accepting that the HH electricity data cannot be located to a specific MSOA.

Road fuel figures are only available at the County level and the break down by vehicle and fuel type allows for a simple division between domestic and non-domestic use. The data also estimates fuel used on road types, defined as Motorway, A-Road and Minor Road. As there are no motorways within Powys, this element can be excluded. Non-domestic use includes:

- a) HGVs
- b) Diesel LGVs
- c) Petrol LGVs

The County level data can be divided by the number of MSOAs in each County, producing an MSOA figure. This is then divided equally amongst the LSOAs.

The non-domestic Residual Fuels dataset provides values for domestic and non-domestic residual fuel use. As with the domestic fuel use, the Residual Fuels dataset has not been used for the audit as it does not provide data at a necessary scale or fuel type to be useful for the localized energy auditing required. The uneven nature of non-domestic consumption makes it extremely difficult to proportion County figures to any individual areas. For domestic consumption it was possible to develop an alternative approach, as there are datasets available to be worked from. These are unavailable for non-domestic consumption. Therefore, no residual fuel data has been included in the audit.

7.2 [Alternative methods for accounting for local non-domestic emissions](#)

Three alternative methods are detailed below. None are entirely satisfactory.

7.2.1 [Carbon emissions from consumption](#)

This process is detailed in point 6 above. While it does have its limitations, it does provide a measurable figure for the total carbon emissions generated by consumption and this would include all the local emissions plus those generated elsewhere but allocated evenly to a per person level.

7.2.2 [Direct measurement](#)

This process gathers energy consumption data from local businesses. These businesses can be allocated an appropriate industry such as retail, hospitality or manufacturing. With enough

data, an average figure for each industry can be calculated and then this scaled up to match the number of businesses locally.

This approach would capture data only from energy use and other factors such as the processing of goods sold by retailers would not be calculated. However, if enough data can be obtained from supportive businesses a suitable estimate could be made.

This approach will rely on engagement from local businesses and their willingness to share energy use data. However, it does not account for supply chain and other carbon emissions, whereas the consumption-based approach does.

7.2.3 Using the MSOA level datasets

There are a number of limitations in making the available dataset convert to meaningful figures at the more local level. Nevertheless, it is possible to use this dataset as a basis and apply local knowledge to creating a proportional figure. This does not produce a locally accurate result.

If the entire community forms a single MSOA then the dataset can be used directly – while noting that data from HH meters is not included.

For smaller areas, an average MSOA consumption values for gas and electricity could be applied to the number of businesses in the area. This would create a figure, but it would not account for the large potential variation in consumption between different businesses.

7.3 Summary of Non-domestic consumption omission from audit

The audit does not use any non-domestic datasets for the reasons outlined above. This is a relative short coming of the audit process but as data cannot be obtained with any degree of accuracy, its inclusion would create an unsound audit and one that could be wildly inaccurate and misleading.

This should not devalue the potential impact on carbon emissions achieved through engagement with local businesses. Many businesses are by necessity energy intensive and so offer potential for the largest savings through de-carbonisation methods. However, as this audit is primarily aimed to encourage action at a community level, focus on domestic energy use ensures it is relevant to everyone.

8.0 Public administration

A number of public services are operating on behalf of the population by central government, local government and various other services including Policing and the NHS. The emissions

from these services can be equally divided amongst the UK population to create a personal figure for the emissions.

Figures produced by the University of Leeds are used to report UK territorial emission to the UNFCCC. The emissions included are divided into:

- Non-profit
- Central Government
- Local Government
- Gross fixed capital formation
- Valuable
- Changes in inventories

Some of these groups are not simple to understand and it has not been possible to find clear definitions used in the development of the dataset. There is also some uncertainty around what has been included in each group. For example, local government figures might include fuel used in private vehicles used by staff, yet these are already included in the domestic energy figures. However, as this audit is based on a local scale from national figures, any discrepancies or overlaps between dataset are likely to generate only small changes to the figures produced for a specific community. However, it is important that the emissions from public services are included in the community emissions or else there is a risk of producing figures that are considerably lower than the actual emissions that we are collectively responsible for.

For the purposes and future use of the audits produced by this methodology, there is little communities can do to directly influence these emissions at any impactful scale. The lack of clarity and detail within this element of the audit can be recognized but should not be a barrier to the development of community action on climate change.

This approach has produced a figure that equates to 2.4 tonnes Co₂e per head of UK Population.

9.0 Cost

Fuel costs vary from supplier to supplier but a typical value for the cost in June 2022 has been selected for each fuel type. The expected increase in domestic energy prices resulting from the OFGEM price cap were not yet known as the audits were produced. It must be understood that the cost elements will change, significantly and rapidly. The audit indicates total costs and also the unit price used to calculate that cost.

Points to note when considering these values are:

- a) Costs for gas and electricity do not include standing charges, levies and tax
- b) Costs for heating oil, LPG and wood do not include delivery costs or tax

10.0 Carbon emissions

BEIS produces figures for the carbon intensity of fuels. This audit has used *Emission conversion factors for greenhouse gas company reporting 2021*. It is a widely used dataset for measurement of emissions.

- a) The value is in kg of *carbon dioxide equivalent Co2e*. This is a standard unit used for emissions measurements and accounts for the relative impact of other emissions from fossil fuels by converting their known impact into a carbon equivalent measure. As well as carbon dioxide, burning of fossil fuels emits nitrogen dioxide, methane and numerous other gases that impact on air quality and atmospheric heat absorption.
- b) The audits use the 2021 figures. The emissions change annually, in particular the carbon intensity of grid electricity and the UK has experienced a continued reduction in carbon intensity as more renewables, and less fossil fuels, are used in grid supply.

This dataset provides detailed figures for a range of energy applications.

The audit has used figures from the *Fuels* table as follows:

Liquid Fuels: Diesel (average biofuel blend); petrol (average biofuel blend)

Gaseous fuels: LPG; Natural Gas

The following has used figures from the *Bioenergy* table:

Biomass: Wood logs; wood chips

12. Data Sources

The following are link to publicly accessible datasets used in the Community Energy Audits.

Sub national Electricity consumption

<https://www.gov.uk/government/collections/sub-national-electricity-consumption-data>

Sub national gas consumption

<https://www.gov.uk/government/collections/sub-national-gas-consumption-data>

Sub national Road Fuel consumption

<https://www.gov.uk/government/statistical-data-sets/road-transport-energy-consumption-at-regional-and-local-authority-level>

Sub national Residual Fuel consumption

<https://www.gov.uk/government/collections/sub-national-consumption-of-other-fuels>

Emission factors (carbon intensity of fuel types)

<https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting>

Energy density of fuel types (CCA draft Technical Guidance Appendix A)

<https://www.gov.uk/government/publications/climate-change-agreements-draft-technical-guidance>

UK Consumption carbon emissions

<https://www.gov.uk/government/statistics/uks-carbon-footprint>

Annual domestic energy consumption

<https://www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics>

Population Estimates

<https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates>

Atmospheric Greenhouse Gas Emissions (used for the Public Administration element)

<https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsatmosphericemissionsgreenhousegasemissionsbyeconomicsectorandgasunitedkingdom>

