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Carbon Jargon

A glossary of carbon- and energy-related terms relevant to the house building community

NHBC FOUNDATION

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Disclaimer

This guide is a general introduction to the subject, and does not remove the need to comply with all relevant standards, regulations, codes of practice and health and safety advice.

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NHBC FOUNDATION

The NHBC Foundation

The NHBC Foundation, established in 2006, provides high quality research and practical guidance to support the house-building industry as it addresses the challenges of delivering 21st century new homes. To date we have published over 90 reports on a wide variety of topics, including the sustainability agenda, homeowner issues and risk management.

The NHBC Foundation is also involved in a programme of positive engagement with the government, academics and other key stakeholders, focusing on current and pressing issues relevant to house building.

To find out more about the NHBC Foundation, please visit **www.nhbcfoundation.org.** If you have feedback or suggestions for new areas of research, please contact **info@nhbcfoundation.org.**

NHBC is the standard-setting body and leading warranty and insurance provider for new homes in the UK, providing risk management services to the house-building and wider construction industry. All profits are reinvested in research and work to improve the construction standard of new homes for the benefit of homeowners. NHBC is independent of the government and builders. To find out more about NHBC, please visit **www.nhbc.co.uk.**

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1 Introduction

The language of carbon can be extremely complicated, and different people can use the same phrase to mean different things. Discussions with members of the house-building community have made it clear that there is a need for a straightforward, simple set of explanations and definitions which housebuilders, designers/architects, planners and other built environment professionals can adopt.

This guide does not attempt to resolve all of the conflicting definitions of some terms, but it does aim to provide a concise, common vocabulary and ensure consistency with official definitions including those used by Government.

The scope of this initial version is England only.

Throughout, text in italics denotes a cross-reference to another entry in the glossary.

2 Energy v. carbon

In the context of buildings, the term ‘energy’ means fuel (gas, oil, coal, wood), renewable resources such as wind and solar, electricity (however generated) and networked warmth/coolth. In common parlance we refer to energy ‘consumption’ or energy ‘use’, although strictly speaking energy is never consumed or used - it is only ever converted from one form to another (eg. from electricity to heat).

When fuels are burnt, they release carbon into the atmosphere. So providing space heating or domestic hot water by burning a fuel causes carbon emissions. Similarly, generating electricity by burning a fuel causes carbon emissions (albeit at the power station, not at the point of use of the electricity).

Consuming more energy generally results in more carbon being emitted [a], but the precise amount of carbon per unit of energy is different for different fuels (see carbon factor). For this reason, whilst it is often useful to regard carbon and energy as proxies for each other, it is also important to be aware of the difference. In particular, one should only ever compare like with like - ie. energy with energy, carbon with carbon.

Units: a home’s carbon emissions are usually expressed in tonnes (t) or kilograms (kg), usually per year (t/yr or kg/yr). Energy in housing is most often expressed in gigajoules (GJ) or kilowatt-hours (kWh), usually per year (GJ/yr or kWh/yr). It can be useful to compare the energy performance of buildings independently of their size, in which instance their energy usage may be normalised by expressing it per square metre of floor area, eg. kWh/(m^2.yr). If the magnitude of the quantities is higher or lower, different prefixes may be used - eg. megawatt-hours (MWh), kilojoules (kJ), etc.

a Except in the case of renewable and nuclear energy

3 Carbon v. carbon dioxide v. greenhouse gases v. carbon dioxide equivalent

The carbon associated with the burning of a fuel is in fact emitted in the form of carbon dioxide gas, CO_2. Where carbon emissions are quoted in kilograms or tonnes, this almost invariably refers to the mass of carbon dioxide, not carbon, emitted. 1kg of carbon dioxide contains only 0.27kg of carbon, so whilst the distinction between carbon dioxide and carbon may seem like a mere technical detail, it is extremely important when setting or complying with targets to be clear which quantity is being referred to.

Although carbon dioxide is the most significant gas for causing man-made climate change, there are many other gases which contribute. These so-called ‘greenhouse gases’ include methane, nitrous oxide and water vapour. Targets for mitigating climate change may be expressed as carbon reductions or greenhouse gas reductions. The resulting strategy will obviously depend on the metric being used.

Units: in order to compare the effects of different greenhouse gases, the Intergovernmental Panel on Climate Change (IPCC) has defined the Global Warming Potential (GWP) of each one. This index expresses the warming effect of a certain amount of the gas over a set period (usually 100 years) in comparison to CO_2. The GWP is expressed as a ‘carbon dioxide equivalent’, CO_2e. For example, methane’s effect on the climate is 28 times more severe than CO_2 over 100 years, even though it doesn’t stay in the atmosphere for as long as CO_2.

4 Operational energy/carbon

Operational energy is the energy consumed in a home during its occupation and use, for space heating/cooling, domestic hot water, ventilation, lighting, cooking and electrical appliances. Operational carbon is the amount of carbon which is emitted as a result of the home's operational energy.

5 Embodied energy/carbon; whole-life energy/carbon

The embodied energy of a building product (eg. a brick, a roll of loft insulation, a boiler) is the energy associated with manufacturing and providing that product. The embodied carbon of the product is the amount of carbon which was emitted as a result of its embodied energy.

It is worth noting that whilst a building product may or may not physically contain carbon or carbon compounds, this is **not** what is known as its embodied carbon. For example, cement physically contains no carbon at all, yet its embodied carbon (ie. the carbon emitted during its manufacture) is relatively high.

There are three main methodologies used for calculating embodied energy or carbon: 'cradle-to-gate', cradle-to-site' and 'cradle-to-grave'[2]. **Cradle-to-gate** includes the energy or carbon required to extract the raw materials, process them and assemble them into the usable products. **Cradle-to-site** adds to this the energy/carbon required to transport the products to site. **Cradle-to-grave** further adds the energy/carbon required to dismantle and dispose of the product at the end of its life; cradle-to-grave is also known as 'life-cycle' or 'whole-life' energy/carbon.

As well as applying to individual building products, the concept of whole-life energy or carbon can apply to a home as a whole. In this instance it also includes the energy/carbon used in the construction process, the embodied energy/carbon of the building products and processes required to refurbish and maintain the home over its lifetime, the home's lifetime ***operational energy/carbon***, and the energy/carbon involved in the demolition of the home and the disposal of its constituent products [b].

Units: embodied energy is usually expressed in megajoules or gigajoules per unit mass of product (eg. MJ/kg or MJ/t), but it may also be expressed per unit area or volume of product (MJ/m^2 or MJ/m^3).

Embodied carbon is usually expressed as the mass of CO_2e per unit mass of product (eg. kg/kg).

One definitive source of the embodied carbon of a building product is its Environmental Product Declaration (EPD). EPDs should be produced in accordance with EN 15804 (the European Standard for the generation of EPDs for construction products), ISO 14025, and other related international standards.

When formally calculating the whole-life carbon of a building, it is important to use a robust, agreed methodology as well as individual EPDs. The NHBC Foundation believes that industry should standardise on the whole-life carbon assessment method formulated by the Royal Institution of Chartered Surveyors (RICS)[3].

b Note that since the whole-life energy/carbon of a home includes operational as well as embodied energy/carbon, it is slightly different to the whole-life energy/carbon of building products (which includes only embodied energy/carbon).

6 Space heating demand (or heat load)

The space heating demand, or heat load, of a home is the amount of heat energy needed within the home to maintain the rooms at the desired temperature. Traditionally, heating demand calculations assumed an internal temperature of 21°C and a fixed external temperature of typically -1°C or -3°C (known as a 'design day'). More modern methods, including calculations such as the SAP[4], take account of variations in external temperature, wind speed, internal temperature rises due to sunshine and electrical appliances, etc.

When used to set targets, space heating demand is usually expressed per square metre of floor area so that it is independent of house size.

Units: kilowatt-hours per year, kWh/yr, or kilowatt-hours per square metre of floor area per year, kWh/(m^2.yr).

7 Delivered energy

Delivered energy is literally the energy delivered to a home, ie. the quantity measured at the location of the gas and electricity meters (and/or heat meter in the case of district heating), oil tank or log store. It comprises the energy used for space heating, domestic hot water, ventilation, fixed lighting and sometimes electrical appliances. One may express the different uses separately, eg. the delivered energy due just to space heating.

When considering space heating in particular, it is important to be aware of the difference between delivered energy and space heating demand. Delivered energy also includes the energy losses due to the imperfect efficiency of the heating appliance. For example, if the space heating demand of a home were 4,000 kWh/yr, and the boiler had an efficiency of 85%, in providing the necessary 4,000 kW of heat to the interior of the home each year the boiler would also lose some 700 kWh via its flue. In this instance the gas consumed by the boiler as measured by the meter - ie. the delivered energy - would be 4,700 kWh/yr.

Units: kilowatt-hours per year, kWh/yr.

8 Primary energy

Primary energy is 'raw' energy before it has been extracted, processed or transported.

By the time any kind of energy reaches the home - be it gas, oil, coal, electricity, waste heat, etc - it has been either:

- extracted, refined and transported by sea, road or pipeline,

or

- (in the case of electricity) generated from a fuel/renewables/nuclear and transmitted along wires.

At each of these stages, energy is used or lost. For example, electricity is used to extract gas from the ground, and diesel fuel is used to transport coal. When a turbine generator is spun to produce electricity, gas is burnt to spin the turbine and there are friction losses in the generator. Gas pipelines leak to some extent. Electricity transmission wires and substations lose energy in the form of heat.

As a result, the primary energy used by a home is greater than its delivered energy. There are numerous international methodologies for calculating primary energy, and many complications around how renewable sources and local generation should be accounted for. The simplest way to calculate primary energy is to apply a ***simple primary energy*** factor obtained from a reputable, authoritative source such as the SAP[3].

9 Regulated and unregulated energy

Broadly speaking, ***regulated energy*** is the energy which a developer has direct influence over. More precisely, regulated energy is all of the energy that is included in Part L of the Building Regulations. This is the same energy that is included in a SAP calculation. It comprises the energy used for heating, cooling, domestic hot water, ventilation and fixed lighting, although the list is kept under review as technology advances [c]. All other energy used in the home is referred to as ***unregulated energy***.

Unregulated energy is the opposite of regulated energy, ie. it is any energy used in a home that is not included in Part L of the Building Regulations or a SAP calculation. Unregulated energy essentially consists of the energy used for cooking, portable heaters, free-standing lights, plug-in electrical appliances (audio-visual equipment, phone chargers, fridges, kettles, etc) and electric vehicle chargepoints.

c Regulated energy currently only includes the operational energy of a home, although there is a good argument - and much ongoing lobbying - that future Building Regulations should also include the home's embodied energy. This argument becomes stronger as the operational energy of new homes becomes ever-lower.

10 Zero carbon

A zero carbon home, sometimes called an 'absolute zero carbon' home, is one which has no carbon emissions and does not rely on ***offsetting*** to achieve this. In practice this means either that the home uses no energy at all, or that whatever energy it does use is both (i) produced in a way that emits no carbon, and (ii) produced on-site or via a dedicated private wire/pipeline.

In the context of housing policy, zero carbon usually refers just to the ***regulated*** component of the home's ***operational carbon***. However, zero carbon definitions do sometimes include unregulated energy and/or embodied energy, which makes standards and compliance harder to calculate and to police. It is important to be sure which definition is being used, and if it is required to calculate unregulated energy to use a reputable method such as that set out in SAP Appendix L[3].

A zero carbon home must not be confused with a ***net zero carbon, carbon-neutral*** or ***zero carbon 'ready'*** home. The latter definitions are sometimes used when site constraints make it impossible to reach zero carbon on-site.

11 Net zero carbon

There are many definitions of net zero carbon[5]. The NHBC Foundation believes the following should be adopted as the industry standard:

A net zero carbon home is one where, after minimising the energy use of the building itself and providing as much as possible of the remaining energy requirement from zero carbon sources on-site or via private wire/pipeline, there is still a residual energy requirement. The corresponding residual amount of carbon must be eliminated by ***offsetting***, in order for the home to qualify as net zero carbon.

As with the definition of zero carbon, in the context of housing policy net zero carbon normally only refers to the ***regulated components of operational carbon***.

*See also **carbon-neutral**.*

12 Carbon-neutral

For housing projects it is acceptable to use the terms carbon-neutral and ***net zero carbon*** interchangeably.

At the corporate operations or national level, however, the generally agreed difference is that a commitment to net zero carbon requires carbon to be removed from the atmosphere, whereas carbon neutrality only requires carbon emissions to be reduced[6]. An additional requirement is sometimes added to the definition of net zero carbon, that any strategy must align with the IPCC objective of limiting global temperature rises to 1.5°C[7] .

13 Zero carbon 'ready'

The Government states that the forthcoming Future Homes Standard[8] "will deliver homes that are zero carbon ready" and goes on to describe those homes as follows:

- they will not be built with fossil fuel heating such as a natural gas boiler;
- they will be future-proofed with low carbon heating and high levels of energy efficiency;
- they will not rely on offsetting;
- no further energy efficiency retrofit work will be necessary to enable them to become zero carbon as the electricity grid continues to decarbonise.

It can be seen that zero carbon 'ready' is similar to ***net zero carbon*** except for the fact that ***offsetting*** may not be used.

14 Offsetting and carbon credits

Offsetting is one way of eliminating the residual carbon that needs to be accounted for in order for a home to qualify as ***net zero carbon***. Offsetting allows a potentially net zero carbon project to claim the carbon reductions achieved by another project, as long as the second project is 'additional' [d].

Offsets take many forms, including:

- the use of surplus renewable energy that is generated on associated buildings;
- paying into local funds that are set up specifically to finance carbon reduction schemes;
- purchasing commercial offsets (otherwise known as 'carbon credits') which guarantee to provide carbon reductions. Carbon credits are not currently regulated by the Financial Conduct Authority (FCA), so it is advisable to check that they are certified by a scheme such as the UN's clean development mechanism (CDM)[9];
- the use of a zero carbon mains electricity tariff, eg. one that is entirely generated using renewable sources. This is considered a legitimate form of offsetting provided the zero carbon electricity is (a) additional – ie. more electricity is generated for each home that contracts to use the tariff– and (b) guaranteed to stay connected to the home – ie. the householder is somehow prevented from switching to a non zero carbon tariff on demand;
- ***carbon sequestration*** schemes that remove carbon from the atmosphere, either industrial or natural (eg. tree planting).

d ie. one which would not otherwise have gone ahead.

15 Carbon sequestration

The removal of carbon from the atmosphere, by either industrial processes such as ***carbon capture and storage*** (CCS) or by natural processes such as local tree planting and overseas reforestation. It is advisable to ensure that offsets based on planting programmes are certified by a UK Accreditation Service (UKAS) accredited certification body, to ensure their authenticity.

16 Carbon capture and storage (CCS)

Carbon capture and storage means capturing CO_2 directly from the air and permanently storing it, by industrial means rather than by trees etc. Air-captured CO_2 can also be used as a climate-neutral feedstock for products that require a source of carbon, such as fertilisers.

At the time of writing only 18 fairly small-scale air capture facilities are operating, in North America and Europe. The first large-scale direct air capture plant is expected to be operating in the United States by the mid-2020s[10].

17 Energy efficiency

Conceptually, energy efficiency represents how much energy a home uses. A home may be regarded as 'energy efficient' or 'energy inefficient'. An energy efficient home uses little energy.

Various metrics can be used to quantify energy efficiency. The NHBC Foundation believes that the industry standard should be a holistic metric which defines a homes' energy efficiency in terms of the ***regulated*** component of its ***delivered energy*** per square metre of floor area per year. This should be calculated using the SAP methodology, and as a result an energy efficient home can be defined as one that exceeds a certain SAP rating or Energy Performance Certificate (EPC) band.

This definition of energy efficiency takes into account the home's heating and cooling appliance efficiencies, ventilation, domestic hot water system, fixed lighting and any renewable energy generation connected to the home, as well as its fabric (insulation, airtightness and thermal bridges). Sometimes, however, the term 'energy efficiency' is used to mean just the fabric aspects of the home, ignoring the other features which increase or lower its energy consumption [e].

e This should more properly be called the 'fabric energy efficiency' of the home.

18 Carbon factor (of fuels)

The carbon factor of a fuel is the multiplication factor used to calculate the carbon (or more strictly carbon dioxide) emissions that result from the use of a given quantity of the fuel, as follows:

carbon emissions = carbon factor x fuel use

Each fuel has its own carbon factor, and some of them can change dramatically over time; for example, the carbon factor for grid electricity dropped by nearly 75% between 2014 and 2022 due largely to the reduced use of coal generation. The NHBC Foundation believes that industry should standardise on the carbon factors given in Tables 12 and 12d of the SAP[3].

Units: kilograms of carbon dioxide per kilowatt-hour of delivered energy (kg/kWh).

19 Primary energy factor (of fuels)

The primary energy factor (PEF) of a fuel is the multiplication factor used to calculate the amount of primary energy which corresponds to a given quantity of ***delivered energy***, as follows:

primary energy = PEF x delivered energy

Each fuel has its own PEF, and some of them change with time as (for example) the electricity grid is progressively decarbonised or biogas is gradually introduced into the gas main.The NHBC Foundation believes that industry should standardise on the PEFs given in Tables 12 and 12e of the SAP[3].

Units: kilowatt-hours of primary energy per kilowatt-hour of delivered energy (kWh/kWh). Sometimes expressed in dimensionless form, ie. as a simple number without any units.

20 Index

21 References

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The NHBC Foundation's research programme is guided by the following panel of senior representatives from the industry:

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