



BREEAM & Passivhaus



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History

BREEAM (Building Research Establishment Environmental Assessment Method), first published by the Building Research Establishment (BRE) in 1990,[1] is the world's longest established method of assessing, rating, and certifying the sustainability of buildings. More than 250,000 buildings have been BREEAM certified and over a million are registered for certification – many in the UK and others in more than 50 countries around the world. Work on creating BREEAM began at the BRE (based in Watford, England, UK) in 1988, and the first version for assessing new office buildings was launched in 1990. This was followed by versions for other buildings including superstores, industrial units and existing offices.

In 1998 there was a major revamp of the BREEAM Offices standard, and the scheme's layout, with features such as weighting for different sustainability issues, was established. The development of BREEAM then accelerated with annual updates and variations for other building types such as retail premises being introduced.

A version of BREEAM for new homes called EcoHomes was launched in 2000. This scheme was later used as the basis of the Code for Sustainable Homes, which was developed by BRE for the UK Government in 2006/7 and replaced EcoHomes in England and Wales. In 2014, the Government in England signalled the winding down the Code for Sustainable homes, since then BRE has developed the Home Quality Mark which is part of the BREEAM family of schemes.

An extensive update of all BREEAM schemes in 2008 resulted in the introduction of mandatory post-construction reviews, minimum standards and innovation credits. International versions of BREEAM were also launched that year.

Another major update in 2011 resulted in the launch of BREEAM New Construction, which is now used to assess and certify all new UK buildings. This revision included the reclassification and consolidation of issues and criteria to further streamline the BREEAM process. The latest update of BREEAM UK New Construction was launched in May 2014, following the most extensive consultation ever carried out for a BREEAM scheme.

Scope

BREEAM has expanded from its original focus on individual new buildings at the construction stage to encompass the whole life cycle of buildings from planning to in-use and refurbishment. Its regular revisions and updates are driven by the ongoing need to improve sustainability, respond to feedback from industry and support the UK's sustainability strategies and commitments.

What does BREEAM do?

BREEAM addresses wide-ranging environmental and sustainability issues and enables developers, designers and building managers to demonstrate the environmental credentials of their buildings to clients, planners and other initial parties,

BREEAM:

- uses a straightforward scoring system that is transparent, flexible, easy to understand and supported by evidence-based science and research
- has a positive influence on the design, construction and management of buildings
- defines and maintains a robust technical standard with rigorous quality assurance and certification

Who uses BREEAM?

- Clients, planners development agencies, funders and developers use BREEAM to specify the sustainability performance of their buildings in a way that is quick, comprehensive, highly visible in the marketplace and provides a level playing field.
- Property agents use it to promote the environmental credentials and benefits of a building to potential purchasers and tenants.
- Design teams use it as a method to improve the performance of their buildings and their own experience and knowledge of environmental aspects of sustainability.
- Managers use it to reduce running costs, measure and improve the performance of buildings, empower staff, develop action plans and monitor and report performance at both the single building and portfolio level.

Highly flexible, the BREEAM standard can be applied to virtually any building and location, with versions for new buildings, existing buildings, refurbishment projects and large developments:

BREEAM New Construction

is the BREEAM standard against which the sustainability of new, non-residential buildings in the UK is assessed. Developers and their project teams use the scheme at key stages in the design and procurement process to measure, evaluate, improve and reflect the performance of their buildings.

BREEAM International New Construction

is the BREEAM standard for assessing the sustainability of new residential and non-residential buildings in countries around the world, except for the UK and other countries with a national BREEAM scheme (see below). This scheme makes use of assessment criteria that take account of the circumstances, priorities, codes and standards of the country or region in which the development is located.

BREEAM In-Use

is a scheme to help building managers reduce the running costs and improve the environmental performance of existing buildings. It has three parts – Parts 1 (building asset) and 2 (building management) are relevant to all non-domestic, commercial, industrial, retail and institutional buildings. Part 3 (occupier management) of the

BREEAM In-Use certification scheme is currently restricted to offices. BREEAM In-Use is widely used by members of the International Sustainability Alliance (ISA) which provides a platform for certification against the scheme.

BREEAM Refurbishment

provides a design and assessment method for sustainable housing refurbishment projects, helping to cost effectively improve the sustainability and environmental performance of existing dwellings in a robust way. A scheme for non-housing refurbishment projects was developed and launched in early 2014 after the piloting and independent peer review processes had been completed.

BREEAM Communities

focusses on the masterplanning of whole communities. It is aimed at helping construction industry professionals to design places that people want to live and work in, are good for the environment and are economically successful.

BREEAM includes several sustainability categories for the assessment, generally:-

- Management
- Energy
- Health & Wellbeing
- Transport
- Water
- Materials
- Waste
- Land use and ecology
- Pollution

Home Quality Mark

Home Quality Mark was launched in 2015 as part of the BREEAM family of schemes. It rates new homes on their overall quality and sustainability, then provides further indicators on the homes impact upon the occupants 'Running costs', 'Health and Wellbeing' and 'Environmental footprint'.

The Home Quality Mark (HQM) provides housing developers with the tools they need to convince customers of the quality and added benefits of their new homes – such as being likely to need less maintenance, being cheaper to run, better located, and more able to cope with the demands of a changing climate.

Many house builders are constructing high quality homes – perhaps exceeding Building Regulation requirements in some aspects – but may not have the appropriate measurements of quality to persuade customers of their benefits.

Star ratings and quality indicators

The Home Quality Mark comprises two elements, a five-star rating giving a clear overall picture of the home's quality, and a set of indicators focussed on specific aspects that are of particular interest to the key groups involved, such as home occupants, developers and planners.



Figure 1.1 HQM star rating

The indicators for householders, for example, are householder costs, positive impacts on health and wellbeing, and the environmental footprint. An example of the HQM 'scorecard' that a home will receive - showing the overall rating and the ratings for each of the three householder indicators can be seen in Figure 1.1. Using a simple overall star rating, the Home Quality Mark will give householders a clear picture of a home's quality.

Work started in February 2015 on the latest inspirational building to be constructed at the BRE Innovation Park in Watford. The Wienerberger e4 brick house™, designed in conjunction with Arup, was one of the first houses built to achieve the new Home Quality Mark launched at Ecobuild in March 2015.

The design and construction of the three bedroom detached house focused on the four pillars of Wienerberger's global e4 concept – energy, economy, environment and emotion. It used a fabric first approach with a clay building envelope delivering a house that has reduced energy needs – meaning lower running costs for the home owner.



Figure 1.2 The Weinerberger House at the BRE

BREEAM Expansion

BREEAM has expanded from its original focus on individual new buildings at the construction stage to encompass the whole life cycle of buildings from planning to in-use and refurbishment. Its regular revisions and updates are driven by the ongoing need to improve sustainability, respond to feedback from industry and support the UK's sustainability strategies and commitments.

Highly flexible, the BREEAM standard can be applied to virtually any building and location, with versions for new buildings, existing buildings, refurbishment projects and large developments:

BREEAM Standards

BREEAM sets the standard for best practice in sustainable building design, construction and operation and has become one of the most comprehensive and widely recognised measures of a building's environmental performance.

A BREEAM assessment uses recognised measures of performance, which are set against established benchmarks, to evaluate a building's specification, design, construction and use. The measures used represent a broad range of categories and criteria from energy to ecology. They include aspects related to energy and water use, the internal environment (health and well-being), pollution, transport, materials, waste, ecology and management processes.

A certificated BREEAM assessment is delivered by a licensed organisation, using assessors trained under a UKAS accredited competent person scheme, at various stages in a building's life cycle. This provides clients, developers, designers and others with:

- market recognition for low environmental impact buildings
- confidence that tried and tested environmental practice is incorporated in the building
- inspiration to find innovative solutions that minimise the environmental impact
- a benchmark that is higher than regulation
- a system to help reduce running costs, improve working and living environments
- a standard that demonstrates progress towards corporate and organisational environmental objectives

BREEAM Accredited Professionals

A BREEAM Accredited Professional (BREEAM AP) has demonstrated specialist skills in sustainability and environmental design combined with a high level of competence in the BREEAM assessment process.

BREEAM APs will provide a design team with expert advice on built environment sustainability, environmental design and environmental assessment. They will facilitate the team's efforts to successfully schedule activities, set priorities and negotiate the trade-offs required to achieve a target BREEAM rating when the design is formally assessed.

The Passivhaus Standard

What is Passivhaus?

Passivhaus or 'Passive House' is the fastest growing energy performance standard in the world with 30,000 buildings realised to date with the majority of those since the turn of the century. The Passivhaus standards strengths lie in the simplicity of its approach; build a house that has an excellent thermal performance, exceptional airtightness with mechanical ventilation!

This robust approach to building design allows the designer to minimise the 'Heating Demand' of the building and in some residential buildings only, specify a heated towel rail as means of conventional heating. This heat can then be recovered and circulated by a Mechanical Ventilation and Heat Recovery (MVHR) unit.

The Standards Origins

The Passivhaus standard was developed in Germany in the early 1990s by Professors Bo Adamson of Sweden and Wolfgang Feist of Germany and the first dwellings to be completed to the Passivhaus Standard were constructed in Darmstadt in 1991. The Passivhaus standard can be applied not only to residential dwellings but also to commercial, industrial and public buildings.

This has led to the following functional definition of a Passivhaus.

"A Passivhaus is a building, for which thermal comfort can be achieved solely by post-heating or post-cooling of the fresh air mass, which is required to achieve sufficient indoor air quality conditions – without the need for additional re-circulation of air."

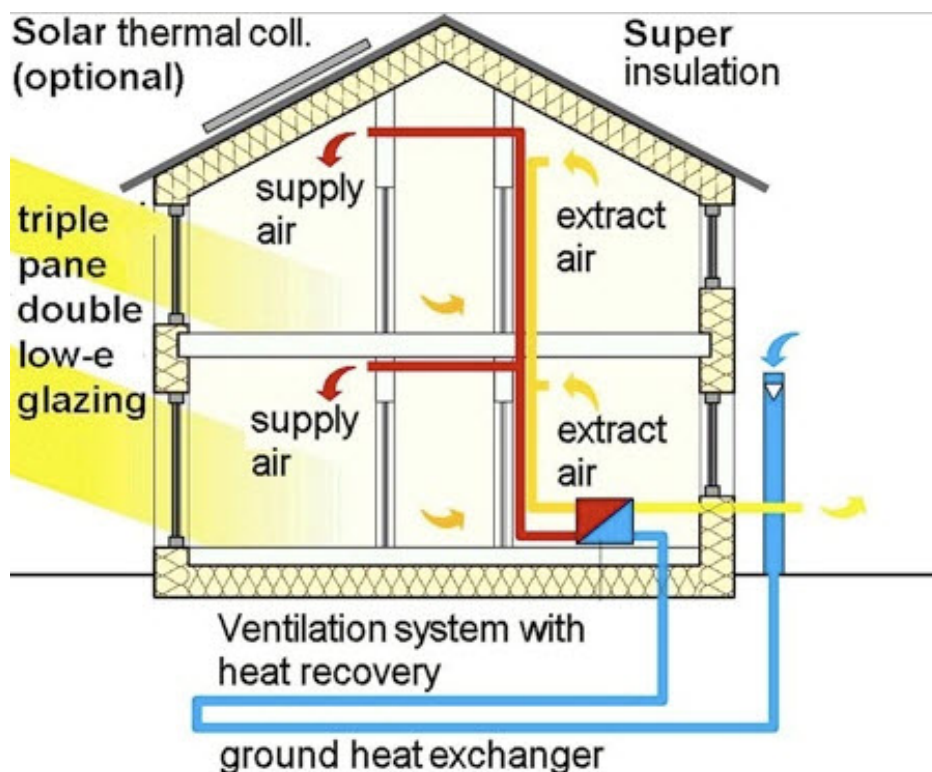


Figure 1.3 The Passivhaus standard applied to domestic dwellings



Figure 1.4 The complete Passivhaus requirements



Figure 1.5 A completed Passivhaus project

...meaning the heating requirement in a Passivhaus is reduced to the point where a traditional heating system is no longer considered essential. Cooling is also minimised by the same principles and through the use of shading and in some cases via the pre-cooling of the supply air. Night purging and the use of natural cross-ventilation through open windows is encouraged during the summer months.

As well as being an energy performance standard Passivhaus also provides excellent indoor air quality, this is achieved by reducing the air infiltration rates and supplying fresh air which is filtered and post heated by the MVHR unit.

Global Application

The Passivhaus standard can be applied to any climate in the world and works equally as well in warm climates as it does in more moderate climates. To date, Passivhaus buildings have been designed and built in every European country, Australia, China, Japan, Canada the USA and South America....a research station has even been constructed to the Passivhaus standard in Antarctica!

Fuel Poverty

As we become more aware of fuel poverty it becomes increasingly important to reduce our dependence on fossil fuels, with fuel prices continuing to rise the low heating demand of Passivhaus Buildings of less than 15kWh per square metre per year means that annual fuel costs are reduced by a factor of 5-10. For example a household living in a 70m² Passivhaus with gas heating could spend as little as £25 on space heating each year.

Basic Principles

The Passivhaus standard is sometimes confused with more generic approaches to passive solar architecture, with which it shares some common principles. Where the Passivhaus standard differs from more generic concepts is in its ability to reduce the permitted space heating demand and primary energy consumption. It can therefore be considered both as a robust energy performance specification and a holistic low energy design concept.

In a Passivhaus thermal comfort is achieved to the greatest practical extent through the use of passive measures listed below which can be applied not only to the residential sector but also to commercial, industrial and public buildings.

- good levels of insulation with minimal thermal bridges
- passive solar gains and internal heat sources
- excellent level of airtightness
- good indoor air quality, provided by a whole house mechanical ventilation system with highly efficient heat recovery

There are no strict requirements with respect to domestic hot water; lighting and appliance consumption the standard imposes an overall limit on the Primary Energy consumption which promotes energy efficiency in all of these areas.

Outline Specification

The Passivhaus standard is a comprehensive low energy standard intended primarily for new buildings. The following energy performance targets in Figure 1.6 define the standard and must be met in order for certification to be achieved.

The Passivhaus standard can be achieved when refurbishing buildings although this can prove costly, for more on Passivhaus refurbishment please see the EnerPHit standard.

The standard requires that the Primary Energy demand target is met in all cases, this figure must include the space heating, domestic hot water, lighting, fans and pumps and also all of the projected appliance consumption. In addition to the primary energy demand the standard permits that either the Specific Heating Demand or the Specific Heating Load must be met.

Energy performance targets and air changes per hour

Specific Heating Demand	$\leq 15 \text{ kWh/m}^2 \cdot \text{yr}$
Specific Cooling Demand	$\leq 15 \text{ kWh/m}^2 \cdot \text{yr}$
Specific Heating Load	$\leq 10 \text{ W/m}^2$
Specific Primary Energy Demand	$\leq 120 \text{ kWh/m}^2 \cdot \text{Yr}$
Air Changes Per Hour	$\leq 0.6 @ n50$

Figure 1.6 The Passivhaus Outline Specification

Energy Balance

The energy balance of the proposed building must be verified using the Passive House Planning Package (PHPP) using the appropriate regional climatic dataset. Either the monthly or the annual method may be applied.

If the Specific Heat Demand is $\leq 8 \text{ kWh/m}^2 \cdot \text{yr}$ or the ratio of free heat gains to heat losses is greater than 0.70 it is recommended that the monthly method is used to ensure accuracy.

The standard provides limiting backstop values for the glazing specification, ventilation system, air tightness levels and thermal-bridging as these factors should not exceed these limits in order that the thermal comfort criteria can be maintained.

Figure 1.7 illustrates the elemental backstop values which should not be exceeded in order for the Passivhaus certification criteria to be met.

<i>Design Component</i>	<i>Limiting value</i>
Walls, Roof, Floor (U-values)*	$\leq 0.15 \text{ (W/m}^2\text{K)}$
Glazing unit	$\leq 0.8 \text{ (W/m}^2\text{K)}$
Installed glazing	$\leq 0.85 \text{ (W/m}^2\text{K)}$
Doors	$\leq 0.8 \text{ (W/m}^2\text{K)}$
Infiltration (ach^{-1})	$\leq 0.6 @ n_{50}$
Thermal bridging (linear ψ value)	$\leq 0.01 \text{ (W/mK)}$
MVHR coefficient (η_{HR})	≥ 0.75
Ventilation electric limit	0.45 Wh/m^3
Appliances	High efficiency recommended
Lighting	High efficiency recommended
On site renewables	No requirement but SHW typical
*please note opaque U-values are only recommended targets and are not critical to certification	

Figure 1.7 Passivhaus individual components minimum standards

EnerPHit Standard

Certification criteria for refurbished buildings

If the certification criteria for a Passivhaus are met when refurbishing a building then it is possible to certify the building as a "Quality-Approved Passive House" based on the same criteria as for new buildings.

However for various reasons it is often difficult to achieve the Passivhaus standard for older buildings with reasonable effort. The use of Passivhaus technology for all relevant building components in existing buildings does lead to considerable improvement in respect of thermal comfort, structural protection, cost-effectiveness and energy requirements.

Buildings that have been refurbished using Passivhaus components and largely with exterior wall insulation can be certified to the EnerPHit standard as evidence of quality assurance and to verify achievement of the specific energy values.

The designation EnerPHit is used if more than 25 % of the opaque exterior wall surface has interior insulation. It will be likely that moisture analysis will be needed where opaque elements are insulated internally.

The standard has slightly relaxed certification criteria as indicated in Figure 1.8.

Criteria	Passivhaus	EnerPHit
Specific Heat Demand	$\leq 15 \text{ kWh/m}^2.\text{yr}$	$\leq 25 \text{ kWh/m}^2.\text{yr}$
Primary Energy Demand	$\leq 120 \text{ kWh/m}^2.\text{yr}$	$\leq 120 \text{ kWh/m}^2.\text{yr}^*$
Limiting Value	$n_{50} \leq 0.6^{-1}$	$n_{50} \leq 1.0^{-1}$

* $PE \leq 120 \text{ kWh/m}^2.\text{yr} + ((SHD - 15 \text{ kWh/m}^2.\text{yr}) \times 1.2)$

Figure 1.8 Passivhaus refurbishment minimum standards

Overarching Sustainability Standards

Passivhaus is sometimes compared to or confused with the Code for Sustainable Homes and BREEAM ratings for non-domestic buildings. In reality the distinction is quite simple: Passivhaus is a specific energy performance standard that delivers very high levels of energy efficiency, whilst the Code and BREEAM are overarching sustainability assessment ratings which address a large number of environmental issues.

These standards are by no means mutually exclusive; sub sections within these sustainability standards account for Energy and Carbon Dioxide emissions which are the most heavily weighted and most difficult to achieve.

The message is simple - by adopting the Passivhaus 'fabric first' approach you are able to reduce the level of renewable energy interventions needed to deliver the higher level targets. Any renewable energy produced on site by a Passivhaus will typically achieve a greater profit margin since a higher component will be fed-back to the grid as a result of the standard's stringent primary energy target.