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Environmental housing standards

Buildings have varied impacts on the environment, arising from energy, water and land use as well as the release of pollutants. Residential buildings also affect occupants' health and wellbeing through their design and placement within the wider environment. This POSTnote summarises the factors affecting a building's environmental performance, the existing governance framework and the potential opportunities for delivering wider social benefits through relevant standards.

Overview

- The environmental performance of homes is responsible for 13% of UK greenhouse gas (GHG) emissions, but energy efficiency is just one aspect of this.[1]
- Occupant behaviour, liveability and impacts on the natural environment should be considerations in building design.
- The design and fabric of a building have significant impacts on residents' health, wellbeing and comfort.
- Adequate metrics, standards and appropriate funding are needed to ensure that retrofit and new development projects produce homes that are fit for the future.
- Constructing a sustainable housing stock presents opportunities for job creation, to improve the health and wellbeing of residents and to deliver the Government's environmental ambitions.

Background

The UK is committed to reaching net zero greenhouse gas (GHG) emissions by 2050 under the Climate Change Act 2008, as amended in 2019.[2] 13% of the UK's GHG emissions came from energy use in residential buildings in 2019, the majority arising from space and water heating.[1] The residential sector has failed to achieve the GHG emissions reductions seen in other sectors.[3,4] Currently, close to 90% of homes in England use fossil fuels, with 85% connected to the gas grid.[5] Emissions from buildings will need to be reduced by 24% by 2030 if the UK is to meet its net zero commitments.[6] The Climate Change Committee (CCC) has recommended that almost all replacement heating systems for existing homes should be low-carbon or hydrogen-ready from 2035 and that no new homes be connected to the gas grid from 2025.[1]

As 85% of existing homes in the UK are expected to still be in use by 2050,[7] the CCC stated 29 million existing homes will need to have been retrofitted by 2050.[8] In addition, the UK Government has made commitments to deliver 300,000 new homes per year by the mid-2020s, which would need to be retrofitted if not built to standards compatible with net zero targets.[9,10] The CCC have also raised serious concerns about the future liveability of homes currently being built given the increasing incidence of extreme weather events.[11]

Alongside GHG emission reductions and energy efficiency, a home must also be a functional, liveable space for occupants. Homes affect residents' health, wellbeing and comfort, as well as their productivity and overall quality of life, with liveability fundamental to housing performance.[12] This is influenced by a building's internal features, including layout, relationship and access to the outside and features and fixings, such as the usability of controls, and location as part of the wider environment.[13] Considering residential buildings within the wider built environment also has the potential to deliver wider benefits at the community level, such as access to green space.

Determining housing performance

The difference between actual and designed environmental performance is known as the building performance gap. A 2016 Innovate UK study estimated that emissions from new homes are 2 to 3 times higher than those expected based on design.[14] Multiple factors determine this, including design, construction, occupant behaviour, resource efficiency and liveability. Each of these needs to be considered and monitored throughout all phases of the lifetime of a building (PB 43).

Occupant behaviour in response to design

Occupant behaviour (how they respond to the design, systems and controls offered in homes) is central to how well buildings perform.[15] Technologies may also not achieve such efficiencies in practice because of factors such as build quality and installation.[16] This is as opposed to how well buildings are designed to perform in ideal circumstances. Behaviours affecting performance include those linked to, and determined by, heating and ventilation systems, such as thermostat adjustment and window opening, the use of electrical appliances and lighting, hot water usage and variable patterns of occupancy.[17] Estimates suggest that behaviour can increase residential building energy consumption by up to 75%.[18] Behaviours associated with heating and ventilation often link to the occupant's thermal comfort (Box 1) and the understanding of or ability to use environmental control systems effectively.[19] Lack of consumer understanding is often cited as a key barrier to maximising efficiency performance from new technologies.[20–22] Awareness-raising may influence behaviour if centred around community-based knowledge sharing and know-how via community-established, trusted service providers.[23,24]

Building efficiency

Several aspects of a building determine its efficiency, including building envelope, heat production, electricity and water usage.

Building envelope

A building's envelope comprises its floors, walls, doors, windows and roof. The air tightness and insulation within a building's envelope determine how well it prevents heat loss. Technologies to improve heat retention include wall and roof insulation and double- or triple-glazed windows. How well these technologies perform is dependent on how well they are designed for functional use and installed and built into a building's design.[25] Interfaces between different elements, such as the edges of windows, are often areas of high heat loss.[26] This is partly to do with a lack of coordination between trades fitting windows, insulation, wiring or pipework.[27] Trades on site often do not overlap, with later-arriving tradespersons unaware how their work can affect the performance of previous work.[27] Homes should be designed to maintain a liveable, comfortable temperature, but 4.5 million homes in the UK are reported to be overheating, with summer temperatures projected to rise with climate change.[8] Homes built to minimise winter heat loss may increase risks of summer overheating without planned ventilation strategies.[15] An increasing cooling need is predicted to be one of the largest future energy demands (PN 642).[11]

Heat production

Most GHG emissions from residential buildings come from space and water heating.[1] The source of the primary energy delivered to a building determines the GHG emissions of the energy used. If the source of a building's energy is a fossil fuel (gas, oil or coal), then emissions will be higher than if the source is wholly or partially renewable. Traditionally, homes have been heated by gas or oil, or by direct electric heating. Heat pumps warm or cool homes by transferring heat to or from the air or ground surrounding the home. The heating or cooling source is carbon-free, and the electricity needed will come increasingly from renewable sources, such as 100% renewable electricity tariffs (PN 632). In 2019, there were 239,000 heat pumps in operation in the UK.[31] Hydrogen boilers have also been developed, but significant technological barriers exist to introducing hydrogen as a low-carbon fuel source into the grid network, including issues with production, scale and cost (PN 645).[32] How useable heating systems are perceived to be may depend on understanding of them.[15,33] For example, heat pumps act differently to a conventional boiler, providing a constant temperature with small uplifts, rather than the instant, noticeable increase provided by a conventional boiler (Box 1). GHG emissions may also be reduced by the use of residential heat networks with renewable heat sources, such as heat pumps, waste heat or geothermal heat (PN 632).

Box 1: Thermal comfort

Thermal comfort depends on several factors, including:[28]

- **Air velocity.** Air moving at 1 m/s feels 1°C colder.
- **Mean radiant temperature.** If the wall temperature is less than that of the air within the room, heat radiates out from a body towards the walls, causing the feeling of cold.
- **Stratification.** The air temperature within a room is hotter higher up as design tends to be optimised for shoulder height comfort. However, humans are sensitive to foot temperature, with cold feet causing discomfort.

Heat pumps can avoid thermal discomfort by heating buildings more evenly than conventional boilers and can be used for underfloor heating (PN 426). Mechanical Ventilation and Heat Retention (MVHR) systems, although still uncommon in the UK, can improve air quality by removing both indoor and external pollutants, without creating the air movement from opening windows.[25,29,30]

Electricity usage

The UK grid is decarbonising rapidly, with almost half the electricity used in 2019 coming from renewable or low-carbon sources, thus reducing GHG emissions from electricity consumption in homes.[34] However, domestic energy consumption increased by 3.9% in 2020.[34,35] The mandatory use of energy-efficient electrical products,[36] as rated by the energy label system, with ratings A to G (PN 646), is intended to reduce electricity consumption.[37] Numerous technologies exist to manage and reduce the carbon emissions associated with buildings' electricity consumption. These include solar panels, storage batteries or power walls, and smart systems that flexibly manage generation and storage (PN 65X).[38] Together, these can help manage periods of peak demand through smart generation and storage of household electricity, such that the collective demands of a neighbourhood do not overwhelm current grid capacity (PN 587).[39]

Water usage

Reducing hot water usage and water heating in the home contributes directly to reducing energy demand and associated carbon emissions. Reducing cold water usage delivers smaller carbon savings but brings wider environmental benefits from water conservation (PB 40). Consumer awareness of their own water usage and the need to conserve water is low. Water reuse systems, such as rainwater harvesting and greywater recycling systems, are already used widely in more water-scarce areas of the world, such as California,[40] and in UK business developments, such as the King's Cross redevelopment.[41] Other approaches include water neutrality, which involves offsetting any new demand on a local area from new developments, and water labelling, analogous to energy labelling for electrical appliances, using ratings A to G.[42,43]

Liveability

Several factors contribute to a building's liveability, which need to be considered in the context of the amount of time spent indoors, such as with COVID-19 pandemic working from home.

Indoor air and noise pollution

Indoor air quality (IAQ) (PN 366) can be affected by pollutants, including from cooking, cleaning, smoking, consumer goods and fittings, and by external air pollution. Air circulation, such that stale, humid internal air is moved outside the building and fresh, clean air is brought inside, can maintain higher air quality. However, IAQ is also linked to physical aspects of the wider environment, such as the location and orientation of a building and windows relative to a busy road.[44] Poor IAQ has been associated with negative impacts on health and quality of life, particularly for vulnerable groups at an increased risk of respiratory, cardiovascular and cognitive conditions.[45–50] A 2021 study detailed the link in London between IAQ and socioeconomic status, with more deprived communities experiencing worse IAQ.[51] Poor IAQ can be an unintended consequence of increased airtightness required by energy efficiency regulations (Part L of the Building Regulations). Requirements for adequate ventilation to ensure reasonable IAQ are set in Part F of the Building Regulations.[52,53] Acoustics are also important for occupants' wellbeing, sense of privacy and sense of comfort.[54] This is an especially important consideration alongside air quality and ventilation. For example, with increasingly warm summers, consideration of how secure night-time ventilation can be achieved while avoiding sleep disturbance from external noise sources, such as busy roads.

Adequate space and natural lighting

Provision of sufficient space and light contributes to good quality of life. Lack of adequate space and natural light provision has been linked with poor sleep, health and wellbeing (PN 585), especially for children, impacting their education.[55,56] Considering window location relative to the passage of the sun can avoid overheating while ensuring adequate daylight.[57]

Accessibility

Safe accessibility of high-quality local amenities, such as supermarkets, parks or green spaces, workplaces and social spaces affects liveability.[58,59] An aging population, children and those with extra mobility needs may need to be considered, as well as if homes will function for the occupant's full life.[60] Public transport access (or planning to encourage walking or cycling) can avoid developments being overly dependent on cars for travel, potentially increasing future transport emissions.[61]

Situation within the wider environment

How a building sits within its environment is important in creating a connection between people and place and in developing community pride in the local environment.[62] New-build and retrofit projects that consider homes in the wider built environment can enjoy greater social benefits (Box 2).[63] Green space access and the location and orientation of a building relative to traffic can influence quality of life and health.[64,65]

Governance of building performance

Appropriate standards and certification processes, alongside provision of funding and support for skills development, are key in creating a sustainable housing stock fit for the future.

Current standards

Building regulations

In England, building standards are governed by the Building Regulations 2010.[66,67] These set out approved standards for energy efficiency and performance, CO_2 emissions, water efficiency, sound insulation, fire safety, ventilation and air tightness. The Government has proposed that the regulations will also cover overheating risks. Part L governs new buildings or projects that result in a change of building use, and certain renovations or replacement of building elements and systems.[53] Part F governs air quality and ventilation.[52] They do not cover predicted or measured embodied carbon, which are the emissions associated with the construction or renovation process in terms of the production of materials (PB 43). Regulations only apply to operational carbon, which are the predicted emissions that result from the use of a building.[68]

Energy Performance Certificates (EPCs)

Every home, when it is sold or rented, is required to have an Energy Performance Certificate (EPC), which is underpinned by the Standard Assessment Procedure (SAP) methodology.[69,70] There are two home energy ratings used on an EPC: a predicted fuel cost-based energy efficiency rating (EER), which is banded from A to G, and a rating relating to predicted carbon emissions.[71] The average annual gas consumption in a home in the EER Band E is double that of a Band B property, with an average £290 difference in annual gas bills.[72] EPCs also include recommendations on home energy efficiency improvements. As part of the Clean Growth Strategy, the Government's aspiration is that as many homes as possible be upgraded to EPC Band C by 2035, with a target for fuel-poor and rented homes to meet EPC Band C by 2030.[73,74] Latest Government data suggest 60%

Box 2: Holbeck Group Repair Scheme, Leeds

The Holbeck Group Repair Scheme was a cross-tenure retrofit project carried out by Leeds City Council,[63] which targeted a neighbourhood ranked in the worst 1% in the country for the Index of Multiple Deprivation 2015. Alongside complementary initiatives, the Scheme contributed to house price rises in the neighbourhood of 75%, compared with a 20% increase for the rest of Leeds between 2015 and 2019.

- **Funding**: The £4.5 million budget of the scheme was provided by Leeds City Council, the Local Growth Fund, the Housing Revenue Account (HRA), Energy Company Obligations and private owners.
- **Energy efficiency improvements**: The energy efficiency performance of 153 properties was improved, at a cost of around £25k per property. The average improvement in EPC rating was from bands F/G to B/C, increasing the room temperature from 12°C to 18°C in some of the worst cases. This equates to an estimated saving of 1,450 tonnes of CO_2 emissions per year overall and £350 in fuel bills per year per household, with significant reductions in fuel poverty and risks of developing cardiovascular and respiratory conditions associated with living in cold housing.[75,76]
- **Wider community benefits**: 14 bin yards were redesigned and refurbished, improving the street scene, refuse collection and recycling. Overall unemployment rates in the area decreased from 21.1% to 12.5%, and antisocial behaviour incidents decreased from 54 per 1,000 people to 26 in 2019. The Scheme won the Yorkshire and Humberside Large Energy Project of the Year in the Energy Efficiency Awards 2019.

of homes in England are currently at EPC Band D or worse, with 6% of new homes built in 2020 to EPC Band D or worse.[5,77] The EPC is set to maximise the EER (reflecting fuel costs) rather than the carbon metric. As electricity is more expensive than gas, replacing a gas boiler with a heat pump can reduce emissions while making the EPC rating worse.[78]

Criticism of EPCs and the SAP
EPCs have been criticised by organisations such as the National Energy Foundation and the Royal Institute of British Architects for failing to use metrics relevant to reducing GHG emissions, using outdated methodologies and producing inaccurate recommendations and ratings, especially for older buildings.[78–80] Arguments in favour of the SAP are that it is a well-developed national methodology, which can be applied relatively quickly and cost effectively. Measuring energy performance, design and cost is essential to protecting households from fuel poverty. Criticisms of the SAP include it being based on predictive modelling of buildings that does not adequately reflect actual build quality and using 'standard occupancy' assumptions, which may differ from the way the building is actually used.[81]

Funding energy efficiency retrofits
Funding processes and needs vary between the different housing sectors (social housing, private-rented housing and owner-occupied housing), as well as between retrofit and new developments.[82,83] For social housing, many local authorities (LAs) are trying to increase their stock by purchasing new-build homes and to improve their current stock through retrofit projects. For example, the ECO4 programme will make available £1 billion per year to spend on energy in fuel-poor households.[84] However, there are retrofit funding challenges, and LAs have to find funding from several different sources (Box 2).[82,85–87] Funding retrofits to landlord-owned and owner-occupied properties is also complex, and additional incentives may be required.[82] Projects may be expensive and the benefits are not immediate, even to those living in the property, with energy-bill savings taking several years to recoup. Carrying out the work can be associated with disruption to occupants and risk altering the character of a property, affecting its market value. The nature of the UK housing market is such that older properties, which are often the least efficient, tend to have higher value.

Commentators have suggested incentives such as a sliding scale of stamp duty based on energy efficiency and a tax rebate for a period after purchase for home energy improvements.[88] BEIS recently consulted on the role of mortgage lenders in the energy-related performance of homes.[89] The Green Homes Grant scheme closed to applications in March 2021. It was highly over-subscribed, but limited in impact because of administrative errors, difficulties with securing work from registered contractors and a lack of contractor awareness.[71]

Skills, competencies and knowledge
A key factor in delivering improvements to building performance will be meeting the training needs of industry.[90] Issues with current provision include a lack of integrated training, high costs associated with upskilling courses, which are unaffordable for many small- and medium-sized enterprises (SMEs), and a lack of professionals equipped with monitoring, assessment and performance-evaluation skills.[27,91] Experts are concerned that the COVID-19 pandemic will exacerbate gaps.[92] They suggest that there is significant potential to create meaningful, skilled jobs as part of greening the construction industry.[93] For example, there are 100,000 registered gas engineers in the UK,[94] but only 600 accredited heat pump installers.[95] Improving awareness of the potential opportunities of low-carbon heating systems and actively supporting suppliers to gain accreditation may close this gap.[6] Other approaches include collaborations between LAs, training centres and apprenticeship schemes that directly employ workforces.[96] This can provide long-term professional development via vocational education and training programmes in low-energy construction to address skills and retrofitting in the social-housing sector.[96]

In 2019, there were more than 410,000 jobs in low-carbon sectors and their associated supply chains, with a turnover estimated at £42.6 billion and exports worth more than £7 billion a year.[97] The number of low-carbon jobs could rise to 694,000 by 2030, but only if the skills gap is closed.[98] Key weaknesses are in technical and communication skills on project teams.[99] The Energy Barometer Report 2021 reveals concern that skills capacity is not yet being given due attention and could replace technology as the biggest barrier to delivering net zero.[100] The Green Jobs Taskforce was launched by the Government in November 2020.[101,102] Its findings have recently been published, along with 15 recommendations on how the Government, industry and skills sector can deliver the green jobs and skills of the future.[97] These include collaboration between the Government, business and the education sector to provide support to pursue careers in good green jobs, including engineers, construction workers, car mechanics and retrofitters.

Expected policy changes
The Future Homes Standard (FHS) is the Government's strategy for new homes and will outline changes to Parts L and F of the Building Regulations.[103] These will apply to all new buildings from 2025, achieving a reduction of 75-80% in CO_2 emissions compared with those built to current standards. An interim change is expected to apply from June 2022 that aims to reduce emissions in homes by 30% compared to current standards. Concerns have been raised about a lack of ambition with respect to net zero targets and timelines and a lack of integration with other relevant policy areas.[10,11,79] In evidence to the HCLG Select Committee, several organisations such as the Royal Town Planning Institute and the National Association of Local Councils recommended bringing forward the FHS and the need for a focus on whole lifecycle emissions, including embodied carbon.[104,105]

Beyond energy efficiency
There is potential to deliver wide-ranging benefits beyond net zero targets and improving the UK's housing stock. These include: the creation of skilled vocations;[106] improving residents' health and wellbeing;[107] fuel poverty reductions;[108] creating a sense of community and place in local neighbourhoods;[109] and delivering wider environmental net gain to benefit biodiversity, the natural environment and people's connection with it.[110] The Government's proposed mandatory biodiversity net gain approach in the Environment Bill (PB 34) has been criticised,[111,112] but other tools to measure wider environmental benefits to people and nature are being developed by NGOs and researchers.[113–115]

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