Innovate UK

Building Performance Evaluation Programme: Findings from domestic projects

At a glance

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The UK is legally bound to reduce greenhouse gases by 80% by 2050. Building better low-carbon homes will help the UK achieve this ambitious goal. This summary of the 'Building Performance Evaluation Programme: Findings from domestic projects' report covers the reasons homes rarely live up to their designers' original aspirations. It also outlines what stakeholders can do to help.

Energy use

- Nearly ten times as much energy was used in the highest energy-consuming home as the lowest.*

- The average grid electricity use across the buildings was 42 kWh/m^2, while the mean for fuel and biomass was 71 kWh/m^2. Electricity and fuel use are important. We can only assess a building as performing well if it achieves low electricity and fuel use – while keeping occupants comfortable.

- Standout success stories from an electricity perspective are many of the Rowner Renewal homes (below 30 kWh/m^2 a year and, in one case, only 14 kWh/m^2), some of the One Brighton flats, and some of the Green Street Houses (well below 30 kWh/m^2).

- From a thermal perspective, the Camden Passive House had exceptionally low fuel use for space and water heating – just 23 kWh/m^2 a year. One of the One Brighton units, one of those at Rowner Renewal, and Dungannon Passivhaus also performed exceptionally for thermal energy, with measured thermal energy use below 30 kWh/m^2 a year. These figures are astonishing, given their level of thermal comfort.

Carbon emissions

- Average total carbon emissions were 2.6 times higher than the average design estimate. None of the 'zero-carbon' design estimates were achieved in practice.**

- Average total carbon emissions were 35.3 kgCO_2 per square metre per year – significantly lower than the average carbon emissions for UK homes, which is around 54 kgCO_2.***

- There is scarcely any link between the SAP estimate of CO_2 emissions for space and water heating, lighting and ventilation, and the actual total emissions.

Airtightness

- Every project had better airtightness than the minimum requirement of Building Regulations. Tests found average airtightness of 4.6 m^3/h/m^2@50Pa – far better than the 10 m3 required by Building Regulations.

- Homes built to Passive House standards achieved the best airtightness and insulation values, which means they had the lowest heat loss and best thermal performance.

New technologies

- The projects had teething problems with some new technologies, including solar water heaters, heat-recovery ventilation, automatic blinds, and heating controls. In most cases, these undermined carbon performance. Part of this is inevitable during early adoption of new technologies, as installers are inexperienced using unfamiliar systems.

Recommendations

Designers

Be wary of using innovative systems unless you know that the installers have used them before in similar contexts.

Contractors

Before appointing installers/operatives, make sure they are experienced in successfully installing innovative systems.

Designers

Specify the simplest controls possible for heating, lighting and renewable energy systems – most householders do not have the time or desire to learn complex systems.

Contractors

Do not substitute controls for lower-cost alternatives if they are harder to use.

Designers

Avoid automatic systems that work against saving energy.

Contractors

Ensure instructions for controls are in English.

Developers/designers

For Passive House projects, find contractors experienced in meeting Passive House standards.

Contractors

Be aware of the additional mechanical and electrical costs of Passive House projects, and the increased time needed onsite.

Designers/contractors/policymakers

Passive House projects emphasise insulation and airtightness more than conventional construction methods. This means they achieve the best thermal performance. Following Passive House principles appears to be the surest route to lower energy use for heating.

Policymakers

Do not assume that all homes achieve the heat-loss figures and airtightness figures submitted to Building Control in planning applications. Most new homes do not.

Designers/contractors

Be more ambitious in your design targets for airtightness. These projects suggest that a quarter of homes are designed to meet only the minimum requirement in Building Regulations – and it is easy to surpass this.

Contractors

Try to achieve good airtightness from the start rather than having to plug gaps with sealant when construction is complete.

Designers/contractors

Show the air barrier clearly on drawings, ideally in a different colour, and monitor this carefully during site work.

Designers/contractors

Wet construction typically achieves better airtightness than dry lining with plasterboard.

Designers/homeowners/policymakers

Remember that airtightness often deteriorates over time – sometimes by more than a third. So the tested airtightness on day 1 is unlikely to endure for the home's lifetime.

Developers/contractors

Allow enough time to commission mechanical and electrical systems properly before handover. Construction delays often limit the time available for commissioning, which can cause serious problems.

Recommendations

Developers/contractors

Handover is a critical opportunity to explain to residents how to operate their homes in different seasons – and outline any maintenance they might need. Prepare clear instructions, and leave a simple summary for householders to refer to afterwards.

Designers/contractors/developers/homeowners

Do not assume that actual carbon emissions have any link to estimates of emissions needed for planning consents (also used in Energy Performance Certificates).

Policy-makers

Do not rely on Building Regulations alone to limit energy use and carbon emissions from new buildings.

Developers

Teething problems in the first year often push up CO_2 emissions – sometimes considerably. Without performance evaluation and some intervention, such problems may never be spotted and fixed.

Designers/developers

Biomass heating and heat pumps are no guarantee of low-carbon emissions.

Developers

Think carefully about your contract choice. There are pros and cons of traditional contracts versus design and build. However, bear in mind that innovative designs often require close collaboration between designers and contractors – but not with a design-and-build route.

Key

* Total energy use per year, comprising electricity, gas or oil, biomass and any use of renewable energy from photovoltaics or known solar water heating.

** The design estimate, taken from SAP, which is used for the energy part of Building Regulations compliance, only includes 'regulated' energy (heating, hot water, ventilation and lighting). Whereas total carbon emissions include unregulated energy (plug-in appliances and lamps).

*** This is a simple estimate, assuming the average UK dwelling has annual emissions of 5 tonnes CO_2, and an average floor area of 92m^2.

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