Enhabit™

Dartmoor National Park Authority

Reducing Carbon Emissions in New Development

Policy Research and Recommendations

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AECB the sustainable building association

Passivhaus Trust MEMBER

CIBSE BUILDING PERFORMANCE AWARDS 2013 WINNER RECOGNISING EXCELLENCE IN MAKING BUILDINGS WORK

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Contents

1 Introduction

Enhabit has been requested to undertake research into an appropriate CO_2 emissions reduction policy for Dartmoor National Park Authority's Local Plan. The aim is to minimise CO_2 emissions from new-build developments within the National Park over and above current Building Regulations (Part L 2013).

This briefing note looks at the evidence for two approaches to reducing CO_2 emissions in new-buildings

1. Applying a further percentage reduction in CO_2 emissions over that required by Part L (2013), such that the thermal performance of the building is improved first (a 'fabric first' approach).
2. Reducing the 'in-use' CO_2 emissions by focussing on improving on-site quality control for thermal elements and airtightness. This will help reduce the energy performance gap that is widespread in the construction industry.

2 Further reduction in CO_2 emissions over building regulations

Government National Planning Practice Guidance allows Planning Authorities to include requirements up to the equivalent of the energy requirement of Level 4 of the Code for Sustainable Homes (this is approximately 20% above current Building Regulations (2013) across the build mix).[1]

2.1 Precedence

The Passivhaus Trust has been undertaking research into emerging or adopted policies for new buildings from Planning Authorities across the UK. These are summarised in Appendix 1. The majority of policies are targeting 19 or 20% CO_2 emissions reduction over Building regulations Part L (2013), but some go further than this requiring higher percentage CO_2 emissions reductions, or even Passivhaus certified developments.

In Dartmoor National Park, the scale of development is smaller than many other Local Authorities. The Local Plan is focussed on meeting local affordable housing needs and the sites allocated to achieve this are around 30 to 40 units. The small scale of development will have an impact on the economic feasibility of the policy. It is considered that limited viability and government guidance indicate the scope of this paper should be limited to considering CO_2 emissions reduction targets of 20% or less.

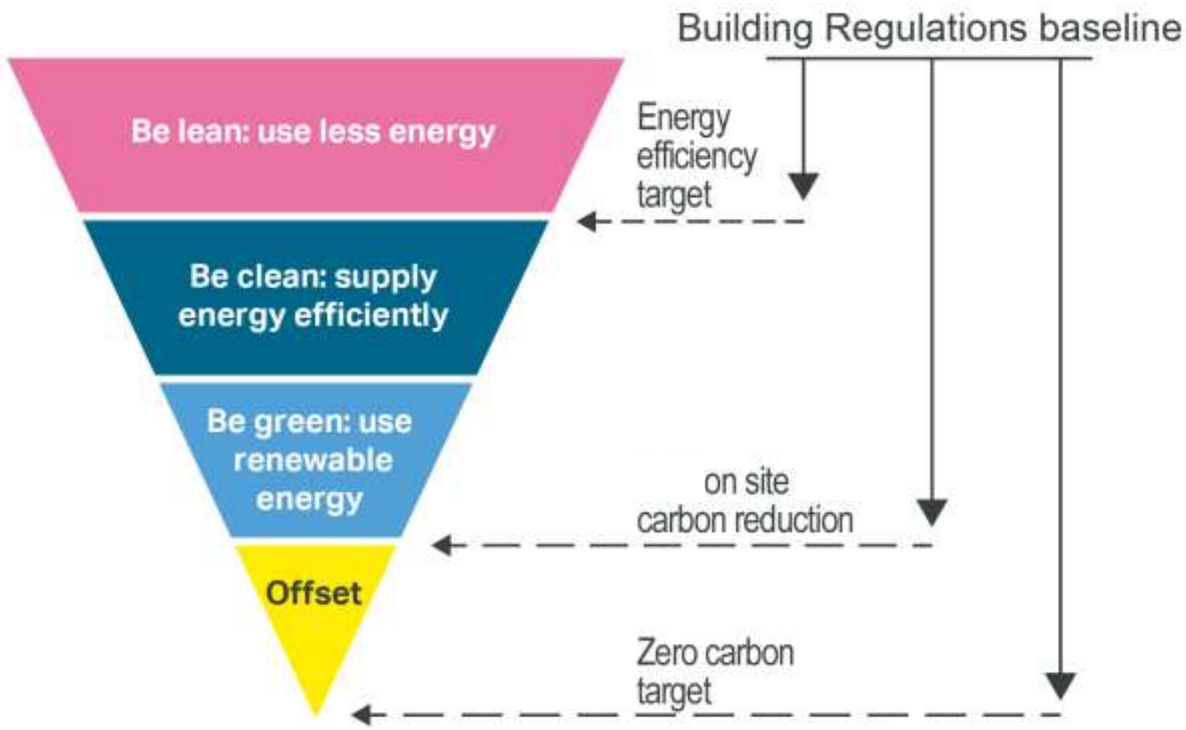
2.2 Fabric first

It is accepted building physics that in order to effectively achieve zero carbon emissions in buildings (with greater certainty as to performance), we must start with reducing the energy required as shown in the energy hierarchy below[2]. Once we have minimised energy demand, then we can design efficient heating and hot water systems, install onsite renewable technologies and finally, invest in national renewable technologies to offset any used on site. The latter may not be required if the energy demand can be sufficiently reduced onsite by designing well insulated, thermal bridge free and airtight homes. This is known as the fabric first approach.

[1] Written Ministerial Statement on Plan Making, 25 March 2015, https://www.gov.uk/government/speeches/planning-update-march-2015

[2] Policy S12 https://www.london.gov.uk/what-we-do/planning/london-plan/new-london-plan/draft-new-london-plan/chapter-9-sustainable-infrastructure/policy-si2-minimising

In current building regulations for new domestic properties (Part L1A)[3], this has been recognised by introducing a fabric energy efficiency target known as the TFEE (Target Fabric Energy Efficiency) as well as the overall target CO_2 emissions rate known as the TER (Target Emissions Rate). However, the TFEE has not been introduced for new non-domestic buildings which must only achieve a TER (Part L2A)[4].



Source: Greater London Authority

2.3 Cost uplift

Several viability reports are available that analyse the cost-uplift associated with between 10 and 20% improvement in CO_2 emissions reduction over building regulations. We summarise the findings from these reports here:

Department for Communities and Local Government, Housing Standards Review. EC Harris[5],

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[3] Approved Document L1A – conservation of fuel and power in new dwellings
https://www.planningportal.co.uk/info/200135/approved_documents/74/part_l_-_conservation_of_fuel_and_power

[4] Approved Document L2A – Conservation of fuel and power in new buildings other than dwellings
https://www.planningportal.co.uk/info/200135/approved_documents/74/part_l_-_conservation_of_fuel_and_power/3

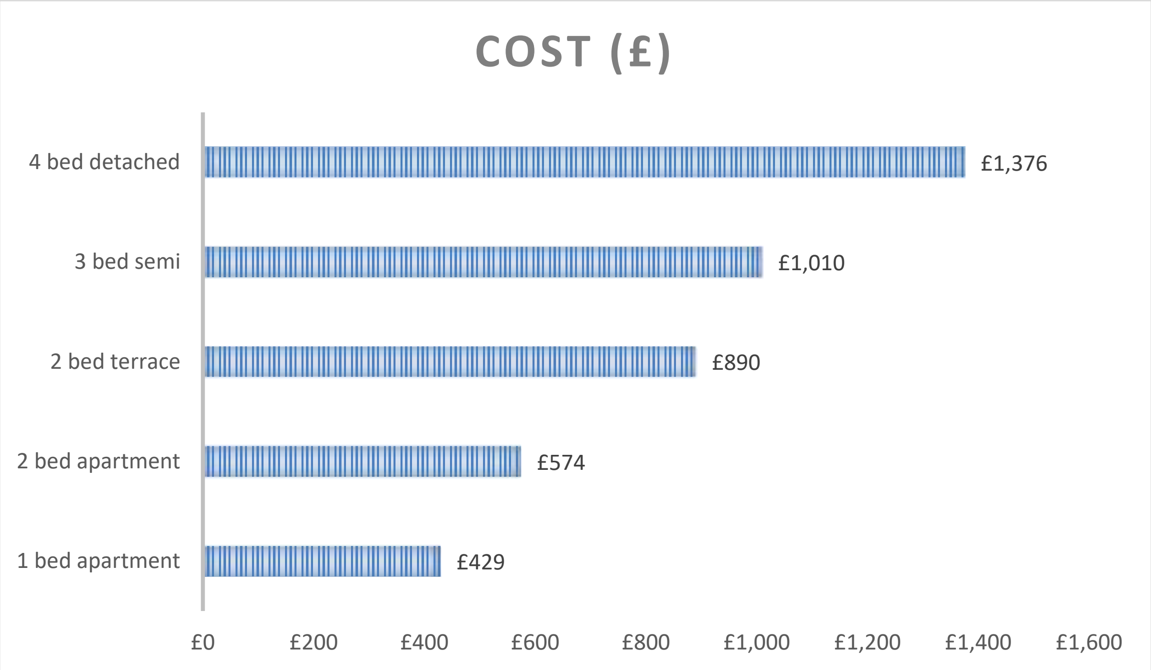
[5] Housing Standards Review, Cost Impacts, EC Harris, Sept 2014
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/353387/021c_Cost_Report_11th_Sept_2014_FINAL.pdf

The report reviews the costs for current and proposed housing standards, including the cost-uplift to achieve Code for Sustainable homes level 4 over building regulations (equivalent to a 20% CO_2 emissions reduction in Part L1a 2013). It also differentiates the costs for a fabric first approach and a renewables-led approach.

It should be noted that the fabric first approach does not exclude renewable technologies, and solar PV has been included in these costs to achieve the reduction in TER. Fabric first implies that the fabric has been improved to maximum levels before energy efficiency building services or renewables are considered. The extent of the savings achievable for a development with fabric only will vary significantly depending upon the construction type and form factor[6] of the building. The definition of 'maximum' levels of fabric may be taken from the Passivhaus standard that is based on the optimum lifecycle costs when capital cost and operational costs for the lifetime of the building are balanced (see Appendix II).

The costs used in the EC Harris report were relevant in 2014 and have therefore been adjusted using the latest building price index for 2019[7].

Figure 1 Average cost-uplift for a fabric first approach to achieve Code for Sustainable Homes level 4 (equivalent to 20% CO_2 emissions reduction in Part L1a 2013) over Building Regulations 2013 for different house types at a UK mean location from DCLG, EC Harris 2014.



Assessment of the Viability of Carbon Emission Targets for New Builds – Main Report, Evora Edge[8]

This report was written for Guildford Borough Council to review the impact of their extant policy of 10% reduction in CO_2 emissions and the proposed policies of either 15% or 20% CO_2 emissions reduction. The

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[6] The ratio of the external envelope of a building (heat loss area) to the internal floor area (useable space inside the building)
[7] https://costmodelling.com/construction-indices
[8] *Assessment of the Viability of Carbon Emission Targets for New Builds – Main Report, Evora Edge, April 2017*
https://www.guildford.gov.uk/newlocalplan/media/23949/Assessment-of-the-Viability-of-Carbon-Emission-Targets-for-New-Builds/pdf/Assessment_of_the_Viability_of_Carbon_Emission_Targets_for_New_Builds_-_issue_2.0_(002).pdf

report reviews both domestic and non-domestic buildings and does not differentiate between a fabric first or renewable approach.

Costs are expressed as a percentage uplift in build costs over building regulations 2013.

% reduction in CO_2 emissions of Building regulations 2013	Cost uplift over building regulations 2013
Housing	
10%	0.56%
15%	0.97-1.16%
20%	0.97-1.16%
Non-domestic	
10%	<1.63%
15%	<2.65%
20%	<3.80%

Cost of carbon reduction in new buildings, Currie & Brown[9]

This report reviews studies by Buro Happold[4,5] and AECOM that were written for the Greater London Authority, and consider the viability of achieving carbon reductions in non-domestic buildings. Significantly, correlation between reduced carbon emissions and the cost of the building is weak[10] or absent[11] due to other factors such as building form, glazing ratio and passive design that effect energy demand and cost. The uplift associated with achieving a 15% energy efficiency target was under 2% of the capital cost (for overall development costs of between £2,000 and £3,000 m^2). It should be recognised that these non-residential build costs are significantly higher than experienced on Dartmoor.

The report concludes that: '*Most (non-domestic) buildings can achieve 10-15% energy efficiency improvements on current regulations, but there are some buildings that might find this standard more difficult due to the energy associated with their type and operational demand, for example hotels.'*

3 The Energy Performance Gap

3.1 Introduction

The energy performance gap is an issue that is widely recognised in the construction industry and amongst asset managers, in that many buildings use far more energy than they were designed to. It is a result of poor modelling, poor design and a lack of quality control in construction. Estimates of the extent of the performance gap vary widely in the UK, the Carbon Trust report from 2011[12] looks at a handful of case studies and finds an average of 16% increase in energy use from that forecast when modelled at design stage.

[9] Cost of carbon reduction in new buildings, Currie & Brown, Dec 2018, https://www.bathnes.gov.uk/sites/default/files/sitedocuments/Planning-and-Building-Control/Planning-Policy/LP20162036/cost_of_carbon_reduction_in_new_buildings_report_publication_version.pdf
[10] Buro Happold, 2017. Driving Energy Efficiency savings through the London Plan - Data Analysis.
[11] Buro Happold, 2018. Energy, daylight and overheating study in tall buildings. www.london.gov.uk
[12] Closing the Gap, Lessons learned on realising the potential of low carbon building design, Carbon Trust, 2011 https://www.carbontrust.com/media/81361/ctg047-closing-the-gap-low-carbon-building-design.pdf

The Passivhaus Trust has recently undertaken research on the performance gap in the UK and concluded that it would not be unreasonable to expect a 40% uplift in operational energy for the average household from that modelled at design stage in accordance with building regulations.[13]

The Zero Carbon Hub report 'Closing the gap between design & as-built performance'[14], brings together a wealth of research with the aim to tackle the Performance Gap in the UK and demonstrate that from 2020, at least 90% of all new homes meet or perform better than the designed energy/carbon performance. The Zero Carbon Hub disbanded in 2016 after the Government withdrew its support for the Code for Sustainable Homes and achieving zero carbon new buildings by 2016.

The report identified three themes that contributed to the performance gap

1. lack of understanding, knowledge and skills
2. unclear allocation of responsibility
3. inadequate communication of information

It is clear from the report that these themes occur all the way through a project, from design to completion. A report from the Centre for the Built Environment at Leeds Metropolitan University (now Leeds Beckett)[15] found that a major contributor to the performance gap in new build houses was heat loss. Therefore, any knowledge and skills improvements should include topics such as thermal bypass, thermal bridging and airtightness.

Significantly, research undertaken by the University of Bath[16] has found that certified Passivhaus schemes do not exhibit the energy performance gap. This confirms research from Germany that Passivhaus schemes perform as designed. AECB Building standard is based upon the Passivhaus certification scheme and is therefore expected to perform in the same way.

We believe that the Passivhaus methodology, rather than the fact of certification, is likely to be the major contributor to building performance.

3.2 Measures to reduce the performance gap

On-site or construction stage policy measures could be used to reduce the impact of the performance gap. Key quality control procedures used in Passivhaus schemes that could be replicated in policy are:

- Airtightness testing of every building
- Passivhaus training on thermal bridging, airtightness, thermal bypass and building services for both designers and contractors, and continued on-site support with this knowledge
- Dedicated airtightness coordinators
- Improved on-site quality control procedures and management

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[13] Passivhaus: the route to zero carbon? Passivhaus Trust, March 2019
[14] Closing the gap between design and as-built performance, End of Term Report, July 2014, Zero Carbon Hub,
[15] Quantifying the domestic building fabric 'performance gap'. Johnston, D and Miles-Shenton, D and Farmer, D (2015) (http://eprints.leedsbeckett.ac.uk/1054/)
[16] Rachel Mitchell, The Performance of Passivhaus in New Construction (Passivhaus Trust, July 2017)

All of these points should be covered in a report submitted at planning stage, on how the performance gap will be mitigated against at both the design stage and in-construction.

Training is available on these topics from specialist consultants, or by attending the Passivhaus Tradesperson course[17]. To reinforce the learning onsite, the Zero Carbon Hub has produced a freely available Builder's Book[18] that contains posters around fabric, ventilation, heating and hot water performance issues that can be displayed on site.

The extent of the improvement in the performance gap due to each of these policy measures is not quantifiable, however the potential for CO_2 emissions reduction could be significantly more than a 20% reduction in CO_2 emissions over building regulations. It will ensure that any policy that requires a percentage reduction on current building regulations, is far more likely to achieve that percentage reduction when the building is in use.

The training and report should help to address the following issues as identified in the Zero Carbon Hub Report 'Closing the gap between design & as-built performance'[19]

[17] http://www.passivhaustraining.co.uk/contractor/ and http://www.passivhaustrust.org.uk/event_detail.php?eId=373#.XVZ2XSNKiHs This is an official 2 day course certified by the Passivhaus Institute and can be taken with or without the exam & revision day. It covers all the major topics required to achieve fabric performance in construction. Costs are around £350 + VAT.

[18] Zero Carbon Hub Builder's Book http://www.zerocarbonhub.org/sites/default/files/resources/reports/Zero%20Carbon%20Hub%202015%20FINAL%20REV%202910_WEB.pdf

[19] Closing the gap between design and as-built performance, End of Term Report, July 2014, Zero Carbon Hub,

- Construction responsibilities for energy performance unclear, lack of collaborative working.
- Product substitution on site without due regard for impact on energy performance.
- Lack of adequate quality assurance on site and responsibility for QA.
- Poor installation or commissioning of services.
- Short term fixes and improvisations on site without understanding of long-term impact.
- Site management - inadequate consideration of sequence of trades and activities on site, later phase work undermining previous works
- Lack of site team energy performance related knowledge and skills and / or care.
- Poor installation of fabric, e.g. due to installation guidance or design drawings not followed.
- Limited tests and agreed protocols available for in-situ fabric performance measurement.

3.3 Cost uplift

Airtightness testing must be undertaken for building regulations compliance. Non-domestic buildings and single dwelling developments must be airtightness tested. However, on sites with multiple similar buildings, usually dwellings, only a selection of these may be tested.

For a typical site size of 25 dwellings, with 5 architypes, the cost uplift from 5 airtightness tests to 25 airtightness tests is in the region of £110 per dwelling, or £2,750 across the site.

Air tightness testing every dwelling	£110 per dwelling on multi-residential projects, otherwise the same
Training programme for thermal bypass, thermal bridging and airtightness	£400-1200 per project, depending on size
Report on performance gap mitigation	£500 to £1,000 per project depending on size.

It should be noted that the training and performance gap report will provide transferrable knowledge and skills for all other projects that the developer, contractor or architect is involved in. Thereby helping to improve the performance gap and reduce carbon emissions beyond Dartmoor National Park.

4 Recommendations and conclusions

It is recommended that Dartmoor National Park considers a planning policy that requires a circa 10% reduction in CO_2 emissions on Building Regulations Part L1A and Part L2A for domestic and non-domestic buildings. This reduction should be required on the Target Emissions Rate (TER), but it should be made clear that fabric should be considered first in order to achieve this reduction in CO_2 emissions. Detailed viability assessment should inform the final policy target. There is sufficient evidence to conclude that the performance gap is a real and current issue in the building construction industry, and that little has been done to address the issue since the release of the Zero Carbon Hub report in 2011. The increase in CO_2 emissions as a result of the performance gap could far outweigh a 10% CO_2 emissions reduction required by planning policy. Therefore, it is essential that any such planning policy reduces the potential impact of the performance gap as far as possible, whilst still allowing the project to be economically feasible.

The quality control procedures listed in section 3.2 address many of the issues during construction, that contribute to the performance gap, and are considered to be high impact but low cost. Therefore, it is recommended that these are included in the carbon emissions reduction policy in addition to a 10% reduction in the TER.

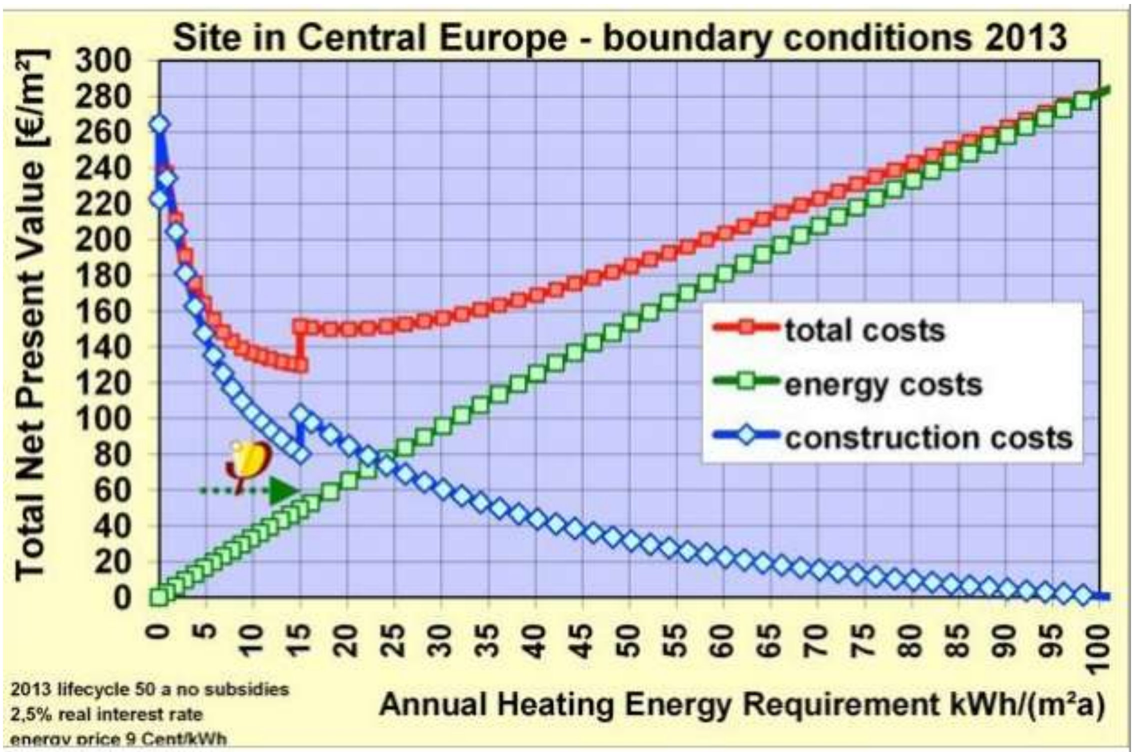
5 Appendix I

Local Authority	Summary of policy	Status
Glasgow City Council	New residential buildings to be Passivhaus	Adopted
Bristol City Council	35% reduction in emissions and then the remainder offset. Passivhaus alternative.	Emerging - consultation stage (May 2019)
Exeter City Council	New council buildings to be Passivhaus	N/A
Norwich City Council	New council housing to be Passivhaus	N/A
Camden Council	Subject to London Plan	Adopted 2017
Lambeth Council	Subject to London Plan	Adopted 2015
Greater London Authority	35% beyond BRegs and the to Zero Carbon via offset	New London Plan is emerging (at EIP stage Apr 2019)
Reading Borough Council	Minimum 19% reduction in TER Major new housing should be a 35% reduction followed by carbon offset.	Emerging - at examination (May 2019)
Suffolk Coastal Draft Plan	20% reduction beyond Bregs	Emerging - at examination (May 2019)
Guildford Borough Council	20% beyond BRegs	Emerging - undergoing consultation (May 2019)
Bedford Borough	19% beyond BRegs	At examination (May 2019)

Brighton and Hove City Council	19% beyond Bregs. Passivhaus as an alternative to BREEAM	Adopted March 2016
Cambridge City Council	19% beyond Bregs.	Adopted Oct 2018
Greater Manchester Combined Authority	19% beyond BRegs	Emerging - undergoing consultation (May 2019)
Eastleigh Borough Local Plan	19% beyond Bregs. Flexibility use Passivhaus alongside BREEAM	Emerging - at examination (May 2019)
Havant Borough Council	19% beyond Bregs	Emerging - pre-submission (May 2019)
Ipswich Borough Council	19% beyond Bregs. Flexibility to use Passivhaus to demonstrate reduction is achieved	Adopted Feb 2017
Milton Keynes Council	19% beyond Bregs on site, another 20% via renewables/low carbon energy and the remaining emissions offset by payment	Emerging - at examination (May 2019)
Oxford City Council	19% Reduction from Bregs. Increasing 2026 and Zero Carbon by 2030	Emerging - submission stage (May 2019)

6 Appendix II

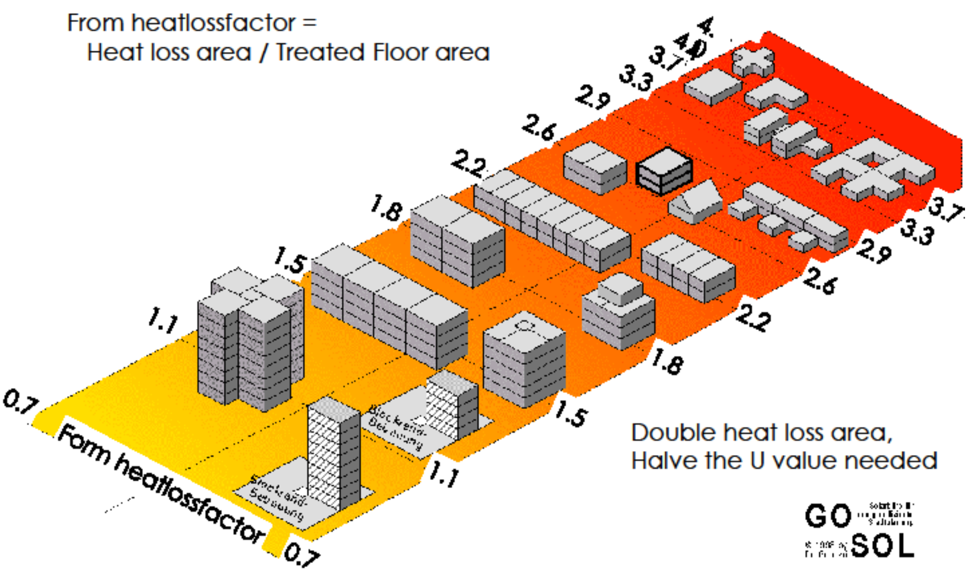
The basis for the Passivhaus criteria is economic and takes into account the capital or construction costs and the total running costs for the building over its lifetime. The minimum total net present value falls at 15 kWh/m^2a which is the space heating demand target for a Passivhaus building.



Lifecycle costs: Feist (editor), *Economy of Energy Efficiency*, working group on cost efficient Passive Houses, 42, Passive House Institute, Darmstadt, 2013

Typical U-values for walls floors and roofs to achieve this would be around 0.10 – 0.15 W/m^{2}K depending on the form factor of the building as is indicated in the diagram and table below. Passivhaus buildings are thermal bridge free, or have very small thermal bridges that have been mitigated against and calculated using thermal bridging software.

The air tightness of a Passivhaus building is below 0.6 ach and it incorporates a high efficiency mechanical ventilation system with heat recovery.



Form heat loss factor	U-value target
<2	0.15
2-3	0.10-0.15
3-4	0.10
>4	0.05-0.10