LETI Evidence Base

The Future Homes and Buildings Standards: 2023 consultation

About LETI

LETI is a voluntary network of over 1,000 built environment professionals, working together to put the UK and the planet on the path to a zero carbon future. Our vision is to understand and clarify what this means in the built environment and develop the actions needed to meet the UK climate change targets.

We do this by:

- **Engaging with stakeholders** to develop a robust and rapid energy reduction approach, producing effective solutions to the energy trilemma of security, sustainability, and affordability.
- **Working with local authorities** to create practicable policy to ensure the regulatory system is fit for purpose, placing verified performance at its core.
- **Encouraging and enabling collaboration** between a large, diverse group of built environment professionals.
- **Providing technical guidance to support exemplar development,** enabling pioneers who aspire to go beyond the current regulatory frameworks

Our volunteers are made up of developers, engineers, housing associations, architects, planners, academics, sustainability professionals, contractors and facilities managers, with support and input provided by local authorities and other organisations.

LETI was established in 2017 to support the transition of the built environment to meet Net Zero Carbon.

LETI has focused on providing guidance on defining what good looks like in the context of the climate emergency, publishing guidance documents, one-pagers, case studies and opinion pieces.

LETI has brought together a wide range of built environment professionals who have prepared our response to the Future Homes Standard and Future Buildings Standard consultations as well as this associated Evidence base document in a voluntary capacity.

For more information on LETI, please see:

www.LETI.uk

LETI

Key Messages

LETI's response to the consultation

LETI has provided a full response to the consultation. In summary, our key messages are the following:

1. **The proposals are not compatible with achieving Net Zero in operation: they do not use EUI as a key metric and do not address the performance gap**
   The adoption of different metrics (e.g. EUI instead of Primary Energy, Space heating demand instead of FEE) combined with a switch to absolute metrics instead of a % improvement over the notional dwelling/building would incentivise better design outcomes and limit the performance gap. This approach is supported by technical evidence produced by industry. The consultation does not provide satisfactory evidence to support the proposed metrics and notional approach other than maintaining the status quo. Unregulated energy has not been addressed. If choosing to adopt a metric other than Energy Use Intensity (EUI), we recommend that the government publish their evidence base supporting it. This evidence base should be peer reviewed and publicly available.

2. **Fabric performance should be better than Part L 2021 to reduce energy use and residents' bills**
   The level of fabric performance required for all new dwellings has not been improved beyond what was in Part L 2021. This is a missed opportunity, the energy cost burden remains on the residents through their energy bills. We think that option 1 does not go far enough (the Future Home Hub suggested better specifications) and we strongly oppose option 2 which is worse than was previously consulted on. Neither option can be considered 'net zero ready'.

   Similar to domestic buildings, fabric performance requirements should be introduced for non-domestic buildings. Non-domestic buildings should be expected to meet space heating and cooling demand limits in order to minimise annual energy demand and peak demand on the electricity grid and to reduce energy bills.

3. **On-site renewable energy generation (PVs) should be encouraged**
   On-site renewable energy has a key role to play to contribute to the decarbonisation of the grid and reduce residents' energy bills

4. **Embodied and Whole Life Carbon are not addressed**
   The UK is falling behind other countries in the EU who have also introduced embodied carbon considerations into their building regulations. The lack of inclusion of embodied carbon in our UK regulations means we cannot legitimately call this the 'future' homes/buildings standard.

Other messages

5. **The wider benefits of better ventilation have not been considered**
   The FHS consultation does not currently encourage mechanical ventilation with heat recovery (MVHR) as it is not included in the notional specification - This is a missed opportunity, beyond energy and carbon as there are wider benefits for the resident of the installation of MVHR - including improved air quality and moisture management, higher levels of comfort and a healthier environment.

6. **Heat networks**
   We disagree with the introduction of the sleeving method. This methodology is not scientifically robust and is biased towards the on-going use of heat networks even when most of their heat is generated by fossil fuels. It does not provide a clear pathway for buildings already connected to the network to decarbonise and ilt has not been peer reviewed by a carbon expert independent from heat network interests.

7. **Developers should not be allowed to 'opt-out' of meeting Part L Regulation**
   Under no circumstances should developers be able not to comply with Building Regulations.

Energy modelling analysis of FHS Options 1 and 2

1. Introduction

LETI have conducted energy modelling to understand the implications of the Future Homes Standard proposals.

Our work compares FHS Option 1 and FHS Option 2 with more ambitious space heating demand and energy targets, which are compatible with genuine operational net zero carbon homes.

Space heating demand and energy use intensity (kWh/m²/yr) are more appropriate metrics to evaluate the energy performance of buildings and are more widely used in the industry than FEES and primary energy (see next section)

We have also assessed the impact of lower fabric standards on peak heating loads using Passivhaus Planning Package (PHPP) and iHEM modelling. The iHEM modelling exercise drew out the inaccuracies of predicting space heating demand and heating load with iHEM. These are already partly understood, but assessment of demand on the coldest days of the year highlights the issue.

2. Key messages

Future Homes Standard options do not result in low enough space heating demand compared with Part L 2021 largely due to a lack of ambition in ventilation and air tightness requirements. **These appear to be 2.5 to 5 times higher than the level of space heating demand recommended by LETI**. These are not picked up in SAP modelling (HEM methodology) due to inadequacies in background ventilation and internal heat gains assumptions.

Future Homes Standard options do not result in low enough energy use largely due to the inadequate space heating demand reductions noted above. **These appear to be 1.3 to 2 times the level of energy use recommended by LETI (i.e. less than 35 kWh/m²/yr) excluding any additional performance gap issue. This will have a huge impact on household energy bills and fuel poverty and carbon emissions**. The SAP modelling (HEM methodology) underestimates this due to heating demand reductions noted above, as well as the exclusion of unregulated energy.

Future Homes Standard options peak heating loads appear to be 2 to 3.5 times higher than the peak heating load associated with LETI net zero specifications according to PHPP, which will have implications on grid capacity**.** The peak heating loads are also double those of the Future Home Hub Contender Specification 3 according to iHEM modelling - note: it is understood that HEM is currently not a reliable tool currently for assessing this, further modelling is therefore recommended.

3. Relevant consultation questions

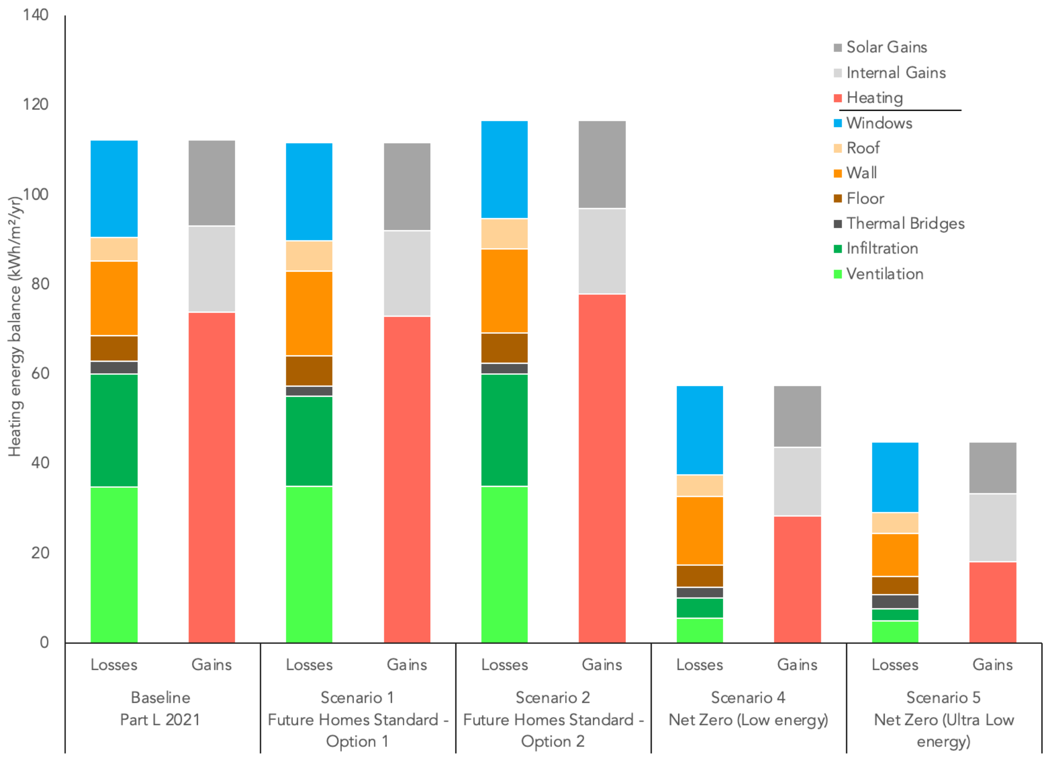
Q7, Q8, Q9, Q12, Q67, Q68

4. Evidence

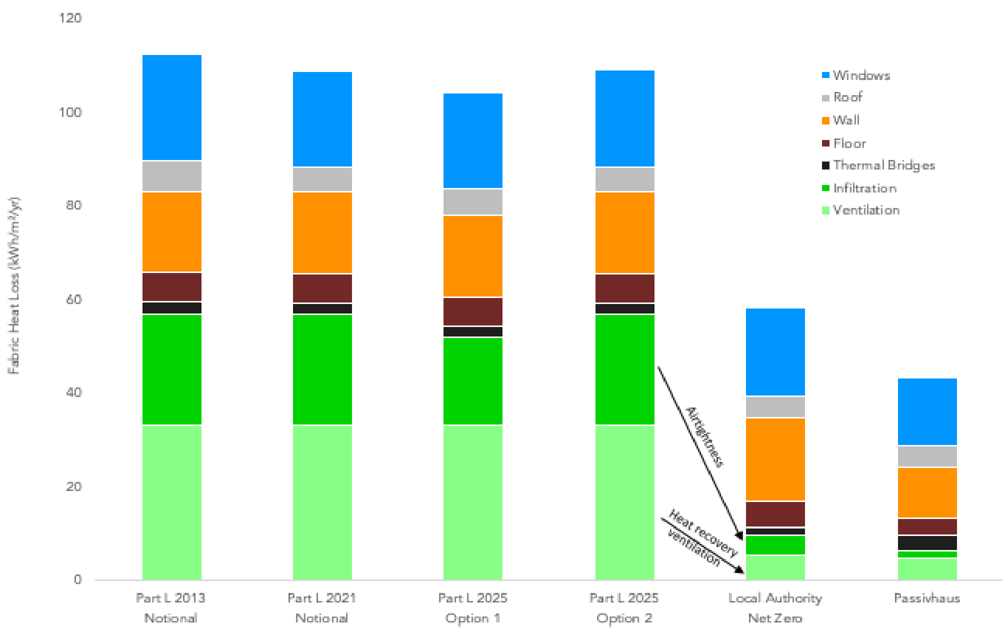
Several modelling exercises were conducted utilising SAP 10.2 (HEM methodology) and Passivhaus Planning Package (PHPP) 10.4, comparing Option 1 and Option 2 of the latest FHS consultation with Part L 2021, and net zero compatible 'low' and 'ultra low' energy specifications. The investigation targeted typical semi-detached houses in Cornwall, Essex and Oxfordshire and were modelled by different organisations and individuals. Whilst the results highlight different issues there are some common themes.

4.1. Space heating demand

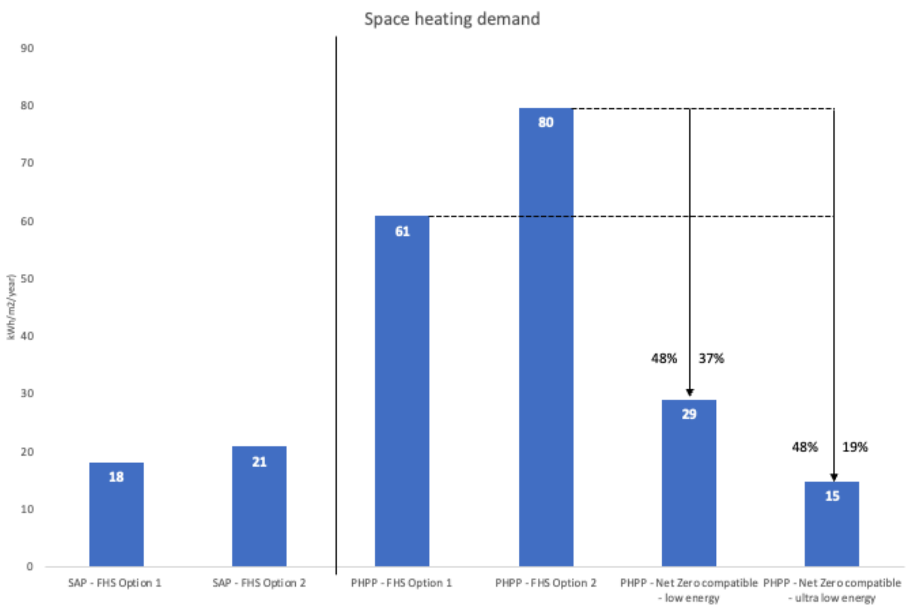
The space heating demand for the FHS options was found to be 2.5 - 5 times higher than genuine net zero compatible low energy buildings, which have been shown to be technically and commercially viable.



Example 1: Semi-detached house in Essex. Space heating demand (red) in kWh/m²/yr for Part L 2021, FHS Option 1, FHS Option 2), Net zero compatible (low energy) and Net zero compatible (ultra low energy) specifications. This modelling showed that in some cases the new standards give potentially worse space heating demand results. Also shows the gap between the proposals and net zero compatible standards.



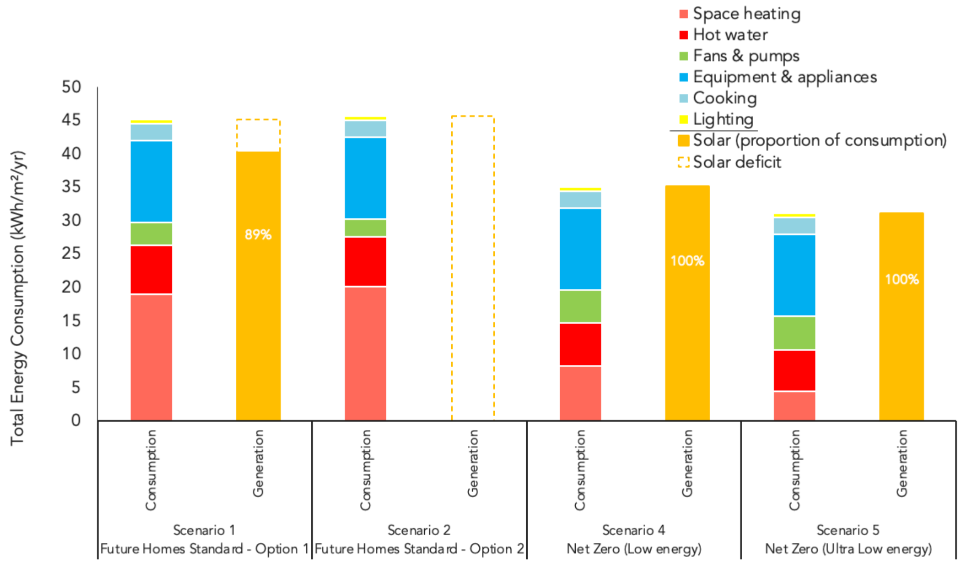
Example 2: Semi-detached house in Cornwall. Fabric heat loss in kWh/m²/yr for Part L 2013, Part L 2021, FHS Option 1, FHS Option 2, Net zero (low energy) and Net zero (ultra low energy) specifications. This illustrates the fact that the lack of improvements in the standards and the significance of airtightness and ventilation on the gap between the proposals and NZC compatible specifications.



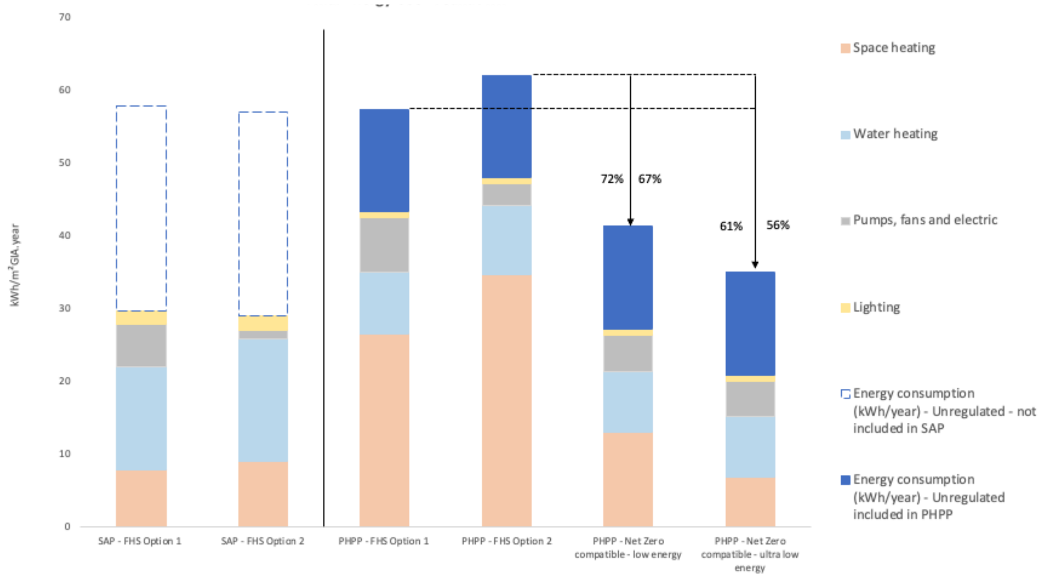
Example 3: Semi-detached house in Oxford. Space heating demand in kWh/m²/yr for FHS Option 1 and FHS Option 2 modelled in SAP (left), and FHS Option 1, FHS Option 2, NZC compatible low energy and ultra low energy specifications (right). This highlights an even bigger difference between FHS option 2 and net zero compatibility, and the inadequacy of the SAP/HEM methodology in representing these differences.

4.2. Energy Use Intensity (EUI)

Energy Use Intensity for the FHS options was found to be 1.3 - 2 times higher than genuine net zero compatible low energy buildings, with a huge impact on household energy bills, fuel poverty and carbon emissions.



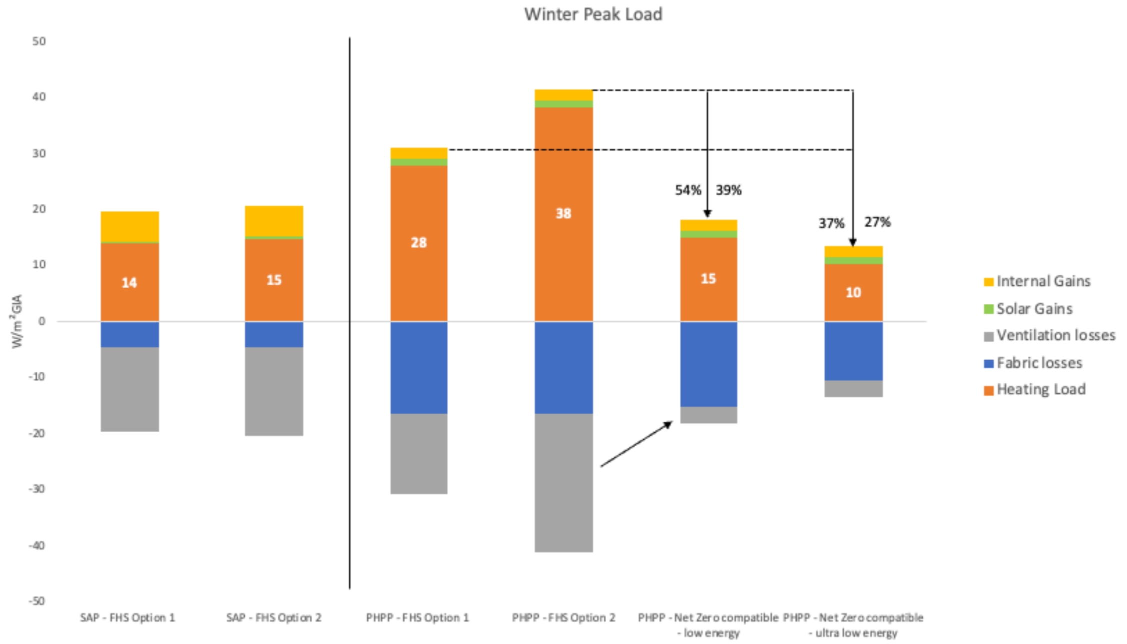
Example 1: semi-detached house in Essex. Energy consumption in kWh/m²/yr for FHS Option 1, FHS Option 2, NZC compatibility low energy and ultra low energy specifications. This shows the impact of a higher space heating demand and of not including unregulated energy in the SAP/HEM calculation.



Example 2: semi-detached house in Oxfordshire. Energy consumption in kWh/m²/yr for FHS Option 1 and FHS Option 2 modelled in SAP (left), and FHS Option 1, FHS Option 2 showing an even larger gap between NZC compatibility low energy and ultra low energy specifications (right).

4.3. Peak heat load

Peak heat load for the FHS options was found to be 2-3.5 times higher.



Peak winter heat load in W/m² for FHS Option 1 and FHS Option 2, and FHS Option 1, FHS Option 2, NZC compatibility low energy and ultra low energy specifications

The National peak heat load is impacted by the reduced fabric performance compared to genuine net zero compatible options.

Peak load prediction was also modelled in iHEM for FHS Options 1 & 2 against the modelled contender specification, which is assumed to be closer to genuine net zero. **It was found that the heat load for the contender specification was less than half for the contender specification (5kW against 2.45kW).**

This difference, extrapolated over the number of proposed houses per year will have implications on grid capacity. The exact impact will need to be assessed in a more reliable modelling tool - as the next section illustrates.

4.4. Comments on HEM

Our modelling has been performed on the Semi-detached house type provided with the HEM consultation project examples with the calculation engine version noted as the HEMv0.27 + FHSv0.19 wrapper.

We note that the existing model does not necessarily perform exactly as intended, and the current code is not designed for policy appraisal therefore, the analysis has been performed for comparative purposes only.

We have compared three energy models:

- The Modelled Dwelling (broadly similar to Future Home Hub Contender Specification 3) is compared to
- Option 1 and 2 within the latest FHS consultation
- Option 2 within the latest FHS consultation -

All fabric assumptions are shown in the appendix, all other specifications stayed the same, including heat pump and DHW cylinder specifications as per the initial configuration provided in the HEM tool.

Space Heating Demand

The results suggest that the **space heating demand is underestimated by HEM**. Space heating annual demand of CS3 type property is **12.6kWh/m²** in HEM, significantly lower than the **20 kWh/m²** predicted for either Notional Option 1 or 2. This predicted annual space heating demand is significantly lower than that predicted from the Future Homes Hub SAP10.2 modelling for a semi-detached property. Sourced from Appendix F of report, the following space heating demand per m² were predicted between the options:

- REF2021 specification - 29 kWh/m²
- Contender specification 2 - 30 kWh/m²
- Contender specification 3 - 14 kWh/m²

This following are likely to be factors in this underestimation:

- **Ventilation Rate Assumptions:** HEM methodology makes assumptions regarding ventilation rates for certain systems, with the presumption that less airtight dwellings have lower ventilation rates - importantly, the allowance for air leakage from background ventilators was inconsistently incorporated.

- **Internal Heat Gains Overestimation:** HEM methodology significantly overestimates internal heat gains. This overestimation was attributed to assumptions regarding appliances, water heating, cooking, lighting, and occupancy patterns - importantly, some of these assumptions were based on outdated or overly conservative data.

Energy Use Intensity (EUI)

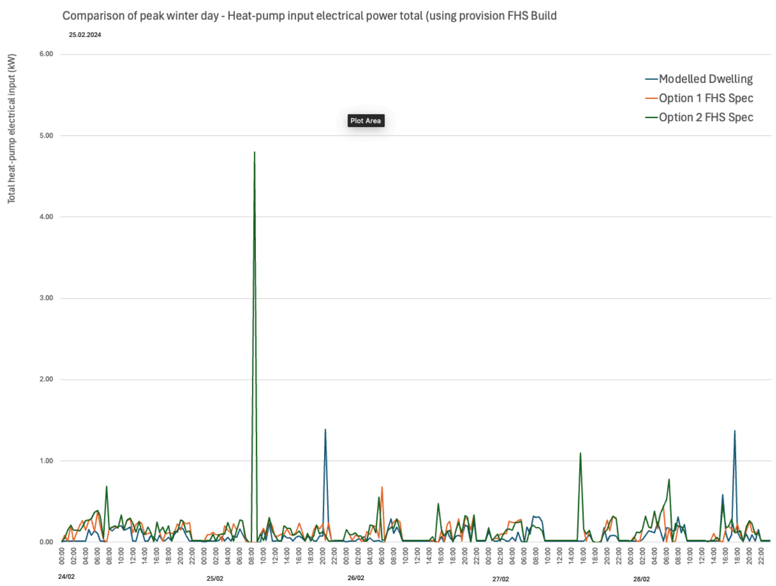
Energy use is underestimated by HEM for the following reasons:

- **Unregulated energy is not included in the HEM methodology.** This leads to a significant underestimation of total energy use
- **Space Heating contribution to energy use is underestimated:** For reasons stated above, also due to conservative methodology for the heat pump efficiency calculation (assuming a continuous heating profile).

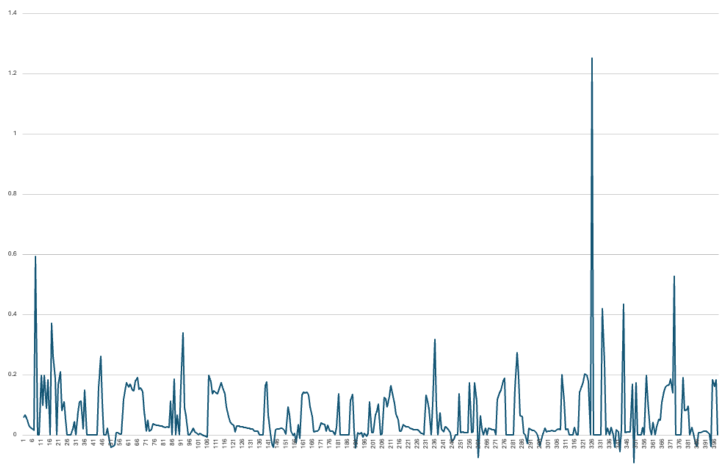
Peak heat demand

Investigating winter peaks further, we have found that Space heating energy consumption is extremely low for all three models, with peaks in DHW consumption dominating peak loads. (Graph 1)

FHS Option 1 assumes a Heat-pump space heating total demand for a very cold week with an external dry-bulb temperature of -5.5C (Graph 2) - this is likely to be an under-prediction given the expected external temperatures. For these reasons, HEM/FHS modelling cannot be used to appraise the impact of lower fabric standards on grid resilience.



Graph 1: Space heating energy consumption is extremely low for all three models, with peaks in DHW consumption leading to peak loads.



Graph 2: HEM predicted heat-pump space heating total demand as follows for a very cold week with estimated external dry-bulb temperature of -5.5C (FHS Option 1). This is likely to be underestimated.

Appendix

Assumptions for HEM modelling:

Building element	Modelled Dwelling	Option 1 - FHS	Option 2 - FHS
Roof U-value (W/m²K)	0.10	0.11	0.11
External wall U-value (W/m²K)	0.15	0.18	0.18
Floor U-value (W/m²K)	0.11	0.13	0.13
Window U-value (W/m²K) [1]	1.0	1.2	1.2
Door U-value (W/m²K) [1]	1.0	1.0	1.0
Air tightness	3	4	5
Ventilation	MVHR	dMEV	Nat vent with intermittent fans

Results:

Results Summary

Output	Units	Actual Dwelling		Notional Option 1		Notional Option 2	
Emission rate	kgCO2/m2	-2.074	(DER)	-1.579	(TER)	2.009	(TER)
Primary energy rate	kWh/m2	-6.263	(DPER)	5.068	(TPER)	45.907	(TPER)
Fabric energy efficiency	kWh / m2.yr	17.436	(DFEE)	21.519	(TFEE)	21.939	(TFEE)
Energy demand :							
Space heating	kWh/m2	12.601		20.664		20.995	
Space cooling	kWh/m2	0.0		0.0		0.0	
Delivered energy use :							
space heating	kWh/m2	3.389		6.193		6.272	
auxiliary	kWh/m2	1.679		2.075		2.069	
water heating	kWh/m2	9.864		12.4		12.924	
electric showers	kWh/m2	0		0		0	
space cooling	kWh/m2	0		0		0	
ventilation	kWh/m2	0.17		0.17		0	
lighting	kWh/m2	1.571		1.44		1.44	
cooking	kWh/m2	6.121		6.121		6.121	
appliances	kWh/m2	27.26		27.26		27.26	
Total	kWh/m2	50.055		55.660		56.086	
Delivered energy use by fuel :							
mains elec	kWh/m2	50.055		55.660		56.086	
Heat transfer coefficient	W / K	51.566		63.783		64.178	
Heat loss parameter normalised for floor area	W / m2.K	0.682		0.843		0.848	
Heat loss form factor	-	2.195		2.195		2.195	
On-site generation :							
Exported	kWh	1,984.840		1,919.710		0.0	
Used on-site	kWh	1,125.342		1,192.307		0.0	
Total	kWh	3,110.182		3,112.017		0	
Peak half hour electricity :							
Consumption	kWh	1.227		2.509		2.556	
Date occured	d M	27 FEB		25 FEB		25 FEB	
Time occured	h	20.0		9.5		9.5	

Metrics

1. Key messages

There are three metrics in the Future Homes Standard:

- an environmental metric (Carbon emissions),
- an energy metric (Primary Energy) and
- a fabric energy efficiency metric (FEE).

The first two are also in the Future Buildings Standard, which does not have a fabric metric. In summary, LETI's key comments on metrics are the following:

- We agree that the environmental metric should be a carbon metric.
- The energy metric should be Energy Use Intensity (EUI) measured in kWh/m2/yr and not Primary Energy Use. There are many reasons for this.
    - Firstly, **there is no need for the energy metric to act as another environmental metric** taking into consideration 'system factors': It should be the most appropriate energy metric.
    - Secondly **there is no agreed and robust methodology to calculate Primary Energy factors**: this introduces unnecessary complexities and potential unintended consequences including delaying the electrification of buildings, a stated policy outcome from DLUHC.
    - Thirdly **primary energy cannot easily be measured by occupants and compared with design predictions**. At LETI we have always believed that creating this connection between design prediction and actual performance was essential and a significant opportunity to unlock positive changes. Finally, Primary energy is not supported by the industry, and has never been.
- The fabric energy efficiency metric should be changed to **space heating demand in kWh/m2/yr** and not FEE. Space heating demand is widely understood and supported by the industry and is used as a metric outside of the regulatory regime. It includes the effect of the ventilation system which is a key component of energy efficiency and is intimately linked to infiltration and airtightness. HTC could be considered too as it can be tested post-completion.
- LETI does not support the on-going use of the notional dwelling/building approach for reasons which are widely supported by the industry including the fact that **it does not reward energy efficient design and that it creates confusion**.
- LETI recommends the inclusion of a new renewable energy generation metric (kWh/m2fp/yr).
- LETI recommends the inclusion of a new energy flexibility metric.

The argument used by DLUHC to keep the same metrics as in Part L 202, i.e. that the status quo is what the industry is used to, **is not acceptable** - it is a circular argument, is not based on any evidence that the industry supports the current metrics over alternative metrics and holds back progress.

2. Relevant consultation questions

Q12, Q31

3. Evidence

3.1. DLUHC's assessment of metrics is not evidenced and we do not agree with its conclusion

The consultation document identifies five policy outcomes that the metrics used for the Future Homes and Future Buildings Standards need to achieve. In order of priority, these are:

1. Protect occupants against high energy bills.
2. Reduce energy demand of homes and non-domestic buildings by requiring high performing building fabric and building services in new buildings, thereby improving energy security.
3. Reduce total operational carbon emissions and produce net-zero ready buildings by requiring low-carbon heating and increasing general electrification of buildings.
4. Are simple to understand and use by industry and provide developers with flexibility in meeting consumer preference regarding design, form and operation.
5. Consider peak electricity demand to reduce costs associated with national and local grid infrastructure upgrades.

The consultation document concludes that the combination of the proposed carbon metric, the primary energy metric and the FEE metric are suitable to deliver these outcomes but does not provide any comparison or justification.

LETI have reviewed different analyses undertaken in the last five years and have undertaken their own assessment against these five policy outcomes. We have reached a different conclusion to DLUHC: **a carbon metric, an EUI metric, a space heating demand metric and a renewable energy generation metric would better deliver the above five policy outcomes.** The table below summarises the comparison between the performance of the current FHS/FBS metrics and the ones supported by LETI.

We would be happy to share additional evidence and would urge DLUHC to publish their own comparative assessment of metrics.

The ability for each set of metrics to deliver DLUHC's five outcomes has been ranked from lowest (0) to highest (5).

DLUHC's policy outcomes	Current proposed FHS/FBS metrics		LETI suggested metrics	
	1. **Environmental:** % over TER 2. **Energy:** % over TPER 3. **Fabric:** % over TFEE		1. **Environmental:** Carbon (kgCO$_2$/m²/yr) 2. **Energy:** Energy use intensity (kWh/m²/yr) 3. **Fabric:** Space heating demand (kWh/m²/yr) 4. **Renewables:** Renewable energy generation (kWh/m²fp/yr)	
Protect occupants against high energy bills	2	There is no energy cost metric in the FHS/FBS but Primary Energy can be used as a proxy. Unfortunately this is challenging due to the use of Primary Energy Factors. Also, unregulated energy is not considered, and it will represent a significant proportion of future homes energy use.	**4**	EUI is not an energy cost metric but can be used as a proxy. It is better than Primary Energy as it relates directly to energy consumption on the energy bills. And it includes unregulated energy.
Reduce energy demand	3	FEE is an assessment of fabric energy efficiency but does not include the effect of the ventilation system. It is not a metric used outside of the building regulations. It is only proposed for the FHS not the FBS.	**4**	Space heating demand is a better fabric energy efficiency metric as it includes the effect of the ventilation system which is closely linked to infiltration. It is used by industry and recognised internationally. It can be used for both the FHS and the FBS. Space cooling demand could be added as a separate requirement.
CO_2 **Reduce total operational carbon emissions**	4	Only regulated carbon emissions are reported.	**5**	Total carbon emissions are reported.
Simple to understand and use by industry	1	None of the three metrics proposed are easily understandable by the industry. Primary Energy and FEE are complex metrics which do not benefit from any industry support. The use of the notional building adds another level of complexity.	**4**	EUI is widely supported by the industry and is a simple metric which everyone in client, design and construction teams would understand. Space heating demand is more widely used and understood by industry than FEE. The use of absolute metrics is simpler.
Consider peak electricity demand	0	No demand flexibility metric	**0**	LETI would recommend the inclusion of an energy flexibility metric
Total score	10/25		**17/25**	

It is clear from the analysis above that a rational analysis of the current metrics with an improved set of metrics demonstrates that the improved set of metrics would be significantly better at delivering DLUHC's policy outcomes.

3.2. The status quo is not a satisfactory justification for the status quo if it is not based on support for the current metrics

Keeping metrics as they are as that is what the industry is used to is not a good argument and holds back progress.
DHLUC states that one of the reasons for keeping them is not wanting to confuse developers with new metrics. We strongly oppose this statement as, especially for primary energy, this is a relatively new metric and it is not very well understood by most people in the industry. We therefore do not believe this would create any extra burden on developers who are still getting to grips with this new metric in any case.
More generally, this justification is not acceptable. Metrics should be chosen based on their ability to best deliver outcomes. The status quo cannot be used to justify the status quo.

3.3. Energy metric: why Energy Use Intensity (EUI) is a much better metric than Primary Energy

3.3.1. There are many more reasons to use EUI than Primary Energy

We believe that the Primary Energy metric should be changed to an Energy Use Intensity metric (EUI). Primary Energy (PE) is useful at a system level but several aspects about it are concerning:

- Primary Energy introduces significant avoidable complexity for occupant and housing /building managers. To compare their actual energy use to the design predictions it would be necessary for them to back-calculate Final Energy use from a single Primary Energy figure that might have been calculated using several different Primary Energy Factors. This is likely to be a barrier for many of them.
- Primary energy factors are calculated based on UK energy supply chains to account for energy losses that occur outside of the dwelling. These may include: grid losses, waste heat as a result of combustion, waste heat as a result of nuclear fuel use, and fuel production. The system boundaries used to calculate primary energy factor calculations are a key issue. For some energy sources there is a good international consensus on where these boundaries should lay, for others there is little consensus.
- There is no agreed methodology for the calculation of PE factors
- The PE factor for nuclear is subject to debate and could vary significantly depending on the methodology used, etc.
- It could delay the electrification of heat as electricity currently has a higher PE factor than gas.
- Unless DLUHC does not intend to follow the recommendations of the Climate Change Committee and use Energy Use Intensity in kWh/m²/yr for the reform of EPCs, the energy metric used by the Future Homes Standard and EPCs will be inconsistent.

Primary energy use has historically been used to capture thermal energy losses that occur upstream of a building. For example, when the electricity grid was predominantly powered by fossil fuels, it made little sense to burn these in a power station, where two thirds of the energy could be lost as heat, and then use this electricity to heat a home. It was often more efficient to burn these fuels directly in an efficient heating appliance within a home. Primary energy factors are generally very good at penalising use of electricity from inefficient fossil fuel generation and promoting direct combustion of fossil fuels within homes. For these reasons, it had its merits a few years ago but we consider that the disadvantages of primary energy as a metric now outweigh its merits.

By contrast, Energy Use Intensity (EUI) has several advantages:

- EUI is internationally understood as energy delivered at the meter, usually divided by the building's internal floor area. There is widespread consensus within the UK industry as to how it is defined in relation to buildings.
- EUI is used in several countries and building energy standards. Examples include TEK17 in Norway, Minergie in Switzerland, and the CaGBC Zero Carbon Building Standard in Canada.
- EUI is easy to understand for consumers and those managing housing/building asset portfolios as it can generally be directly derived from utility meters and does not rely on 'system' conversion factors (such as Primary Energy factors) which will change over time and may not be consistent.
- EUI also provides a practical 'real-world' steer on the energy efficiency of housing/buildings that relates to metered energy use, and in turn energy costs. It can be used by residents and housing/building managers. It offers a direct feedback loop from metering data, and allows comparisons between buildings.
- Use of Energy Use Intensity in kWh/m².yr would be consistent with the recommendations of the Climate Change Committee for the reform of EPCs.

<u>3.3.2. Clarification on Energy Use Intensity (EUI), delivered energy and unregulated energy</u>

Energy Use Intensity (EUI) covers all energy uses in the home, including the energy uses which are currently not covered by Part L of the building regulations (i.e. cooking, appliances and equipment).

DLUHC uses the term 'delivered energy' in the consultation document but it is not clear whether this term also covers 'unregulated energy' or not.

LETI would like to clarify why the EUI should cover all energy uses:

- This enables the EUI to be directly related to the energy use 'at the meter' and therefore residents and occupants to compare their actual energy use to the design prediction. This is key to enable a feedback loop which will help to reduce the performance gap.
- Cooking, appliances and equipment used to represent a small proportion of energy use in a home but they are likely to represent between 30 and 50% of energy use in a FHS compliant house. Ignoring such a large proportion of energy use would be a problem.
- As our homes and buildings become electrified, it makes sense to assess all energy uses, especially given that solar energy generation can be used to cover both types of energy use.
- Estimating energy use from cooking, appliances and equipment is not more complex than assessing energy use from hot water consumption. While it is common sense that behaviours may vary once a building is occupied, energy modelling can be used to reliably establish predicted energy use using statistically representative standardised assumptions.

- Two options are possible: capturing the energy uses from cooking, appliances and equipment in the regulated energy or simply assessing them and adding them to the regulated energy assessment. Either way, it is not correct to say that capturing energy uses from cooking, appliances and equipment cannot be done.
- In section 5.3 of the FHS consultation, it states why the EUI approach has been considered but not suitable as it includes unregulated energy which designers and housebuilders have little or no control over. This should be considered in detail as cooking and appliances are often provided as part of new homes and, even if they are not, using a standardised assumption to assess their future energy use is very straightforward (in fact the Home Energy Model is already doing this).
- LETI recommends the use of a distinct renewable energy generation metric instead of netting out energy use.

We would urge DLUHC to meet with us and discuss openly and constructively solutions to address the lack of understanding associated with EUI, delivered energy and 'unregulated energy'.

3.3.4. Primary energy is not supported by the industry

Primary energy has always been a very difficult concept for the industry to understand. Unlike energy use it does not correlate directly to energy bills and unlike carbon, it is not widely used by the general public. As a consequence, it does not seem to have gathered much support in the building industry, if at all. This was raised in the Part L 2021 consultation and we disagree with the Government's decision to use this metric despite the negative feedback received.

- 76% of respondents to the previous FHS consultation in 2020 opposed Primary Energy as a metric (out of a total of 2,417)
- 85% of respondents to the SAP 11 industry survey in 2021 favoured EUI against Primary Energy (out of a total of 337)

3.3.5. The EUI metric is favoured by industry

Over the last six years LETI has been building consensus on the steps that need to be taken for a zero carbon built environment. The following table outlines the strong support for the EUI metric, that has been gathered over various consultations:

Dates of consultation	**Details**	**Outcome**
LETI - GLA - London Plan consultation (March 2018)	**39 organisations and 200 individuals** signed up to the LETI energy policy proposals which included the implementation of an EUI metric.	LETI started developing a more detailed approach using the EUI metric.
LETI/UKGBC Net Zero framework consultation (April 2018)	LETI has received feedback from **140 built environment professionals from 78 organisations** through an online survey and through a workshop. **85%** thought that net zero carbon	LETI started developing a more detailed approach using the EUI metric.

	framework must set a kWh/m² requirements for each key building type.	
LETI – Reforming compliance modelling – (August 2019)	Evidence based on a specific survey that was completed by **99 built environment professionals** in June/ July 2019, and a technical expert workshop of **20 people**. **75% of people** stated that a key metric in regulation and policy should be metered energy use.	
LETI – Operational Net Zero one pager (August - December 2019)	**331** people took part in a survey that asked: Given that we are in a climate emergency and we need to reduce our carbon emissions as much as possible and as fast as possible, what should these targets be? •28% said the result of bottom up approach based on industry best practice (e.g. Passivhaus) •9% said the result of top down approach based on the amount of renewable energy that the UK can produce to power buildings **•56% based on a mixture of the two**	Both a bottom-up and a top down approach was used to set the LETI EUI kWh/m² target. For more information see https://www.leti.london /cedg
LETI – FHS consultation response (March 2020)	LETI developed a key messaging document as part of the 2020 Future Homes standard consultation response. The key messaging included-including performance metrics such as Energy Use Intensity (EUI) in KWh/m²/y. LETI made this document available online and received strong consensus from a wide range of built environment disciplines in agreement with the issues identified. **219 organisations have signed up in support of this document, who between them employ over 8898 people. In addition, 833 individuals signed up in support, 665 of whom are built environment professionals.**	
LETI/ CIBSE – What is LETI survey (November 2021)	**198** people responded to consultation Operational carbon: 175 respondents "expert" or "medium" **•90%** agreed that meeting Net Zero Carbon - operational energy requires meeting Energy use target e.g. EUI, energy rate	The LETI CIBSE FAQs on what is Net Zero, states that an energy use target must be met for Net Zero buildings. This work is supported by the Institution of Structural Engineers,

		RIBA, RICS, BRE, Good homes alliance and WLCN.
The UK Net Zero Carbon buildings standard (NZCBS) consultation Summer 2023 (the NZCBS is a joint initiative between many organisations including LETI)	524 people responded to the NZCBS consultation in 2023. Relevant questions relating to the EUI metric are outlined below: *Q12) In general, do you agree with the proposals put forward for the metrics for the Standard?* Note: the metrics includes EUI **73%** of the **272** people that answered question 12, that they agreed or strongly agreed with the proposals. *Q18) What are your views on the approach to verification of operational energy based on actual outcomes?* **84%** of the **257** people that answered question 18, that they agreed or strongly agreed that the verification of operational energy based on actual outcomes?	UK Net Zero Carbon buildings standard will require new and existing buildings to meet an EUi limit

3.3.6. The EUI metric is being taken up by Local authorities in Net Zero policy

Many local authorities are using the Energy Use Intensity (EUI) in their local plans. This includes Cornwall Council, Bath & North East Somerset Council as well as Central Lincolnshire. The energy policies of these local authorities are widely recognised as exemplary and pioneering a better way to set standards for new buildings.

In addition to the above the **Greater London Authority** requires that EUI is reported in planning applications in London.

3.3.7. The following government departments are using an EUI limit as part of their briefs and guidance

Department of Education

EUI targets are in the Department of Education requirements for schools.

3.2.2 Energy Use Intensity Targets

3.2.2.1 To meet the EUI Targets, the energy model shall have energy end use for school per m² of GIFA (kWh/m2) excluding unheated (transition spaces). [PM_40_20]

3.2.2.2 The following EUI values define the minimum standards for New Building(s) and shall be achieved before the application of renewable technology. [PM_40_20]

School Type	Energy Use Intensity (minimum)	Units
Primary School	52	kWh/m²
Secondary School	67	kWh/m²
SEN_D	52	kWh/m²

Table 1 Energy Use Intensity Targets

3.2.2.3 The following breakdown below provides an indication of how to achieve the overall EUI targets, by end use system. [PM_40_30_27]

Extract from guidance from the Department of Education

Ministry of Justice

The Ministry of Justice has set an EUI requirement of 55kWh/m²/yr (excluding any renewable generation), fossil fuel free for all new build cat D (open) prisons (Currently in draft version – within an overall aim of net zero carbon).

Government Property Agency

The Government Property Agency (GPA) has introduced EUI targets in the GPA Sustainability requirements for government estates buildings.

2 – Operational Energy

Consideration shall be given to integrated structural and services systems to improve performance of the building, such as the use of thermal mass from concrete structures to reduce operational energy.

Key targets to achieve Net Zero Carbon for operational energy all office buildings within the GPA Portfolio:

	Target
Operational Energy Use (EUI)	70 kWh/m²/yr (NLA), 55 kWh/m²/yr (GIA)
Space Heating Demand	15 kWh/m²/yr
DEC Rating	In the top quartile of performance
EPC Rating	Energy Performance Certificate (EPC) Rating should be A (New Builds) or B (Refurbishments)
Renewable Energy (RE) Supply	Local Plan requirement for minimum % on-site RE achieved
Energy Performance of Equipment	Energy consuming equipment including building services equipment, ICT and white goods should meet the relevant Government Buying Standards and Article 6 of the Energy Efficiency Directive. Items with an A rating should be used where possible.

Extract from Sustainability and Net Zero Design Guide – Sustainability Annex - Government property agency

NHS

A bespoke EUI target is developed depending on the use of the building in the NHS Net Zero Carbon Standard.

3.3.8. *Further organisations that advocate for an EUI limit*

The UK Net Zero Carbon buildings Standard

The UK Net Zero Carbon buildings Standard is currently under development. It will be the UK's first cross-industry Net Zero Carbon Buildings Standard that brings together Net-Zero Carbon requirements for all major building types, based on a 1.5°C trajectory. Whilst significant progress has been made in defining what 'net zero' means for buildings in the UK, a process of market analysis showed a clear demand for a single, agreed methodology.

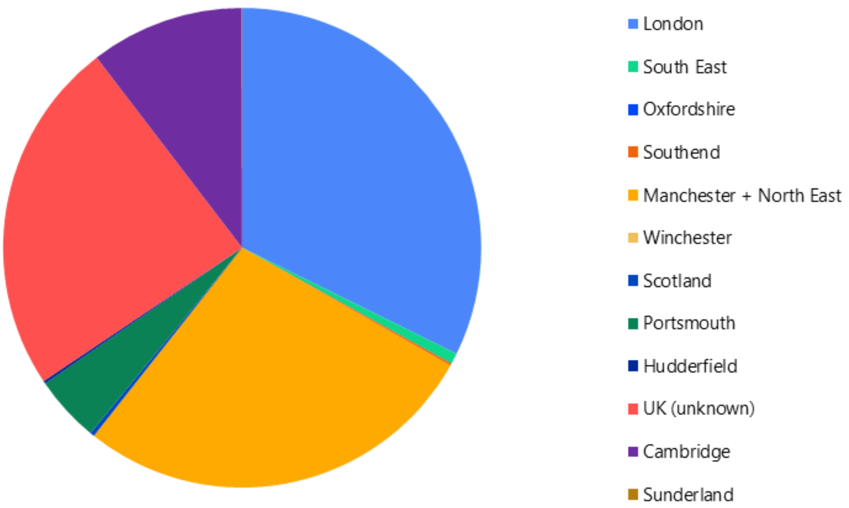
The UK Net Zero Carbon Buildings Standard will enable industry to robustly prove their built assets are net zero carbon and in line with our nation's climate targets. This voluntary Standard will be applicable to new buildings, retrofits and existing buildings. The Standard is a joint initiative between BBP, BRE, the Carbon Trust, CIBSE, IStructE, LETI, RIBA, RICS, and UKGBC , PIA, RIAS and ICE.

EUI is the metric which is being used in the NZCBS, and thus is supported by the BBP, BRE, the Carbon Trust, CIBSE, IStructE, LETI, RIBA, RICS, and UKGBC , PIA, RIAS and ICE.

Developers, architects and engineers

In 2020 LETI launched the LETI climate emergency design guide, which provided EUI targets for homes, schools and offices. In 2023 LETI undertook some research to understand the impact this guidance, and found over **60,000 homes** across 138 schemes that are aiming to meet the LETI target of 35 kWh/m²/yr.

These homes are located in various places across the UK, see below for details.



It should be noted that this research was carried out by receiving information from 20 organisations (developers, engineers and architects) that shared information about their projects. It is very likely that this is a small snapshot of the industry and that many more homes are being designed to meet the LETI EUI target of 35 kWh/m²/yr.

<u>3.3.9. Develop a robust evidence base that evaluates industry supported and currently proposed metrics</u>

Based on the information that is in the consultation we do not believe that sufficient work has been done by DLUHC to consider how a regulation based on a Primary Energy rather than an EUI metric and FEES rather than Space Heating Demand would support DLUHC's proposed policy outcomes. We believe that DLUHC should undertake or commission a piece of work that looks at evaluating metrics that are proposed and those supported by the industry, including the EUI metric, and then the relative benefits of the proposed approach versus alternative approaches can be understood. We have outlined a scope for a piece of work that we feel should be commissioned below.

<u>The commissioned piece of work should include:</u>

Part 1: Approach/scope decision making

1.A. Regulated and unregulated energy

- Evaluate whether the proposed and alternative metrics, such as EUI limits, should include both regulated and unregulated energy. This should be considered in relation to the policy outcome review in Part 4.

1.B. Bespoke vs templated assumptions

- Unregulated energy assumptions - Consider whether unregulated energy assumptions should be fixed and constant per typology or bespoke for each building.
- Occupancy schedules – Consider whether occupancy schedules should be fixed for different typologies or bespoke according to the design/client team input.

1.C. Scope of energy uses included

- Outline the scope of energy uses included. For example if process loads in an industrial building should be included.

1.D. Approach to limit setting

- Evaluate how to categorise buildings, in terms of different EUI limits and other metrics.
- For EUI consider whether secondary metrics with a different denominator are relevant for some buildings types, for example for office it might be per desk space or for homes it might be per occupant.
- Evaluate any conditions where the limits might need to be different, for example larger homes.
- When deciding what level to set the limit at, the following will need to be agreed:

  Is it a defined limit per typology or range?

  The level that the limit is set at will need to be based on cost assessment and viability testing, it is not suggested that this is carried its self in this piece of work, (see Part 5)

  Will the set limit will have to be reviewed every 5-10 years as new technologies emerge and material availability changes?

Part 2: Lessons from others
Research, and learn from other policies and regulations, with reference to those based on relative and absolute energy metrics.

Part 3: Modelling software
Evaluate appropriate options for energy modelling software and if/ how HEM and NCM can be used.

Part 4: Evaluation of the proposed approach compared with alternative approaches such as EUI set out in the 2023 consultation against objectives
Fully evaluate against the objectives and compare with the approach set out in the 2023 consultation against objectives.

1. Protect occupants against high energy bills
2. Reduce energy demand
3. Reduce total operational carbon emissions
4. Simple to understand and use by industry
5. Consider peak electricity demand

Part 5: Next steps
If an alternative approach, such as one based on absolute EUI metrics was adopted in policy, outline what work would need to be undertaken, and what previous work can be drawn upon to make this process quicker and less resource intensive, and how this compares to the metrics and process currently proposed. This would include:

- How limits would be set
- An assessment of the cost of undertaking compliance modelling vs predictive energy modelling?
- An assessment of the skill shortage and the cost of upskilling, and how different this cost is compared to upskilling that is required for the FHS in its current proposed

3.4. Fabric energy efficiency metric: FEE vs space heating demand vs HTC

<u>3.4.1. The Building Regulations' Fabric Energy Efficiency Metric (FEE) has limitations</u>
While we acknowledge that the proposed FEE metric does a good job at ensuring that a new dwelling's fabric specifications (e.g. U-values, Airtightness) perform better than a minimum level and preventing that the target Carbon and Energy metrics are complied with poor fabric, it is important that it has a number of limitations:

- it does not include the effect of the ventilation system which is closely related to the issue of airtightness and ventilation and a key factor to deliver energy efficient new homes.
- It is not a metric which is used in the industry or internationally.
- As it is a purely 'conceptual' metric, it is not understood by client, design and construction teams.
- It cannot be directly converted to energy use for space heating or cooling.

3.4.2. LETI recommends the use of space heating demand instead of FEE

We believe the FEE metric should be changed to a space heating demand metric. We think that space heating demand is a more tangible concept and one that links more closely to the design decisions that clients, designers, contractors and builders can make. Its advantages include the following:

- It takes into account the effect of the ventilation system, thereby covering all key design and construction parameters which will have a key impact on energy efficiency (other than the heating and hot water system).
- It is a metric widely used in the industry and internationally.
- Many clients, designers, contractors and builders have become more familiar with it through other energy/carbon schemes such as Passivhaus.

3.4.3. What about cooling?

One of the declared advantages of FEE is said to be its inclusion of energy demand for cooling. If reducing cooling energy demand is considered an important policy outcome, it is recommended to use space cooling demand as a separate metric instead of combining the two together which is not satisfactory from a scientific point of view.

3.4.4. What about the HTC?

The Heat Transfer Coefficient (HTC) could be a valid alternative to FEE or space heating demand. Compared with the other two, It has the significant advantage of being measurable on completion. Unfortunately, like FEE it is purely a 'fabric' metric and excludes the effect of a key factor in the energy demand of new dwellings: ventilation.

3.4.5. DLUHC should undertake a comparison of these three alternative metrics

The consultation documents do not suggest that DLUHC have considered any alternative to the FEE metric. Given the wide industry support for space heating demand, we would strongly recommend that a comparison between the three alternative metrics above (i.e. FEE, space heating demand and HTC) is being undertaken by DLUHC.

3.4.6. There should be a fabric energy efficiency metric in the Future Buildings Standard

The Future Building Standard does not have a fabric energy efficiency metric. As a result, a building can comply with it even with a poor level of energy efficiency as long as it has a low carbon heating system and/or a large PV installation. This is clearly a missed opportunity so LETI would urge DLUHC to introduce a fabric energy efficiency metric in the FBS. LETI recommends the adoption of space heating demand (kWh/m2/yr) which is already being used in voluntary energy standards.

3.5. LETI recommends the inclusion of a new renewable energy generation metric

New buildings should contribute to the significant increase in renewable energy generation required between now and 2050.

The most robust way to deliver the overall objective of a balance between total energy use and renewable energy generation for new buildings at a system level is to seek to achieve this balance at the site level.

This would also have the advantage of generating 'free' electricity close to its point of use, helping to deliver significant energy cost savings for residents and building users.

LETI would therefore recommend the inclusion of a renewable energy generation metric in the Future Homes Standard and the Future Building Standard.

3.6. LETI recommends the inclusion of a new energy flexibility metric

As all energy uses in more and more buildings become 'electrified', there is a growing consensus that being able to shift electricity use to coincide with renewable generation, at both the building scale and grid scale, will be crucial to minimise reliance on fossil fuels as cost effectively as possible.

The FHS and FBS therefore have a critical role as a key 'route to market' for several enabling technologies. The most robust, transparent and clear way to do this would be through the introduction of a new energy flexibility metric.

3.7. Comments on emission factors

We agree that the carbon metric should be retained as the 'environmental' metric in the FHS and FBS. This metric aligns with what is commonly understood by the general population and those in the building industry. It also allows a good way for developers to assess their buildings against their own internal ESG targets as most want to reduce the carbon associated with their operations.

An important choice is the time range used to calculate emission factors. As the FHS and FBS will be used to design buildings, a forecast emission factor that is relevant during the operational lifetime of the building (and particularly its heating system) is helpful to inform designers how much carbon their building is likely to emit.

Different options are possible:

Time range	Emissions calculated by HEM/NCM would represent…	Comment
Short term (e.g. 5 years)	Average annual emissions over the period 2025-2030	As most buildings designed to the FHS and FBS are likely to become operational in 2027 at the earliest, carbon emissions estimated by HEM/NCM would only be representative of the very initial period (1-3 years). Operational emissions over the lifetime

Time range	Emissions calculated by HEM/NCM would represent…	Comment
		of the house/building and its heating system are likely to be overestimated.
Medium term (e.g. 15 years)	Emissions over the period 2025 and 2040	Carbon emissions estimated by HEM/NCM would be representative of the initial period (10-15 years), likely to correspond to the lifetime of the heating system.
Long term (e.g. 25+ years)	Emissions over the period 2025 and 2050	Carbon emissions estimated by HEM/NCM would be representative of the whole until 2050..

LETI would favour 'medium term' over 'short term' for the emission factor time range.

Ventilation

1. Key messages

- **Reliable ventilation is critical for occupant health and wellbeing, it is not suitably addressed by the Future Homes Standard missing an opportunity to improve indoor air quality and health in our homes.**
- **Where ventilation occurs and how it is controlled is critical, air infiltration through unknown air paths does not provide effective ventilation.**
- **Mechanical Ventilation with Heat Recovery (MVHR) gives a significant improvement in energy efficiency, alongside co-benefits of good ventilation.**
- **The assessment of energy and carbon savings from ventilation systems (including MVHR) must be reliable. The savings in energy from heat recovery are significantly greater than the fan electricity.**

2. Relevant consultation questions

Q7, Q9, Q13, Q29

3. Evidence

3.1. Reliable ventilation is critical for occupant health and wellbeing and is not suitably addressed by the Future Homes Standard

The Policy objectives state that the Future Homes Standard should ensure that homes are "high quality" and "safe". Good and reliable ventilation to each room is crucial to reducing the energy demand of homes without affecting air quality and health, affecting both home quality and safety of occupants. The importance of ventilation and its impact on occupant health is missing from the proposals and consultation. Air quality relies on sufficient supply air to bedrooms and living rooms; the proposals deal with pollutants, but does not ensure humidity control and fresh air in bedrooms.

Unfortunately the notional dwelling specifications currently assumed for the Future Homes Standard (i.e. Option 1 and Option 2) respectively assume two ventilation systems which are known to deliver poor performance and air quality, potentially putting residents at risk.

3.2. Where ventilation occurs and how it is controlled is critical, air infiltration through unknown air paths does not provide effective ventilation.

The building regulations allow for some 'ventilation' to be provided by air leakage and poor construction quality, however where and when this ventilation occurs is unknown and not designed. This does not address health concerns of under ventilation and causes local over ventilation with dry air and discomfort.

Natural ventilation with intermittent extract fans rely on large openings in the facade (e.g. trickle vents and faults in the building fabric) to provide fresh supply air to bedrooms. A 2019 Government-funded study[1] has shown that they under ventilate the whole building or some rooms periodically, whilst over-ventilating at other times. Therefore these strategies do not meet the policy objectives of achieving high quality and safe homes. There is also evidence that this system relies on optimistic assumptions in SAP and HEM but will actually perform much worse in practice. For example, blocking trickle vents in windows during the air test will provide a very optimistic assessment of the dwelling's actual infiltration rate.

De-centralised MEV (dMEV) systems are prone to users switching off and some of the systems have very poor performance characteristics. They can actually perform even worse in terms of air quality than natural ventilation with intermittent extract fans. De-centralised MEV (dMEV) systems do not appear reliable for whole house ventilation[2]. The only key advantage of this system is that it is cheap.

MVHR is the only solution that provides a designed supply air flow to bedrooms and living rooms. This provides a constant flow of filtered fresh air, and can be supplemented by opening windows. Although MVHR has many benefits and is generally lower risk than other options, it is important that it is designed, installed and maintained properly. Some requirements to address this are already included in the building regulations but currently act as a deterrent compared to other systems, the future homes standard should seek to promote MVHR done well.

3.3. MVHR is energy efficient and would deliver co-benefits (e.g. indoor air quality)

The winter ventilation strategies that have been shown to deliver a satisfactory level of performance in terms of indoor air quality are:

- Constant mechanical extract ventilation (MEV) with good air tightness (<$3m^3/m^2/h$@50Pa).
- Balanced supply and extract ventilation, typically with heat recovery (MVHR) where there is a ducted air supply to each bedroom and living room.

Summer and purge ventilation can still be achieved by opening windows and doors as required.

1 https://assets.publishing.service.gov.uk/media/5d91be8040f0b65e62c6cfb0/Research_-_ventilation_and_indoor_air_quality.pdf

2 Performance of decentralized mechanical ventilation in airtight homes, University of Strathclyde, John Gilbert Architects, Anderson Bell and Christie Architects

Reducing energy consumption of new homes relies on reducing winter heating demand. In our project experience, cold air brought into the property to provide ventilation typically makes up 30-50% of the heating energy needed by a building. Reducing the energy consumption of homes therefore relies on careful control of ventilation rates, and takes a large benefit from heat recovery. That is why LETI promotes the use of MVHR in all new homes. MVHR has been shown to improve indoor air quality (IAQ) when paired with good levels of air tightness[3].

3.4. The assessment of energy and carbon savings from ventilation systems (including MVHR) must be reliable

The SAP calculation engine does not give accurate energy saving estimates for heat recovery ventilation. Therefore conclusions based on calculations for energy savings or carbon reduction from MVHR that have used a SAP calculation engine are unreliable and should not be used as the basis for policy. The savings from MVHR are likely to be significantly higher.

SAP ventilation energy calculation uses several correction factors and un-validated assumptions that give the false impression that MVHR has less benefit, particularly in reference to heating energy, and at higher infiltration rates. See Passivhaus Trust research report 'The Case for MVHR' for details. https://passivhaustrust.org.uk/guidance_detail.php?gId=46.

It is crucial that the assessment of ventilation systems is more accurate in HEM, otherwise the comparison of ventilation system options by developers may lead to the wrong conclusions.

[3] https://www.sciencedirect.com/science/article/abs/pii/S0378778823011131?dgcid=coauthor

Airtightness

1. Key messages

- **Airtightness is a cheap way to improve energy efficiency and reduce both the need for space heating and energy bills.**
- **High air infiltration is a strong indicator of poor construction quality and can be tested: airtightness should be improved in the Future Homes Standard.**
- **Delivering a good level of airtightness is simple during construction, but tricky to retrofit later**.
- **The notional building airtightness options will not improve the current new build standard.**

2. Relevant consultation questions

Q7, Q9, Q13, Q29, Q39

3. Evidence

3.1. Airtightness is a cheap way to improve energy efficiency and reduce both the need for space heating and energy bills.

The materials needed to deliver airtight dwellings are inexpensive, training resources are readily available and testing is quicker and simpler than ever before, for example with the option for pulse testing. With reductions in space heating demand similar to other fabric measures, it is the most cost effective and material/embodied carbon efficient way to lower a home's energy use and the associated energy bills.

The impact assessment shows that airtightness is an inexpensive measure. The impact assessment lists the cost of improving airtightness from 5 $m^3/m^2/hr$ to 4 $m^3/m^2/hr$ as only £5-11 per m^2. Costs would likely decrease as the knowledge and skill level of the workforce increases. This aligns with our combined project experience. Airtightness is mostly achieved through well-considered design work and good quality workmanship on site, both of which should be encouraged.

Airtightness products themselves can be easily built into the building fabric and be fitted by non-specialist tradespersons (in general), adding minimal expense. There is an abundance of inexpensive airtightness products on the market to deal with the various construction methodologies and situations that might arise.

Given the cost effective nature of this measure and its beneficial impact, we believe a more ambitious level of airtightness should be set within Part L.

3.2. High air infiltration is a strong indicator of poor construction quality and can be tested: airtightness should be improved in the Future Homes Standard

Infiltration is due to a building defect and is a sign of poor construction quality. In our projects high infiltration rates are nearly always down to junctions between building elements not being built correctly on site.

Low levels of air infiltration improve acoustic performance and fire safety as well as improving thermal performance.

Our large scale housing projects are routinely achieving an air permeability of less than 1.0$m^3/m^2/h$@50Pa. This demonstrates that contractors and house builders can readily achieve this level of performance.

3.3. Delivering a good level of airtightness is simple during construction, but tricky to retrofit later

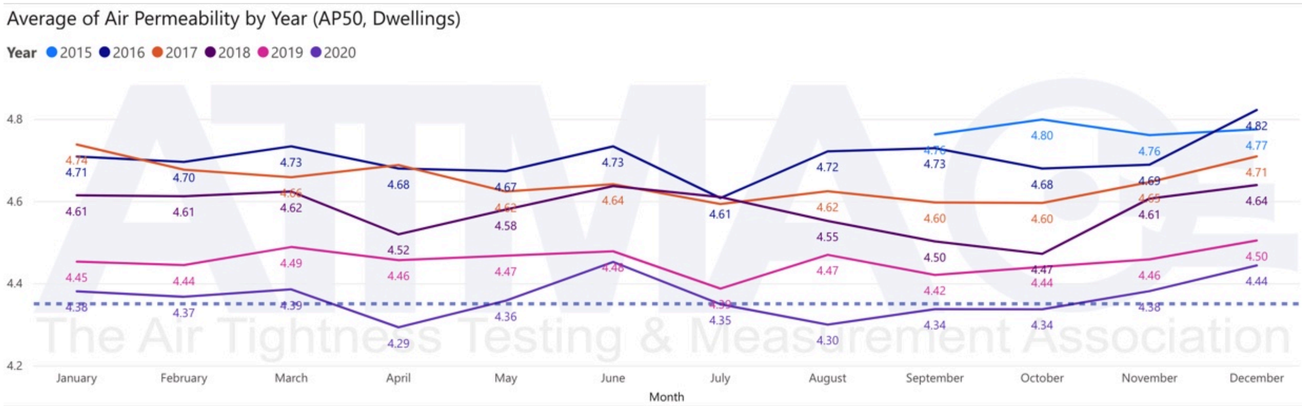
Good levels of airtightness are relatively easy to achieve during construction, as they are often embedded into the construction of the building. Improving airtightness at a later point is a complicated process with homeowners.

3.4. The notional building airtightness options will not improve the current new build standard. Many housebuilders are already delivering much better standards

The notional dwelling specification outlines the following for airtightness :

Option 1 proposes an air permeability rate of **4 $m^3/m^2/hr$** (when tested at 50Pa)
Option 2 proposes airtightness at **5 $m^3/m^2/hr$** (when tested at 50Pa)

The average airtightness of a new dwelling in 2020 was less than 4.5 m^3/m^2.hr and there has been a continual improvement demonstrated in the last decade. The knowledge in the industry to achieve these lower targets aligns with data from the UK's Airtightness Testing and Measurement Association that indicates the average air permeability of new homes in the UK was just under 4.5 $m^3/m^2/hr$ in 2020. There has also been a year-on-year improvement since 2015, even though there had been no change to Part L expectations during that period, demonstrating that housebuilders are organically improving and that they do not see a financial penalty in doing so.



The proposed air permeability of the notional dwellings would therefore not incentivise any improvement in airtightness given where housebuilders are now.

Better levels of airtightness are achievable and we believe that Part L should go further.

From our knowledge of the new build sector we understand that larger housebuilders are comfortable with achieving an air permeability of around 3 $m^3/m^2/hr$ on average across their development without significant efforts. Plenty of housebuilders and contractors are regularly achieving lower than this <1 $m^3/m^2/hr$ and the uptake of the Passivhaus standard is a clear indicator of the building sector's ability to achieve better airtightness, with over 2,000 certified Passivhaus homes in the UK. Elsewhere the Norwegian Building Code was updated in 2017, requiring residential airtightness of 0.6 air changes per hour (@ 50 Pa).

3.5. Improving airtightness would deliver on the aims of the FHS

The FHS consultation recognises that high performing homes have considerable health and wellbeing benefits. Good building fabric and airtightness, coupled with adequate ventilation provides many benefits for residents and their homes, including:

- Better thermal comfort for the resident, via the prevention of drafts and minimising temperature variations throughout the home. Movement of air at just 0.1m/s can be felt as a draft in cold climates during the winter month.
- Improved indoor air quality that can limit the introduction of outdoor pollutants such as pollen, dust and fumes. When coupled with balanced mechanical ventilation systems, the outdoor air can be filtered and pollutants removed from the indoor environment.
- A robust, well-placed airtightness line prevents warm internal air from moving into the building construction where it may cool down and lead to condensation. Protecting the building structure from moisture damage prolongs the lifespan of the home and component materials.

We are encouraged that the quality of homes for residents is a priority for the government in setting these new standards, however we believe the levels of airtightness proposed in the consultation will not fully realise this vision and that there is need to go further.

Weather data

1. Key messages

- **It is very a very positive improvement on SAP that HEM:FHS is able to use regional weather data as opposed to average national weather data**
- **Unfortunately, due to the notional dwelling approach, the target will also change, meaning that a house in the North of England will have to be less efficient than a house in the South of England. These homes will have higher energy bills.**
- **LETI believes that the Future Homes Standard should seek to deliver the same benefits across the country.**
- **Mechanical Ventilation with Heat Recovery (MVHR) is energy efficient and would deliver co-benefits (e.g. indoor air quality)**
- **The assessment of energy and carbon savings from ventilation systems (including MVHR) must be reliable**

2. Relevant consultation questions

Q68, Q69

3. Evidence

3.1. Use of regional weather data

We think it is a very positive step forward that the HEM:FHS will use local CIBSE weather data as:

- Space heating demand will be more accurately estimated
- Local weather data will allow more accurate sizing of heat pumps within the model
- Generated electricity yields from PV will be more accurate for the location

It also brings domestic compliance modelling in-line with non-domestic modelling in this respect.

However, the notional dwelling will also use local weather data and therefore the target will be raised in colder and less sunny locations. This means that new homes in colder parts of the country will have higher heating bills and use more energy than those in warmer areas. We believe that 'levelling up' this inequality should be a priority.

We see several potential solutions :

- The Notional dwelling could use a fixed weather file that represents an average for the UK (e.g. Birmingham)
- The methodology of comparing against a Notional target could be scrapped in favour of performance based targets

NB We have not been able to do any modelling to demonstrate the scale of this effect as it is not currently possible to change the weather file within the prototype HEM. Have the government done any tests to explore the specifications that would emerge in the North vs South of England if home energy costs were to be equalised?

3.2. Reliability of weather data

Weather is inherently changeable and micro-climates can make relatively close locations very different in their profiles, plus the effects of climate change are still unfolding, so predictive weather data will never be ideal.

We recognise that CIBSE weather files represent the best available UK weather data. We are aware that new CIBSE data based on the UKCP18 projections will be published later in 2024. Can the government confirm whether this will be adopted and what quality assurance will be applied to test that the weather data that will be mandated for use in Building Regulations is robust for use in each context?

Cost impact assessment review

1. Introduction

As part of the Future Homes Standard and Future Buildings Standard consultation documents, DHLUC released two impact assessments focused on the respective changes to Part L of the building regulations for domestic and non-domestic buildings. Whilst the assessments are beneficial and follow logical reasoning, they omit key aspects.

For **Option 1**, the total estimated benefit appears to be of **£7.2billion** in Net Present Value (NPV) over 70 year time period.

- Total costs of £3.1billion, with £0.7billion on replacement and maintenance, and £2.4billion on capital expenditure
- NPV benefits total £10.3 billion, including CO2 savings AQ benefits of £6.6 billion, and £3.7billion of occupant energy savings compared to existing regulations

For **Option 1**, the total estimated benefit appears to be of £5.6 billion in Net Present Value (NPV) over 70 year time period)

- Lower costs than current by -£0.8billion due to absence of solar panels compared to part L 2021 current
- Total benefits of £4.8billion, including £6.2billion of CO2 and AQ savings. Consumer bills increase, at a cost of £1.4billion

The assessments have been made using the 2023 Green book supplementary guidance on Valuation of energy use and GHG emissions.

2. Key Messages

Lack of detailed cost data transparency. Only the outcomes of the assessments are shown, and the lack of transparency on detailed underlying cost data makes it very challenging to assess the quality of the cost assessment and provide detailed constructive comments. We urge DLUHC to publish a more comprehensive set of cost data.

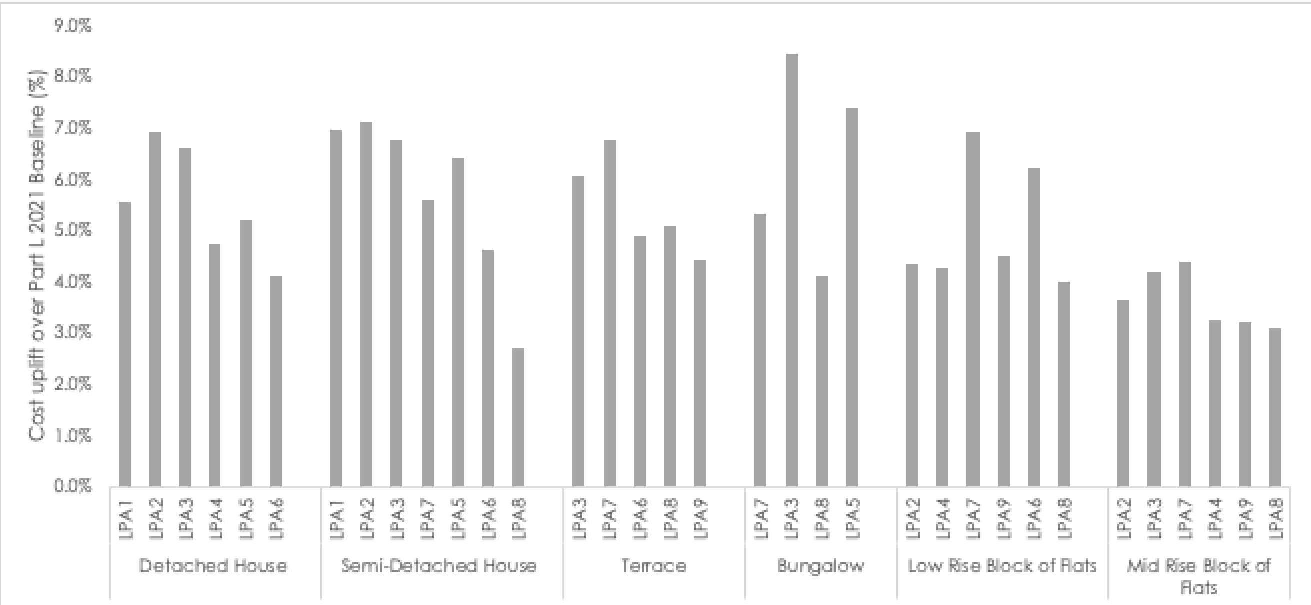
Key cost assumptions have been omitted. Grid resilience and reinforcement has not been factored into the NPV calculations. This is one of the largest areas of system costs associated with moving to a fossil fuel free future for buildings. Grid reinforcement costs and impacts of further fabric standard upgrades can be quantified.

Airtightness appears to be the cheapest energy efficiency measure. Airtightness uplift is negligible in comparison to other measures. We recommend investigating how further improvements in airtightness would further improve the net benefit of the Future Homes Standard.

Better standards in line with LETI's recommendations are affordable. We have gathered data from various technical and financial evidence bases undertaken in support of Local Plans The graph below summarises the expected total capital cost uplift for each of the studies completed.

For dwellings (detached, semi-detached, terrace block and bungalow) – the cost uplift ranges between 2.7% - 8.5% over a Part L 2021 baseline. For apartment blocks – the cost uplift ranges between 3.1% - 6.9%. This generally shows that the larger the building, the lower the cost uplift required to meet Net Zero specifications.

The cost uplift for the proposed FHS policy options have been quoted as 4% and 1% for options 1 and 2 respectively, this is for a 3-bed semi-detached property. Based on the cost data from the local authorities then, improving the specification to hit a net zero operational standard would likely cost a further 1-3%. But in doing so the resident bills would be reduced, the ability of the homes to shift their peak demand would be improved and this would reduce the capital expenditure required on the grid.



Viability and housing supply

1. Key messages

- **Unfortunately we have not found any research in the public domain substantiating this point.**
- **LETI's own research indicates that previous improvements in building regulations and/or planning policy have had no impact on housing supply.**
- **Previous Part L uplifts have never had a measurable impact on housing supply**

2. Relevant consultation questions

Q7, Q8, Q9, Q11

3. Evidence

A common reason used to justify poorer energy and carbon standards is that increasing standards will impact viability and therefore reduce housing supply. Unfortunately we have not found any research in the public domain substantiating this point.

LETI's own research indicates that previous improvements in building regulations and/or planning policy have had no impact on housing supply.

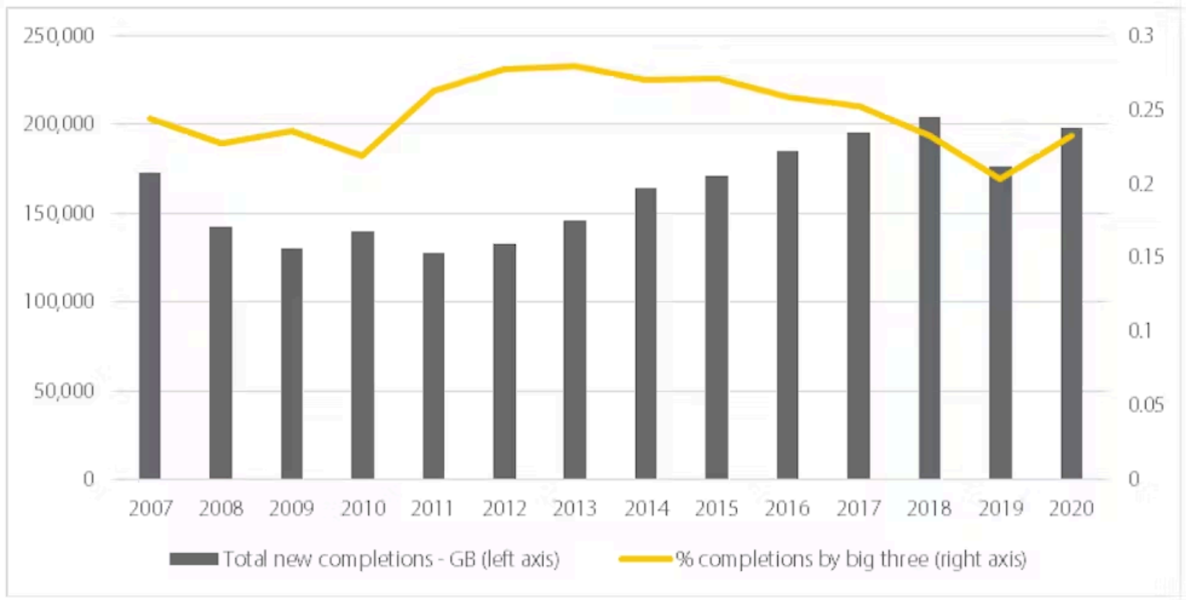
3.1 Previous Part L uplifts have never had a measurable impact on housing supply

The overall trend in housing delivery is ultimately determined by the trajectory of the economy rather than any changes in Part L of the building regulations.

Last year the CMA found that the profitability of the 11 largest housebuilders has been generally higher than expected in a 'well-functioning market', discounting the Global Financial Crisis and its immediate aftermath. Profits in the period from 2013 to 2019 were noted to be 'particularly high'.

The cost of delivering a home for the largest 3 housebuilders has consistently been falling over the last 10 years, from around 18-23% in 2013 to under 15% since 2020, despite significant economic events. Data from the largest 3 house builders also shows that completions have steadily been increasing since the Global Financial Crisis until Covid.

It is clear that previous increases in standards due to Part L revisions have had no measurable impact on the number of completions and ultimately the high profits of at least the major house builders.



Note: Total New Completions counted via ONS (England), Stats Wales and Scottish Government. Completions by big three counted using Annual Reports.

3.2 Local planning authorities have introduced net zero policies and demonstrated their viability

Many councils have sought to deliver on their commitment to declaring a climate emergency by going further than the current Part L 2021 Building Regulations. Since January 2023, three local authorities (Bath & North East Somerset, Cornwall and Central Lincolnshire) have begun implementing energy use intensity and space heating demand targets to deliver net zero standards. Crucially, these policies are supported by extensive evidence bases that demonstrate feasibility and viability, as shown in the table below.

Local authority	**Policy**	**Evidence**
Bath & North East Somerset	40 kWh/m²/year – Energy Use Intensity 30 kWh/m²/year – space heating demand On-site renewable energy generation to match Energy Use Intensity	Feasibility and costs: Climate Emergency DPD-Energy review and modelling-Rev J (cornwall.gov.uk) (Feb 2021) Technical Evidence base for policy section 1 - new housing (cornwall.gov.uk) (July 2021) Viability: https://beta.bathnes.gov.uk/sites/default/files/2021-08/B%26NES%20LPPU%20Viability%20Study.pdf
Cornwall	40 kWh/m²/year – Energy Use Intensity 30 kWh/m²/year – space heating demand On-site renewable energy generation to match Energy Use Intensity	Feasibility and costs: Climate Emergency DPD-Energy review and modelling-Rev J (cornwall.gov.uk) (Feb 2021) Technical Evidence base for policy section 1 - new housing (cornwall.gov.uk) (July 2021) Viability: https://www.cornwall.gov.uk/media/vtigrrk3/sd06-ce-dpd-viability-report-nov-2021.pdf
Central Lincolnshire	35 kWh/m²/year – Energy Use Intensity 15-20 kWh/m²/year – space heating demand On-site renewable energy generation to match Energy Use Intensity	Feasibility: https://www.n-kesteven.gov.uk/sites/default/files/2023-03/CLC006%20Task%20G%20-%20Feasibility.pdf Costs: https://www.n-kesteven.gov.uk/sites/default/files/2023-03/CLC007%20Task%20H%20-%20Cost%20Implications.pdf Viability: https://www.n-kesteven.gov.uk/sites/default/files/2023-03/INF002a%20Central%20Lincs%20Whole%20Plan%20Viability%202021.pdf

Their work on viability seems to be confirmed by the fact that the new policies have had no measurable impact on the number of applications.:

Cornwall council

- Quarterly average ***before*** policy implementation - 1,554 total applications received
- Quarter ***following*** policy implementation - 1,469 total applications received

Bath & North East Somerset (B&NES) Council

- Residential applications granted ***before*** policy implementation - 104
- Residential applications granted ***following*** policy implementation - 112

Central Lincolnshire

- 2021 major residential applications received (Jun-Dec) - 16
- 2022 major residential applications received (Jun-Dec) - 20
- 2023 major residential applications received (Jun-Dec), ***post policy adoption*** - 17

3.3 More energy efficient buildings are starting to reach a higher value

It should not be assumed that higher build costs necessarily translate into a negative impact on viability. Instead, any estimation of viability impact should take into account the ability of land values to absorb some of the cost, and, at the other end of the equation, the completed development sale value uplift that can be achieved by homes that are more energy efficient (not just 'lower carbon' relying on grid decarbonisation).

There is evidence that more energy efficient homes fetch higher prices::

- A 2021 study by Lloyds/Halifax found that "homes in all regions sold for a higher price as their energy performance – a measure which considers energy efficiency – improved". This study found that a home rated EPC A sold for 1.8% more than EPC B, which in turn sold for 2% more than a home rated EPC C.
- A 2016 study of 30,000 homes showed lower arrears (approx.1.7 months of arrears in EPC A, compared to approx 2.5 months of arrears in EPC band C), and reduced void periods (only 15.6 void days per year in EPC A, compared to approx 27.5 void days per year in EPC C). As well as generally improving income and cash flow, these reduce administration cost, and also for every 10-point SAP improvement the study found a reduction of £90 in the average cost per 'responsive repair'. These benefits will help bolster the long-term financial picture for excellent energy performance by developers that will own and operate the asset, and for buyers of build-to-rent.

Heat networks

1. Key messages

- **We are extremely concerned about the proposed 'sleeving' approach to heat networks which seem to be designed to enable the expansion of heat networks, even those fueled largely by fossil fuels.**
- **There is a considerable risk that heat networks will decarbonise at a much slower pace with this approach and that they will continue to use a significant proportion of fossil fuels in the foreseeable future.**
- **A central register of heat networks with independently assessed and reviewed carbon contents of heat should be the basis of assessment of heat networks in the FHS/FBS.**

2. Relevant consultation questions

Q9, Q53, Q54, Q55, Q56, Q57, Q58,

3. Evidence

3.1. The use of fossil fuels in heat networks is a significant issue.

For dwellings not connected to heat networks, the FHS and FBS represent a very positive way forward: the end of fossil fuel based heating systems.

Unfortunately, the very large majority of heat networks operating in the UK (10,766 of the 11,847 networks, i.e. 91%) use natural gas or oil as their primary fuel. In addition, the pipeline of expansions to existing networks continues the reliance on gas further into the future: over 45% of expansions have gas (for boilers or CHP) as their primary fuel.

Under the current FHS and FBS proposals, these heat networks using large proportions of fossil fuels will be able to supply new dwellings as long as they add small capacities of heat pumps to their energy mix. The proposals will encourage the expansion of heat networks rather than their decarbonisation.

If heat networks are to be encouraged:

- This must be on the basis of evidence.
- This must be based on justified and robust carbon accounting.
- There must be clear requirements and incentives for their decarbonisation, much beyond the current proposals. The current proposals are far from encouraging decarbonisation of existing networks, and they allow the continuing development of high-carbon networks, which will by 2050 require additional expenditure and efforts to decarbonise.

3.2. We are very concerned about sleeving and the assessment of ‘spare capacity’: this could result in misleading calculations of the carbon content of heat for fossil fuel dominated heat networks

Proposals for sleeving do not sufficiently encourage the decarbonisation of existing networks: they only address, potentially, the installation of low carbon plants to serve new connections, not the existing fossil fuel plant. And in addition, the proposed sleeving methodology may well in fact result in some existing networks increasing their average carbon content of heat.

Some of our concerns on the proposed sleeving methodology include:

- There is no guarantee that a capacity of low carbon heat generation will generate a certain amount of heat; a 1 MW heat pump may generate as much 8,000MWhs or only 1,000 MWh.
- The contribution of low carbon heat sources is likely to be limited by the heat capacity of the system they are serving and the commercial benefit of running high carbon heat sources which generate an income (e.g. gas CHP).
- Any low carbon heat added to an existing heat network will incur the losses of existing networks, which are very high. Unfortunately there is very little transparency of heat networks on their level of losses.
- The sleeving process will also lengthen the time that gas CHP and gas boiler heat networks will continue to operate, indirectly encouraging them to continue, rather than addressing their existing plant issues

The current proposals, through artificial factors and accounting methods, create a real risk of misleading assessments against alternatives, and significantly under-estimating and misrepresenting the operational carbon impacts of heat networks.

3.3. A central register of heat networks with independently assessed and reviewed carbon contents of heat should be the basis of assessment of heat networks in the FHS/FBS

It is crucial that a comprehensive public register of networks be created, maintained, and regularly audited by an organisation independent from heat networks interests. It should:

- Be publicly available.
- Be maintained and regularly audited.
- Include access to data from previous years, to allow tracking of progress.

- Be the single source of information for any policy relying on operational energy and performance of networks, in order to provide full transparency and avoid loopholes and double accounting i.e. not just for FHS / FBS calculations, but also planning applications, EPC calculations, and other relevant policies and financial incentives. It should also be used for reporting linked to heat metering regulations, to reduce the reporting burden and improve consistency of information across data sources.
- Include information currently included in the heat metering register, but with additional data on individual networks, and including energy use per fuel, allowing analysis of primary and secondary losses, and carbon content of heat. Details of the amount and source of "sleeved" heat should be declared.

This is unfortunately far from being provided by the current PCDB, which is largely empty.

3.4. LETI does not understand the apparent bias towards heat networks

The consultation states, as one reason for encouraging heat networks, that they can run heat pumps at high SCOPs, for example through ambient loops or by making use of waste heat sources. However, the notional network SCOP (i.e. 3) currently proposed is lower than that in the notional dwelling with on-site plant. For the potential benefits of heat networks to be realised, then the notional building should reflect their potential, and drive performance through a better notional network SCOP.

It is also explained that heat networks can be highly efficient because they can be linked to thermal stores allowing heat to be produced at low carbon/cost times. This is true of any heat pump system, including individual systems in homes where a hot water tank is standard. Because of the diversity on a heat network, they actually have smaller thermal stores overall than the aggregate of individual systems. This suggests a bias towards heat networks in the consultation that should be addressed.

The evidence is that heat networks typically have losses of around 50% of the heat generated and are therefore very inefficient.It is not clear how the losses in the notional network have been set; CP1 recommends 10% as best practice primary losses, so why is the notional network proposed to be worse than this (i.e. 12%)?

The fact that no heat network is currently registered in the PCDB, but instead that all networks choose to be assessed using the default assumptions, clearly illustrates how advantageous default values are likely to be.

In summary, the benefits of heat networks have to significantly outweigh their disadvantages to be favoured against other systems. LETI is not aware of any Government document which can be considered as a robust evidence base on heat networks and their role towards Net Zero in 2050. In particular, LETI would like to see the evidence base for encouraging heat networks and aiming for them to provide around 18% of heat by 2050, a very significant increase compared to the current 2%. Our understanding is that this 18% figure relates to the 2015 report for the CCC (Research on district heating and local approaches to heat decarbonisation, Element Energy,
https://www.theccc.org.uk/publication/element-energy-for-ccc-research-on-district-heating-and-local-approac

hes-to-heat-decarbonisation/); however, the aim of this 2015 report was to evaluate the effect of various policy interventions on the deployment of heat networks. It was not an assessment of whether these levels of deployment would be the lowest cost and /or lower carbon solution, against non-network alternatives.

In the absence of satisfactory evidence that there should be a bias in their favour, we propose that there should be no bias in favour of the expansion of heat networks. If they are beneficial when compared fairly to alternatives despite their higher losses, new low carbon heat networks with heat pumps can and will be built, with heat pumps.