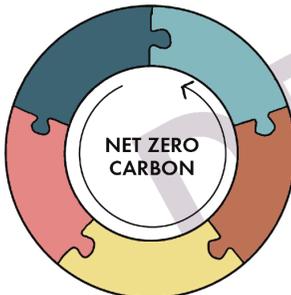


# Net Zero Carbon 1-pager | Survey results

**FIVE KEY COMPONENTS OF**  
**Net-Zero Carbon Buildings**

The proposed key requirements for a new building to qualify as 'Net-Zero Carbon' in operation are summarised below. Each requirement should be independently verified post-construction.

We recognise that new buildings in operation represent only one pathway to net-zero, in addition to whole-life carbon (including emissions from construction) and existing building retrofits. These alternative pathways will be considered separately.



**LOW ENERGY USE**

1. Annual Energy Use Intensity (EUI) should be less than 35 kWh/m<sup>2</sup>/yr for residential, 55 kWh/m<sup>2</sup>/yr for schools and 72 kWh/m<sup>2</sup>/yr for commercial office buildings.
2. Space heating demand should be less than 15 kWh/m<sup>2</sup>/yr for all building types.

**EMBODIED CARBON DISCLOSURE**

3. Whole life carbon assessment should be carried out to inform understanding of building impact.

**LOW CARBON ENERGY SUPPLY**

4. Combustion on site is prohibited.
5. Report carbon content of heating used on site (gCO<sub>2</sub>/kWh).
6. On-site renewable energy is incorporated to satisfy the zero carbon balance.
7. Report building annual peak energy demand.
8. Incorporate metering and controls to facilitate smart grid development.

**MEASUREMENT AND VERIFICATION**

9. Annual energy use and renewable energy generation must be independently verified in-use.

**ZERO CARBON BALANCE**

10. Demonstrate a net zero carbon balance on an annual basis.
11. Any energy consumption not met by onsite renewable energy should be met by investment into additional renewable energy capacity off-site OR a minimum 15 year renewable energy power purchase agreement.

**LONDON ENERGY TRANSFORMATION INITIATIVE**

**UK GBC**

15<sup>th</sup> November 2019



Number of responses:

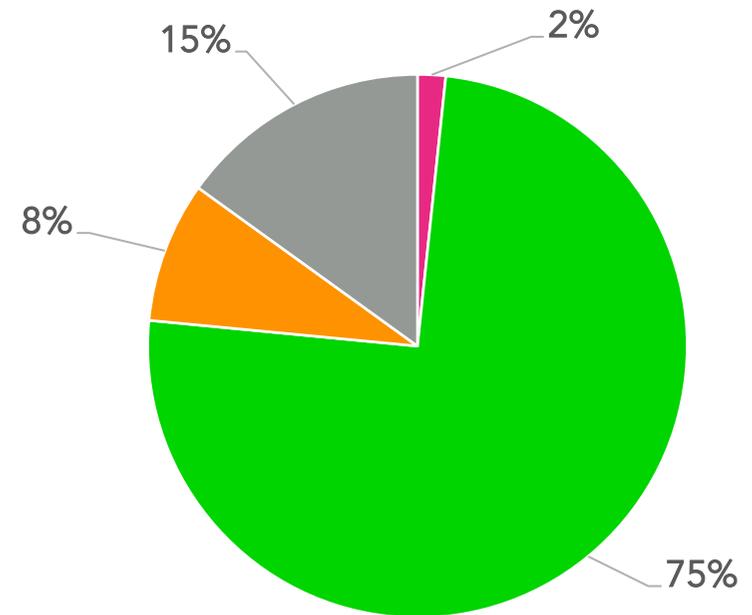
**331 !!**

# Survey Results

# Overall Comment

Do you think that it is a good idea to prepare this one-pager to summarise the key requirements for a new building to qualify as 'Net Zero Carbon buildings in operation'?

- No, it is premature, we do not know enough.
- Yes, and I generally agree with the 1-pager as it is.
- Yes, but I do not think the 1-pager is there at all.
- Other (please specify)



## ***Proposed action***

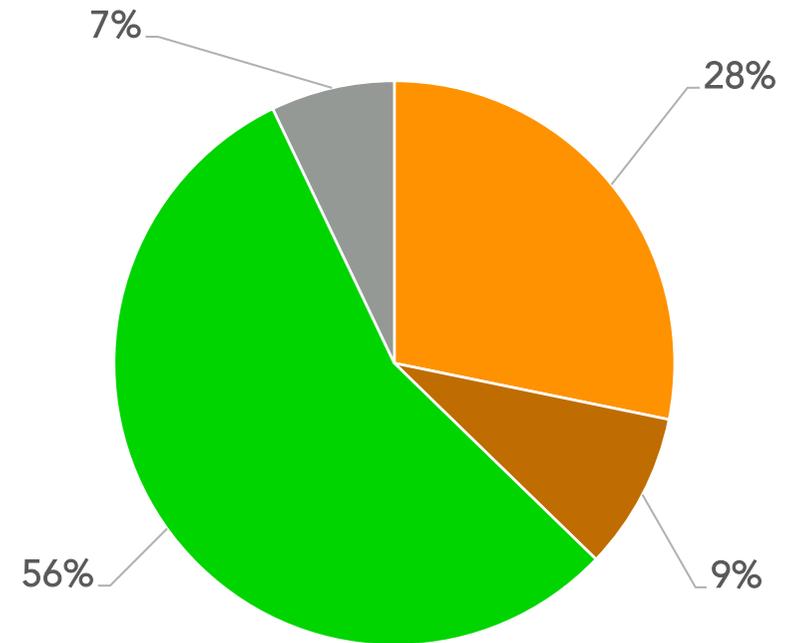
- > The document seems to have been received positively. We need to continue to improve it.

# Low Energy Use

## Setting the kWh/m<sup>2</sup> requirement

LETI and the UKGBC are clear that an absolute energy target is required for a zero carbon building. 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?

- the result of a bottom up approach based on industry best practice ( e.g. Passivhaus).
- the result of a top down approach based on the amount of renewable energy that the UK can produce to power buildings (i.e. a school could only use X kWh/m<sup>2</sup>/year in 2050 as there will only be Y kWh of renewable energy available).
- Based on a mixture of the two.
- Other (please specify)



### **Proposed action**

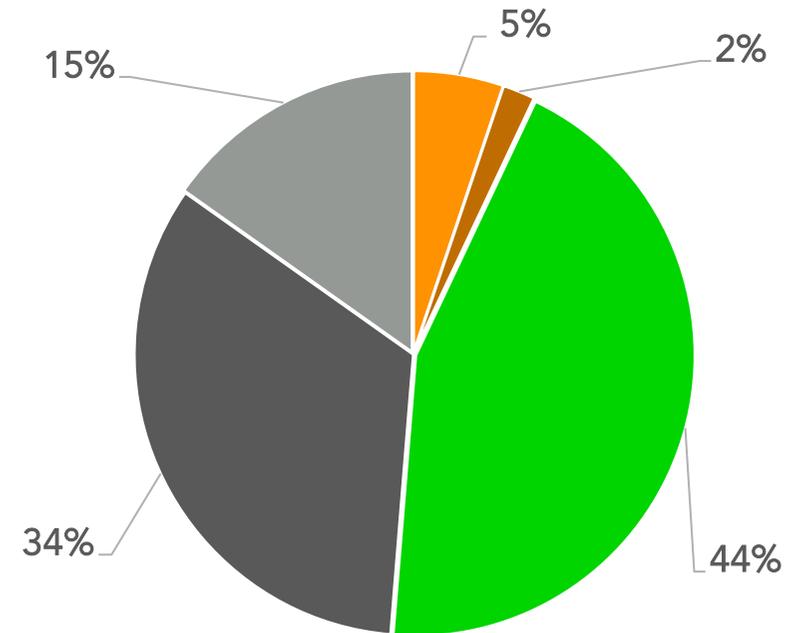
- > Both a bottom-up and a top-down approach should be used to set the kWh/m<sup>2</sup> targets.

# Low Energy Use

## Residential

We are proposing an energy use intensity requirement of 35 kWh/m<sup>2</sup> for Net Zero Carbon residential buildings (excluding PVs). Do you think it seems:

- Too high (explain why and what should be the target)
- Too low (explain why and what should be the target)
- Appropriate
- I don't know
- Other (please specify)



### **Proposed action**

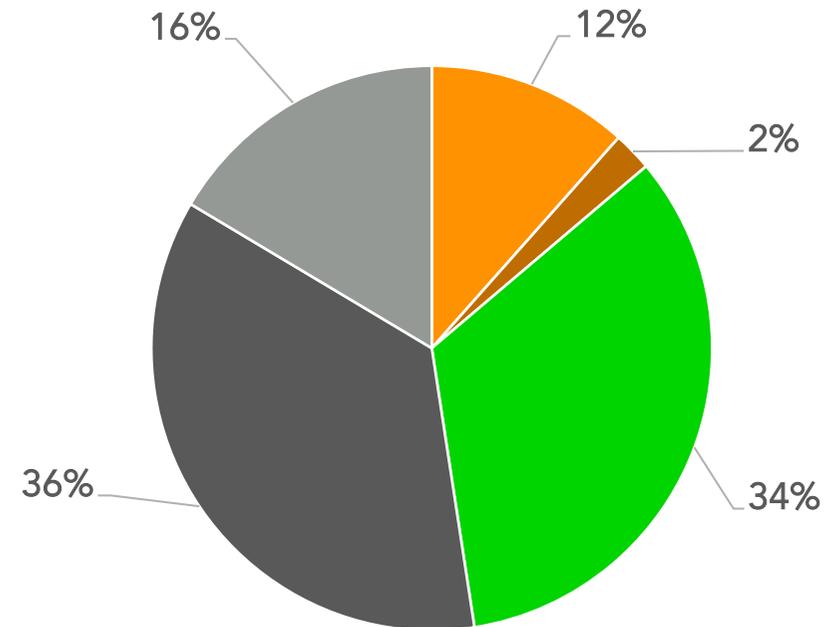
- > We will not change this requirement for version 1.0 of the 1-pager.

# Low Energy Use

## Non-domestic (Offices)

We are proposing an energy use intensity requirement of 72 kWh/m<sup>2</sup> for Net Zero Carbon office buildings (excluding PVs). Do you think it seems:

- Too high (explain why and what should be the target)
- Too low (explain why and what should be the target)
- **Appropriate**
- I don't know
- Other (please specify)



### **Proposed action**

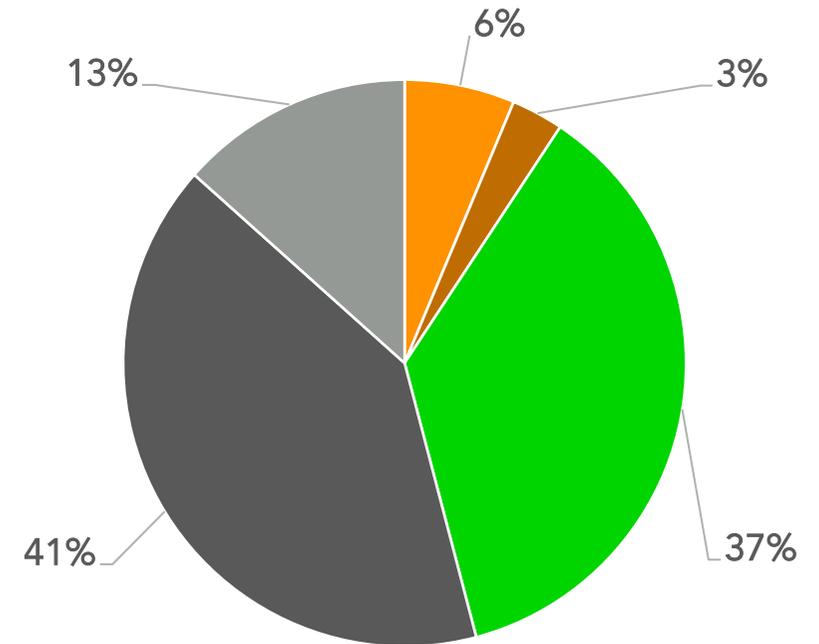
- > We should review this requirement for version 1.0 of the 1-pager with CIBSE, RIBA and others.

# Low Energy Use

## Non-domestic (Schools)

We are proposing an energy use intensity requirement of 55 kWh/m<sup>2</sup> for Net Zero Carbon schools and other non-domestic buildings (excluding PVs). Do you think it seems:

- Too high (explain why and what should be the target)
- Too low (explain why and what should be the target)
- **Appropriate**
- I don't know
- Other (please specify)



### **Proposed action**

- > We should review this requirement for version 1.0 of the 1-pager with CIBSE, RIBA and others.

# Low Energy Use / just a sample – please refer to the ‘comments section’ to see all comments

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## **Setting the kWh/m<sup>2</sup> requirement.**

*“Maximum carbon emissions value should be set for different types based on different latest technologies available in the market to motivate developers to use more unconventional technologies. For instance, study should be carried out how much carbon emission be reduced if we replace gas boiler with heat pumps or heat pumps with ground source heat pumps etc.”*

## **Residential / non-domestic (offices) / (schools)**

*“I’m not a residential expert - but the key question is where does this figure come from? Is it credible? (the one-pager does not explain)”*

## **Non-domestic (office)**

*“RIBA 2030 Climate Challenge sets a 2030 target of 55 for non-domestic buildings. Where appropriate, can/should we ensure consistency between guidance.”*

## **Non-domestic (schools)**

*“Does it cover both regulated and unregulated energy? Or is it just regulated? Are there recommendations/suggestions of how to meet this standard (U-values, % glazing, equipment efficiencies etc.)”*

## **Any other questions**

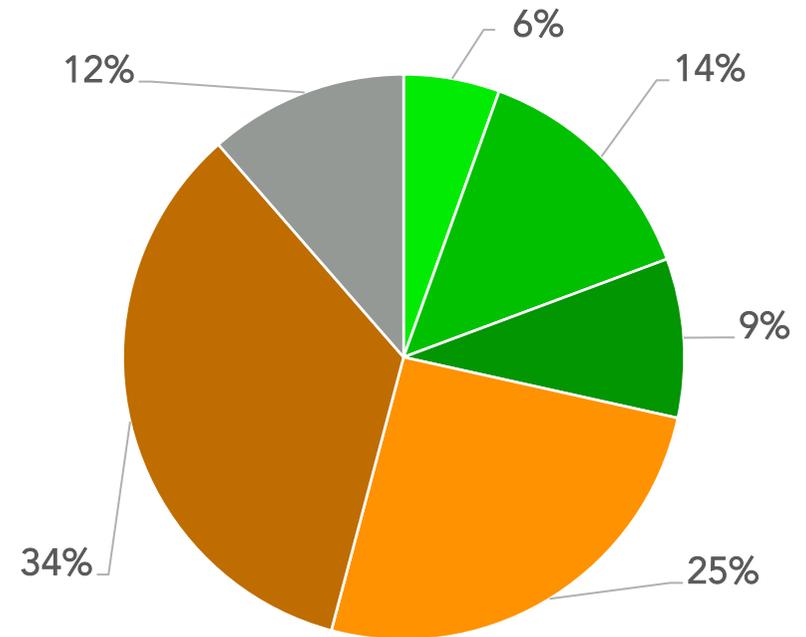
*“ Ideally there would be more building types specified, in terms of non-domestic buildings offices and schools represent relatively lower energy building types. Hotels, student accomm and leisure centres ideally would also be included, these tend to have high energy use per floor area when compared to resi’ or other non-domestic buildings.”*

# Embodied Carbon

## *Embodied carbon*

This one pager focuses on zero carbon operational emissions but mentions the need to disclose and report embodied carbon and whole life carbon. Among the following statements, please select the one you agree with the most:

- This paper should focus on operational emissions only - take out the embodied carbon disclosure section.
- The embodied carbon disclosure is adequate, but should be moved to the end of the list as this paper focuses on operational energy.
- The embodied carbon disclosure is adequate and in the right place.
- The embodied carbon disclosure section should also state that embodied carbon should be reduced.
- For a building to be deemed a 'Net zero carbon building in operation' I think that as well as carrying out a Whole life carbon assessment, module A should be verified post completion with as built data.
- Other (please specify)



### **Proposed action**

- > The embodied carbon disclosure will be adjusted to state that it should be reduced and verified post-construction.

# Embodied Carbon / just a sample – please refer to the ‘comments section’ to see all comments

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*“Embodied carbon is not given enough significance. It is essential to minimise embodied carbon, not just report it. The design team has a massive obligation to not waste material just because they can, as a risk mitigation strategy. The carbon associated with materials is very significant. I would change this on the poster.”*

*“I agree with both statements on the right and we need to include specific targets/benchmarks. The RICS PS needs to include default figures in the matrix they provide. At present it highlights in purple boxes that need to be filled "as a minimum". There is nothing to incentivise doing more than the minimum so if you have particularly high defaults it would be in the interest of the LCA consultant to provide more data to improve over the default.”*

*“'Embodied carbon' could be first item, with 'measurement and verification' last to represent the sequence of project construction/operation.”*

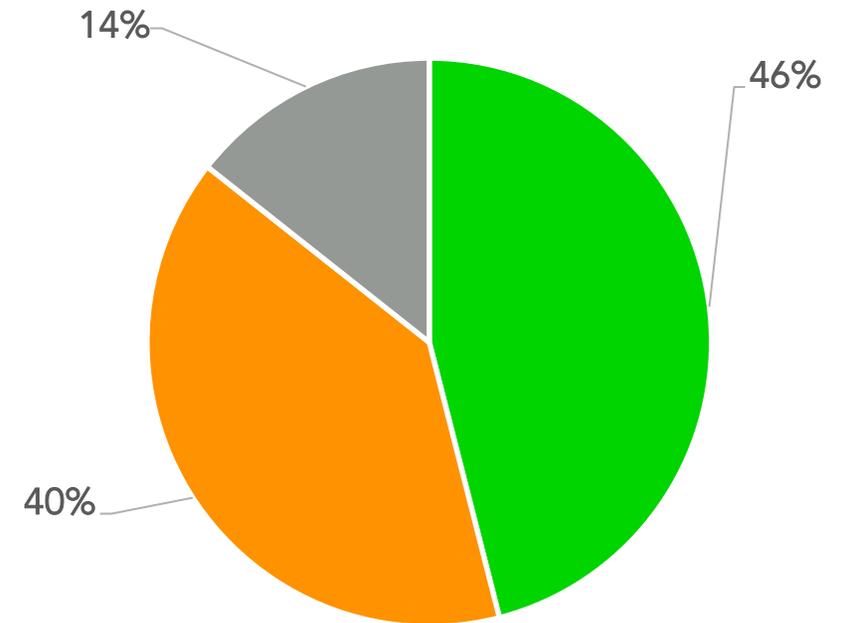
*“This is crucial going forward. Providing embodied carbon data for new build is relatively easy during the costing stage. As we get smarter with this information we can begin to reduce embodied carbon of materials through improved local manufacture of materials and products. Whilst in-use carbon is typically a far higher value over a lifetime, we must reduce all carbon emissions and maximise value of embodied, while protecting and creating local jobs, where possible.”*

# Low Carbon Energy Supply

## *District heating*

We are not explicitly referring to District heating/energy sharing. Please select the statement below that you most agree with:

- I agree with the simple messaging.
- Need explicit reference to energy sharing, waste heat and heat networks.
- Other (please specify)



### ***Proposed action***

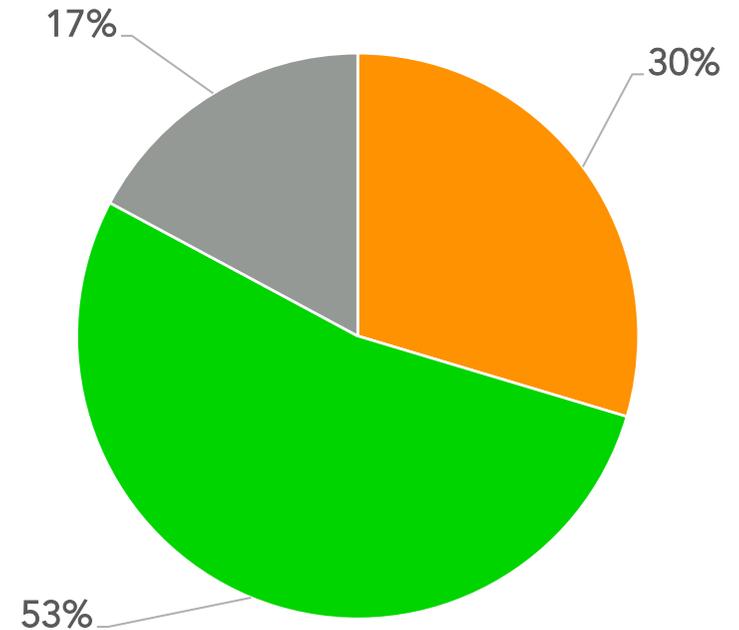
- > We will not change the simple message as there is no strong support for being more explicit about district heating than other systems.

# Low Carbon Energy Supply

## *Demand response*

Do you think we need demand response and energy storage as part of the narrative, as some say this is key to Net Zero?

- It should be a separate point and should set clear quantitative targets.
- It should be mentioned in the 'Low Carbon Energy Supply' section as a 4th point, but in a more qualitative way.
- Other (please specify)



### ***Proposed action***

- > Demand response and energy storage inclusion will remain; with a more qualitative description added.

# Low Carbon Energy Supply / just a sample – please refer to the ‘comments section’ to see all comments

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## **District heating**

*“Absolutely agree with not referring to DH. A clear focus on the heat source (e.g. non-combustion) is far more important than the heat distribution system. Blanket support for DH makes no sense at all as in many cases it is more expensive and less efficient than distributed heating systems (e.g. ASHP on each building).”*

## **District Heating**

*“DH can also involve off-site combustion. I was unclear what degree of combustion LETI think is acceptable e.g. combustion near site? Does no combustion 'on site' mean no combustion in the dwelling/non-residential unit but a communal heat source within the same building is acceptable? I would expect choice of heating to be set through the planning system.”*

## **Demand Response**

*“Demand response yes. Although, energy storage unlikely to be successful in many school / commercial projects. Due to large onsite loads in comparison to energy generation potential, therefore little excess energy for storage; and cost. Batteries currently cost £450-1100 / MWh of storage for large installations. This money could be better spent on further onsite renewables or better control / demand response systems. Batteries do have a place where there is excess generation but there is unlikely to be common for many projects in the UK.”*

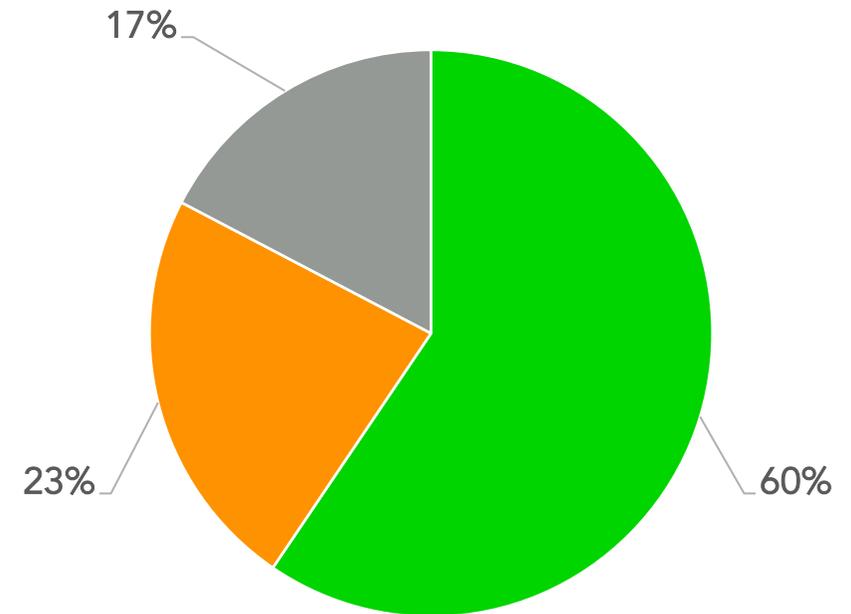
## **Any other questions**

*“The line ‘On-site renewable energy is incorporated to satisfy the zero carbon balance’ could suggest that on-site renewables must offset all energy use to meet zero carbon. This is rarely going to be possible, so this should actually convey the point renewable use on site is to be maximised. This could, for example, be a ratio requirement between site footprint and generation capacity.”*

# Zero Carbon Balance

Should the title of this section be Zero Carbon balance or Zero energy balance?

- We are talking about zero carbon buildings, so it makes sense to call this section zero carbon balance.
- Zero carbon is about energy balance - kWh used and kWh generated renewably - therefore this section should be called energy balance.
- Other (please specify)



**Proposed action**

> The title will remain "Zero carbon balance".

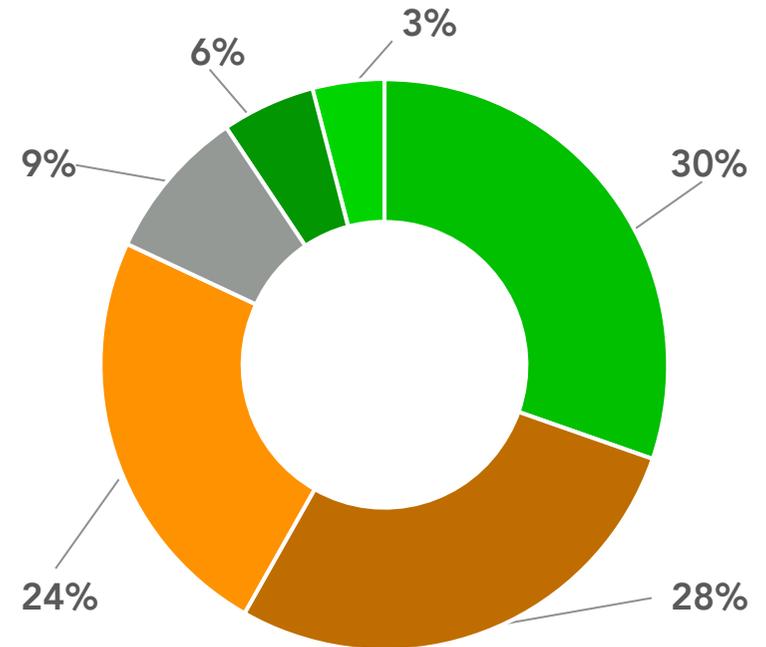
# Zero Carbon Balance

## Grid losses

Should the annual balance cover storage losses in the grid?

i.e. should we add another sentence in zero carbon balance such as: *the additional renewable energy generated must account for storage and transmission losses in the grid?*

- No – It is obvious to me that this is what it means anyway.
- No – we do not know enough how much these losses represent.
- No – It is better to keep the messaging simpler.
- Yes – but only if we are able to use an accepted industry figure (e.g. X%).
- Yes – It is very important that grid storage losses are included in zero carbon, otherwise we are not capturing everything, this must be made explicit.
- Other (please specify)



### **Proposed action**

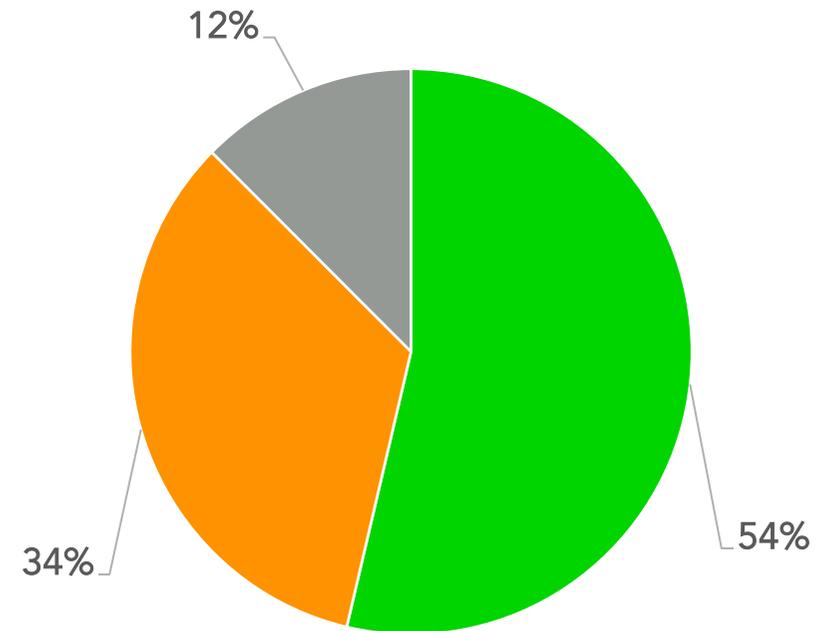
> As opinions are split, it is proposed to reference to grid losses, but only when there will be an accepted industry figure for them.

# Zero Carbon Balance

## Renewable energy supply

Please select the statement that you agree with the most:

- A building is only zero carbon in operation if it meets the kWh/m<sup>2</sup> target, is fossil fuel free and either generates all its annual energy use on site, or directly invests in offsite renewables or has a long term 100% renewable energy Power Purchasing Agreement (PPA) in place (e.g. > 15 years).
- A building is only zero carbon in operation if it meets the kWh/m<sup>2</sup> target, is fossil fuel free and either generates all its annual energy use on site, or directly invests in offsite renewables or has a long term 100% renewable energy Power Purchasing Agreement (PPA) in place (e.g. > 15 years) or purchases energy using a green tariff.
- Other (please specify)



### Proposed action

- > There is a clear majority in favour of not including a green tariff as an option, therefore the message will stay the same.

# Zero Carbon Balance / just a sample – please refer to the ‘comments section’ to see all comments

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## Grid losses

*“No - this is about the BUILDING being net zero, not about it compensating for wider problems, however real they are. This could be a recommendation for being 'above-and-beyond' net zero.”*

*“First or last option. Keep it simple or include it if we have an agreed industry figure”*

*“yes, but this needs to be an industry accepted standard figure and needs to be variable as improvements in storage efficiency are realised.”*

## Renewable energy supply

*“The above is far too bureaucratic and simplistic. What is needed is less regulation and encouragement of new energy sources thereby increasing small and large scale competition. The last thing that is needed is the type of regulation that creates moats around large scale suppliers. In fact the larger the supplier the greater the rate of corporation tax should apply.”*

*“Do not agree with buying green tariff - did that for 10 years before concluding it was double accounting.”*

## Any other comments

*“When off-setting or buying green energy, it is important to make sure it is an investment that will increase the amount of renewable energy in the grid, rather than just re-distributing it from one point to another.”*

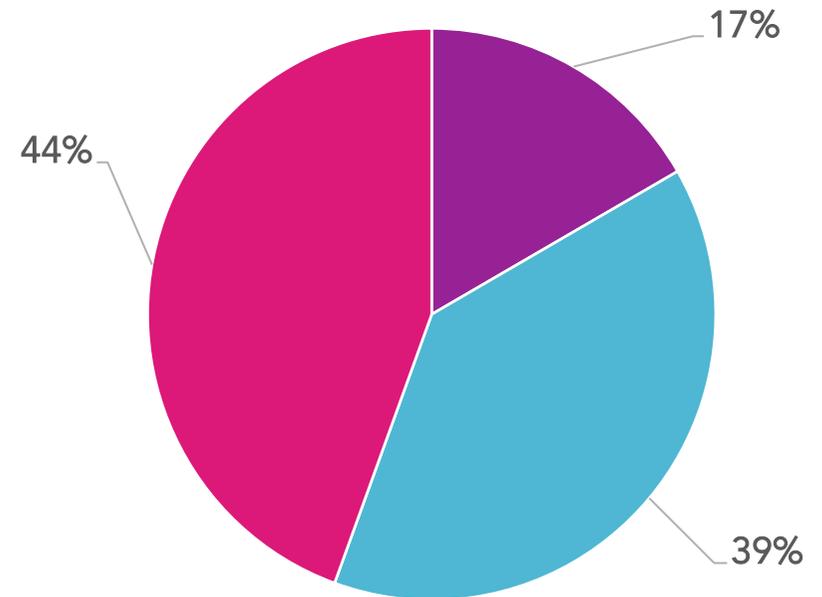
*“including grid losses here generates another level of complexity. Since building owners have no control over grid losses, I think this should be the responsibility of the network operators to find solution to.”*

# Measurement and Verification

## *Themes of discussion*

there was an open question for measurement and verification to  
The following three main themes were present in the responses gathered from this question:

- Clarification on methodical approach
- Data gathering / usage
- Cost



### ***Proposed action***

- > The Measurement and Verification section will be moved to the end to signal it is post-construction.

# Measurement and Verification / just a sample – please refer to the ‘comments section’ to see all comments

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*“Who will independently assess this? How will it be enforced? Where will information go? Who will pay?”*

*“‘Annual energy use and renewable energy generation must be independently verified in-use’. What about embodied carbon, retrofits, maintenance, green tariffs and offsetting. Details of all need to be publicly disclosed?”*

*“A set period of M/V should be carried for the building to ensure that the building is performing as required. Otherwise, the performance gap will be difficult to control. A net zero building can be defined as the one that maintains the net zero during its operation therefore M/V is important”*

*“ This is critical and should be mandatory”*

*“A much bigger deal should be made about this - there is currently a massive performance gap that is not being addressed and independent verification is the only way to achieve this. I would also recommend a second bullet point that says energy use and performance data must be made publicly available”*

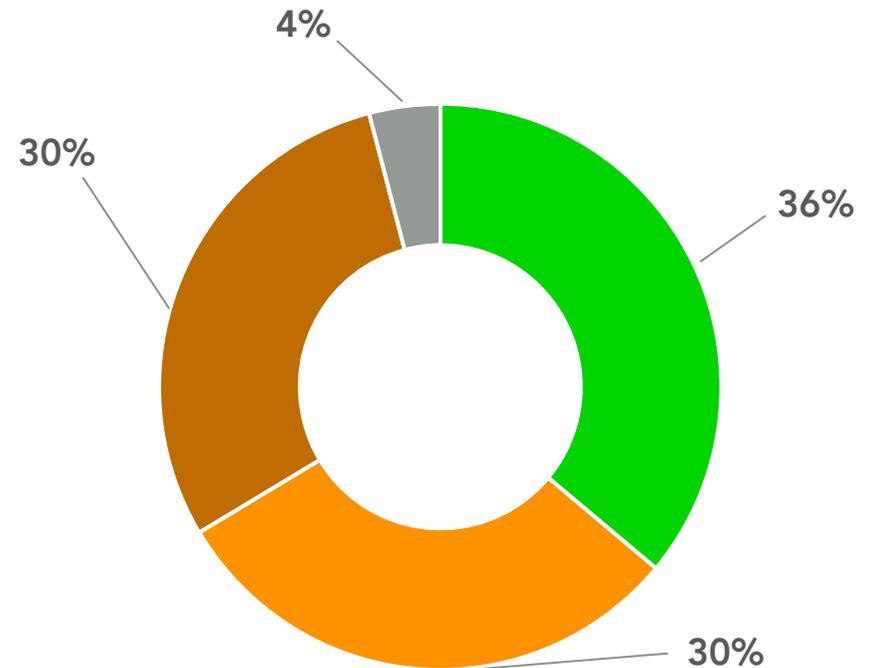
*“Are we proposing independent verification as intermediate step to legislation? Also, the introduction to the one-pager already requests all elements are independently verified, are we adding anything here. Maybe the section could be beefed up by including reporting requirements, allowing for energy supply section to be ordered a bit more?”*

# Cooling and Overheating

## Cooling and overheating

We are trying to keep the message clear and simple - with just 5 sections. However do we need to mention cooling or overheating as part of the narrative?

- Yes it should be a separate point and should set clear quantitative targets to be met e.g. compliance with CIBSE TM52/TM59.
- Yes it should be mentioned in the 'Low carbon energy supply' section as an additional point, but just in a more qualitative way, e.g. overheating should be reduced through passive design, such as appropriate glazing, external shading etc.
- Cooling and overheating should not be mentioned: it overcomplicates the message and cooling is captured in the maximum energy use intensity (EUI) target anyway.
- Other (please specify)



### **Proposed action**

- > Cooling and overheating will be mentioned in the 1-pager in reference to adaptation to climate change.

# Final Comments / just a sample – please refer to the 'comments section' to see all comments

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*"Overall survey comes across very technical. most of my architect colleagues wouldn't have much of a clue how to answer. the challenge to communicate to the masses is very high."*

*"It's surprising there's no mention of CEN / BS standards e.g. BS EN 15978 "Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method". This could go in the section on measurement and verification. There's also some debate in CEN at the moment on how to report energy exported to the grid (e.g. which Module in relevant standards)."*

*"I like your ambition with this and support your intentions."*

*"Good work, Gets the grey matter whirring."*

*"I am appalled at the lack of common sense in this document."*

*"Great work, LETI team!"*

Detailed comments

Overall comments

# Comments on Question 3 (Overall comment)

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*Whatever system is devised it is got to be kept simple and concise and carefully thought through to ensure it is deliverable and produces meaningful and realistic results both now and in future.*

*New Build: Every tenant/owner will all be different so how can you calculate net zero for all these differing users. It is impossible.*

*Any renewables should be limited to on-site to ensure they are easily quantifiable/measured. Off-site will be far too difficult to manage, measure, record, audit, allocate and could easily be accounted for more than once.*

*All buildings are different and have differing building overlooking them. Therefore you need a system that is generic. This is why energy in use is so unfair and unrelatable to other dwellings of the exactly the same type. The current SAP/ISBEM is the right way to do it to measure a building alone. Then you can have a in-use measurement/metric to trap poor users.*

*Reality is far more complicated than the one-pager suggests and it would not be efficient/meaningful in practice due to too many environmental variables.*

*I think the 1 pager is useful but do not know if it addresses energy supply up or down stream satisfactorily. It potentially suggests you can "buy" a green footprint for energy by investing elsewhere. How will these investments be verified*

*I think the one pager is good but we need more technical, practical information.*

*Yes, and I mostly agree with the paper but think we should not ignore - previous Code for Sustainable Homes factors: Water. Materials. Surface water run-off. Waste. Pollution. Health and wellbeing. Management. Ecology. - User friendly heating/ energy controls - Along with embodied carbon, more detail on the environmental impact, potential impacts and fore toxicity of materials used (without meaning to be alarmist or deter from plans, I would be keen to see closer collaborations with researchers such as Professor Stec/ material scientists and chemists).*

*Yes, it is good, but I do not know enough to know if it is has the right level of information or the targets are appropriate*

*Yes, I think the one-pager is a good idea. I appreciate the aim is to keep it brief but think it could benefit from a sentence or two explaining how these EUI figures have been arrived at (modelling, comparison of benchmarks of nearly zero buildings etc.)*

*I think it's very good in terms of outlining what people need to do to become net-zero, but you need to follow this up with detailed guidance on how they can achieve all of the requirements listed.*

*Yes and its mostly there. However maybe there should be a section on building waste, recycling, goods in/out and water usage that are required, used and given out as waste from a building. (unless this is all considered within embodied carbon/ Life cycle assessment)*

*I am struggling with this separation of operational and embodied to be honest. Specify on-site renewables but the embodied carbon budget on these is often huge. Should we be offsetting the embodied carbon from renewables? Is it radical enough?*

*Yes it is a good idea, however it could be more ambitious - e.g. we should start measuring in  $\text{kgCO}_2$  and not kWh - and the requirements need to become stricter every 5 years.*

*I think the 1-pager is good, however I'm not sure if the metrics are too prescriptive. If you can deliver sufficient renewables on-site to offset all your load, but you average is higher than the kWh/m<sup>2</sup> rates set, does that mean you're not zero carbon? I think the metrics are great for assisting the uneducated, but there should still be some room for nuisance with more experienced designers*

*Whilst a design standard is probably needed we need to make this clear that it is a design assessment. We need to remove terms such as "net zero carbon in operation". We need to move the industry away from design into operational performance. The only way to know if a building is net zero in operation is by M&V. Also any numbers must be demonstrated by NABERS type energy assessment not simplistic Part I compliance modelling.*

# Comments on Question 3 (Overall comment)

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*I don't know enough about the technical aspects to agree or disagree.*

*I think with regard to embodied carbon (I am a structural engineer) more requirements need to be given in terms of setting maximum limits.*

*I think the one pager is useful, but perhaps can give links to more detailed information on each of the requirements.*

*There should be targets for embodied carbon.*

*I think it will be very difficult to summarise everything into a single pager. This is a very complicated subject with many issues and considerations affecting the performance of a building. For example, the one-pager simply refers to embodied carbon but does not explain where End-of-Life impacts (which could be significantly high for some types of products) count: Is it part of embodied or operational or not accounted for at all?! British Precast feels that Net Zero carbon needs to be assessed on a Whole-Life basis in accordance with BS EN 15978. PAS 2080 (for infrastructure) calls for a similar approach (Whole life) and EN 15804 warns that all life cycle modules need to be accounted for when comparisons between options are carried out. It is important that a summary document (whether 1 or 2 pagers) explain this.*

*If whole life carbon is to be considered separately, having embodied carbon disclosure as one of the five elements could be a little confusing.*

*No, it is too simplistic: Net zero carbon must be assessed on a whole-life basis in accordance with BS EN 15978:2011 'Sustainability of construction works. Assessment of environmental performance of buildings - calculation method'. This provides a common, robust standard that takes account of both operational and embodied emissions across the complete building lifecycle. It also aligns with the broad principals of a Circular Economy. Operational and embodied carbon must be considered in tandem during the design process as a failure to do so can lead to unintended outcomes and sub-standard buildings. We believe whole-life assessment represents the only credible way forward in meeting the net zero carbon challenge. This is a view we have shared with the UKGBC, who have told us that next year they are likely to develop a whole-life carbon approach for their framework.*

*The intention is right but my primary concern is that the term renewable is not defined. A heat pump using grid electricity during peak demand is not renewable or zero carbon - there are still carbon sources used to generate power. If we are talking about true zero carbon this is a critical point to address. I also do not agree that on combustion should be prohibited. The grid is simply not ready to supply all energy demands, there is no doubt that on site combustion, albeit via heat networks in a dedicated plant room, is still required. If you push everything on to the grid, in the short term this will simply come from the coal and gas CCGT plants as the peak demand increases and our actual grid carbon factor will not stay on its current downward trajectory. My concern is whether it is possible to address this on one pager... but I still support the intention as I think it is needed.*

*I think the document is good and appears to lead the conversation on what represents "net zero" and should hopefully engage those producing legislation when the time comes. However the document could be clearer in defining whether the requirements refer to all energy used by a building or just those to maintain the environment within.*

*Low energy use can be improved further, especially the heating part. It talks in terms of kWh/m<sup>2</sup>/yr only. While in UK the most commonly used heating source is gas boilers due to its low cost. If someone is using gas boiler (which emits more carbon dioxide emissions), how the heating energy use be compared. Though if gas boiler is replaced with energy efficient heat pump, the operating cost might come down nearly close to gas boiler with much lesser Carbon dioxide emissions. It is better to compare performance in terms of kgCO<sub>2</sub>/m<sup>2</sup> area of the building.*

*There needs to be a disclaimer as to which buildings are excluded from this framework. Hospitals, data centers, industrial buildings (factories), and others may stray from the energy use targets, or may require backup generation. Otherwise I think it is good.*

*It's going to be confusing to distinguish between 'in operation' and net zero carbon. Why are we not requiring embodied impacts to be accounted for and offset. What does this mean for building in 30 years' time? We can still use as much carbon as we want? Net Zero means Net Zero.*

# Comments on Question 3 (Overall comment)

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*I think it's pretty much there. What's unclear is how many industry professionals are out there that are confident enough to do a WLC (Point 3). This is particularly pertinent because we are doing this post completion. It's too late to do anything about it by then, if it is deemed to be particularly high. It needs to provide a target in the same way that Point 1 does...*

*It's succinct, but the logo is quite large and doesn't help explain things - by the fact that the five colours are the same size, does that mean that all points are given exactly equal weighting? Is the idea that all five areas must be covered? I reckon the dark blue is probably the most important aspect to achieving net zero, so this should be weighted as such. Points 9 and 10 seem quite similar. Another issue is that it's a mix of pre-, during and post-construction items, rather than focusing on net zero "in operation", which I'd assume is post-construction. Low Energy Use would be pre-con, and "Combustion on site" would be during con. Measurement and Balance are the "in operation" points. Also, there's a typo: "seperately"*

*It's a good high level guide. For embodied carbon, would recommend stating that this should be quantified and reviewed at all stages of a building's design, as well as ops and demo too. Furthermore, all buildings to be demolished should be appraised for the most optimal process for keeping reuse of elements as high as possible, as well as limiting the waste produced as much as possible.*

*Yes, this is great idea. However rather than "Net Zero Carbon buildings in operation" we should promote "Whole-life-Net Zero Carbon buildings". As far as I know this could be quite confusing. E.g. average lifespan for office buildings is 40, for domestic 50 even if they are designed to operate 50-60. I am happy to assist in this work if needed. Regarding Embodied Carbon Disclosure - Whole-life-carbon - Indeed. This is a key point.*

*Yes, but I think the one-pager needs some additional commentary (somewhere between options 2 and 3 above).*

*All that is required is a definition of what net zero energy is. Attempting to go further than this could be constricting to other means or routes to net zero carbon.*

*Yes, think the 1 pager is a great way to introduce the principles but should have direct links from each of the statements to guidance or further information.*

*I generally agree, but my perspective is from California; thus may be different from UK.*

*Yes but I think you are mixing up Net Zero carbon definition which needs to be as simple as possible with other good practice things which whilst undeniable have nothing to do with Net Zero carbon in operation.*

*Yes and the 1 pager needs more development. Currently it focuses on scope 1 emissions, I would include scope 2 & 3 so that clients and future users understand better the carbon issue and their responsibility. It does not lie solely with the design team, particularly in the operation phase and can account for up to 80% of the overall emissions*

*These numbers in their own right do not give enough information. Is this total energy usage, is it the same number for a school with a pool as one that doesn't, what about primary schools, how is it measured?*

*New buildings should complement wider initiatives for the much larger existing stock, such as low carbon community heating and the development of thermal storage to make better use of renewables. e.g. Should have connections at street level available for community heating.*

*Yes, I agree with need for a simple one pager summary but I do not agree that much of the content is feasible.*

*Does combustion on site prohibits biomass boilers?*

*I think it needs more description of the key components and support documents*

*This page fine. Maybe having something in relation to passive building design at the beginning would be good. Orientation, windows/ wall ratio, efficient fabric.*

# Comments on Question 3 (Overall comment)

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*Yes, good to prepare this Real concern about the robustness of the recommended kWh/m2 numbers Also no mention is it includes unregulated energy Suggest there might be an indication that any suitable low energy building up to 4 storeys should capable be ZC on-site using renewables across its roof area.*

*Yes, I think it's a good idea to prepare this one-pager. But I do think it needs a little more work. The context of this one-pager needs to be more clear. Is this one-pager is sitting as a suite of other one-pagers that take into account existing buildings, whole life carbon etc? This can be made more clear in the title somehow - very simply and visually.*

*Currently, the two paragraphs to the left of the page aren't saying anything useful about the topic itself - and are taking up valuable space. They acknowledge that we also need to consider existing buildings, whole life carbon, but they don't make clear the overall strategy for that.*

*It seems to me this note should be one a suite of four one-pagers:  
New buildings: in operation  
New buildings: whole life carbon  
Existing buildings: in operation  
Existing buildings: whole life carbon*

*Also, I am not sure the graphic adds much value as is stands.*

*I acknowledge it's very easy to be a reviewer, "critiquing" a piece of work. I am sure a huge number of hours of discussion and work have gone into this, for which I applaud everyone. My comments are intended to be constructively critical only :)*

*I meant to comment on the one-pager, but I cannot turn back. Is the embodied Carbon calculated on a one-off basis or a circular economy basis? I vote for the circular economy basis. I am told that 42% of steel is currently recycled. Over the coming centuries it will be about 95%. If you use the 42% figure concrete will be chosen, which cannot be recycled later.*

*Yes, not to early, heading in the right direction but not there yet.*

*Sorry - the options above are confusing. Generally I don't think the one-pager as presented works. I can't see the route to zero and net zero in operation isn't enough. What about net zero whole life carbon? All new builds will emit carbon and this has to be offset. How is investing in other renewable energy offsetting?*

*Yes speaking personally but I am not sure that the wider organisation will be technically or spiritually up for it.*

Energy Use Intensity (EUI) targets  
in kWh/m<sup>2</sup>/yr

# Comments on Question 4 (Setting the kWh/m<sup>2</sup> target)

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*See previous answer. There are too many external environmental variables to fix to a single figure. If a dwelling is overlooked by a large tower block on the south it would be discriminated against due to poor solar gains to reduce heat load etc.*

*Based on a performance standard that is measurable in use - maybe? And what about actual usage? No point having a Passivhouse if the occupants leave the windows open and plug in electric heaters. Can't make school kids shiver if the trades don't deliver the planned high performance buildings.*

*Gathering an evidence base for best practice operation, with an awareness of what further measures are possible would be a good scientific approach.*

*I would say bottom up but once again the whole life cycle approach is really important.*

*Top down, but stretching in terms of demand reduction*

*similar to a bottom up approach. It should reflect best practice based on real data, e.g. analysis of DEC's*

*More common sense needed. The UK housing stock still old and based on pre-high insulation construction. Also anything based on m<sup>2</sup> is devoid of common sense. Old style living rooms work well allowing those that need most heat to be closer to the fire, bedrooms should always be colder, etc*

*Maximum carbon emissions value should be set for different types based on different latest technologies available in the market to motivate developers to use more unconventional technologies. For instance, study should be carried out how much carbon emission be reduced if we replace gas boiler with heat pumps or heat pumps with ground source heat pumps etc.*

*The trajectory should be established through linkage to the UK's climate targets.*

*Based on optimisation algorithms.*

*Based on whole-life carbon. Operational carbon over the time is connected with embodied carbon over the time and vice versa.*

*Society is not going to shut down buildings because of arbitrary targets. The range of renewable capacity in 2050 is wide and so top down approach is not sensible. The industry and government is better focused on setting the trajectory and encouraging innovation to deliver the means.*

*Generally agree with a bottom up approach but would add that any target should be tested against real-life metered data.*

*LETI/UKGBC need to be clear on what you are trying to achieve and only put targets on those items. Why are you trying to limit kWh/m<sup>2</sup>? Surely we are trying to limit carbon emissions, household energy costs, overheating, poor air quality and perhaps peak electrical demand. I'm not sure what a kWh/m<sup>2</sup> total energy is trying to achieve. It will drive solutions which will be in contrast with other targets.*

*Suggest a bottom up approach, with top-down used to sense check. Is 15kWh/m<sup>2</sup>/yr space heat demand too low? Ambitious but may be very difficult in some situations (eg due to shading etc.)*

*Bottom up e.g. Passivhaus but to be clear, the metric should be delivered energy not primary energy*

*Based on mixture of the two, plus simplicity - avoid multitude of numbers for different buildings*

*I don't think you can neatly categorise it either way. Sustainability is "messy" and if we accept climate change is an "emergency" we need to take whatever pragmatic actions we can, which will be a mixture of the above plus other actions.*

*I do think it makes sense to consider a top-down approach too. However, this landscape is going to change considerably over the coming decades and I think it's going to be impossible to predict. Better to do the BEST we can do with our buildings... have the overall aim to get energy use down as far as possible.*

# Comments on Question 5 (EUI - Residential)

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*See previous answer, the building stock are far too varied to limit to a single figure.*

*It's not clear what is included in this target - is it all energy used in the dwelling? If so, it seems low.*

*Needs to be balanced with area possible for energy generation*

*Not clear what energy use intensity refers to. Is it related to primary energy? If a domestic Passivhaus allows for a 120KWh/m<sup>2</sup> per year, this number seems quite low for immediate application*

*Appropriate if offsets included. Ideally offsets not included, in which case this may be slightly too high.*

*Should be context specific.*

*I'm not a residential expert - but the key question is where does this figure come from? Is it credible? (the one-pager does not explain)*

*Not sure what evidence exists for this figure. It would be good to have a supporting note to show what has been measured in Passivhaus projects.*

*Although I think challenging requirements as close to zero as practicable should be set, have done little work with residential and not seen many cases of this being achievable*

*Space heating and domestic hot water (even more so) are not linearly proportion to floor area. Has a study been carried out on actual new build operational energy use intensity? What is the source of the 35 kWh/m<sup>2</sup>.yr?*

*I do not have enough information to comment on this - what does this intensity requirement represent in terms of usage?*

*I don't have enough information about where this comes from or how achievable it is in New Builds. Also, if it is mandated by policy, it won't be designed to achieve these limits - how is this going to be addressed? Will policy follow these figures?*

*I assume this is regulated energy use. I think this is an ok place to start but Passivhaus shows us that this target could be lower, so perhaps a note that this will reduce over time. Just a thought, but I am not sure how you check this back from metered supplies, as this will be total energy consumption.*

*So this is an operational target for residential buildings? What would be the calculation method to work that out? From our experience with POE, the variance in in-use performance for identical residential buildings can be up to 5 times based entirely on user behaviour. It would be impossible to accurately model operational energy for resi without a big error bar...*

*Need further information to understand what the figure is based upon.*

*It is generally difficult to set a target given the fact that significant amounts of energy is unregulated + based on lifestyle and end-user preferences/ attitude!*

*Anything based on a blanket m<sup>2</sup> basis is missing the point that houses are not and need not be uniformly heated. Also many houses use as fuel waste materials from their own property that would otherwise just rot and produce methane e.g. farms burning their own wood.*

*Perhaps LETI's net zero carbon initiative should be limited to regulated energy as this is within their sphere of influence; unregulated energy lies outside the control of architects and designers.*

*Does the 35kWh/m<sup>2</sup> cover both regulated and unregulated energy? Or is it just regulated? Are there recommendations/suggestions of how to meet this standard (U-values, % glazing, equipment efficiencies etc.)*

*It can be to high or too low depending on the building form and the opportunities to implement renewables. E.g. high-rise residential towers with limited options for renewables , might need to go lower than 35 kWh/m<sup>2</sup> to meet net zero carbon targets.*

# Comments on Question 5 (EUI - Residential)

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*Per year ? Question not specific*

*Constricting and conflicting to new technologies.*

*I think occupancy needs to be considered in this sector. I agree it is standard practice to apply an area based target but have concerns that this encourages under-utilisation. A family of 6 being crammed into a 3 bed flat would be penalised compared to a retired couple in a 500m<sup>2</sup> mansion. Perhaps a weighting of some description - x kWh/m<sup>2</sup>/occupant? Or at least an acknowledgement that this is based on 'normal' occupancy.*

*more certified research required*

*There needs to be justification and calculation behind whatever final number is decided*

*It seems like a case of one size fits all, since residential represents a wide range of building types with a wide range of uses.*

*It appears to be a sensible target, assuming it includes regulated loads only.*

*Not sure about this. Presume it is 35 kwh/m<sup>2</sup> per year? I think it would also be clearer to specify excluding onsite renewables, rather than just onsite PV*

*It does not take into account density of occupation.*

*As per my experience it should be around 150 kWh/m<sup>2</sup> which includes DHW Heating too*

*I think an all electric goal should be identified, that combustion based power should not be included. but that the value is close.*

*quite strict, even for a passive house, needs a lot of architect education & skills improvement and contractor skills improvement to achieve this level.*

*As per the previous question, I do not believe such a target is required. I also think a 35kWh/m<sup>2</sup> for all energy uses is not feasible in new housing, for a space standard compliant 2b4p home that is under 3000 kWh demand, hot water use would be 2/3rds of that, heating would have to be below Passivhaus standards which drives solutions which may not be viable in some tenures. I support the ambition but not the need for this target.*

*Assuming this is final energy delivered to the building it is very challenging but theoretically achievable with heat pumps to minimise final energy required for heating.*

*Need more info on where this figure comes from*

*I think the space heating demand is good as per Passivhaus. However, the overall EUI would seem to need some context to it to differentiate between building and user. E.g. a typical apartment?! It's a tricky one, because there is value in having an ambitious, clear and simple target but we have seen small power and appliance use rise sharply over the last decade and there is little designers / construction can do about that, so how do we deal with that aspect?*

*Energy demand is changing so this is difficult to anticipate for 10 years hence but this is consistent with other guidelines including RIBA 2030 challenge.*

*I think creating an energy requirement per m<sup>2</sup> is restrictive as it may discount many existing constructions. Although achievable for many new builds and retrofits achieving this may be difficult for some buildings due to location / construction etc. It may restrict viability of technologies such as off peak thermal storage, demand side response. That would be able to reduce carbon intensity of a building.*

*it is all dependent on number of people living within the buildings. In apartment blocks is the requirement going to be per flat?*

*I think this is broadly appropriate but may need some transition so that the industry can adjust to the new standard.*

# Comments on Question 6 (EUI - Offices)

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*Why do offices have higher energy use than schools or other non-domestic buildings?*

*the value seems high but does it take account of potential processes within commercial offices?*

*RIBA 2030 climate challenge advocates designing to < 0 to 55 kWh/m<sup>2</sup>/y for non-dom buildings; clearly this is a blanket target across different non-dom building types as is perhaps a bit of a blunt target and is a 75% improvement over CIBSE TM46 benchmarks which is over a decade old, but it is ambitious.*

*Appropriate if offsets included. Ideally offsets not included, in which case this may be slightly too high.*

*Too low - a per m<sup>2</sup> basis shouldn't be applicable for all organisations and will vary considerably with occupancy density, hours of use & the type of businesses operating (servers). Also is this NIA or GIA?*

*Should be context specific*

*This really depends on what is classed as a non domestic office. Business Trading where dealers can have 4-6 screens each will struggle to hit that target probably. Also temporary accommodation? Will that need to comply?*

*Key question is where does this figure come from? Is it credible? (the one-pager does not explain)*

*Could there a star rating- like NABERS- that recognises different efforts to reduce energy use?*

*I do not have enough information to comment on this - what does this intensity requirement represent in terms of usage?*

*Should be specific to 'in use' and 'out of use' I think*

*It's decent, e.g. about 4 stars in terms of design for performance right? It will need a step change in modelling approaches, commissioning and fine tuning to achieve for all buildings.*

*For certain building types I think metrics that factor in the utilisation of the building should be factored in. Low density office buildings for example have an inherently low EUI but are not sustainable.*

*Don't know- would need further information to understand what the figure is based upon.*

*Is it necessary to be so much greater than Residential?*

*It is generally difficult to set a realistic target given the fact that significant amounts of energy will be unregulated + based on the lifestyle and preferences of an end-user.*

*There needs to be recognition that people wear less clothing in the summer and more in the winter so summer and winter need dealing with differentially.*

*As above. Does it cover both regulated and unregulated energy? Or is it just regulated? Are there recommendations/suggestions of how to meet this standard (U-values, % glazing, equipment efficiencies etc.)*

*might be Ok for a office but what about other commercial building types?*

*As per my experience it should be around 90 kWh/m<sup>2</sup>*

*The BRUKL reporting for our last three projects have achieved on average 43kWh/m<sup>2</sup> for regulated energy, 86kWh/m<sup>2</sup> if you include plug loads. This was done relatively easily (no fossil fuels on site; ASHP's for all heating, cooling, DHW; no PV) granted this is from a simple thermal model and the performance gap issues in the industry raises questions over the validity of the info, but still...!*

# Comments on Question 6 (EUI - Offices)

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*Constricting and conflicting to new technologies.*

*I think that a non-domestic target is too restrictive and we should wait to see what is declared in the first tranche of net zero carbon framework buildings*

*As my answer above. High density is a very efficient use of the built environment, low density is wasteful. Perhaps give different targets for occupant densities ranging from 6-12 m<sup>2</sup>/person?*

*more certified research required*

*There needs to be justification and calculation behind whatever final number is decided*

*A bit arbitrary. A building used 24hrs per day 7 days a week with 1:5 occupancy would then have the same target as a building used 8 hrs per day, 5 days a week with 1:10 occupancy*

*RIBA 2030 Climate Challenge sets a 2030 target of 55 for non-domestic buildings. Where appropriate, can/should we ensure consistency between guidance.*

*This target is too high if it excludes unregulated loads but is too low if it includes unregulated loads. Using GIA or NIA affects the results significantly - what is this metric based on? When tenant ICT of a mid-range office can be responsible for 25kWh/m<sup>2</sup> GIA alone it is important to understand whether the metrics are to include unregulated loads, and the extent of the loads to be included.*

*Assuming this is final energy delivered to the building it is very challenging but theoretically achievable with heat pumps to minimise final energy required for heating.*

*I think a target of 50kWh/m<sup>2</sup>/year is appropriate and in line with EPBD.*

*Too high. This is not only an issue for the building provider, we should also seek to better influence fitout to reduce unregulated.*

*Point about user small power loads also applies. On the whole, air conditioned offices will probably struggle achieving that level of energy use (recent benchmarks e.g. from BBP are 190 - 260 kWh/m<sup>2</sup> for best practise to typical offices). But then maybe we want to incentivise moving away from high-rise, super-glazed, air-conditioned offices.*

*RIBA 2030 challenge sets this as 55/kwh/m<sup>2</sup>*

*I think an all electric goal should be identified and that this is high.*

*I think creating an energy requirement per m<sup>2</sup> is restrictive as it may discount many existing constructions. Although achievable for many new builds and retrofits achieving this may be difficult for some buildings due to location / construction etc. It may restrict viability of technologies such as off peak thermal storage, demand side response. That would be able to reduce carbon intensity of a building.*

# Comments on Question 7 (EUI - Schools)

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*See previous. For instance a Nursery would almost always have to be single storey where as a primary school could be at least two storey. Single storey buildings are naturally less energy efficient due to volume to surface area ratio and will always be worse than two storey. Why discriminate against single storey when it is necessary?*

*Will this be appropriate for all school types? Does this include higher education facilities? This category needs to be broken down further.*

*Will depend on site conditions and competing requirements leading to mechanical vent solns. A good target to ensure efficient systems and controls.*

*Appropriate if offsets included. Ideally offsets not included, in which case this may be slightly too high.*

*Probably about right, but this being the case then something needs to be considered around ventilation and overheating because in London where you will undoubtedly need filtration of the air that will require mechanical systems and whilst not by any means impossible it is difficult to meet both without a great deal of education around Passivhaus design and the way it needs to be operated by occupants. Again temporary buildings (such as the one PTK put in for the replacement Grenfell affected school will be problematic here).*

*Key question is where does this figure come from? Is it credible? (the one-pager does not explain)*

*A supporting note on the evidence would be useful.*

*I think there are too many other non-domestic buildings other than schools that have different functions that might struggle with this?!*

*There needs to be justification and calculation behind whatever final number is decided*

*more certified research required*

*I don't really have data in my head about this, but it seems quite high if the building is naturally ventilated? Might you introduce split targets?*

*Similar to offices. Schools tend to have a more consistent density and usage profiles so are more comparable on a per m2 rate than other building types but there is still a large variance. One of the ways to make schools more sustainable is to open them up out of hours for other uses e.g. community sports, teaching, meeting etc but this will increase the EUI even though the overall energy/hour of use may go down*

*Don't know- would need further information to understand what the figure is based upon.*

*It is generally difficult to set a realistic target given the fact that significant amounts of energy will be unregulated + based on the lifestyle and preferences of an end-user.*

*Schools as for offices above. Also long school holidays need to be dealt with e.g. no point in keeping a whole school warm/cool just for minimal staff in holidays.*

*As above. Does it cover both regulated and unregulated energy? Or is it just regulated? Are there recommendations/suggestions of how to meet this standard (U-values, % glazing, equipment efficiencies etc.)*

*Should be able to take into account out of hours community use*

*65 kWh/m2 seems to be more practical if natural ventilation is not taken into account.*

*Subtly different to the above but a 'school' does not have a standard usage. Some are essentially community centres from 4-10pm, and sports facilities etc. Others shut up and everyone goes home. I think it is reasonable to apply a space heating demand but not an energy use target for this sector. The range that would be appropriate would devalue it.*

# Comments on Question 7 (EUI - Schools)

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*Assuming this is final energy delivered to the building it is very challenging but theoretically achievable with heat pumps to minimise final energy required for heating.*

*most building types should be able to achieve 50kWh/m<sup>2</sup> in their basic form. The issue comes with kitchens, sports facility and other site specific process loads. These should be dealt with separately because not all buildings have them and not diluted into a higher overall average. Also a similar issue with seeking to influence fitout systems (inc ITC) to pull the number down.*

*All types of schools, but especially secondary schools, have seen an increase in appliance use. Heating plus DHW use is probably achievable at ~ 20 kWh for new construction, but we have seen electricity in recent schools to range around 50 - 70 kWh/m<sup>2</sup>\*yr in itself.*

*consistent with RIBA 2030 challenge*

*An all electric goal should be identified and this seems a bit high.*

*I think creating an energy requirement per m<sup>2</sup> is restrictive as it may discount many existing constructions. Although achievable for many new builds and retrofits achieving this may be difficult for some buildings due to location / construction etc. It may restrict the viability of technologies such as off peak thermal storage, demand side response. That would be able to reduce the carbon intensity of a building.*

*Too arbitrary, there are many different usages*

# Comments on Question 8 (EUI - Any other comments)

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*The category of buildings need to be further broken down.*

*We need to identify the key criteria of the construction project. It is not purely about the carbon intense plant items that are used - but how the building is particularly occupied and managed.*

*Appropriate if offsets included. Ideally offsets not included, in which case these may be slightly too high.*

*I think the single page summary should be published immediately. Upgrades and revisions can always occur after the fact.*

*I think buildings of all types should aim for the lowest possible intensity requirement. I realise a stringent target is needed to drive innovation, but also think flexibility to fit the most appropriate balance of energy demand and energy supply per building is the right way.*

*Low energy? Yes! Setting targets requires a joined-up skilled supply chain delivering high performing buildings to the quality we need.*

*Hotels. Hot water heating is always going to be at a massive disadvantage to other buildings where it's more about iaq. Heat pumps are great for offices etc but for hot water heating they just don't have the recovery rates needed for large commercial users like hotels etc. Where they are not located near the heat network this is going to make it difficult or require massive amounts of PV to offset their high consumption. This needs much more careful consideration*

*If the building has on-site renewables, is there more flexibility in the EUI target? I.e. the building can be less energy efficient. I think so, as the top-down calculations are based on economic wide renewable generation, not considering initiatives on site. This is a minor point, but could be clarified in the explanatory notes.*

*If absolute figures are going to be included there must be some sort of content to explain why they are credible and not just "plucked out of the air".*

*I have answered "too low" to the 3 above questions because the figures are lower than all the BEIS Energy Mission report case studies, and I know how much work went into finding these. This is especially the case for resi - the only case study approaching the proposed LETI EUI is Lark Rise, and I think that benchmark is partly due as it is a much larger-than-average dwelling (: higher sqm, ie lower kWh/sqm figure). I think we need to push as much as we can, but have figures that people can relate to and which we are confident are already achieved by at least some best practice examples.. Another minor point: why doesn't the text specify "commercial" offices - what about public offices or owner-occupied, shouldn't they also be included ?*

*It would be good for LETI to collaborate with CIBSE, RIBA and BBP to coordinate approach to energy targets. the RIBA 2030 challenge shows different energy targets. Will there be more refinement later for different building types, such as retail, leisure, hotel and university buildings?*

*I am not an energy person, however, i would ensure that the approach is in line with those set out by schemes such as BREEAM to avoid confusing the industry and leading to inconsistencies. CLC has also been working on indicators for domestic dwellings and it would be good to make the link.*

*I have little if any idea of what existing values are and, hence, what proposed values should be.*

*I am worried that the categories are too few and simplified. Simple is good but do we need to pick up other things like student accommodation, retail units etc.*

*Would it be possible to define a target for general retail/commercial space, as this generally forms part of new residential developments*

*I don't have enough background information on this to judge the EUI, - some information would be useful -what are typical current levels, what is best practice?*

*Designers need to be 'led' to a certain extent; what are realistic targets to meet net-zero performance? I have no idea other than the figures organisations such as yourselves suggest.*

# Comments on Question 8 (EUI - Any other comments)

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*For some buildings, setting an operational energy target can be proved to be impossible to achieve in practice. For example, schools with high usage of IT equipment will most probably be above the 55 kWh/m<sup>2</sup> limit, even with optimized passive design and energy efficient systems. There must be some flexibility to cover that with additional renewables.*

*Overall the targets seem high. Not only should Space heating/cooling and HVAC be regulated, but also appliance efficiencies (there is still room for user behaviour change). Additionally, the definition should impose targets for whole-life carbon, and not only limit energy consumption. There are some measures, normally on the last mile for extra energy savings, that would increase the overall CO<sub>2</sub> footprint of the building. France has already implemented this mindset in a few forward-thinking competitions, where design teams get a carbon budget that cannot be exceeded. The document is set to define industry best practice, and shouldn't fall short in ambition.*

*There should be an indication of an on-going and future commitment to reduce the energy usage, perhaps a showing a percentage reduce per 3-5 years.*

*I do think you need to mention ventilation and I do think we need to be mindful of iaq*

*If the one-pager is distributed more widely an example of what this means might be helpful for people who do not think in these figures all the time.*

*educating users is essential.*

*Is the EUI based on regulated load, or does it include unregulated load?*

*It's very helpful to finally have some numbers to reference, but what is the 'science' or calculations behind them? I feel a supporting appendix is needed to justify the approach.*

*For the non-domestic offices, there may be a need to think about the typology of the office and its scale.*

*Agree with using EUI over compliance linked calculations.*

*Simplistic compliance modelling should not be used for energy performance. NABERS style modelling is essential.*

*What about existing buildings? Lots of organisations have committed to zero carbon and they have lots of existing buildings.*

*It would be use to understand how each of the above three numbers were calculated in order to give an informed opinion on whether these are appropriate.*

*It's not clear what the rational for having different targets for different sectors is here.*

*It should not be assumed that the only sources of energy have to be converted to electricity for transmission. Transmission always involves significant losses which needs recognition. Apply common sense not bland rules.*

*There is no mention of energy for cooling. We are moving towards more of a cooling-led climate, so this should be considered with equal weight to heating energy.*

*Provide details of how these numbers were selected*

*kWh gas and kWh electricity have different environmental impacts and costs. I'd prefer a measure that directly reflects these quantities*

*It's really not clear what the basis of the figures are. For example is it actual meter readings, PHPP, SAP, SBEM, TM54?*

*I agree that there should be energy benchmarks and I like the approach of setting out what the space heating demand should be. I think it would be useful to provide suggestions on how to meet these energy benchmarks, obviously this would change from building to building but it would give a starting point of what typical things would be required.*

*Levels need to be reasonably achievable initially and to establish the design and monitoring principles with a published plan of improvement over time*

# Comments on Question 8 (EUI - Any other comments)

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*Its better to include WWR or equivalent shading without affecting winter solar gain. Also, good to include different figures for different area ranges.*

*I'd like to see reference to circular economy principles in the one-pager.*

*I'm wondering if more can be done to explain other areas of action required / collaboration between other professions that are not energy specialists. For example, behaviour change is a big issue and integral to achieving low carbon living- also sustainable placemaking , resilient landscapes, etc...*

*Hospitals, university research buildings, data centres, may have higher energy usages than this.*

*What is the documented basis for the figures proposed in questions 4, 5 6 & 7? Without giving the background as to where these proposed figures have come from how can one make informed decision as to them being appropriate or not?*

*Is this regulated and unregulated loads combined? I presume it is but it doesn't say...*

*A bigger focus on operational items including computers, machinery, plant and equipment. Time managed energy use and managed shut-down outside of operational hours should be under stricter guidelines.*

*I believe we need to look at the whole picture for new buildings including that of embodied energy which there is no regulation or measurement of currently. Also Part L1B & 2B need to be seriously more stringent to reduce carbon in existing sectors.*

*As I stated for office, 'in use' and 'out of use' would be an important measurement, also would highlight the amount of time buildings are not in use generally.*

*With all the developers and clients there is a question of economical feasibility of the end design to reach the target. This is in the most cases hardest bit for average private clients and public and governmental sector, which makes it harder to coordinate and design to specific energy consumption figure*

*I think energy and carbon should be considered separately. E.g. even if higher energy intensive building is, it can turn out that it is better solution due to e.g. lower carbon energy sources. It should be considered both with embodied carbon.*

*We need some info on current use and what the proposed levels mean*

*We are finding EA and AI algorithms are finding better and more cost effective solutions to those produced by standard or routine calculation and even Passivhaus methodologies. The approaches adopted to determine routes to zero energy should point to the objective but be restrained in prescription of how it should be achieved. What is more important is that zero energy should mean zero energy as defined by LBI.*

*Sounds like a lot of expensive ground-source heat pumps will be required to get down to 35kWh/m2 but if you don't set a target, no-one will know what is acceptable. Who is going to pay for the digging and pipework required? Why should offices be allowed to use more than residential?*

*Need to have evidence based targets otherwise it's knee jerk reactions like RIBA climate commitment. It's hard for clients like us to adopt ambitious goals if there is no transparency on how industry has set them. Even if we don't know all the answers - thats ok but transparency on assumptions is fundamental.*

*We need to provide guidance, potentially as an appendix, of benchmarks for low energy targets for various technologies if we are to achieve ambitious energy use intensities. As the margins for energy reduction become smaller and more strenuous, we need to engage further stake holders. IT design is a huge part of this. Granted this cannot be easily influenced in a residential setting but we must deeply engage IT / Commercial buildings to reduce operational consumption. This could be through guidance on power benchmarks for computers, designing systems with kill switches*

*I think we should allow for a multitude of responses before more stringent criteria are applied. I am in favour of the RIBA 2030 commitment in parallel to the Net Zero Framework as a way to drive down primary energy use*

# Comments on Question 8 (EUI - Any other comments)

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*I am generally wary of this. We want our buildings to be used as intensively as possible so that we have to build and operate fewer of them. This necessitates greater energy use. We would need a whole host factors, caveats and alternative metrics to correct for usage that means capturing this as a single number is distracting. e.g. a school tries really hard and gets 100 kWh/m<sup>2</sup>, this is an excellent result for their usage but they give up trying as they are miles off. Next year they get 120 kWh/m<sup>2</sup>, the year after 150 kWh/m<sup>2</sup> etc. We need users to remain engaged. I think the targets are too blunt to achieve this.*

*Do you account for other climate zones?*

*Not actually a prerequisite for Net zero though (mathematically)*

*We need to be setting stretch targets to reduce energy use and motivate us all to do this by investing in better buildings and greater awareness. These need to be mins and why stop at these.*

*Cooling should be restricted*

*A low energy approach is essential and current models are ineffective*

*Can these include a step by step reduction roadmap to reduce energy use below the limits set in future?*

*The target should be negative. Why can't buildings make a positive difference to the climate.*

*There is no guidance as to what a zero carbon building is besides a number of targets which most people don't understand.*

*Target need to be different for existing build and new build. The existing build need cost effective and appropriate measures for the type and age of building; this doesn't mean a cop out - all of this needs a step change in the degree of investment and the tenant-landlord relationship*

*The definition of net zero carbon seems to be based on the building's use of energy, not the occupiers use. So plug loads in commercial buildings are not counted, nor appliance loads in housing. Provided on-site renewable energy collection and storage are sufficient, occupier loads can be carried, but to limit the definition to the base building seems naive. It relies on the grid to be zero carbon, which won't come soon.*

*I'm all for the 15kWh/m<sup>2</sup>/y heating target as in Passivhaus but for other energy use others would know better than me.*

*We should have more building types included in the study, and different types of residential buildings (low rise, high rise, detached, semidetached)*

*Ideally there would be more building types specified, in terms of non-domestic buildings offices and schools represent relatively lower energy building types. Hotels, student accomm and leisure centres ideally would also be included, these tend to have high energy use per floor area when compared to resi' or other non-domestic buildings.*

*Although I have marked the energy use intensity requirement targets as appropriate in each case this shouldn't stop both the industry and legislators seeking to improve on those figures. I have marked them as appropriate because I believe that they are achievable using readily available technology and design. It is important that a holistic view of energy targets is taken and behaviours challenged in order that improvements continue. WE should not accept the above targets as being the be all and end all but instead they should be just a step on the journey.*

*Could/should the one pager provide example approaches for meeting the targets, for example typical U-Values, available systems. I think the values needed to be grounded slightly and demonstrated as achievable. There are lots of kWh/m<sup>2</sup> values out there and some times these can feel very arbitrary.*

# Comments on Question 8 (EUI - Any other comments)

*Kwh/m2 could do with a 'real life' comparison / descriptor: ie. 3 efficient kitchen appliances, 15 low energy lights, power for \_\_\_\_ & \_\_\_\_, etc. Something we can all imagine (even if crude)*

*mandate zero standby current*

*A. For new build residential (qu 5), assuming this figure includes all regulated and unregulated loads (which i believe EUI does) then it seems unrealistically low as it is nearly half the energy consumption of Passivhaus (60 kWh/m2/yr). B. Whilst i support the figures given as targets, if a Passivhaus residential project achieved net zero carbon in every respect, except that their total energy consumption was 37 kWh/m2/yr, then would LETI / UKGBC refuse to recognise it as a 'net zero carbon' building? C. I presume that EUI would measure the heating energy consumed, not the demand, so using a low carbon heating supply (e.g. ground/air heat pump) would benefit the EUI, but it needs to be made clearer somewhere.*

*It's important to consider the optimum balance between building fabric efficiency and efficiency of heating system, DHW and other end uses. In the case of a home, reducing space heat demand from 20kWh/m2/yr to 15kWh/m2/yr may be difficult and costly in some buildings (for example those with poor solar exposure), where as achieving the same 5kWh/m2/yr reduction through a heat pump, more efficient DHW system, or more efficient electrical appliances may be cheap and straightforward. There is a risk that if the fabric standard is too challenging it may generate avoidable opposition to the standard. On the flip side, Passivhaus is the logical end-point in terms of recent improvements in fabric efficiency, so adopting it has the benefit of being conclusive, where as a higher figure may be subject to ongoing debate.*

*I would like to see the a paragraph to explain the thinking behind these targets and why LETI believe this is most appropriate.*

*Would you be able to provide the current energy consumption (kwh/m2) of offices, residential buildings and schools please? Then I would be able to see if the targets are too high or too low compared to the benchmarks.*

*Understanding heating is key, The document does not require disclosure of gCO2/kwh of other services. (Lighting, cooling if any, hot water, ventilation).*

*I'd like to see some cost-benefit analysis to back up the targets Those proposed seem reasonable but I would also like to see some flexibility E.g. if buildings are near a copious supply of affordable, green energy, why be so frugal on energy use? You need to be clear about how heat pumps are analysed in your energy targets. One assumes you will include energy consumed by heat pumps in operation but do your energy targets include energy input to heat pumps from the source? The source could be renewable/ambient heat, waste heat or non-renewable heat generated specifically to feed into a heat pump - care is needed before this aspect of energy use is ignored.*

*Go for simplicity - not a multiplicity of different numbers for buildings providing basing the same comfort levels and similar small power and lighting. We should be aiming for a common baseline, because once we get into the many other building types everyone will want to claim a different target. Hence a common baseline with additional process load options only where appropriate.*

*Whilst I would not advocate an alternative standard to Passivhaus, the general background performance standards must match the industry leading standards.*

*Need to know science behind the figures. Cost info of uplift to building costs would be useful*

*I note a space heating limit is given. Two comments: 1. Is it too simplistic for it to be the same for all building types? 2. With air tightness and insulation improving, should there also be a space cooling limit for commercial office buildings and / or a combined limit for buildings with hybrid 4-pipe (polyvalent) systems?*

# Comments on Question 8 (EUI - Any other comments)

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*I would recommend in II 2) that you say "all energy brought to the site" not just "heat energy" as just saying heat energy creates a big loophole. Also, I would specify what amount of offsets are tolerable. Someone could just do a lot of offsets or otherwise defeat the intention of the scheme here. I had another idea but not being able to see the sheet at the moment I I can't recall now. Good luck with this! #moregreenbuildings!*

*As said above, what is the context of the energy use intensities, do we need a bit more detail.*

*The targets will be easier to achieve on some buildings more than others depending on occupant needs which can not always be anticipated, so the overall target for net-zero with renewables or legitimate offsets is more important that energy use intensity.*

*I think the ideas are sound though we do not do sufficient monitoring to really assess the energy in dwellings especially as we do not control them, except perhaps with metered communal heating systems where we can at least communicate to the residents. We also need to accept that the have invested a lot of money in a high carbon lock in for about 25 years for example through the installation of oversized communal heating plant. These are not going away anytime soon.*

*Too high or too low does not depend on kWh, but on kgCO<sub>2</sub>e. UKGBC has calculated the targets with a top-down approach, assuming certain renewable capacity in the future. The figures and source of this capacity are quite optimistic and do not match the EUREF 2016 projections. This calculation does not take into account the expected growth of the real estate sector and assumes that buildings will have available the same share of energy than they are now consuming. This is also too optimistic.*

*Why rebuild the wheel? Use existing best practices like Passivhaus and Living Building Challenge. How will you acknowledge the benefit of density of use (24 hour buildings vs buildings that are not usable large portions of the week/year)*

*We have to push further to ensure that we compensate for the existing buildings which will not achieve the same high standards.*

*I think that we need to start capturing the data and understanding it, how it relates to different buildings and typologies before setting specific requirements. There could be a ramping up to get to the requirements but without having a clear understanding of what the current usage is and how we are going to capture it is difficult to comment if these are the right intensity targets.*

*I'm all for the 15kWh/m<sup>2</sup>/y heating target as in Passivhaus but for other energy use others would know better than me.*

*The energy target should be related with the location of the building*

*Other building types will need targets in due course.*

Embodied carbon

# Comments on Question 9 (Embodied carbon)

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*Don't disagree with embodied carbon on the whole, but how do you then account for existing building stock? Also for example, Portakabin use a lot of Steel in the buildings but they are reused after 25 years on hire by being overclad and go back as effectively brand new (fully refurbished buildings). Assessments tend to take cradle to grave approach not cradle to cradle to cradle approach, this it would disproportionately disadvantage modular building companies like Portakabin etc*

*The "operation" of the building should include its eventual replacement by another building, with the minimum of demolition and maximum of reuse of components (including frame components)*

*I would put the embodied carbon at the start of the section. Almost as a pre-qualifier*

*If the focus is on Net Zero Carbon in operation, the document leaves out a very large portion of CO2 emissions - even more than half in some cases. More importantly and unlike operational carbon, embodied carbon happens now, not over the next 50 years*

*It would be useful to have some numeric limits for embodied carbon not to be exceeded.*

*Be clear. Either state that the focus is operation carbon only and leave it there or expand the scope*

*Its not clear what you refer to as module A. Embodied carbon disclosure should be included and verified post completion with As-built data. Whole-life assumptions should be clearly stated and any on-going maintenance carbon costs should be included in the operational assessment.*

*If embodied carbon is to be included then there is a need to account for End-of-Life as part of embodied carbon. Some buildings can have a significant impact at End-of-Life stage: Especially if products are not recyclable. I think there is a need to focus on Whole Life (including End-of-Life) or simply focus on operational at this stage.*

*Embodied carbon has to be related to building life and energy cost of maintenance.*

*The two need to be linked as a lower embodied carbon traded off against an increased operational carbon usage over a defined design life. Design life is fundamental to the full understanding of this.*

*I agree with the assessment if there is a target to hit. Without one I am not sure it is adding value to the process, but this is not an area of my expertise so I could be missing something.*

*I would have chosen the fourth option, however I wonder whether the supply chain has this data to allow analysis. However I think this document and future legislation should definitely reward and encourage reduction in embodied carbon*

*I struggle to decide between the option to reduce embodied carbon, and the as built data. Both are necessary, but neither is sufficient*

*I agree with both statements on the right and we need to include specific targets/benchmarks. The RICS PS needs to include default figures in the matrix they provide. At present it highlights in purple boxes that need to be filled "as a minimum". There is nothing to incentivise doing more than the minimum so if you have particularly high defaults it would be in the interest of the LCA consultant to provide more data to improve over the default.*

*Indeed, embodied carbon should be (and can be) reduced. But embodied and operational should considered in parallel.*

*The two are important but should be separated.*

*The embodied carbon will be huge compared to operations. Embodied should be net carbon zero too if we are to achieve the rate of emissions reduction required. There should be targets in kgCO2/m2 for embodied and an agreed methodology for the assessment.*

*Embodied carbon is not given enough significance. It is essential to minimise embodied carbon, not just report it. The design team has a massive obligation to not waste material just because they can, as a risk mitigation strategy. The carbon associated with materials is very significant. I would change this on the poster*

# Comments on Question 9 (Embodied carbon)

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*The statement is very simplistic and does not capture the complexity of embodied carbon and the end of life issues, issues of availability of resource and the interaction between embodied and operational energy.*

*The embodied carbon disclosure section should be moved to the end and state that embodied carbon should be minimised.*

*Embodied carbon' could be first item, with 'measurement and verification' last to represent the sequence of project construction/operation.*

*The embodied carbon disclosure should have further guidance on methodology and set benchmarks.*

*I do not know enough about embodied carbon, but what I do know makes me suspicious of the accuracy of its reporting and so I would focus on operational emissions.*

*The statement is appropriate. This is an iterative process. In the future the disclosed embodied carbon statements can be used to tailor a future intervention, and help shape attention to the carbon intensity of so many high-performance materials/strategies.*

*Embodied carbon does not go far enough, it should cover the plant serving the building as well.*

*Is LETI about embodied carbon? Being as it is not covered fully by this one pager, I suggest omitting it. LETI may want to set out a separate definition for embodied carbon.*

# Comments on Question 10 (Embodied carbon)

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*Benchmarks will be needed to prove reductions against.*

*for me it is crucial that current buildings have a low embodied carbon as built but also that end of life is duly considered. Having a zero carbon building at end of life wont help now but nor will putting problems off to the future. There has to be a balance.*

*RIBA 2030 Climate Challenge presents target metrics and i think it would be good to push for ambitious targets here too.*

*It should be one of 5 key components of building design with clear per m2 targets, alongside 'Energy demand', 'low carbon heat', 'renewable energy generation' and 'demand side management/storage'. 'Measurement and verification' should wrap around the whole thing, as should 'zero carbon balance'.*

*There should be guidance on the methodology - BS EN 15978 is very broad, RICS Whole life carbon is also slightly different, BREEAM also. In order to gain any value from the embodied carbon disclosure - the scope of the modules assessed & the building element categorised should be standardised. If a project is having a BREEAM assessment (likely in London) then the LCA will not align with other LCA guidance documents.*

*Measurements of Embodied energy needs to be more standardised for wider acceptance and application. Lifecycle analysis of CO2 embodied energy is very important particularly as we reduce the operation energy use of the building. If low embodied energy building techniques and materials are rewarded this will encourage growth in the industry and they can become more competitive with more common high embodied energy materials.*

*This is crucial going forward. Providing embodied carbon data for new build is relatively easy during the costing stage. As we get smarter with this information we can begin to reduce embodied carbon of materials through improved local manufacture of materials and products. Whilst in-use carbon is typically a far higher value over a lifetime, we must reduce all carbon emissions and maximise value of embodied, while protecting and creating local jobs, where possible.*

*If anything, the step should be moved to number 1. A whole life carbon assessment at design stage should inform operational and embodied carbon reductions... so it's a design stage initiative so would logically be step 1?*

*The headline states "embodied carbon" but the text states "whole life": be clearer about whether you mean "initial embodied carbon" or "embodied carbon over the lifetime of the building or a 60yr cycle" (ie including the impact of maintenance, re-fits etc); my preference would be for initial only, as it otherwise gets highly theoretical, but that's only my opinion*

*Would be good for LETI to align with RIBA and RICS on embodied carbon methodology and sources of data on embodied carbon*

*See my comment about the circular economy basis for calculation EC.*

*embodied carbon relates mainly to the carbon emissions generated now and should therefore be minimised as much as possible*

*We should be looking to reduce embodied carbon and consider whole life*

*It's essential to take embodied carbon into account.*

*I think it is confusing to include it in a one pager for zero carbon in operation especially in its location. Maybe include as a 'pre-requisite'*

*Embodied carbon is very hard to assess accurately, and may well lead to double accounting: the embodied carbon might be attributed to the residential sector of the economy and the manufacturing sector and the transport sector.*

*Embodied carbon is crucial in determining a buildings total lifetime carbon emissions. Please do not remove this section.*

*On your one pager you have a title embodied carbon disclosure, then a sub title "whole life carbon". This is the wrong way around. Whole life carbon is what we should be talking about and it covers embodied, operational, maintenance, demolition and re-use. You also need to be clear on what design life you want the assessment to cover.*

# Comments on Question 10 (Embodied carbon)

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*Embodied carbon is one of the areas designers can have a real (and measurable) impact. Operational carbon is and will continue to be aspirational.*

*Our organization has been banging on about the importance of whole life carbon and bringing embodied energy upfront for 8 years now. One of our members (Architype) have developed their own tool to measure energy and carbon, others routinely measure and I am pleased that the ICE database is gradually being updated. RICS have adopted the old WRAP whole building carbon database, so we have the beginnings of a benchmarking tool. I point to Holland where every building over 100m<sup>2</sup> has to be assessed. However we acknowledge this a fiercely complex area, so we intend to set up a working group in the new year to assist with the more complex areas of measurement. We're based in London and so we can discuss further.*

*It's essential that a whole life perspective is maintained, to avoid the potential for unintended consequences with worse environmental outcomes.*

*designers must be aware of these criteria and design scopes should be referenced back. the current discrepancy between BREEAM ratings and EPC is as a result of the difference between theory and fact. to get the best out of this initiative, in use needs to be considered during design.*

*It is important to talk holistically about carbon emissions, I really like the idea of disclosing and verifying module A, hence this is where we actually do have data.*

*Declaring embodied carbon is critical to reducing the environmental impact of the built environment and as operational and embodied carbon should be considered together.*

*Check SECS papers in research gate. We are using up to 60 times more structural material than required.*

*It is essential to include this in the assessment for it to be considered complete.*

*You can have Net Zero Operational buildings with very high Embodied Energy. These things cannot be considered in isolation, but designers of both aspects need to work more closely together to bring down total building Carbon. We should have a rating for the total building carbon & we should also find a way of standardising how we arrive at these figures.*

*This country has a huge number of buildings that have already survived hundreds of years and are still well loved. Many new buildings longevity is not known and many are not well loved. If you leave this out of assessments then you are missing a big point.*

*yes, as set out in the comment above, this needs to be linked to design life and there needs to be guidance included on design life as part of this.*

*The focus should be on what you can do to reduce embodied carbon at different life stages. For new buildings and major refurbishments it should be measured and disclosed alongside operational carbon For existing buildings the scope for reduction is much more limited.*

*An embodied carbon target and suggestions of how to meet it could be useful.*

*Though I think there should be a requirement to reduce embodied carbon on the one-pager, as it's not the focus of this document it should be moved to the bottom of the list.*

*How will calculation of embodied carbon be standardised?*

*The construction industry needs training, support and possibly regulations to consider and include Building Life Cycle Analysis (LCA). It must be a sustained campaign over years (not just a magazine article) by a group of organisations, particularly architects, so the RIBA needs to be a major influencer. The WGBC is pushing on this and it's time for action, not talking.*

*At this stage metrics for embodied carbon should be kept as simple as possible and guidance rates provided for broad categories of construction and refurbishment.*

# Comments on Question 10 (Embodied carbon)

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*It would be good to include materials reuse in demolition plans etc and incentivise the reuse of materials.*

*Not disclosing the overall embodied energy would hide the true carbon lifecycle of the building and lead to false claims of net zero carbon.*

*Look at MEICON. to see how many engineers habitually over-design out of commercially expedience and carbon ignorance.*

*I worry that there is inadequate focus on embodied impacts of construction. If we are faced with net zero by 2050, how does our built environment get created? There is currently no improvement trajectory to address this. Do we stop building in 2050?*

*I think the requirement to report the whole-life carbon is a great addition, even though it is outside the operational scope, since more data is needed on embodied carbon.*

*A methodology for accounting for module A1 to A5 and B1 to B5 needs to be developed whereby there is some kind of ledger that allows the embodied carbon to be paid down over time. The figure will start with all carbon from modules A1 to A5 increase during the life of the building to account for carbon that occurs due to actions in modules B1 to B5. The amount of carbon requiring offsetting will need to be recalculated every year.*

*Hopefully, embodied carbon calcs will become easier to do as a database/software is built*

*There must be a requirement to minimise embodied carbon as well as in use carbon emissions. Putting a limit on embodied carbon will help to drive industry to a lower carbon model, allowing 'business as usual' is not OK.*

*A tool needs to be established for assessing embodied carbon and targets for pass and fail such as SAP etc.*

*Point 3 (red dot). There can be misunderstanding in this. The pager shows that whole life carbon assessment mainly focuses on embodied carbon. This can bring huge confusion. It should be highlighted that embodied carbon is both cradle-to-handover (A1-A5) but also embodied carbon in operation (maintenance, repair, etc.). There is no information regarding e.g. recycling/reuse - end of life actions that allows to reduce building carbon footprint.*

*Most embodied carbon is in the structure. Radical change requires industry recalibration in materials use, particularly substitution of cement.*

*The architects and engineers are looking for better materials to use, but how much timber is acceptable? We can build 6 storey timber buildings but how many trees do we want to cut down to make them? What other material can replace concrete or steel, for example?*

*Embodied carbon section is too light and distracts. For example we are moving beyond carrying out whole life carbon assessments, we need the industry to help us work out what embodied carbon targets we should be setting. We're using 650kg/M2 for current developments as a stretch target.*

*We should move away from thinking we can accurately measure the embodied carbon within a given building. The standard deviation around the available data sets is huge. Because of this we need to agree on a data set that all uses will use for reporting, even if we cannot be accurate; we can be precise and more importantly, allow for comparisons between buildings.*

*new tools are being developed in the future, (i.e. EC3) and keeping tab to reference these would be good. thanks.*

*It should probably be at the end*

*Best tools for designing with / measuring? HBERT seems best at front end but then need to transition to others. Work needed in industry to streamline*

# Comments on Question 10 (Embodied carbon)

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*considering embodied carbon properly will result in the use of high efficiency gas firing which must be a consideration as a transition technology until fusion energy is commercially available.*

*Any LCA calcs must include real life data, as it is often very different to modelling data.*

*Be more ambitious please. Embodied carbon is something we think about a lot as structural engineers, we need much more engagement from Architects and Clients.*

*Increase the importance. Set targets, report, identify best practice, improve design.*

*Embodied energy could be covered by BREEAM and its various schemes. we need to concentrate on the existing build because it is 97% of the building stock and operational energy is 80% of the lifetime energy.*

*Managing down embodied carbon will be a bigger challenge than operational carbon. It requires product makers to make verified declarations of the embodied content of their products as they leave the factory, then to add the carbon cost of siteworks. Whole-life carbon inputs during maintenance, repair and replacement will need predicting and recording. The circular economic potential of materials and products will need logging so that carbon burdens can be clear. All this will depend on proper standards and digital information provision to those standards.*

*Embodied carbon of different options should be compared and the lowest whole-life carbon option (lowest "demolition + construction + whole-life operational") should be selected. Then only the operational carbon should be offset for the building to be "operational zero carbon". This would encourage retrofit against demolition and new build starting from now. For "whole-life zero carbon" buildings, also construction carbon should be offset in addition to operational.*

*Net zero target must be there too for embodied carbon - embodied is upfront, happening now not in 50 years. Embodied carbon is thus more immediately impactful than operational carbon, so in a climate emergency is arguably more urgently in need of vast reductions beyond current industry standards (whereas operational has improved already significantly, and should continue to reduce). If we say we need to cut carbon emissions by 2030, this means a time scale for studying operational carbon is relevant for 10 years, in which time the bulk of a building's whole carbon will originate from its embodied carbon. Operational carbon impact accrues over a building's lifecycle and is of course important, but prioritising only this is potentially damaging, as build ups/systems will be developed that are only good for reducing operational carbon, and potentially neglecting to consider their own embodied carbon of systems employed for reducing operational - e.g. thermal mass is great, but is it great in whole life terms?*

*There are initiatives such as the ILFI 'Declare Label' scheme that I feel should be more widely promoted and adopted by manufacturers and specifiers and buyers need to be educated on what to look for and how to use the labelling to be able to compare products used within the built environment.*

*Can a target be set? The RIBA 2030 climate challenge sets targets for embodied carbon.*

*Someone needs to 'own' the data set to show embodied carbon. I don't know who that would be, but it needs to have standing and be trusted. At the moment there are various numbers in use of unknown provenance.*

*Replace current clause with the following: Whole life carbon assessment should be carried out to inform understanding and optimisation of the total building impact.*

*The learning curve at the design end is steep enough already. Embodied energy is probably better managed by manufacturers. e.g. They could use renewable electricity to make things.*

# Comments on Question 10 (Embodied carbon)

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*We can't ignore embodied carbon. The buildings we build over the next two decades could be responsible for creating a substantial legacy of emissions during a critical phase of efforts to reduce emissions. It is vital that we transition to building systems with low embodied energy. There is an ethical responsibility on nations with historically high emissions such as the UK to adopt these solutions, which other larger nations will hopefully copy as they develop. Achieving net zero based on the inclusion of embodied emissions is difficult and will probably not be possible for certain construction types/materials in a way that can be scaled. For example, a concrete framed building with high embodied emissions that relies on tree planting to achieve net zero. The CCC's guidance suggests that our tree planting capacity is already 'used-up' by hard to treat sectors such as aviation and agriculture. There needs to be a clear driver to reduce embodied emissions regardless of whether net zero is achievable once these are included. Suggest a practical short-term approach could be to adopt a net zero operational emissions requirement in combination with a simple target for embodied carbon based on best practice.*

*Set the methodology for embodied carbon, and ensure it can be compared with operational.*

*I don't believe reliable data is currently available to support ALL beings being assessed. It may be necessary in the short term to have a policy which requires some form of reporting without a threshold of compliance and allowing an answer of 'unknown' where there are gaps in information. This may help to improve datasets, supporting formation of a clearer medium term policy, with better consistency of measurement across the industry.*

*I agree that Embodied carbon disclosure is important but am not convinced it should be one of the 5 key components of net-zero in operation buildings. I am interested to hear the arguments for keeping it there.*

*The summary should emphasize how the embodied carbon of buildings should be reduced.*

*We can only do generic embodied energy targeting at the moment - with the exception of building services for which there is in effect no data. The challenge of getting real data for real installed components is a long way off. Not least because exactly the same component can have double the embodied carbon depending on where it was made. We have a potentially enormous embodied carbon performance gap.*

*Embodied carbon is extremely important, and my sense is that it should be given its own platform and one-pager, with targets / frameworks in place. It's complex and needs more thought. Incorporating it into "operational energy" seems an odd fit and could be seen as pointless. There are no targets for embodied carbon stated, just a reporting requirement. A simple reporting requirement without targets will only turn into a tick-box exercise.*

*In the long-term, we do need to get to a point where whole life carbon assessments are verified post completion with as built and in operation data. Otherwise we end up with a 'whole life carbon performance gap' similar to what we have seen for operational energy. Maybe this is something that LETI/UKGBC can push through their other activities.*

*There needs to be a Net Zero (whole life carbon) goal*

*Embodied carbon accounts for about 50% of whole life carbon for a house and hence if we are to reduce carbon emissions over the next 5-10 years this is much more important than carbon in-use, especially as with decarbonisation of the grid energy in-use will by default become net-zero. So it is critically, but I am not sure if the remit for your document can adequately cover both.*

*Methods for accounting for embodied and operational carbon should be accredited*

*Maybe have embodied carbon first and then low energy.*

# Comments on Question 10 (Embodied carbon)

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*concerned that by accelerating build of low energy use buildings we don't use excessive carbon to achieve the required efficiency.*

*I would refer to embodied carbon disclosure and reduction, but I would make it optional as this paper focuses on net zero operational.*

*A clear and consistent approach is required.*

*I think that this is something that the industry wants to kick under the carpet and we need to be open about it.*

*I would favour compulsory disclosure of embodied carbon reductions on stage A, as the commitment aims to disclose energy and emission savings that can be verified. Stages B and C calculate predictions based on assumptions of average lifespan, future use and action. Disclosure of embodied carbon and potential reduction in B & C is good practice as a guideline for future practice, but the commitment should certify and validate actual reductions, also in embodied carbon. WLC assessments will need to estimate the carbon impact of the operational energy consumption (kWh) disclosed in the previous section. Disclosing in two units will make comparisons difficult.*

*After gathering a few years of data, a cap should be identified for embodied energy.*

*I think that Embodied Carbon should be in the suite of documents, but do not water it down by including this in this paper. It is vital to cover it. But as yet there are no "good" standards to aim for.*

*Some actions to meet the energy targets in operation might have a negative impact to the embodied carbon. Embodied carbon and its relationship with the carbon in operation should be studied and overall targets set.*

*The embodied carbon disclosure is adequate and in the right place but i think the scope of the embodied carbon assessment (e.g. cradle to cradle, assumed building lifetime) should be defined so that disclosed data can be compared.*

# District heating

# Comments on Question 11 (District heating)

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*Unlike much of Europe the UK has never embraced DH seriously and there is not enough room for the infrastructure to install on our congested streets. However contained on-site should be encouraged.*

*I don't know but it is important that if this document is to be for London but then used to inform decisions in the rest of the country that it takes account of rural or isolated locations*

*The simple messaging is easy to read but could perhaps include a link to more detailed info and advice?*

*It really depends on who the audience is and the level of understanding they have. My hunch is that keeping it simple would be more effective.*

*Offsite combustion should be banned as well (gas-fired district heating systems). Also there maybe a guidance of renewable drive Distrcit heating networks...when are they worth? Where is the point that the efficiency of the heat generation will offset the distribution losses (and piping infrastructure etc..) of the network?*

*Agree with the energy sharing point, however 5th generation heat networks are not necessarily superior to 4th due to the required temperature uplifts*

*Allow combustion on site for stand-by operations.*

*The low carbon energy supply section should make explicit reference to future proofing the development for connection to a district heating network in the future. The term "District Heating" is sufficient and shouldn't be confused with 5th gen or waste heat. They all fall under the same umbrella. The current GLA hierarchy is adequate.*

*As previously stated, the simple wording is ok for the one pager, but more detailed guidance needs to be provided somewhere.*

*energy sharing (5th generation heat networks), waste heat and heat networks should be used where applicable and taking into account the embodied carbon of the systems*

*why does a zero carbon building have to be combustion free?*

*Prohibiting combustion on site is ill advised. This is the oldest type of heating and changing it will be resisted. Also it needs to be the net CO2 that needs to be measured i.e burning materials to CO2 that would otherwise rot to produce CO has to be taken into account e.g. producing combustible pellets from material that would otherwise rot. Smart grids only make sense if they allow the consumer to change supplier either at the touch of a button or even automatically.*

*Centralised heat networks and sharing should be referred to, but they must not be deemed to be a one size fits all solution. It should be acknowledged that they are not always a feasible solution and authorities should listen to consultants' reasoning instead of continuing to believe that they are always an appropriate design measure.*

*It should be noted that the design should be carried out by competent people, part of which is to keep yourself up to date on the current best practice.*

*Make take up easy; if it all looks too hard, it will end up on the too difficult pile. Small steps will gain more traction.*

*I don't feel it needs to be explicitly referenced but I don't agree with the combustion statement (why can't this be offset like any other non renewable source) and the term renewable is ill defined.*

*I don't think district heating will be the most appropriate solution in all cases. The framework should specify aims rather than choose technologies.*

*Don't know enough to comment*

*Low temperature heat networks should be encouraged to combat overheating*

*All combustion sources of heat are best avoided.*

# Comments on Question 11 (District heating)

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*district heating networks are hugely wasteful and have high embedded carbon*

*I agree with bullet point two but I would avoid explicit references to 5DH until the technology has been proven in real life operation*

*It's too simplistic and gives no guidance.*

*I think that the long-term approach has to be all-electric. Heat pumps could use surplus heat as a source but it will be hard to manage shared systems.*

*Agree with second point although would need to be clear that this would only be where feasible.*

*I don't know. Getting to heat networks is necessary, but I just don't know how to get people ready for them.*

*The message on heating is not clear*

*Absolutely agree with not referring to DH. A clear focus on the heat source (eg non-combustion) is far more important than the heat distribution system. Blanket support for DH makes no sense at all as in many cases it is more expensive and less efficient than distributed heating systems (eg ASHP on each building).*

*it is not clear that the page is referring to district heating since the statement to prohibit on-site combustion is too vague and can exclude district heating as well.*

*I think if you change the second question to describe "energy brought into site" it would cover the mix: heating/cooling, lighting, plug loads, and district/steam energy used at the building.*

*DH can also involve off-site combustion. I was unclear what degree of combustion LETI think is acceptable e.g. combustion near site? Does no combustion 'on site' mean no combustion in the dwelling/non-residential unit but a communal heat source within the same building is acceptable? I would expect choice of heating to be set through the planning system.*

*Should include 5th Gen (as above). But why does it seem to allow off-site combustion (ie: next door..!)?*

*should the section be called low carbon supply & renewable energy generation?*

Demand response

# Comments on Question 12 (Demand Response)

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*New build should be low carbon not zero carbon. Most of the buildings that will be around by 2050 have already been built it is these we should be concentrating on. We are wasting too many resources on a small amount of newbuild when there are thousands if not millions of buildings that are leaking energy.*

*It depends as being overly prescriptive will not allow engineers to seek out different strategies.*

*I don't know what you mean by demand response.*

*The provision of energy storage does not in itself drive down energy usage, only reduces peaks and troughs, so I feel it is right not to separate out the point. Demand response is a useful mechanism to emphasise as it implies a smart control system, which can modify itself in response to need.*

*Yes, should be included in energy supply.*

*Future development.*

*Energy storage is a key part of the issue and is often overlooked. Simple inclusion here is an absolute must.*

*I think it should be mentioned but as part of point 8, making it an overall point about reducing peak demand and facilitating demand management e.g. metering, controls, storage.*

*not sure on this. Will the benefit of having energy storage will be higher than the damage caused batteries production and disposal...?*

*Keep it simple but reference other sources of information*

*I'm not clear which section this even refers to after reading it twice, so further clarity is required.*

*on the one pager this is the biggest section, but probably the least important! zero combustion is import. the rest is just process for achieving low energy in use. Smart reporting is covered in the measurement section.*

*keep it simple*

*No, it can be part of the solution however I think the one pager should stick to quantifiable characteristics, not become prescriptive on solution.*

*I think the industry needs more upskilling on designing for demand response and energy storage, so am inclined to leave off the 'requirements' in the document. It's better to give designers flexibility I feel (and keep messaging simple).*

*Leave as is for now and be prepared to update the guidance*

*No*

*I think better to set goals and then leave flexibility about how the goals are achieved.*

*There should be something to encourage energy storage at the consumers house to give the consumer more control or even automated choice of both energy source and how it is consumed. E.g. individual stored energy might encourage householder to reduce heating in Winter to just one or two rooms.*

*Yes. Energy storage using domestic hot water cylinders and the building fabric are important elements in the use of demand side response to maximise the carbon savings provided by grid supplied renewable energy. It can also help reduce fuel poverty by enabling occupants to take advantage of real-time domestic energy pricing, the details of which, OFGEM will be finalising next year.*

*I think selection of technology should solely be decided by the owner and its team.*

*If you mention it you need to use even less technical language. Whose your target audience, hopefully not sustainability people, so clear and simple language for less well known issues like demand response is key.*

# Comments on Question 12 (Demand Response)

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*Demand response yes. Although, energy storage is unlikely to be successful in many school / commercial projects. Due to – large onsite loads in comparison to energy generation potential, therefore little excess energy for storage; and cost. Batteries currently cost 450-1100 / kWh of storage for large installations. This money could be better spent on further onsite renewables or better control / demand response systems. Batteries do have a place where there is excess generation but there is unlikely to be common for many projects in the UK.*

*No. Storage carries roughly a 10% inefficiency. For it to be valuable the way in which it is deployed needs to overcome this. Grid scale storage is currently being built and it is far from certain that building level storage/demand response will be needed/valuable.*

*The message is too simple with not enough guidance. Energy storage both thermal and electrical should be a consideration.*

*DK*

*Demand response should be included. "Energy storage" should be avoided, Thermal added, as ES is usually taken to mean batteries.*

*This is likely to become a part of energy supply processes and I am not sure the building owner will see this. It will happen in the background.*

*It should be mentioned, but as part of a strategy for peak reduction, e.g. energy storage should be incorporated wherever possible to encourage recovery and smart use of otherwise wasted energy. In my opinion, demand response is not related to low carbon per se.*

*Can be incorporated into point 8.*

*Yes, I think a peak demand target could be applied or a requirement to support demand response.*

*Neither. Your document is setting out "REQUIREMENTS" for net-zero. Energy storage and demand response should be strongly encouraged but are a separate issue.*

*Suggest this should be downplayed for now. A lot more work needs to be done on this on conjunction with grid experts to determine the best approach. UK has 3GW of utility scale storage with another 5GW likely to be built in near future, plus interconnector capacity is on track to triple in the next few years - what is the need and role for DSM within this context? Should batteries be deployed behind the meter or at utility scale? Is the issue a national one at the transmission level or a local one at the distribution level? Should we be placing focus on chemical storage or thermal mass? Peak demand from new buildings with heat pumps and excellent levels of fabric efficiency is likely to be so low that it will be a small part of the issue - existing buildings with heat pumps will presumably lead to much greater demand peaks. Also note that many existing studies incorrectly apply operating profiles for gas boilers to heat pumps, which results in spikes in demand that do not represent how heat pumps operate in practice (e.g. running continuously). Demand from EV's is also likely to be far higher than for buildings.*

*I do not think you need it. Demand response and storage is not necessarily low carbon. E.g. it can be more economic to store PV generated power on site for use at a later time (even though the round trip efficiency is <100%) rather than exporting. This still holds if the grid is brown at time of generation but green at time of consumption.*

*I would like to say yes to the first answer, but not that sure its practical.*

*I don't think it needs to be mentioned, it is a technicality that most readers may not understand.*

*Demand response is important, on the communal systems i am familiar with, there is often a ration of 1 to 10 between the lowest and highest energy user. this means that unless the hgh energy users come down to where the low ones are we will not get very far.*

Low carbon supply

# Comments on Question 13 (Low carbon supply)

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*Does combustion include biomass and logs? Has this been carefully considered? For homes not aiming for Passivhaus they may still be valid options.*

*I am not sure about the requirement to incorporate renewable energy on every site (unless you are counting heat pumps as part of this, which I don't think you are nor should). You could end up with tokenistic systems eg PV on shaded sites. I see you don't want to offer an easy way out, but what about adding something along the lines of "unless absolutely not viable or worthwhile on a whole life carbon basis"?*

*At many city sites it will be difficult to install sufficient renewable energy equipment to satisfy the zero carbon balance. Off-site renewable energy investments or other offsets should be recognised as a suitable strategy.*

*note that i am not an expert in operational carbon - so my responses should be considered in that way*

*I think it is inappropriate to say "combustion on site is prohibited". When taking into account marginal carbon factors, gas CHP can still have a roll to play. Biomass boilers are also low carbon and can have appropriate air emissions if specified correctly. I'm unclear what useful information item 7 provides. We only need to be concerned with energy (kWh) not peak (power). I appreciate it has to be a very short and succinct document but Item 8 is extremely vague and it's not clear what it really means. All residential and commercial buildings currently have meters and controls. It's the ability to extract the information quickly, remotely and automatically that is the key benefit.*

*I don't think it is clear what is meant by a zero carbon balance*

*The line ". On-site renewable energy is incorporated to satisfy the zero carbon balance" could suggest that on-site renewables must offset all energy use to meet zero carbon. This is rarely going to be possible, so this should actually convey the point renewable use on site is to be maximised. This could, for example, be a ratio requirement between site footprint and generation capacity.*

*Point no. 4 (Combustion on site is prohibited) seems a bit like drawing a narrow boundary around the system (akin to saying your electric vehicle is emission free, when the electricity may well be coming from a fossil fuel power station). I don't agree that wood burning stoves should be prohibited (if that is the intent).*

*why not have a little combustion. Biomass in Scotland, Green gas in Gateshead.*

*Incorporate easy controls to enable householders to select which rooms are heated.*

*Focusing on single buildings in isolation feels too restrictive - community scale solutions need to be part of the equation. Connecting buildings into existing or new schemes should be highlighted and encouraged in this document. This is the key part missing for me. Also, the focus on new buildings only and not including retrofits in the same guidance seems odd to me - why should we not be striving for the same targets on both?*

*Energy networks and storage has a significant role to play in delivering "net zero" and this should be presented.*

*This section should look differently and should cover cooling and lighting as well. The main point is to have low carbon supply, but how to make it? If there is not supply, what is better to have high-carbon supply or have combustion? This section should present general information. 5 - should not be there, as well as 7 and 8. These are not "Low carbon energy supply"*

*Batteries can provide useful profile smoothing but are inherently inefficient devices.*

*All very well saying that District Heating is the way forward built only on estates of newly built properties. Even if we build 250,000 new zero-carbon homes a year, by 2050 it will only change the carbon footprint of the country by 5% on a good day! The vast majority of properties have been around for 80+ years already and the priority should be on making those as close to zero-carbon as possible.*

# Comments on Question 13 (Low carbon supply)

Define the time period for the peak. I would suggest 30 mins to tie in with half hourly utility meters.

Please include a short statement on current extant supply and support for purchase/ use of any local zero carbon (100% renewable)source availability (i.e. in USA, Community choice aggregate, or clean district energy sources.

all comparative analysis must be undertaken using kWh

Ruling out combustion on site goes against hydrogen boilers, biofuel CHP etc.

No, but your work to get councils away from gas CHP is great!

Energy networks can be much more carbon intensive than decentralised options in many cases! So we should NOT refer to them in the document, and these are the 2 main reasons: - They produce much higher heat losses than decentralised options, especially in the case of electric solutions where bigger plants do not imply higher efficiency - They involve enormously higher embodied carbon to build the pipework Thermal storage, load sharing and demand response should be mentioned among the possible solutions to achieve zero carbon, but there might be cases where they are not necessarily the most effective solution. So I don't think they should form part of the key elements.

Buildings ability to use intermittent wind energy should be taken into account. e.g. Water based thermal energy storage over a period of a week can use wind energy for heating (or cooling). Otherwise wind energy is wasted, as battery storage has not enough capacity for heat demands.

I feel that it is vital that we press home the message that technology gives us choices and that a mix of generation and storage methods is important. WE need to think flexibly about where our energy comes from instead of the traditional choices (coal, oil, gas, electricity) where we tended to plump for just one to the exclusion of all the others.

Add a requirement for sourcing a % of the energy demand from renewable sources - minimum 25% perhaps?

Performance requirements for PV should be introduced and deployment of best practice PV at scale should be encouraged in a similar way to the PHI's Passivhaus Plus and Premium standards. As heating and transport electrify the National Grid's 2 degree compliant scenarios suggest that the UK's demand for electricity is likely to increase by around 45% and the UK's solar capacity needs to increase by 3-4 times. Wind and solar are the leading renewable technologies in the UK and across the world. Collocating PV with buildings avoids the need to develop greenfield sites that could be used for forest or food production. It delivers electricity at 4-5p/kWh at the point of use that is not subject to price inflation. Landlord submetering within buildings can deliver this cut-price electricity to residents so they benefit directly. The annual energy yield from a given rooftop can often be doubled by adopting best practices for little additional cost. As an indication, monopitch solar arrays using monocrystalline modules with module level power electronics (microinverters or DC optimisers) can provide enough electricity to heat and power up to a six storey residential Passivhaus building with heat pumps in the South East.

I think the more explicit the better. Not restrictive but comprehensive

You do not explain what 'the zero carbon balance' is or why on-site renewable generation is more beneficial than off-site renewable generation

Are we in danger of going down the electric grid route as it decarbonises? Impact on infrastructure? What about the decarbonisation of the heat network ... bio & hydrogen? Difficult to factor in the impact of future tech solutions... don't want to be too prescriptive, limiting future flexibility

item 5 - should refer to heat used on site, not heating, because this ignores domestic hot water. What is renewable energy? Should it be renewable energy generation? According to the GLA 'renewable energy' includes some heat pumps and not others. Strictly speaking using simply heat recovery could fall into the same GLA definition! Other countries do not include heat pumps as renewables. Item 8 - change to 'Incorporate metering and facilities for smart grid development'. As written does not allow storage/batteries for smart grid.

# Comments on Question 13 (Low carbon supply)

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*If demand response and energy storage are key to getting to zero carbon it should be in here. By removing embodied carbon (see my thoughts on that in my previous response), you will still be left with 5 points. The order of the points that are made on the one-pager for low-carbon supply could be better ordered - I would group the design/physical elements together first, and the reporting elements last. Indeed, should the reporting points be in the "Measurement and verification" section? Who is the reporting supposed to be to? On-site renewable energy to satisfy the zero carbon balance - does this mean if this can't be done on-site it's not a zero carbon building? This is not clear. Once you get to "zero carbon balance" section it seems to say you can effectively offset elsewhere, but is that just within a "range" for those years where it didn't work out?*

*Who do we report to on carbon content and peak energy demand? Maybe the points on reporting can be merged into one to make space for the above point on demand response / storage.*

*I think it is reasonable to harness offsite renewables, as the entire grid is going that way, anyway, and users choosing these sources/funding new deployment will accelerate the transition, not just from their own rooftops and façades.*

*Please can we get people to report on the peak demand and the average. Too often we oversize the energy centres in developments because we are designing for the extremes. We need to understand the average demand so this can be the main energy load and then we can have back up systems for the peaks.*

*this will be really tough as I do not believe that there is sufficient low carbon supply available. heat pumps which are seen as the big green god requires electricity which is already hard put to match existing demands as the black out in August may have shown. then we add on the demand from EVs and heat pumps. The August event may have been an unfortunate confluence of failures but with climate change and more adverse weather this may well be more frequent;*

*I found the sentence "On-site renewable energy is incorporated to satisfy the zero carbon balance" difficult to understand.*

*Waste heat with a master plan to electrify should be the only combustion source permitted.*

*This is tricky as there are numerous ways of achieving a zero carbon building. I think looking at the bigger picture, energy storage and demand side response should be included in all new zero carbon buildings to help balance the electricity grid in periods of over supply of renewable energy. Perhaps it should be a separate issue alongside smart grid inter-connectivity, as it reflects the buildings interface with the wider UK energy system.*

*Should it not be called ' low energy supply and renewable energy generation'?*

# Measurement and verification

# Comments on Question 14 (Measurement and verification)

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*You need to keep it simple enough to audit, measure and keep fees to perform. Accounting for any off-site elements is fraught with complexity, and cost to record and make available nationally to all energy assessors.*

*It is very difficult to separate occupant behaviour from building performance when using basic measurement techniques. If the building misses its target, it could be costly to work out if it is due to occupant behaviour or deficiencies in the construction.*

*We have to make sure we are measuring the same information to make benchmarking possible. For example regulated versus unregulated energy loads. Or assumptions made on embodied carbon as some items are hard to measure including finishes, FF&E and M&E.*

*whilst I think measurement and verification is critical it should not be expensive or become an industry of its own.*

*suggest this data is reported and shared with the industry (anonymously) via REEB or similar*

*'Measurement and verification' should wrap around the whole thing, as should 'zero carbon balance'.*

*Verified how? I feel that many buildings are being commissioned with a metering strategy which doesn't align with a standardised approach to energy density benchmarking: NIA vs GIA vs NLA. We should at least mandate reconciling building level and sub meter energy data (sub metered energy consumption of landlord spaces often go amiss as they aren't required by the metering and billing regulations)*

*Who will independently assess this? How will it be enforced? Where will information go? Who will pay?*

*Must adhere to IPMVP and signed off by a qualified practitioner.*

*Only that it needs to be done by properly qualified people not your 1 week trained EPC/DEC/RE assessor that doesn't even visit site and does it from their desk.*

*Who will be doing this verification? Also what is done with the data/information? Could be taken as a wheeze by sceptics as a way of consultants drumming up business for themselves!*

*- independently verified and - who do you intend should do this? - I think you should add "and reported"*

*Clarity on what is measured in the energy would be useful, e.g. all landlord's and tenant's energy use. The floor area metric could be clarified as the industry uses a range of floor area measurements.*

*How will this be funded?*

*sounds like a good idea , but what would the costs implications be?*

*Again, you need to follow this up with detailed guidance on how they can achieve these requirements.*

*What standard are you proposing?*

*"Annual energy use and renewable energy generation must be independently verified in-use". What about embodied carbon, retrofits, maintenance, green tariffs and offsetting. Details of all need to be publicly disclosed?*

*require M and V*

*This is an essential part of closing the performance gap and needs to start happening ASAP*

*Could it be made more stronger, such as "Monthly energy use and renewable energy generation must be measured, collated and reported, with independent verification."*

*This is so important but it does require a budget. You could use POE as a title perhaps...?*

# Comments on Question 14 (Measurement and verification)

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*You need more verified data from manufacturers (EPDs) to really being able to conduct this. Furthermore you need free /opensource software for designers to use for calculating the embodied carbon.*

*Not really, other than it is key to demonstrate measured performance, not designed.*

*The sentence should be extended to say "...with a commitment to achieve the operational energy target".*

*needs to be a commitment to analyse every year the performance and ensure that corrective actions are taken. Follow the NABERS approach. Zero carbon in design with no commitment to understanding operational performance is deluding yourselves.*

*There should be a clear framework on the energy monitoring process, so that it is consistent and all building types can be benchmarked.*

*Why every year? What is verification? Is this ESOS light?*

*A set period of M/V should be carried for the building to ensure that the building is performing as required. Otherwise, the performance gap will be difficult to control. A net zero building can be defined as the one that maintains the net zero during its operation therefore M/V is important.*

*The definition of 'Independent verification' would need to be clarified, but perhaps elsewhere rather than the one pager.*

*The method of measurement should be stipulated as well as what it includes- for example external lighting for related facilities such as school playing fields should be part of the schools energy limit.*

*Ongoing O&M carbon costs should be measured against the Whole-life embodied carbon assessment and used to feed-back into this.*

*buildings change over time so I think this is a fundamental requirement as it can be extremely useful in identifying opportunities to improve operational performance*

*This is critical and should be mandatory.*

*This is just setting up another contentious gravy train, itself inefficient in terms of energy use.*

*This should be linked to design life as well.... this should be measured for the design life of the building. Alternate assessments may be required if/when the building exceeds or does not meet its design life and the assessments around the embodied carbon need to be reassessed.*

*'in-use' is not pulling its weight in that sentence.*

*....and restorative action taken if the energy performance falls outside previously agreed limits, if unjustified on the basis of building use (for example, weekend use, when not originally planned). This could be used to identify the requirement for recommissioning of building services.*

*Include a very brief description of what the measurement and verification process will be. E.g. through energy bills, DECs etc.*

*Don't impose bureaucracy or a new industry of assessors. People will have to make a financial outlay, don't make it higher than absolutely necessary otherwise take up will be lower than it could be.*

*does the annual energy use being measured annually need to stay within the specified EUI limits. That's not clear from the wording here. Also is there provision to update the EUI targets if needed in the future?*

*What about explicit reference to standards? Should we be trying to consolidate these?*

*What are the metrics?*

*Certification should be a requirement. Annual reporting of energy use. Post occupancy evaluation periodically.*

*A point about how the data should be made public for external scrutiny and competition by all*

# Comments on Question 14 (Measurement and verification)

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*Monitoring of buildings and comparison back to design should be mandatory. Re-commissioning of buildings on an on going basis should be encouraged and the benefits explained. This would be in keeping with the National Digital Twin programme from CDBB.*

*Use building regs submissions for standardised data collection.*

*I presume that this will be explored more fully in the supporting notes.*

*See previous comments on having an embodied carbon ledger.*

*A point on reporting targets against results would be beneficial and encourage best practice of in-use energy management.*

*I think there should be an element which will describe improvement through measurement and verification.*

*indeed. should include: 5, 6, 7, 8 from "Low carbon energy supply" I am happy to discuss it further.*

*Verification should be 1 year after stable operation, not point of design.*

*Needs to be done digitally connected to a central system hub. This cannot involve the same people hours as the DECC initiative. If there was ever a need for AI.*

*The most important mechanism in my opinion.*

*I like the fact this is a little vague for this guide. I think it needs to bring in disclosure and be titled: 'Measurement, Verification and Disclosure'. The body text needs a tweak to include public disclosure.*

*There need to be standards for measuring and verifying for sure.*

*This is a very complex area and requires very careful consideration in order to have a robust and fair means to enact this aspect.*

*A much bigger deal should be made about this - there is currently a massive performance gap that is not being addressed and independent verification is the only way to achieve this. I would also recommend a second bullet point that says energy use and performance data must be made publicly available.*

*What about measurement of embodied carbon in use (maintenance).*

*No indication on what should be reported on. Description of the building, breakdown of loads etc.*

*Energy management needs measurement and controls needs use of metering. No point in verification if only data not information and intelligence.*

*The NABERS style culture of published performance of in-use-evaluation has worked wonders in Australia. UK practice has failed to produce compliance with predictions based on EPSs or BREEAM. We must publish reality and be damned, or praised.*

*What happens when things don't perform as designed? Should there be some kind of threat if they're too bad?*

*We should be gathering energy use data for all buildings by now to inform economic decarbonisation.*

*See the earlier point about a data source 'owner'.*

*Why would meter readings given by the organisation concerned (e.g. the school of office occupier) not be considered adequate? Do they really have to pay a third party or not qualify as "net zero carbon"? This seems unnecessarily onerous.*

*What is the methodology? Who verifies and how? In line construction observations and checks should be mandatory, and signed off by the designer, as in Europe and America.*

# Comments on Question 14 (Measurement and verification)

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*It would be useful to include a timescale over which independent verification is mandated - 1 year? 3 years? 5 years? Indefinitely?*

*By accredited verifiers. overlap with ESOS etc.*

*Add in peak demand reporting - to emphasis its growing importance.*

*Does this also need to be reported? This isn't stated. I would argue that all reporting requirements are moved to this section, rather than being incorporated in the other sections. It makes the other sections clearer and more to the point.*

*Are we proposing independent verification as intermediate step to legislation? Also, the introduction to the one-pager already requests all elements are independently verified, are we adding anything here. Maybe the section could be beefed up by including reporting requirements, allowing for energy supply section to be ordered a bit more?*

*All buildings must have POE's carried out after a years cycle of heating, otherwise there is no way of evaluating the effectiveness of the standards of measures that have been calculated.*

*I would set a low threshold for "formal" certification as I think it is more important to get everyone doing this in the first instance rather than being too concerned about the validity of every supporting document.*

*This is a really tough one as we do not meter sufficiently. ideally we want meters on gsm without infringing on peoples rights etc*

*verified by who?*

*Title should not be awarded until at least 1 year at full occupancy*

*Need to be published and on display for all building users / owners.*

*Independently verified by whom? and how?*

*For home owners they are unlikely to verify their own home.*

Zero Carbon Balance

# Comments on Question 15 (Zero carbon balance)

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*Neither keep it to Low Carbon and nobody will end up disappointed that it won't be achievable in practice. An advert can say what you want it to. But Builders, designers, energy assessors have to be able to deliver it.*

*The whole document confuses energy and carbon, as the main target is in kWh. Call it zero energy balance.*

*I appreciate the perspective of both and I don't have a preference.*

*Agree in the principle of investing in renewable energy to offset on site energy. Surely a carbon offsetting mechanism is required in the short term? Can energy providers keep up with the renewable energy purchase power agreements?*

*I don't think energy and carbon should be confused. You can have an "energy balanced" building that isn't zero carbon.*

*Maybe this question highlights the fact that you need to explain the relationship between energy and carbon?*

*Either way I think 'balance' should be defined on the one pager as it has been here. kWh used = kWh generated*

*Zero carbon but needs to be clear this is operational and there is separate issue with construction.*

*All energy generation and consumption has an associated carbon impact. Keep it as Zero Carbon Balance.*

*Achieving Net Zero Carbon Building.*

*if embodied carbon is not a part of it, then perhaps energy is better.*

*I think it can be argued both ways, in essence you are balancing the lack of carbon, by balancing the energy needed with zero carbon energy generated.*

*No preference. I guess carbon?*

*Surely needs to be done in terms of primary energy nowadays*

*Until I read this question I had assumed that it was about Zero Carbon balance. Be clear, it is one or the other*

*Yes reducing anything to a single metric makes it simple but also inherently unsuitable for some situations.*

*It is not Zero Carbon! Maybe 'Net Zero carbon'*

*The real issue is trying to stop the effect of man made CO<sub>2</sub> and CO enhancing the green house effect. This is not just about kWh it is significantly about direct combustion of CO and CO<sub>2</sub> without any direct beneficial energy e.g. crops that produce more material that simply rots producing CO than useful product. If material that normally just rots is converted into pellets that can be burned by household and burned in such a way that the residue is itself carbon that can be used to enhance soil the net effect can be negative carbon. Don't suppress innovation with mindless rules.*

*Shouldn't the title include the word "net" otherwise it risks introducing unnecessary confusion?*

*Zero Carbon is better as mixed utilities are being used for energy generation (electricity, natural gas etc.)*

*We need to make this accessible. So while ZEB is probably the right way to go, ZCB is a more widely recognised term and should be adopted.*

*Whole-life carbon should be included. Time matters a lot.*

*Zero carbon is considering direct energy usage in operations but not upstream and downstream carbon of water usage and treatment, transport to and from the building, etc.... Better to call it Energy Balance*

# Comments on Question 15 (Zero carbon balance)

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*I think this is the most important question of the survey. Energy and Carbon being used interchangeably is distracting and we are trying to deal with the fact that our industry deals in energy (LETI!) rather than carbon. As written it should be title zero energy balance. Of course, it is perfectly possible to meet the requirements set out in the paragraph and have a remaining carbon offset to pay. Renewable energy does not have a carbon intensity of zero.*

*"Net" in Current title may be confusing. Is there a reason "zero carbon" is not considered? (yes, fugitive refrigerants is an issue?)*

*zero energy suggests that no energy will be required to the uninitiated so better to use carbon*

*don't mind as long as offsetting not allowed*

*It is only about zero carbon if more emphasis is placed on embodied. At the moment this looks like a document focusing on energy and not on true whole picture of carbon.... I would argue the section should be about Zero Carbon Balance though, and more targets given for embodied.*

*I think should be 'zero carbon balance' or 'energy balance' but not 'zero energy balance' - because we are not talking about 'zero energy'...*

*Zero carbon (on site is not practically achievable on site on all house and building types at present. An all electric building will become lower carbon and zero carbon as the grid decarbonises. A tough but achievable carbon target using SAP10.1 carbon factors will drive all electric buildings which will become zero carbon by 2040 when grid should be zero carbon.*

*While zero energy is simpler, we are primarily concerned with carbon, therefore zero carbon is a sensible way to capture carbon intensity of fuels/materials and is a good alternative to primary energy.*

*Net Zero Energy Balance*

*Zero carbon balance. Yes, this is an energy balance but the variable to measure climate change impact is CO2.*

*Zero Carbon Balance but in point 10. it should be clear that this should include embodied energy as well as energy use.*

*How about energy use carbon balance (excluding on site generation)? Given there is no combustion on site, homes could have imported electricity and possibly heat or cooling which might have a carbon content per kWh depending on the network supplying the energy.*

*can both be used ?*

*Semantics. Stick with zero carbon balance as the headline. The detail will be elsewhere - not least how embodied energy is handled.*

*I would only talk in carbon units, even in section 1.*

*either is fine*

# Comments on Question 18 (Zero carbon balance)

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Exactly the same single dwelling or commercial premise would produce different results from the following environmental variables and this is why you cannot make it as simple as the one-pager; 1. Orientation Location in UK Altitude Wind pattern 2. Shading from adjacent buildings and/or landscape. 3. Carbon efficiency of District Heating systems that are locally available which is out of control of developer 3. Number of occupants 4. Age of occupants 5. Hours of occupancy 6. Occupation of occupants. The variation in user patterns alone show that an in-use metric is unusable as an efficiency metric across the building stock. You need to measure it against a fixed pattern for the building and then measure the users separately. This way two buildings of the same environmental variables above would yield the same rating but the users would not. If you are buying an asset looking at a user in-use rating would tell the purchase nothing at all about the physical asset. Could write a book on this.

15 year agreements are good but I'm sure most tenants of said building wouldn't sign up to that let alone occupier owners. I think the idea is right but it would impact market competition and whilst I'm not the most strident advocate of market forces etc I think many would take issue with this.

Perhaps we need a technical standard to cover off these nuances? The one-pager is great in its current form, so these technical issues should fall into another piece of work.

probably obvious in most cases, but I would add "in the UK" after "invest in offsite renewables", otherwise it could be seen as international offsets.

This is a great summary. Getting engagement with clients and funders will be useful to help give confidence the targets can be delivered and there aren't unintended consequences.

focusing on energy is important as ultimately, you want to push people to use less energy regardless of how the energy is generated. however, if you include embodied environmental impact, then carbon is a good metrics.

It might be worth stating that 'any energy consumption not met by onsite renewable energy should be met by investment into additional renewable energy capacity off-site OR a renewable energy power purchase agreement', without adding a timeframe, as this should be the case always.

just wondering if you should have anything relating to commissioning, optimization and maintenance of systems.

When off-setting or buying green energy, it is important to make sure it is an investment that will increase the amount of renewable energy in the grid, rather than just re-distributing it from one point to another.

PPA is a must. Green tariffs should be avoided as additionality is very important, however I think the construction industry needs more guidance on how to get a PPA agreement in place.

Green tariffs are already contributing to the lowering of the grid carbon emissions.

What about existing buildings? How do they become zero carbon?

I think the alternative of green tariff is necessary as not all building owners/occupiers will be in a position to commit to a >15 year PPA.

The wording used in the proposed definitions seems to exclude nuclear power, which produces no CO2 emissions, but is perhaps not 'renewable' in the sense implied here. Perhaps the wording should be amended to include it.

Instead of using low energy use, indicate everything in terms of kgCO2/m2/yr.

"15 year renewable energy power purchase agreement." is not long in terms of climate change. A legal requirement requiring renewable energy to be used in perpetuity would be more appropriate.

# Comments on Question 18 (Zero carbon balance)

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*Who is this pamphlet meant to reach? You are talking about new buildings designed by architects and engineers. How can they affect the National Grid?*

*Green energy tariffs may not mean green kWh's directly extracted from the grid but it does allow for further investment in renewable energy. It is a positive and should be encouraged.*

*must be energy based*

*Rather than investing in offsite renewables, I would prefer to see local investment in existing buildings.*

*Buildings with active thermal storage can provide revenues for wind farms elsewhere, accelerating wind energy development. This might be recognised in a system of 'heavy versioning' with dated versions of the standard reflecting the stage of the carbon transition at that date. e.g. Points for a building that is 'Community Heating Ready' when community heating with very large heat reservoirs can be close to zero carbon.*

*The two points under this section are essentially saying the same thing and could be merged.*

*Green tariffs are being green-washed and should definitely NOT represent a solution to net zero carbon.*

*I think that there needs to be scope for carbon trading ie some sort of benefit for carbon negative operations.*

*Being able to 'offset' carbon by investing in offsite renewables, although well meaning, may set a dangerous precedent, and muddies the waters considerably. Surely an operationally net zero building should not add more net annual load to the grid?*

*The problem with trying to incentivise deployment of solar through a net zero target is that there is no link to best practices in solar deployment. The point at which a developer switches to using offsite renewables could vary wildly between projects and the purchase of 'green electricity' offers a free pass to those looking to avoid investing in renewables on site. A separate performance requirement for solar generation in kWh/m<sup>2</sup> of building footprint could be a simple way to avoid this issue that would work across most building types. It is worth encouraging solar on buildings as it avoids the use of greenfield sites and roofs are often perfect unshaded locations for solar, with electrical demand and infrastructure right there. Ultimately buildings will become net zero carbon because the grid decarbonises. Using grid electricity is a natural part of this process that should be comfortably accepted (within reasonable levels) rather than discouraged. A solar performance standard would enable this approach to be adopted.*

*If a building exceeds its kWh/m<sup>2</sup> target due to site specific fitout process loads, and certified additional renewables are purchased to cover these separately metered loads, surely the building is still zero carbon in operation?*

*Not that I have thought about this a great deal - but including grid losses here generates another level of complexity. Since building owners have no control over grid losses, I think this should be the responsibility of the network operators to find solution to.*

*What about refrigerants? Do they need to be included somewhere?*

*The UKGBC sets guidelines which prioritise energy efficiency and on-site generation above offsetting, and that needs to be emphasised.*

Grid losses

# Comments on Question 16 (Grid losses)

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*Grid losses should be accounted in the carbon factors for the grid. Again keep it simple.*

*I appreciate that simplicity is key for engaging the industry but if it can be captured with an accepted industry figure (e.g. X%) then this will be (more) simple to apply and will help in ensuring we deliver on rapid and ambitious carbon reduction.*

*Yes, if a local industry figure can be used.*

*Keep messaging simple, add a footnote to best practice in this area.*

*Isn't this already accounted for in the SAP carbon factors? I disagree that marginal carbon factors are not included but this is probably outside of the scope of this document.*

*No, keep it simple. It just becomes too complicated if you try and take grid losses into account (and it's something which building designers have no control over).*

*Its important to consider grid losses, but it doesn't need to go explicitly on a 1-pager.*

*Better to encourage non grid storage i.e. storage in each household to give individuals more control. Storage at the source of generation should be left to the supplier who will know best how to profit from it. Storage within the grid is bound to be inefficient because of the losses in and losses out all in control of people only interested in following the rules not making the whole system more efficient.*

*yes, but this needs to be an industry accepted standard figure and needs to be variable as improvements in storage efficiency are realised.*

*No, because that is not under control of the end user. The losses should be attributed to the distributors to encourage innovation.*

*I am unsure between "No – It is better to keep the messaging simpler" and "Yes, if there is metered data of renewable energy actually used"*

*may be too difficult to apply consistent figure? the beauty of a 100% renewable grid though , may simplify or make this moot?*

*No. Grid losses are like 8% or something so giving the impression that they're a massive deal might not be helpful.*

*Losses are not just through storage, but also transmission and distribution. They should be assessed for a project as its supply characteristics and distance to a supply will be germane.*

*No - we do not know enough about how much these losses represent and do not have control over them. It is the national grid's responsibility to overcome their transmission losses.*

*No - this is about the BUILDING being net zero, not about it compensating for wider problems, however real they are. This could be a recommendation for being 'above-and-beyond' net zero.*

*Absolutely not - this would be complicated to calculate and these losses will change over time so it does not make sense for it to influence the way buildings are designed. Lets focus on the big things that are locked in for the lifetime of the building like the fabric, heating system and roof design for solar.*

*First or last option. Keep it simple or include it if we have an agreed industry figure.*

*Carbon accounting is complicated and insufficient detail is given on the proposed approach. The carbon factor applied to grid electricity (and network supplied heat and cooling) should be undertaken on a marginal basis and take into account distribution losses. The marginal analysis may need to take into account time of use. If storage systems are marginal at any time , their round trip efficiency should be taken into account.*

*In the fullness of time yes, but for now while we are selling the concept keep it simple. Perhaps the reporting should state that renewables sources identified with delivery efficiency?*

Renewable energy supply

# Comments on Question 17 (Renewable energy supply)

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*Keep it Low carbon so that we can deliver goals not look good on paper only.*

*Care must be taken for wording which could mean 'offsetting carbon emissions' - could be seen as a buy out easy option and not always adhered to.*

*I think smaller organisations need to be offered the simpler green tariff option otherwise the zero carbon target badge will only be available to large organisation that can arrange PPAs. Is there sufficient audit in Green Tariff generation.*

*The first statement is better than the second, but personally not sure about explicit targets (but I accept this is the chosen route of LETI/UKGBC), signing up to a 15 year agreement could be a bit weak, how is it effected by change of ownership or bill payer? Could it involve a large non-refundable upfront payment?*

*Zero carbon in operation needs a nationally accepted definition. Proposing different definitions to the UKGBC creates confusion. Keep the messaging simple.*

*A 15 year PPA tied to a single asset. Have you talked to the lawyers about what this really means? What happens when a client wants to sell a building? I think offsetting will happen at the organisational level not the building level. Also what is wrong with investing in other forms of carbon reduction rather than energy generation?*

*A building is only energy zero carbon in operation if it meets the kWh/m2 target, is fossil fuel free and either generates all its annual energy use on site, or directly invests in offsite renewables or has a long term 100% renewable energy Power Purchasing Agreement (PPA) in place (e.g. > 15 years) or purchases energy using a green tariff*

*Add as credited after 1 year of stable operation.*

*or purchases energy using a verified green tariff.*

*A building is only zero carbon in operation if it meets the kWh/m2 target, is fossil fuel free and generates all its annual energy use on site.*

*A building is only zero carbon if the energy it generates is sufficient to offset carbon emissions from external energy supplies.*

*In my views, zero carbon balance building should not exceed kgCO2/m2 for a particular type of building and offset the emitted CO2 through renewable energy resources.*

*I think the danger of just saying "green tariff" is that it may be ambiguous. If a green tariff is a standard that involves 100% renewables generation (not offsetting) then this is better.*

*I would go with the second of these, but there needs to be protection - subject to rules - over the use of 'green energy tariff'*

*again, zero carbon in operation should be considered both from embodied carbon and operation carbon perspective.*

*As long as the 'Green Tariff' itself directly invests in long term 100% PPAs.*

*This is the most problematic part of the statement. Carbon Drawdown is essential to most of the 2 degree scenarios. Creating more renewables is not the only or even the best carbon offsetting approach. The framework should enable carbon drawdown advice.*

*It should be simple maths. The public need simplicity. The rest is good practice but falls outside my definition of Zero Carbon in operation.*

*I don't think that it has to be fossil fuel free as this can be reduced in carbon intensity and ultimately replaced.*

# Comments on Question 17 (Renewable energy supply)

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*Its a good idea to have low usage targets but if a building meets its needs from renewables it doesn't matter if those needs are low or high. Plug loads are an issue too.*

*Direct investment would be hard for smaller occupiers but don't most green tariffs just rebrand power that's getting generated anyway? Would some caveat / qualification of the green tariff help?*

*The second point above but also including 'or is part of a localised generation and/or shared smart grid'*

*KWh/m2 energy target is not linked to zero carbon.*

*Green tariffs should not be permissible as there is no security that these will be retained, however 15 year PPA's may not be commercially available so may not be realistic. Suggest a kWh/m2/yr renewable energy generation target based on projected building footprint would be a more practical way of promoting best practice solar installation and could be linked to the PHI's standards.*

*I don't have a preference as I'm not sure of the detail of "green tariffs" and their measured carbon emissions.*

*None of them. It is the problem between market based and location based carbon accounting approaches for the electricity grid. The investment in offsite renewables would only be valid if purchased offsite renewables are not accounted in the national carbon factor for the electricity grid. Otherwise there is a gap in carbon accounting as no one is addressing the extra dirty electricity.*

*I think an operationally net zero building is one that generates renewable energy on site annually to cover or exceed its energy needs. In my view, this should be independent of a kWh/m2 target.*

*Care is needed here to ensure that before the benefits of renewables are assigned to a new building, it is clear that the renewables in question are additional. Green tariffs and even long-term PPAs do not drive investment in renewable generation. They are simply a paper exercise in green-ness. A more rigorous approach is needed to carbon accounting.*

*Do not agree with buying green tariff - did that for 10 years before concluding it was double accounting. Beware of the meeting the kWh/m2 target - what if a fitout includes a site specific process?*

*The above is far too bureaucratic and simplistic. What is needed is less regulation and encouragement of new energy sources thereby increasing small and large scale competition. The last thing that is needed is the type of regulation that creates moats around large scale suppliers. In fact the larger the supplier the greater the rate of corporation tax should apply.*

Cooling and overheating

# Comments on Question 19 (Cooling and overheating)

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*The UK climate does not lend itself to full blow Passivhaus. Too high insulation and you turn a heating problem into a overheating problem. We need to be able to open our windows and get fresh air not mechanically ventilated dirty ducted air. You could get free cooling from hot water heating etc but nobody does it yet etc etc.*

*Will maximum energy intensity need to be increased to allow for cooling?*

*Possible re-visit in near future? Overheating forecast to increase in duration and intensity but it could be problematic to promote cooling before exploring external cooling possibilities in urban areas - such as increased green space etc.*

*It should be mentioned in the introduction, in the same way that you mention whole life carbon being a separate stream. I would say something along the lines of "other essential performance requirements, such as comfort, minimising overheating risk, and resilience to climate change, as not mentioned here as this paper focuses on defining what "net zero carbon" means".*

*Think you need to define what the EUI accounts for, heating, cooling etc...*

*Not forgetting that TM/52/59 will need to be updated as well*

*It should also refer to the adaptive comfort standard EN 15251*

*If we are using hard performance metrics, then I think it's up to the designers what they use that energy for, if they can include cooling within the total EUI, then fine.*

*A simple statement could just be included to say that the above energy and carbon limits should be achieved without adversely impacting the health and wellbeing of building occupants.*

*Overheating followed by energy being used for cooling is fundamental waste, reductions would have environmental and financial benefits. So yes highlight!*

*we need to ensure unintended consequences are avoided.*

*Compliance with CIBSE TM52/TM59 is a challenging exercise and it often means that low carbon solutions like natural ventilation cannot be an option if overheating risk is defined through these standards. This is not to be underestimated, the 1-pager as it stands completely appears to disregard cooling.*

*Why is it standard to install cooling in non-domestic buildings in London?*

*Cooling and overheating are part of the functional requirement of buildings and the functional equivalence which designers use to assess options in accordance to EN 15978. This should be mandatory and never an option.*

*There should be recognition of need e.g. residential care homes for the elderly should be significantly warmer but only education should be used to help those concerned balance insulation and passive design vs purchased energy.*

*Particularly for residential development where cooling is rarely specified, this is vitally important to ensure that buildings are habitable as well as energy efficient and zero carbon.*

*It is quite concerning that the final statement has been included as an option in this consultation. It only serves to help legitimise a compartmentalised approach to design issues. This not only applies to the treatment of overheating, but the assessment of carbon and energy too, which all require a whole-life / LCA approach to get a meaningful outcome where all design needs are evaluated in unison to arrive at the best, overall outcome.*

*Important to avoid zero carbon impacting on the internal environment and hence the comfort of building occupants and their ability to perform effectively.*

# Comments on Question 19 (Cooling and overheating)

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*a key part of this "discussion" is the internal environment "quality" and the measures (wearing more or less clothes) and impacts (view out, fresh air) it places on the building occupants. This should not be overlooked by designers but should not be defined when trying to communicate and measure what represents a Net Zero carbon building.*

*People like well-being and this relates to well-being so suggest you include.*

*Cooling is a big issue and cannot be treated simply.*

*we are moving into a seasonal overheating situation and to treat heating as the only issue misses the need.*

*Would be helpful to get some architects away from 90s 'solar house' thinking.*

*Thermal comfort should be ensured in all cases in accordance with the existing best practice guidance, and the thermal energy demand parameter should account for heating AND cooling demand. Designing a building that reduce heating demand and produce overheating or require higher cooling loads will lead to extreme uncomfortable summer conditions or occupants buying additional cooling devices that produce even more carbon emissions.*

*reference needs to be made to 'in a changing climate, future adaptation may be required'*

*Cooling systems are fast becoming more of an energy user than heating in the commercial sector. It should be mentioned as I noted in an earlier response.*

*I think if we mention overheating then there are other comfort and wellbeing targets that would need to be addressed. We shouldn't pick off one issue and not the others. This then complicates the message. So my answer would be no - but I also don't think this is really covered by the EUI either. Ideally this would be dealt with by Building Regs.*

*overheating is a real problem and so should be included.*

*This is going to be an increasing problem which may increase energy demand.*

*Why not have a space cooling target within the 'Low Energy Use' section alongside the space heating target? The 'Low Carbon Energy Supply' section is already getting complicated.*

*Overheating should be separate. It happens on all buildings, so should be picked up in Building regulations.*

*yes but in this case what is 'energy use intensity' should be explained further and include targets.*

*The presumption is that building amenity is provided. Quoting TM52/59 is a red herring - they are assessment predictions, not in operation performance. One of the key reasons offices are perceived to need more energy is because their cooling and heating with oversized windows is disguised in SBEM.*

*It could have a target in the Low Energy Use section, if this is feasible. Alternatively, it should be simply referenced in point 1, if point 1 made it clearer which energy uses were included.*

*The qualitative sentence should be in the low energy use section. I think reference to overheating matter, because a changing climate may increase cooling loads and we need to create an awareness for this.*

*With climate change, overheating is likely to become a bigger problem, and to become a problem where it has not previously even been considered.*

*If the building is incurring overheating this will flag as the cooling demand will be higher than the notional calculation. Therefore risk of overheating should be addressed to reduce cooling demand on the building. A cooling demand target should be placed on the building in addition to the heat demand.*

*addressing these issues is part of basic good design, just like avoiding thermal bridges, etc. Don't think it needs to be mentioned. the message is more effective if kept simple, like the 1 page approach. A visual explanation showing : Energy in use + Embodied = Renewables + Carbon offsetting to illustrate the concept would be good.*

Any other comments?

# Comments on Question 20 (Any other comments)

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*Thank you for putting this together and seeking responses. Overall, really pleased to see it!*

*Great work, LETI team!*

*The World GBC definition of a net zero carbon building is a building that is highly energy efficient and fully powered from on-site and/or off-site renewable energy sources. The LETI document should reference and/or build on the WGBC definition. Otherwise the one-pager is introducing a new, different, definition for the same term that is already reasonably well known. This risks creating confusion and diluting the message.*

*Think the graphic could be stronger, i.e. more modern and vibrant, its an exciting topic but its quite a dull page.*

*I like your ambition with this and support your intentions.*

*We at British Precast are a bit concerned about a number of industry initiatives lately which attempt to address Net Zero Carbon in buildings but fail to introduce assessment systems which holistically look at the entire Whole Life cycle (Cradle-to-Grave) of buildings and structures. Both European standards EN 15804 (especially the new one) and EN 15978 includes requirements and provisions which help in carrying out such assessments systematically and we feel that such requirements/ provisions should be employed.*

*overall survey comes across very technical. most of my architect colleagues wouldn't have much of a clue how to answer. the challenge to communicate to the masses is very high.*

*Natural vent must be prioritised where ever possible which under current building regs it is not.*

*Overheating and reduction of cooling should be mentioned to keep it in peoples minds. It is easy for early stage design teams to not consider it when coming up with building form*

*Good work Gets the grey matter whirring.*

*Well done on making the document. It's simple but fills a gap in the knowledge base.*

*The introduction text explaining the purpose of the leaflet is poor. The introductory text on this survey is clearer than the text on the leaflet. Thanks!*

*Guidance notes should highlight the interdependence of air quality, thermal comfort and noise. It's important designers are made aware of these impacts in energy strategies. Climate change adaptation is another issue that should be highlighted in guidance. Heat waves could cause occupants to install comfort cooling if the building isn't designed to be adaptive to warmer climates.*

*Are there any plans to roll out this initiative beyond London if it proves successful?*

*It's surprising there's no mention of CEN / BS standards e.g. BS EN 15978 "Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method". This could go in the section on measurement and verification. There's also some debate in CEN at the moment on how to report energy exported to the grid (e.g. which Module in relevant standards).*

*I think instead of having low energy use section in place, indicate everything in terms of kgCO2/m2/yr.*

*It is extremely important to include cooling demand in the thermal energy parameter (instead of space heating only). We are going toward warmer climates; designing buildings to be super-efficient in winter will inevitably produce unliveable spaces in summer. Cooling and heating loads should definitely be balanced and the building envelope and passive strategies should be designed to optimise the balance.*

# Comments on Question 20 (Any other comments)

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*I'm in two minds as although I think it should be assumed to be a part of the EUI and therefore not need its own topic (answer C), active cooling is likely to be a growing aspect of building energy usage, so it should be flagged that when we talk about Net Zero, we're not just talking about heating in winter. Answer A might be too complicated for the succinctness you're looking for, but a mix between Answer A and B might work. Risk of overheating should be flagged in any case.*

*Emphasis should be to avoid mechanical cooling and also GWP leakage to atmosphere.*

*Given that the ecological emergency is just as critical as the climate crisis I would like to see a positive ecological impact included as part of the guidance. Maybe not on this one pager but if a net-zero standard is introduced it could be incorporated there. If we go zero carbon but all the pollinators continue to die then we still face societal collapse.*

*I skipped the first question on the appropriateness of the one-pager, thinking I might come back to it later. It's now too far to go back, so commenting here instead. Basically, I think LETI and the UKGBC has been doing great work through bringing people across the industry together to discuss and jointly develop solutions and definitions. I think it's those large scale collaborations that really add value and develop impact. It's maybe that I have not been sufficiently engaged in the work you have been doing recently, but the definition of what net zero carbon in operations means, to me would need to sit within a wider context. I think many of the questions that the one pager touches upon are already contained in the UKGBC Net Zero Carbon Framework report, while most key open questions are not really developed much further through the one pager. The areas that the one pager does develop upon seem to be the energy use intensities and the power purchasing agreements. Maybe does could receive more room, adding some of the relevant details?*

*I encourage you to work with other organisations with a similar objective such as #Architects Declare*

*I am appalled at the lack of common sense in this document.*

*you need to spell separately correctly.*

*Thanks for the chance to comment on some very interesting issues. For operational energy, I would simply focus on 1) Setting tight targets for operational energy use 2) Choosing to take energy from networks which can be expected to decarbonise significantly 3) Encouraging on site systems which help decarbonise the energy networks I would not try to prove a building is net zero carbon In terms of proving a building is net zero carbon, while it is not clear from this questionnaire exactly how you propose to undertake accounting, I am concerned that you are not being rigorous on calculating residual emissions and you do not appear to be rigorous on the offsetting approach either. Anyway, given energy networks are likely to be decarbonising over time, the residual emissions at time of construction may not apply in the long-run.*

*These are confusing times for all stakeholders, with ever changing legislation, regulations, guidance, codes of practice, think tanks, expert bodies, professional bodies etc etc The rapid decarbonisation of the grid is forcing particular solutions for heating and DHW (which have other impacts like costs and increased demand for refrigerants, in the context of HFC phase down and the search for replacements). Just like we were all forced down the CHP route (even though we knew the grid was decarbonising). Now CHP units and systems are being designed and installed in legacy projects which don't stack up from a carbon reduction perspective. There is no silver bullet at the moment.*

*Future power demands will increase as the need for air conditioning increases over the life of the building. Therefore cooling energy demand needs to be reduced.*