Additional written evidence from Will Arnold, Head of Climate Action, the Institution of Structural Engineers

Following the 17 November 2021 oral evidence session of the Environmental Audit Committee inquiry into the sustainability of the built environment, I requested the opportunity to provide additional written evidence to the inquiry. This document adds to the evidence given in my session on regulation, as well as providing additional comments in response to the questions asked in the first session on materials.

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1 SKILLS

1.1 Tools – There are plenty of carbon calculation tools out there already, including paid-for tools (e.g. OneClick LCA[1]) and free tools (e.g. The Structural Carbon Tool[2]). Engineers, architects and contractors are also creating in-house tools (e.g. Carbon.AKT[3], FCBSCarbon[4], AutoBIM Carbon Calculator[5]). Tool creation is relatively straightforward as they typically follow the RICS Professional Statement (RICS PS)[6], which has been the de-facto standard on whole life carbon assessment (WLCA) in the UK for four years. Note that in Netherlands, a free tool was created to assist with carbon submissions (https://dgmrsoftware.nl/producten/gebouw-en-installatie/mpgcalc/).

1.2 Upskilling of supply chain – It is not necessary for every employee along the supply chain to upskill to the level of competency required of the design team. Designers (engineers, architects, surveyors etc) must be able to undertake quick carbon calculations to enable decisions to be made that save carbon, and to feed into a final WLCA to report back to the client, local authority, or building control… However, those along the supply chain need to understand that EPD communicate the carbon impact of any given product, and that this will be needed as part of the final WLCA. They need to know that making changes will impact the WLCA, and that different EPD will be required for different products. They don't need to be able to undertake complete WLCA.

1.3 Upskilling generally – Huge progress has been made in the UK since the government's 2019 announcement of net zero 2050. Major firms such as Arup[7], Buro Happold[8] and WSP[9] now calculate carbon routinely as part of their designs; a skill that was a niche specialism in 2019. Progress will continue – but regulation will increase the speed and efficiency of this.

2 WIDER MATERIALS QUESTIONS

2.1 Is one material better than another? – There is no one silver-bullet material, and each material has its use. Examples include:

- *A mid-rise domestic building will likely be most carbon-efficient in timber;*
- *A long rail bridge will likely be most carbon-efficient in steel or concrete;*
- *An open-plan office with columns spaced far apart is likely to be most carbon-efficient in post-tensioned concrete, or a steel frame with composite concrete slab.*

This is why it is important to get designers to calculate and report carbon emissions of designs, to ensure that the most carbon-efficient solution is used each time.

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[1] https://www.oneclicklca.com/
[2] https://www.istructe.org/resources/guidance/the-structural-carbon-tool/
[3] https://www.akt-uk.com/latest/akt-carbon-calculator/
[4] https://fcbstudios.com/fcbscarbon

[5] https://www.autobim.co.uk/auto-bimpopulate
[6] https://www.rics.org/globalassets/rics-website/media/news/whole-life-carbon-assessment-for-the--built-environment-november-2017.pdf
[7] https://www.arup.com/news-and-events/arup-commits-to-whole-lifecycle-carbon-assessments-for-buildings-and-withdrawal-from-fossil-fuels
[8] https://www.burohappold.com/wp-content/uploads/2021/01/Buro-Happold-Global-Sustainability-Report-2020.pdf
[9] https://www.wsp.com/en-GB/news/2020/wsp-leading-sector-in-halving-carbon-emissions-by-2030

2.2 Transport – Imported timber was used as an example (at the hearing) where the transportation is responsible for a lot of emissions. It was compared to UK-made concrete which releases more carbon in production, but less in transport. The question was about deciding which is "better". Transportation is part of the minimum scope for WLCA when following the RICS PS – so designers will account for travel distances when reporting at carbon footprint – a reason to look at WLCA regulation, rather than just material emissions at the factory.

2.3 Carbon capture and storage (CCS) – Caroline Lucas highlighted the 61% reliance on CCS in the UK concrete industry net zero roadmap[10], it is also worth noting that the UK steel industry roadmap also has a 42% reliance on CCS[11]. However we will need both materials throughout the rest of the century in the UK and abroad for many purposes, they're not going away.
Therefore we need three things:

1) *Government should drive research and development into alternative routes to decarbonisation of the two materials not outlined in the roadmaps (e.g. alternative cements)*
2) *Government should help drive investment in CCS so that it can become useful as quickly as possible.*
3) *Planning/regulation/tax is required to ensure that the remaining materials are used efficiently.*

2.4 Low-carbon hierarchy – All of this points to a need to minimise material use *(reduced quantities)* as well as minimising the amount of carbon released when producing a material *(reduced carbon factors).* This is why decarbonisation policy must focus on embodied carbon emissions for construction (i.e. the output of WLCA), as *embodied carbon = material quantities* x *carbon factor*.

3 CONCRETE

3.1 Government actions required to reduce emissions in concrete – This question was asked directly, and the answer is similar to that written above for 2.3.

1) *Government should drive R&D into alternatives to Portland cement*
2) *Government should help drive investment in CCS*
3) *Government can implement planning/regulation/tax that ensures that materials are used efficiently*

3.2 Thermal mass of concrete – I haven't studied this broadly, but I did run analysis on one project in 2020. Office design, timber structure (no thermal mass) versus a concrete alternative (plenty of thermal mass). We calculated that after 25 years, the thermal mass would have resulted in a carbon saving of 3 $kgCO_2e/m^2$. By comparison, the embodied carbon emissions of the concrete structure were about 55 $kgCO_2e/m^2$ higher than the timber structure – meaning that the building would have to be standing for 450 years for the thermal mass to 'pay back' the additional embodied carbon emissions.

4 STEEL

4.1 Low carbon steel – A question was asked about Electric Arc Furnace (EAF) and Blast Oxygen Furnace (BOF) steel. There are two things that affect steel's carbon footprint: 1. production method (EAF is electricity based, BOF is coal based) and 2. quantity of scrap used (EAF can use up to 100%

[10] https://thisisukconcrete.co.uk/TIC/media/root/Perspectives/MPA-UKC-Roadmap-to-Beyond-Net-Zero_October-2020.pdf

[11] https://www.steelconstruction.org/custom/uploads/2021/11/BCSA-2050-Decarbonisation-Roadmap.pdf - note that the roadmap on pages 8 and 9 includes three items that are not related to steel-making emissions (1 design efficiencies 17.5%, 2 circular economy 15%, and 6 transport-fabrication-erection 8%). The three steel-making emissions related items (3 direct emissions reductions 28%, 4 decarbonisation of the grid 6.5%, and 5 CCS 25%), add up to 59.5% in total. Of this total, CCS constitutes 42% (25 / 59.5 = 42%)

scrap, BOF can only use up to 30%). In the UK, it would be of benefit to move from BOF production to EAF production, and then stop exporting our scrap steel and recycle it in-country. Note however that this approach doesn't scale globally, as we consume 3x as much steel globally as is produced in scrap. So other countries will need to find ways to reduce BOF emissions. So there is an opportunity here for the UK to lead the way in lower carbon BOF technologies that can then be sold overseas – but in the meantime our quickest route to decarbonisation involves increased EAF production.

4.2 How government can encourage the reuse of steel? – To encourage reuse of any material, the reuse of materials, components, and whole buildings should be subject to 0% VAT.

5 TIMBER

5.1 Role of timber in reducing emissions – As mentioned in 2.1, timber is not *always* the lowest carbon solution, however we certainly build a lot of buildings out of other materials that would be lower carbon if built in timber. There is clearly scope to increase the amount of timber used in the UK projects. As mentioned in 2.1 and 2.4 though, this increase must happen in conjunction with incentivising efficient use to ensure that emissions reduce. This requires WLCA on all projects.

5.2 Durability of timber – Timber is susceptible to water damage when poorly detailed and poorly maintained. But with the correct detailing and maintenance, timber will stay dry, or will dry out after getting wet, ensuring a long life. There are many examples of timber buildings standing for hundreds of years. It should be noted that all main structural materials need to be detailed to prevent water damage and often require their own coatings to ensure long life (e.g. painted steel).

5.3 UK timber industry – Almost all engineered timber is imported from Europe, though this is only about 1% of all structural timber used in the UK. The rest of the timber is sawnwood ('joists') and boards. 65% of these are imported from Europe, the other 35% produced in the UK. This probably won't change quickly, but it shows potential to produce more UK-grown structural timber.

5.4 Trees being cut down – Seconding Michael, we make poor use of trees by cutting them down and burning them for energy rather than using them in structure. Across Europe, about 60% of all felled timber is burnt for energy, 12% is turned into short-lifespan pulp, and only 28% is used as long-lifespan structural timber[12] *(note also that burning timber releases more CO_2e per unit of energy gained than coal, oil or gas[13])*. So 72% of the carbon sequestered by trees is released to the atmosphere very quickly after felling. This means that there are currently inefficient incentives to use timber for structural purposes, outweighed by the incentives to burn it for energy.

6. REUSE

6.1 Designing for end-of-life and future reuse – There was much conversation about designing things to enable future reuse of elements. Yes, this is important, but reducing today's emissions is even more important. We are in a climate emergency today. Global emissions need reducing starting today. Yes, designing for future reuse will help us to keep emissions low in the second half of the century, but we need to halve emissions by 2030. So we must get our priorities right.

[12] Figure 3.13, Camia et al. *Biomass production, supply, uses and flows in the European Union: First results from an integrated assessment*, EUR 28993 EN, Publications Office of the European Union, Luxembourg, 2018, doi:10.2760/539520, https://publications.jrc.ec.europa.eu/repository/handle/JRC109869
[13] https://www.chathamhouse.org/sites/default/files/publications/research/2017-02-23-woody-biomass-global-climate-brack-final2.pdf

7. POLICY

7.1 Embodied carbon emissions – The total magnitude of embodied carbon emissions in the UK haven't changed much in the last 30 years. They reduced during the last recession due to construction downturn. This indicates that existing incentives to reduce embodied carbon emissions are insufficient.

7.2 Industry demand – in addition to the 126 firms (as of 23 November 2021) that have written messages supporting the principle of embodied carbon regulation in response to the Part Z initiative, there are several other notable cross-industry groups calling for this. Three other relevant initiatives are:

1) The UK Green Building Council (UKGBC) highlighted WLCA reporting and regulation as key features in its Whole Life Carbon Roadmap, noting that "Business as usual (BAU) projections, informed by the existing government policy framework, indicate that the sector will fall well short of 2050 net zero targets."[14].
2) The Climate Change Committee has also repeatedly recommended whole life carbon regulation, most recently in the 2021 report to parliament which calls on DLUHC (MHCLG), BEIS, Defra and DfT to develop policies by Spring 2022 that include "Setting out a plan for phasing in mandatory whole-life reporting followed by minimum whole-life standards for all buildings, roads and infrastructure by 2025, with differentiated targets by function, scale, and public/private construction."[15]
3) Finally, the Industrial Deep Decarbonisation Initiative launched at COP26 by governments including the UK committed to introducing disclosure of emissions on use of structural materials on all major public projects by 2025. Emissions reductions targets are also planned, with more details to be announced next year[16].

7.3 Other complimentary policies – It should be noted that WLCA reporting and regulation is only one aspect of the breadth of policy change required to deliver Net Zero for the built environment. The IStructE refers to the UKGBC roadmap, which has five key priorities for government and industry to support. These are the nationwide retrofitting of homes, energy performance disclosure of non-domestic buildings, reform in how energy performance is evaluated in building regulations, WLCA measurement and limits, and a need for systems-thinking across the wider built environment and infrastructure system.

7.4 Wider opportunities with existing regulation – There is an opportunity here for government to review the entire building regulations to search for 'low-hanging fruit' on carbon reduction. One example is in Part A, structural design, which dictates what minimum load a structure should be able to carry. Research all shows that some clients request further increased loading and most engineers then add a bit of extra capacity ('sleep at night factor')[17]. This can double the capacity of the structure compared to the minimum load.
So a regulations review would show that introducing "and no more"-type wording into Part A would ensure that structures would only be designed to carry the loading given in the Eurocodes - and no more. This would reduce structural sizes (including the concrete foundations), and reduce carbon.
I'm sure that other such examples exist across the rest of the regulations.

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14 https://www.ukgbc.org/wp-content/uploads/2021/11/UKGBC-Whole-Life-Carbon-Roadmap-Summary-for-Policy-Makers.pdf
15 https://www.theccc.org.uk/wp-content/uploads/2021/06/CCC-Joint-Recommendations-2021-Report-to-Parliament.pdf
16 https://www.unido.org/IDDI
17 www.meicon.net