

Technical Position Paper

Structural timber and global greenhouse gas emissions

The Institution of
StructuralEngineers

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This paper outlines the Institution's recommended approach to minimising greenhouse gas emissions when designing and specifying timber.

It sets out the routes by which structural timber production is responsible for carbon emissions, the three main considerations required to tackle such emissions (maximising sequestration, using timber efficiently, and prioritising long-life), a note on the expected effects of increasing timber use, and a series of recommendations for structural designers and policymakers

The paper's scope includes the use of timber for all structural applications globally, but it is recognised that the authors' most direct experience is based in the UK.

The paper does not consider other aspects of sustainability, such as human rights, biodiversity loss, or the flood resilience benefits that forests can provide. It doesn't comment on approaches to sustainable sourcing, which are well-covered elsewhere. It also does not tackle the question of whether timber is the right material for a particular design.

Recommendations

The Institution recommends that structural designers should:

1. **Support and inform clients in setting appropriate carbon limits** for their project, explaining the concepts in this paper to avoid overambitious and unachievable targets being agreed.
2. Treat **upfront carbon emissions and biogenic sequestration separately**, in-line with accepted LCA practice, including setting upfront carbon limits separately from consideration of biogenic sequestration.
3. **Where timber is to be used, do so as efficiently as possible.** Work collaboratively with the wider design team, from the start of the project, to identify key design decisions that **follow the Institution's Hierarchy of Net Zero Design**¹, enabling inherent efficiencies from aspects such as closer column spacing, straightforward load-paths to ground, and timber-appropriate detailing.

continued overleaf...

¹ <https://www.istructe.org/resources/blog/the-hierarchy-of-net-zero-design/>

4. Work to **maximise the lifespan of timber** by:
 - a. Advocating for the **retention and re-use** of existing timber buildings and structures
 - b. Prioritising the use of **reclaimed timber** coming from demolition/deconstruction.
 - c. Designing for **long life, durability** (with emphasis on protection from moisture and fire through good detailing), reuse, adaption, and disassembly.
5. Adopt project requirements that give **loads and spans that are efficient** for timber, in order to maximise the amount of floor area created from the same amount of forest:
 - a. Use of timber on projects **where timber makes efficient sense** and can be used to maximise carbon reductions.
 - b. Efficient use of timber products, **minimising the volume of timber per m²** of floor area.
 - c. Finding ways to use **sustainably sourced timber that wouldn't typically be used in construction**, such as lower grade homegrown timber, green timber, small coppiced sections, non-solid timber products such as strand- or chip-based products
6. As a minimum, **source all timber sustainably** to ensure that felled trees are replanted, such as through schemes such as FSC, PEFC, Grown in Britain, FLEGT, or equivalent².

The Institution recommends that policymakers should:

1. **Understand how timber and forestry emissions relate to net zero pathways (and consumption-based footprint)**, forecasting future timber demand and accounting for fossil emissions and biogenic storage in both forests and products to inform policy making.
2. Consider the need for **long-term, sustainable supplies** of construction timber in afforestation, reforestation and forest management strategies, in balance with the other benefits forests provide.
3. Work with the construction industry to **maximise the lifespan of timber** products by creating financial, education and planning policies that:
 - a. Incentivise the **efficient use** of timber in construction where spans and sizes suit its use.
 - b. **Upskill of current and future designers and builders** to ensure long-life timber design.
 - c. Support insurers and the supply chain to **enable atypical timber to be able to enter the construction chain**, such as reclaimed timber, coppicing, or diseased wood³, - supported by the [Mass Timber Insurance Playbook](#).
 - d. Improve **building regulations** (in the UK, notably Parts A and B) to ensure the safe use of timber in construction.
4. Work with the timber supply chain to maximise the lifespan of timber products by creating financial, education, business and planning policies that:
 - a. Incentivise the use of wood in long-lived products.
 - b. Enable the use of 'waste' or reclaimed timber.
 - c. Support timber innovation that allows more efficient timber use
 - d. Actively discourage the burning of timber as far as possible.
 - e. Increase the supply of timber through afforestation, with planting strategies that balance benefits across a region's forests, when considering a range of aspects such as biodiversity, forest resilience, local prosperity and amenity, and timber production.
 - f. Ensure timber is always sourced sustainably to ensure replanting.

² <https://timberdevelopment.uk/sustainability/responsible-sourcing/>

³ In this paper, we use the term 'wood' in reference to the material prior to turning into a timber product of any kind.

5. Enable increased **fire testing** of timber products and construction typologies (in the UK, by the proposed fire research body in line with the Grenfell recommendations) to increase understanding of safe use of the material, and unlock its use in more appropriate scenarios.
6. Use **publicly funded projects to accelerate the adoption** of the policies contained within this paper, where appropriate to do so.

Context

The use of structural timber in construction is growing in popularity due, in part, to national, local and project-level commitments to reducing carbon emissions. However, it is important that where timber is used, it is used efficiently, if it is to help the world reach net zero by 2050.

Not all timber from felled forests is currently used for structural and other long-life uses – in fact, most is used to create short-life wood products such as cardboard, or burned to create energy.

In Europe, only around 30% of felled forest becomes structural timber⁴. It is also worth noting that tree felling is around one fifth lower than the sustainable maximum level. Finally, it should be noted that in the UK, almost all waste timber is currently either downcycled into typically shorter-life products (32%), or burned to create energy (67%)⁶.

This means that while short-term increases in timber demand could be met through increased sustainable felling rates, the preference is that it is met by means such as diverting from other shorter-life uses, or through innovation in timber reuse. This would increase the amount of timber with long-life uses, locking carbon away for longer. We note that afforestation to increase future yield is needed regardless of how short-term increases in demand might be met.

Related to this is the fact that emissions are released at two points during the lifespan of a structural timber product:

1. At the start of the structural timber product's life, fossil emissions occur through the burning of fuels for forestry activity and to process the wood into timber (mostly due to drying and transportation⁷). Biogenic carbon is also released when burning biofuels (including timber) as part of these processes, though this is considered carbon-neutral by most carbon accounting methods.
2. At the end of the structural timber product's life, fossil emissions occur through the removal of timber from the structure it's being used in. Biogenic carbon will be quickly released into the atmosphere if the timber is burned, or slowly released if sent to landfill. If reused or downcycled, all or most of this biogenic carbon remains within the timber, though most carbon accounting methods still show this as a "transmission"⁸ away from the structure it was being used in.

The end-of-life emissions can be as much as an order of magnitude larger than the upfront emissions, and so avoiding these is very important – see "3. Prioritising long life" below.

More information as to the origin of carbon emissions for timber can be viewed on the Institution's website⁹. Discussion of fossil and biogenic emissions is also contained in Section 2.2.2.5 of *How to calculate embodied carbon*¹⁰.

⁴ <https://foresteurope.org/state-of-europes-forests/>

⁶ <https://timberdevelopment.uk/resources/assessing-the-carbon-related-impacts-and-benefits-of-timber-in-construction/> gives end of life rates for different kinds of timber but not for "waste timber" as a whole

⁷ <https://timberdevelopment.uk/resources/net-zero-roadmap/>

⁸ Carbon accounting methods use the term 'transmission' to indicate that the stored emissions move from one project/product to the next.

⁹ <https://www.istructe.org/resources/guidance/arup-material-guides/>

¹⁰ <https://www.istructe.org/resources/guidance/how-to-calculate-embodied-carbon/>

Reducing greenhouse gas emissions related to structural timber at a global scale

There are three main aspects to consider regarding timber and emissions.

1. Maximising biogenic carbon sequestration

As a forest grows, it absorbs carbon dioxide from the atmosphere, sequestering this within the trees and soil in the form of biogenic carbon – and reducing atmospheric carbon dioxide levels. Sustainable sourcing¹¹ should be used to help ensure that felled trees are replanted. Land-based storage is currently humanity's most credible managed source of carbon capture at scale¹². As such, afforestation and reforestation form a crucial part of our global route to net zero.

The benefits of sequestration only last for as long as the biogenic carbon remains sequestered in the forest, or in wood products such as structural timber. Once the wood or timber burns or decomposes, stored biogenic carbon is released back into the atmosphere. As such, maximising the lifespan of timber products minimises the atmospheric carbon dioxide levels for as long as those products exist.

It is also important to avoid the felling of old growth forests, as these lock away more biogenic carbon than a commercial forest does (as it also stores carbon in its non-tree species, and the soil), and so warrant additional protection.

Most carbon accounting methods, when looking at the whole lifespan of a timber product, interpret the upfront sequestration of biogenic carbon and the end-of-life release of biogenic carbon emissions as cancelling each other out¹³. This can portray the burning of timber as 'carbon neutral', however the reality is that there is greater benefit to atmospheric emission levels if the biogenic carbon remains sequestered within the timber for as long as possible. Several studies also demonstrate that the burning of timber releases more emissions per unit of energy generated, than burning fossil fuels¹⁴. Timber should only be burned for energy where there is absolutely no other possible use for it, and if burned, the maximum energy should be recovered for use.

Timber is not 'carbon negative'. This is because sequestering biogenic carbon does not 'cancel out' the effects of the fossil emissions released when turning wood into structural timber products (e.g., drying and transporting it). Policies, codes or financial instruments that emphasise the benefits of sequestered biogenic carbon (or assign carbon credits to it) without also ensuring efficient use of that timber could risk portraying timber as carbon negative, leading to inefficient use of the material, thereby both increasing upfront emissions, and restricting timber availability for other projects. But policies that incentivise lower-carbon end of life pathways for timber or extending the first life of a timber product would lead to lower overall atmospheric carbon.

2. Using timber efficiently

Because of the upfront emissions released from turning wood into structural timber products and because of the limit on rate of extraction of wood (due to its finite supply), it is important that wood is treated as a highly valuable resource, and thus that structural timber is used efficiently.

This means using a given amount of timber to create as much structure as possible – for example, using more efficient (usually, shorter) spans, creating ribbed wooden slab approaches (rather than solid CLT slabs), and efficient beam design (rather than over-rationalised designs which result in adoption of larger sizes than needed throughout most of a scheme).

Low-rise and short-span buildings also lend themselves well to the use of a lightweight, efficient, timber structure. This includes single-family homes, which make up a large proportion of all construction.

There is more information on efficient timber design available from the IStructE¹⁵ and TRADA¹⁶.

¹¹ Examples of sustainable sourcing schemes include PEFC (www.pefc.co.uk), FSC (<https://fsc.org>) and GiB (<https://www.growninbritain.org/>)

¹² This is true regardless of the differences between commercial and 'old growth' forests, monocultures and polycultures, and so on.

¹³ Note that the end-of-life 'release' of biogenic carbon is only a release from the system in which the timber has been stored, and is not necessarily a release into the atmosphere – i.e. when timber is removed from a structure, the biogenic carbon stored within it is counted as a 'release' whether it is being emitted into the atmosphere through burning, or transferred into a new structure through reuse.

¹⁴ Chatham House, 2017. Woody Biomass for Power and Heat. <https://www.chathamhouse.org/2017/02/woody-biomass-power-and-heat>

¹⁵ [https://www.istructe.org/journal/volumes/volume-99-\(2021\)/issue-8/design-solutions-for-efficient-timber-buildings/](https://www.istructe.org/journal/volumes/volume-99-(2021)/issue-8/design-solutions-for-efficient-timber-buildings/)

¹⁶ https://bookshop.bmtrada.com/bookshop/view/1F33B2C6-56A0-4552-B8FD-F94954F4FBFD/Structural_timber_elements_a_prescheme_design_guide_2nd_edition

3. Prioritising long-life

Because structural timber can be one of the longest-lived of all wood products, there are climatic benefits brought by retaining long-life structural timber products for as long as possible rather than allowing them to be downcycled into a shorter-life products or burned for fuel. Figure 1 below shows how emissions can be minimised by keeping timber within forests and long-life products for as long as possible.

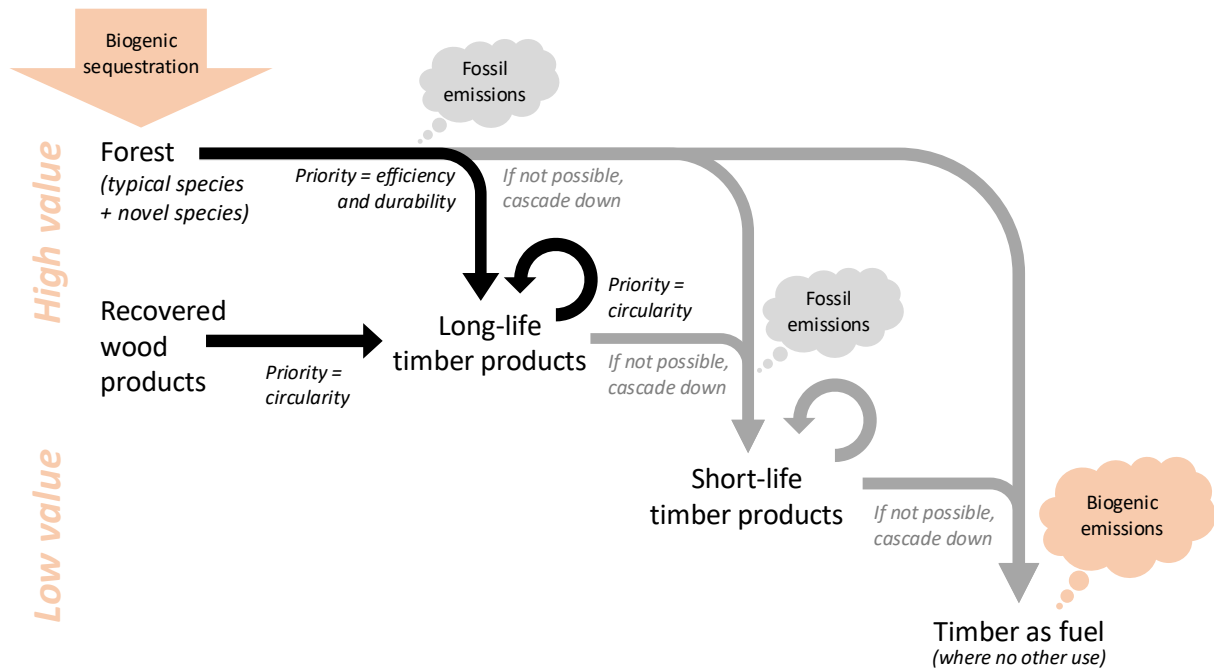


Figure 1: Cascading hierarchy for timber use

Long-life can be prioritised in different ways, each of which should be considered as part of the design and construction process:

- **At the building or asset level**, the lifespan of existing timber structures can be lengthened through creative reuse, upcycling, inspection and maintenance, and careful detailing when interfacing with existing structures.
- **At the element level**, timber should first be detailed for longevity and durability, but also to minimise waste today, and to allow future recovery in the event of dismantling.
- **At the material level**, using timber that wouldn't typically make it into construction can help to divert more wood to longer-life structural products – such as increasing the specification of lower-strength timber (e.g. home-grown C16 timber in the UK), small coppiced sections, strand- or chip-based products.

4. Impacts of using more structural timber

An increase in demand for structural timber must either result in increased felling of trees, a reduction in the amount of timber entering the supply chain for other (typically shorter-life) products or fuel, or an increase in the re-use or upcycling of reclaimed timber and resulting reduction of waste.

Where there is capacity to do so, it is expected that in the first instance, increased demand for timber will result in increased felling¹⁷. Many countries protect against the impacts of this by mandating sustainable forestry practices to counteract any short-term impacts of increased felling, and certain regions (including the EU) set a limit on quantities of felling to ensure that forest carbon stocks continue to grow¹⁸.

¹⁷ Ceccherini G et al. Abrupt increase in harvested forest area over Europe after 2015. Nature 583(7814):2020; 72–77, 1476–4687. doi:10.1038/s41586-020-2438-y. ISSN 0028-0836

¹⁸ <https://forestpolicy.org/policy-law/eu-regulation-deforestation-free-products-eudr>

Rather than encouraging increased felling, the priority should be to first find other ways to satisfy timber demands, including the increased diversion from short-life products supply chains, increased interest in circularity and use of reclaimed timber, innovations in timber products, and increased efficiencies in the how structural timber is being used. This maximises the proportion of timber held high up the hierarchy shown in the figure above, while also enabling maximised afforestation. When felling tends towards legal sustainable limits in any given location, supply chain pressure may also help encourage this approach.

Specifiers should be aware of the risk of malpractice in timber supply, and take steps control and monitor timber supply on projects through specifications that require chain of custody certificates, to ensure that sourcing does not originate in regions without suitable protection¹⁹.

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¹⁹ <https://timberdevelopment.uk/sustainability/responsible-sourcing/#timber-specifiers-and-responsible-sourcing>