Wood based panels in modern methods of construction for housing: greenhouse gas abatement analysis

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WOOD BASED PANELS IN MODERN METHODS OF CONSTRUCTION FOR HOUSING: A GREENHOUSE GAS ABATEMENT ANALYSIS

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ABSTRACT

The Construction Sector have developed a roadmap for reducing built environment carbon emissions by 50% by 2025, which will contribute to national carbon emissions reduction targets net zero by 2050. As energy efficiency of buildings has improved significantly, there is a growing interest in the embodied carbon of the buildings themselves, in addition to the operational carbon which has been the primary focus until this point. This paper reports a study which was undertaken to compare the embodied carbon of timber framed and masonry residential structures. The work indicates a significant benefit per dwelling for timber framed systems. This was in line with previous studies using different building designs and different functional units.

Embodied carbon is the carbon associated with the input materials and manufacture (including processing, transport, etc.) of a product, as well as later demolition, recycling or disposal. It is possible to determine embodied carbon for single materials or for whole buildings. BS EN 15804 is a standard for evaluating and comparing the Environmental Product Declarations of building materials, and guidance to the industry for applying this data within calculations for buildings has been developed by RIBA and RICS. However, many factors influence the ability and willingness of companies within the sector to consider and apply these new calculations when designing new buildings.

Timber and wood based panels in structures are an especially interesting element within the discussion of low carbon construction, due to their multiple different roles. The study demonstrated that timber structures can reduce embodied carbon of a building, in addition to providing a long-term storage role for biogenic carbon, i.e. the carbon sequestered in the forest, but stored in the built environment. Using a stocks and flows approach to carbon storage in buildings offers insight into the potential role of timber and wood based panels in long term storage of carbon. It also offers an opportunity to compare carbon accounting within bioenergy (short cycle) and long cycle systems. A discussion on wood industry co-products and wood waste from demolition, and carbon accounting for their role in bioenergy or energy from waste is timely.

This paper considers the importance of wood based panels in modern methods of construction, such as timber frame and SIPs. It also highlights the role of wood based panels in reducing the embodied carbon of new build dwellings.

INTRODUCTION

It is widely recognised that action is required to reduce greenhouse gas emissions and mitigate or minimise the impact of global warming. Projections from the IPCC for future global greenhouse gas (GHG) emissions allow simulation of future climate effects. While these may be referred to on the basis of the average global temperature increase over pre-industrial levels, such as the 1.5°C scenario, on closer inspection they show much larger changes in temperature at individual locations. In addition, there are predicted significant changes to rainfall, extreme weather events and ice cap melting. Data in Figure 1 is taken from the IPCC fifth assessment report (AR5) and show estimated temperature relative to 1986-2005 levels for a low GHG emissions scenario and a high GHG emissions scenario.

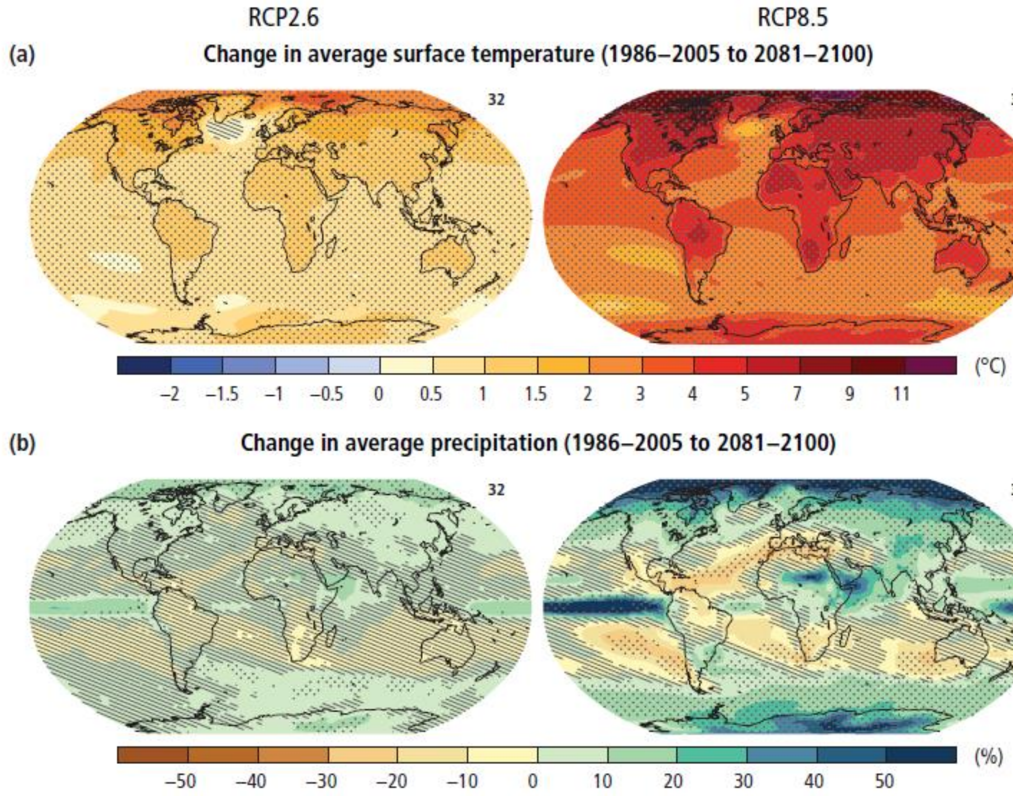

Figure 1. Change in (a) surface temperature and (b) average precipitation based on multi-model mean projections for 2081-2100 relative to 1986-2005, under the RCC2.6 (left, low emissions) and RCP8.5 (right, high emissions) scenarios. Fuller information can be found in the IPCC AR5 report (https://www.ipcc.ch/report/ar5/syr/)

The recent special report on the 1.5°C scenario indicates that we are likely to reach this level by 2030 to 2050 if emissions continue to increase at the current rate. Warming greater than this average value is being observed in many land regions, with the arctic two to three times higher. In order to stabilise the temperature at the 1.5°C increase, a massive decrease in global GHG emissions is required.

As a result of this pressing need to significantly reduce GHG emissions, many governments have adopted national policies to monitor and mitigate emissions. Within the UK, HM Government has set a series of carbon budgets, applicable to five-yearly periods (Table 1), which act as stepping stones towards significant reduction by 2050. The target of 80% reduction in emissions by 2050 was set in the Climate Change Act (2008). It was revised to net zero (compared to 1990 levels) by 2050 in 2019. Net zero allows the total of active emissions removals (e.g. due to photosynthesis by trees in afforestation) to be offset against emissions from the rest of the economy. The removals of CO_2 are expected to be important going forward, given the difficulty in completely reducing emissions in certain sectors.

Table 1. Carbon budget periods and emissions figures for the UK.

Carbon budget	Period	Carbon budget level	Reduction below 1990 levels
First	2008-12	3,018 $MtCO_2e$	25%
Second	2013-17	2,782 $MtCO_2e$	31%
Third	2018-22	2,544 $MtCO_2e$	37% reduction
Fourth	2023-27	1,950 $MtCO_2e$	51% reduction
Fifth	2028-32	1,725 $MtCO_2e$	57% reduction
	2050	Net Zero	100% reduction

The Committee on Climate Change reports on progress towards the levels set in the carbon budgets. We are currently in the third reporting period, and plans to ensure that we meet targets for the fourth carbon budget are under consideration, as lead times for new technologies or changes in industry or consumer behaviour can have significant lead times. Figure 2 shows the progress in reducing emissions in the UK by sector, and indicates that progress in the past decade has been greatest in industry and waste. A very strong change in the power sector has occurred relatively recently with reduction in reliance on coal, or recommissioning of coal fired plants for biomass energy, and increased use of renewables. By contrast, change in buildings has been slower. The energy efficiency measures in buildings (e.g. cavity wall insulation) have led to a general downward trend, but much remains to be done to reduce emissions by the construction industry.

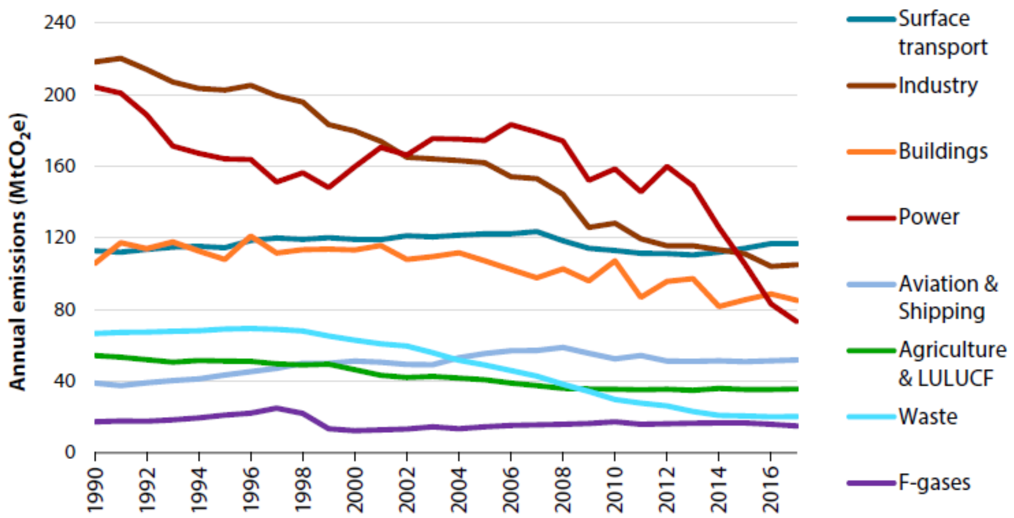

Figure 2. Progress reducing UK annual GHG emissions by sector. Source: CCC (2019) Net Zero: The UK's contribution to stopping global warming.

<u>The Construction Sector</u>

The emissions associated with the construction sector and the built environment have been studied by the Green Construction Board (2013), in defining the 1990 benchmark for emissions relating to construction and buildings in service. Their routemap for the built environment indicated that it was technically possible to meet the 80% target by 2050. This relied upon substantial reductions in operational carbon in dwellings, non-residential and infrastructure, but also reductions in capital carbon associated with construction activity.

The Industrial Strategy document, Construction 2025 (HM Government 2013) set an ambition of 50% reduction in GHG emissions from the built environment by 2025. This is in line with projections from the Green Construction Board's routemap.

One of the areas requiring development identified by the 2011 Low Carbon Action Plan for construction was carbon measurement tools for buildings and their materials. This can be split into two aspects – the life cycle assessment of the material or component (i.e. global warming potential of extraction, manufacture, transport, use, recovery or recycling and end of life) and the operational carbon (i.e. the carbon associated with energy consumed during use in service). At that time, some LCA data was available for individual products, and some data and systems for evaluating operational carbon were in use.

During the eight years since the Green Construction Board report significant progress has been made in the LCA area, with the definition of methodology for Environmental Product Declarations (EPDs) under BS EN 15804, and the emergence of a great number of product EPDs for construction materials. Many EPDs have been prepared for wood based panels, solid wood, engineered wood (Figure 3). Variations in value of CO_2e per kg of product for a given panel type result from differences in manufacturing location (and the electricity grid mix in that region), different glues and additives, different press factors and energy efficiency between mills, and many other variables relating to the manufacture process and feedstocks. Care is needed when selecting EPD data to ensure that it is representative of the product in use, and is up to date. For example, improvements in energy efficiency, manufacturing efficiency and mix of renewable energy within the electricity grid are likely to reduce EPD values, as industry strives to improve environmental credentials.

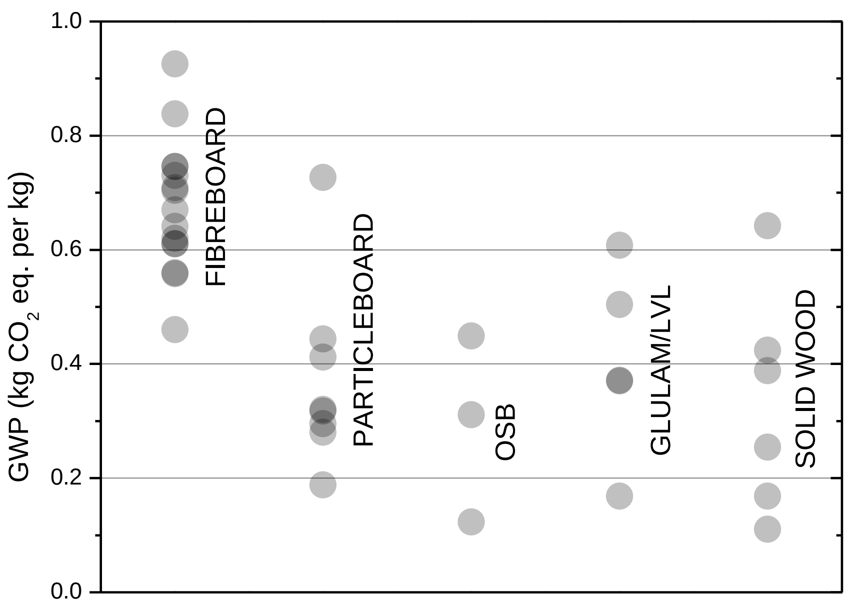

Figure 3. Summary graph showing the range of global warming potential (GWP) values (equivalent to embodied carbon) reported in the literature for wood and wood-based building materials (Hill and Dibdiakova, 2016)

In addition to the widespread availability of EPD data, progress has been made towards defining a system for building level calculations. In the UK RICS have also introduced a methodology for calculating the embodied carbon of buildings (RICS 2017). In other countries similar systems and concepts are being explored. In the Netherlands the use of LCA for buildings is increasingly required. Many developments in this area are reviewed by Zizzo et al. (2017).

Other countries have considered the quantity of timber within the building as an environmental benefit. In France for example, the Grenelle legislation introduced a minimum quantity of wood per square metre floor area of a building. The initial requirement was 20 cubic decimetres per square metre for dwellings, increasing to 35 cubic decimetres beyond 2011 (TTJ 2009, Legifrance 2010). In Switzerland the Wood Resource Policy sets required quantities of wood per dwelling, as well as seeking a greater quantity of Swiss wood is used (UNECE/FAO 2016).

In the operational carbon arena, the methodology has also been standardised to some extent. In the UK the requirements for calculations are connected to the target emissions rate (TER) and building emissions rate (BER) as defined in Approved Document L of the building regulations (England and Wales, or equivalent in Scotland and Northern Ireland). These are calculated based on a monthly quasi-steady state energy balance methodology SBEM (Simplified Building Energy Model) based on BS EN ISO 52016-1 (thermal) and BS EN 15193 (lighting), or by using approved dynamic simulation modelling software. The use of the Building Regulations to drive energy efficiency in both residential and non-residential structures has led to improvements in new build and where repairs or renovations necessitate structural work. In addition, roof and cavity wall insulation, energy efficient boilers and other simple steps have led to reductions in the existing building stock.

As operational carbon is reduced, the embodied carbon of construction has become more prominent, leading to greater consideration of the materials used in construction, and the building systems within which they are combined. A typical secondary school, built to 2006 regulations, had embodied carbon equivalent to 8.4 years of operational carbon. The same school to 2010 performance levels (25% reduction in building emissions) had embodied carbon equivalent to 10.5 years operational emissions. Projecting forward to a 70% reduction in operational emissions, it was suggested by Target Zero (2010) that it would take 19.4 years to reach the same level as the embodied carbon of the structure.

The balance of operational and capital carbon varies significantly from sector to sector, as shown in Figure 4. Well heated or air conditioned buildings, such as new-build homes, schools and offices tend to have greater operational carbon, while infrastructure projects, sports and leisure, government buildings and warehouses tend to have higher capital carbon.

This study was undertaken as part of a larger project to consider the effects of using a greater proportion of wood in construction (WIC). The first step was to calculate for individual dwellings the materials consumption and the associated embodied carbon of these materials. The data included information on the volumes of timber and wood based panels consumed, alongside other construction materials. Within the study different construction systems (timber frame and masonry) were compared for different house sizes and designs. Flats were also considered in two additional systems – cross laminated timber (CLT) and concrete frame. A wide variety of modern methods of construction (MMCs) exist, and several of them (e.g. open panel timber frame, closed panel timber frame, structural insulated panels (SIPs), CLT) use a significant volume of timber.

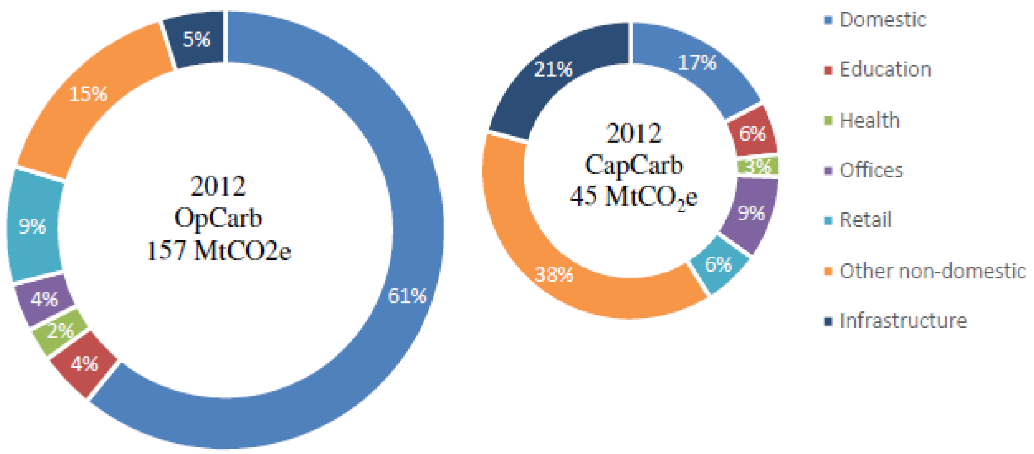

Figure 4. UK operational carbon (OpCarb) and embodied carbon (or capital carbon CapCarb) for buildings in 2012, segregated by sector. Source: Green Construction Board (2015)

Timber provides two distinct possibilities to abating greenhouse gas related climate change. The carbon sequestration which occurs in the forest while the trees are growing leads to a pool of carbon stored within that tree on felling or conversion into a product (such as timber, wood based panels, etc). The duration of this storage depends on the product type, as reviewed by Hill (2019) and others. In addition, structural timber and structural panels may provide a reduction in embodied carbon in their use, when compared with other building systems and other construction products. In this study both contributions were assessed on the basis of a single house functional unit.

The timber framed and masonry house archetypes included in the CCC study permit an interesting study on the impact of the wood based panels within the drive towards timber framed construction systems. It is possible to use this to consider/quantify the importance of the wood based panels industry within the wider supply chain of harvested wood, and its contribution to carbon storage, and reduction of embodied carbon. Traditionally the feedstocks for wood based panels have relied on small roundwood, e.g. forest thinnings and upper portions of the stem of more mature trees, as well as the growing use of recycled timber. Competition for these feedstocks from the biomass energy sector places new demands on this material, and some consideration of the relative GHG abatement achieved by use in WBPs versus bioenergy generation is timely.

METHOD

Single house model

Individual dwellings with 2, 3 and 4 bedrooms were evaluated, in both a masonry and an open panel timber frame design. The footprint of the house was identical for the two structural types, meaning that roof construction and services could be assumed equal for the site. All structural elements were included for the substructure and superstructure, roofing timbers were included for both structural systems. However elements such as window and door joinery systems were excluded, to leave the effect of choice between uPVC, metal and timber frames outside the scope of the study. Similarly the roof covering was excluded as a wide range of choice is available for tiles and slates of different materials. Selection between roof covering systems of differing GWP was out of scope.

Global warming potential (GWP) values were obtained for each material from recent EPDs, or in a few cases derived from scientific literature to better represent an average product for the UK. GWP is the impact category used within LCA and EPDs for the embodied carbon. While this relates to all of the Kyoto protocol gases, it is expressed in kg of CO_2e per functional unit. In this study the embodied carbon or GWP was calculated on the basis of the extraction and production stage (modules A1-A3 as set out in EN 15804), i.e. from cradle to factory gate. Values of GWP are shown in Table 2.

For the products which contained wood or biomass, there is a storage of the carbon which was sequestered in the forest. For this study the kg of stored sequestered carbon was calculated as kg CO_2e per kg of material, and was calculated based on the chemical composition of timber. Values are shown in Table 2. This allowed an analysis of duration of storage to be undertaken within a separate part of the project.

Table 2. Embodied carbon emissions and sequestered carbon stored by the products used in the housing archetypes.

Material	**Data source**	**Emissions intensities (kg CO_2e/kg)**	**Sequestered CO_2 (kgCO_2e/kg)**
Sawn wood	Wood for Good EPD	0.189	-1.598
CLT	Stora Enso EPD	0.318	-1.555
Wood-based panels	OSB Kronoply Gmbh EPD	0.128	-1.593
Plasterboard	Gyproc Wallboard EPD	0.251	-0.072
Fibre insulation	Knauf glass wool EPD	1.162	0
PUR insulation	PUR average (Hill et al 2018)	2.900	0
Brick	BRE UK brick EPD	0.158	0
AAC block	BRE AAC EPD, IBU EPD	0.280	0
Cement mortar	CAPEM GB	0.204	0
Reinforced concrete	Ecoinvent 3	0.295	0
Fibre cement rainscreen cladding	Rockwool Rockpanel EPD	1.752	0

RESULTS

Single house model

The profile of embodied carbon associated with the building materials present in the dwellings was calculated. Figure 4 shows the profile for a timber framed and a masonry system used in the detached 4-bedroom house. It is clear that the total embodied carbon in the timber framed example is lower than for the masonry structure, and the difference can be traced to a reduced requirement of mortar, a reduced use of AAC blocks (lightweight autoclaved aerated concrete blocks). Other elements vary, relating to differences in the quantities required in the two systems. The increased timber and WBPs usage has a relatively minor impact on the total embodied carbon as it is outweighed by the offset made in cementitious materials.

By exchanging the brick facing of the timber framed house with a timber cladding option, a further reduction in embodied carbon was seen (Figure 5). An intermediate level of reduction was seen when the brick facing was exchanged for a fibre cement rainscreen cladding system. Both options offer simple additional steps to reduce the embodied carbon of a new build house.

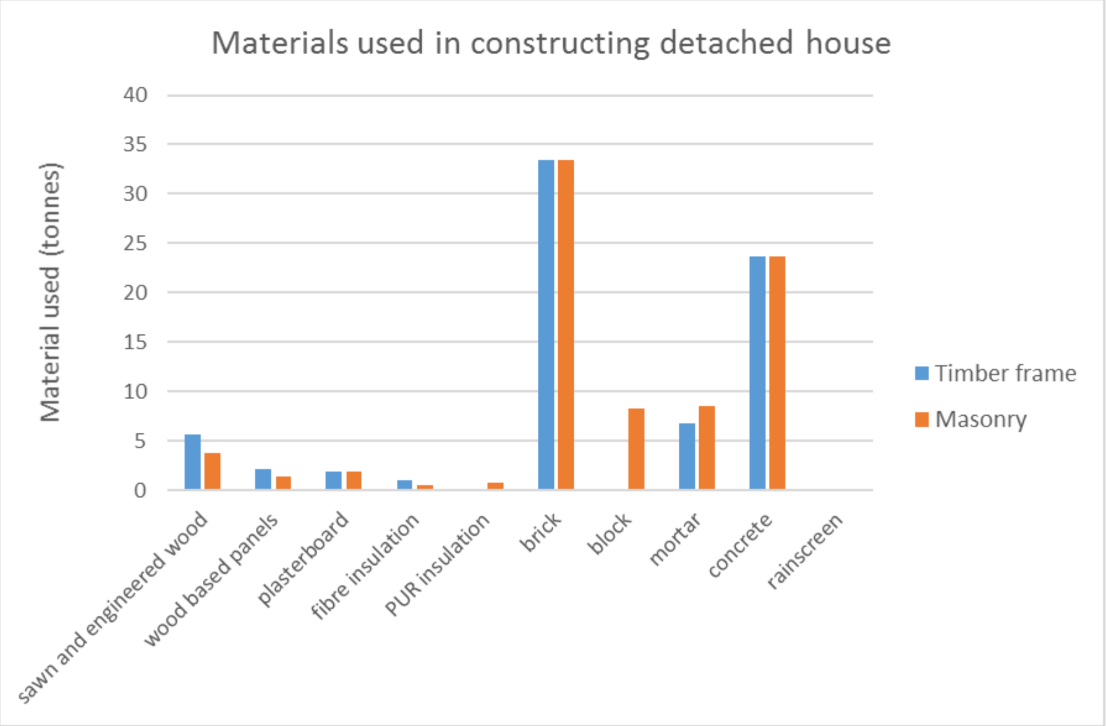

Figure 4. Comparison of materials used in a timber framed and a masonry 4-bed detached house.

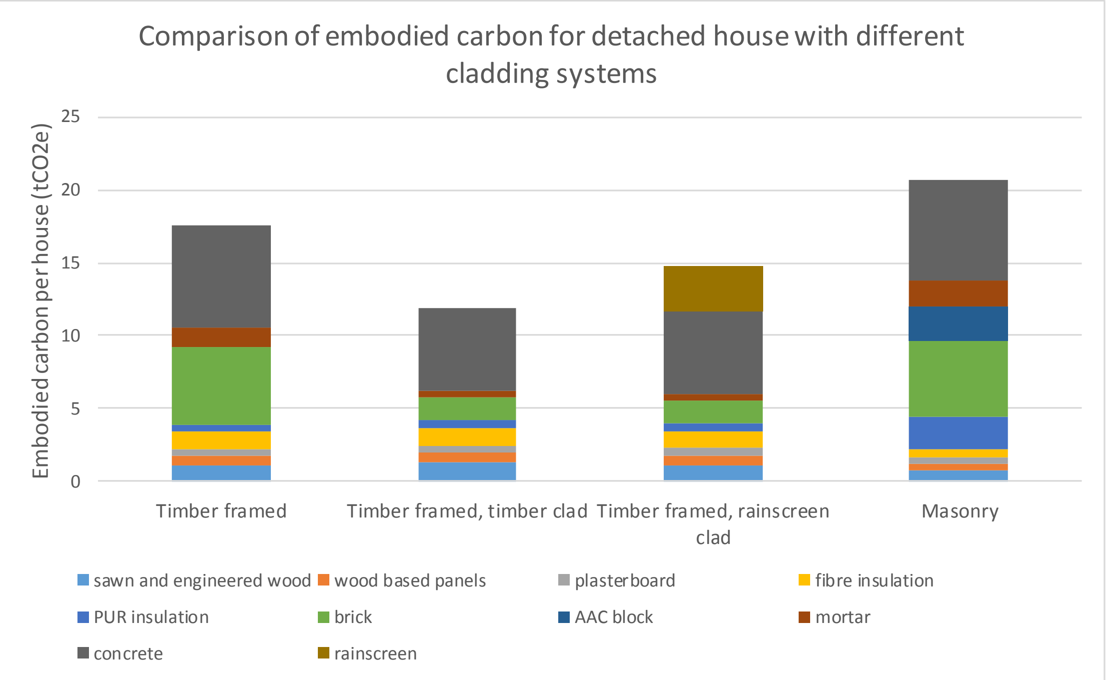

Figure 5. Embodied carbon associated with the materials used in four detached house designs. Timber framed (with masonry cladding), timber framed with timber cladding, timber framed with fibre-cement rainscreen cladding and brick and block masonry system.

A similar comparison process could easily be used to consider other permutations of wall design, such as closed panel timber frame, structural insulated panels (SIPs), other insulation materials, other brick options or different combinations of thicknesses of each layer while retaining the desired level of thermal performance (U value).

The calculation process easily allows identification of material elements which contribute significantly to the carbon emissions of the structure. In this example the cladding systems offer a reduction compared to brick facing on the exterior of the house. In the lighter weight structures it may also be possible to reduce the quantity of concrete used in foundations. Therefore building level evaluations such as this offer a significant tool to the housebuilder or architect in optimising designs for embodied carbon.

For the same house designs the stored sequestered carbon was calculated (Figure 6). The timber and wood based panels are seen to offer a storage function which is significant, in this case 72% of the embodied carbon would be offset by the carbon stored in the structural elements. However, caution is required when comparing the values of sequestered carbon with the embodied carbon emissions, as the storage function is time-related. Discussion about appropriate methods for comparing or combining this data are still under way. For clarity, throughout this paper, and the study which it is based upon, the two quantities were reported separately as is best practice in the field.

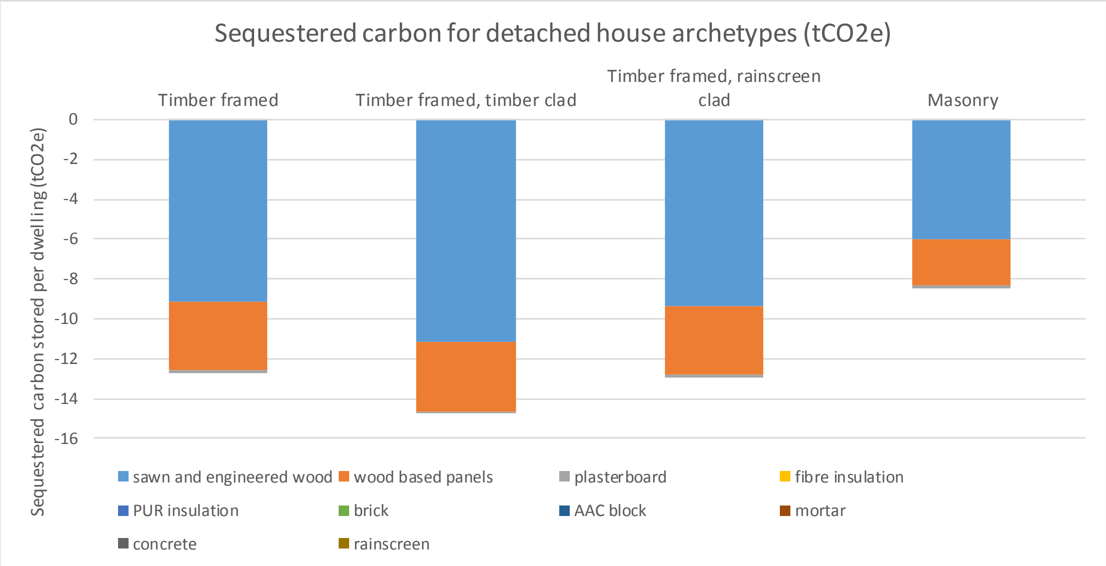

Figure 6. Sequestered carbon stored in structural elements of the building.

It is notable that in the detached house example above, the WBPs used in flooring, wall panels etc. contributed significantly to the storage of sequestered carbon within the building. There was still a relatively large contribution from WBPs in the masonry houses. A similar effect was seen for the other housing archetypes studied. In the semi-detached and terraced houses there was OSB within party walls and spandrel panels within the roof space, in addition to the timber frame wall elements and floor cassettes.

Table 3. Stored sequestered carbon within wood elements within the timber framed house archetypes, expressed as weight CO_2e per floor area, units $kgCO_2e/m^2$.

	Detached	Semi-detached	Terrace of 20 units	Bungalow	Flats (block of 12 units)
Sawn timber	77.95	75.47	72.86	93.44	56.59
Wood based panel	29.37	28.26	29.11	15.6	39.51
Plasterboard	1.14	1.46	1.51	0.75	1.33
Total	108.46	105.19	103.48	109.79	97.43

Within the timber framed houses, the stored sequestered carbon per square metre was compared. This has been attributed to sawn timber, wood based panels and the paper content of plasterboard as shown in Table 3.

The quantity of timber, OSB and particleboard used is influenced by the floorplan of the dwelling. However a greater influence was the number of storeys (note that bungalows stored more CO_2 in solid wood and less in WBPs than two-storey houses on a per floor area basis). In the block of flats, which had three storeys the quantum of timber used was lower and wood based panels higher, due to the greater proportion of wall elements in this additional storey, and in the internal walls separating flats, which were a different composition than simple internal partitions in the detached house.

It is clear that considering timber use on a floor area basis provides a reasonable method for estimating the stored sequestered carbon in other similar designs. For example, between the detached house and the semi-detached house the difference in floor area (117 m^2 compared with 84.4 m^2) had a very minor effect on the total stored sequestered carbon per area (108.46 $kgCO_2e/m^2$ cf. 105.19 $kgCO_2e/m^2$). Given that many residential properties in the UK are two-storey, 105 $kgCO_2e/m^2$ might provide a useful rule of thumb for estimating the carbon storage by timber frame. However differences may become significant if buildings are of different height, or if future designs are constructed with differing dimensions of timber, for example altering panel thickness to accommodate different insulation materials etc.

Projections for national WBP use in residential construction

The calculated data for materials utilised in the individual dwellings can be used to estimate quantities used in large numbers of houses and flats, e.g. within a new build development in one town, or aggregated to represent national activity. For example a model of 190,000 dwellings could represent approximate building activity in 2017-18 (where actual reported housing starts were 193,390 for the UK, (National Statistics, 2019)).

Using an average split of 31% flats, and 69% houses, it is possible to approximate the materials consumed, and the associated embodied carbon, and stored sequestered carbon. Within the houses, an assumed proportion of 24% detached, 10.5% semi-detached, 15.5% end terraces, 17% mid-terraced houses, and 2% bungalows was used. Timber framed and masonry flats in structures of nominally 3 storeys were used and concrete and CLT were used in taller structures (nominally 6 storeys).

Using the reported percentage of timber framed dwellings 28% (STA, 2016), and an estimated 0.3% of flats in CLT, a profile of materials used to construct new buildings on a national scale was generated. This used 772 kt of timber and wood products in the structural elements, alongside 151 kt of insulation products, 4.472 Mt of brick and block, 916 kt of mortar and 5.023 Mt of reinforced concrete. Other elements such as plasterboard and fibre-cement rainscreen cladding were also calculated. The embodied carbon associated with these materials is shown in Figure 7.

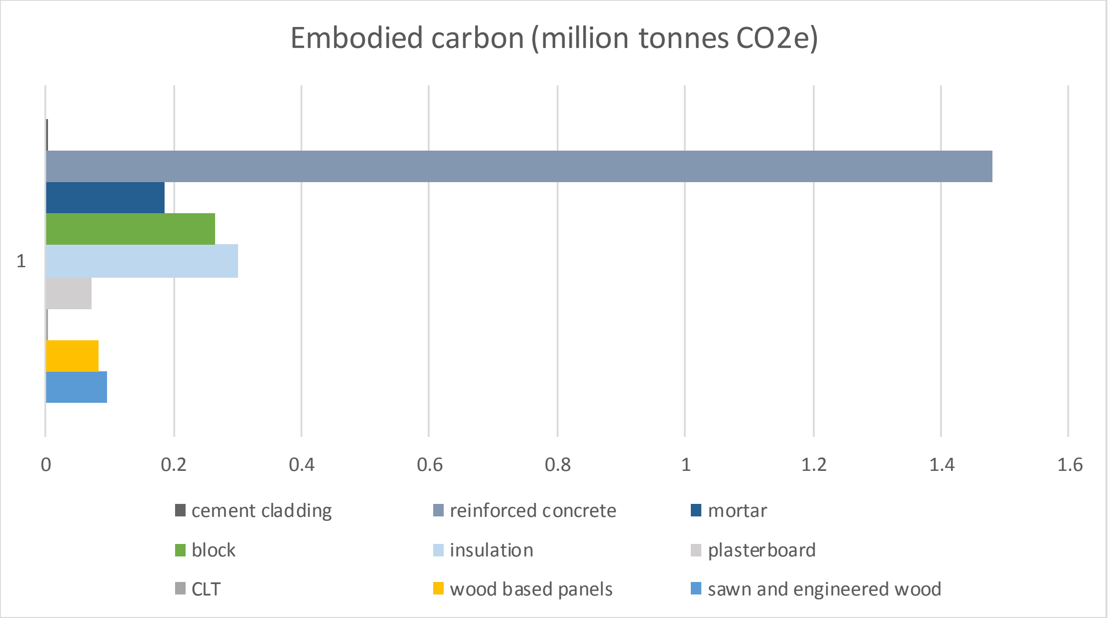

Figure 7. Embodied carbon associated with the various construction materials present in 190,000 new build dwellings.

Within the timber and wood based materials, wood based panels are an essential element. The open panel timber frame system relies on the load distributing properties of the oriented strand board (OSB) skin to deliver rigidity and resistance to shear forces in service. Flooring systems also use the load bearing properties of particle board and OSB to good effect. Many other minor components within the wall or roof may use plywood or OSB for load transfer, for example in hipped roofs or as backing plates for electrical ducting.

As a result, the wood based panels comprised 33.9% of the total wood products used in the superstructure. CLT, as a niche market comprised only 0.2%, however this is likely to change rapidly as numbers of CLT projects increase, due to the large volumes of this product used per dwelling.

In the case where the timber frame market share increases, the consumption of wood based panels for housing remains strong (reaching 30.2% of wood use at 100% timber frame adoption), and if masonry systems are preferred then percentage WBP consumption *appears* to rise (reaching 41% at 100% masonry systems) due to the decrease in sawn timber used, but the actual quantity of WBPs used decreases. This consumption depends on exact details of the masonry building systems, i.e. flooring options.

On the national scale, the embodied carbon associated with the superstructure and foundations of 190,000 new build dwellings (using the above split of house types and timber frame, masonry, concrete and CLT) was calculated to be 3.041 Mt CO_2e. This figure would be increased if all services and fittings were included in the house model (i.e. plumbing ceramics, metal pipework, electrical cables, ventilation ducting, glazing, internal joinery etc). These were omitted from the study to allow the main effects of structural elements to be considered. It can be reasonably assumed that the mixture of such components varies uniformly across all house types, and is not specifically affiliated to the timber frame system or the other structural system employed.

Note that the figure here is low compared to the 45 Mt associated with construction activity as a whole in Figure 4 (data for 2012, from Green Construction Board, 2015). This is due to the relatively small size of the carbon emissions of residential construction, when compared to other forms of activity, such as infrastructure and non-residential buildings. Differences in material systems used (such as the greater reliance on concrete and steel) will lead to very different trends being seen in these sectors. The 17% domestic construction contribution to capital carbon in construction in 2012 was 7.65 $MtCO_2e$. The 3 $MtCO_2e$ calculated here for life cycle stages A1-3 compares well, with the balance being made up of the additional fixings and fit out, as well as the life cycle stages which were not included in the current study (transport, on site activities, demolition etc).

DISCUSSION

It is clear that wood based panels are an integral and essential part of the timber framing system. As a result, there is a great onus on producers to maintain output of the grades of OSB and particleboard which are required in timber framing, e.g. OSB3 and P5 which have the necessary moisture resistance and load bearing qualities. There is also a clear case to argue for ongoing access to the necessary small roundwood feedstock required to maintain this performance quality, to support the housing market.

Wood availability is an ongoing concern for wood based panel mills. Reports of expansion in the bioenergy sector have sparked concerns. Biomass energy produced 10% of UK energy in 2017, compared to 3% on 2008 (CCC 2018). The strength of the pallet and packaging sector, and the cost of imports following Brexit (in addition to the anticipated delays at borders) may also increase pressure on domestic timber reserves. Other factors such as the lack of data on wood consumption by combined heat and power plants have also been raised by the industry (Heald 2018).

There are signs that the wood based panels industry needs to be proactive in this market. For example one UK mill recently invested in new planting to ensure access to timber supply in the future. Nevertheless, consideration of wood availability on the longer time horizon may be more stable. The CCC report Biomass in a low carbon economy (CCC 2018) explored the available timber supply, and revised their prioritisation of timber. The preferred use is in long term applications such as structures, while short term solutions (such as burning biomass for energy) will increasingly be combined with carbon capture and storage. The report also called for forest planting to increase, with an extra 27,000 ha per annum until 2030 advised. An important finding was that per tonne of biomass used, timber in structures had the greatest effect in both sequestering carbon, and displacing higher carbon materials.

Currently UK sawmills produce 3.7 million cubic metres of sawn timber p.a. from 6.5 million green tonnes of timber (Forest Research 2019). Particleboard and OSB production is 3.1 million cubic metres, using 1.2 million green tonnes of roundwood and a significant input of recycled wood (1.6 million green tonnes ex sawmill and 0.9 million tonnes of recovered wood). Total removals of softwoods are higher, 11.4 million green tonnes, and also supply the pulp and paper industry, wood fuel, export and other uses such as round fencing.

An important point to note is that recycling of timber, either direct from wood processing industries such as sawmills, secondary processors and wood users provides an additional supply. For the quantities of timber used within the housing model above (508 kt of sawnwood), the roundwood intake requirement was 2.082 million m^3 of roundwood. From this volume it was possible to cut the required 1.041 million m^3 sawn wood, generating a significant quantity of sawmill residues (bark, slabwood, chip and sawdust). It was also estimated that felling these trees was estimated to be associated with generating 339 thousand m^3 of small roundwood (from the tops of the trees). Thus, although the reported oven dry material required for structural elements was small, the forest generated a significant volume of co-products, suitable for supplying the wood based panels sector and other sectors.

It is possible to use these co-products to good effect in the wood based panel industry, or to supply onward into biomass energy, pet bedding, landscaping and other recycled wood products. While small roundwood is the preferred intake of OSB mills, the particleboard and MDF sectors may find reliance on recycled material supports future activities. However, even here competition for wood residues with the wood pellet and bioenergy industry again emerges.

CONCLUSIONS

This paper has presented several essential steps in considering how wood based panels may contribute to greenhouse gas abatement.

Timber is a low embodied carbon material, which can significantly contribute to reducing the embodied carbon of building activity.

In the housing archetypes studied, the effect of using timber frame to displace masonry systems was shown to reduce the embodied carbon for all designs.

The quantity of timber within the timber framed houses was greater than the quantity present in the masonry houses, leading to a greater quantity of stored sequestered carbon in the timber framed houses.

The use of wood based panels within timber frame structures is significant, and depending on house type, up to 27% of the stored sequestered carbon was due to WBPs. In the timber framed flats, 40% of stored carbon was within WBP elements.

Future availability of timber to produce the structural elements required within timber frame housing was considered. Access to UK grown timber, especially the roundwood required for OSB manufacture, is important to support the growth of timber frame in the housing sector, and the GHG abatement which this achieves. This is compatible with cascading use of sawmill co-products into other applications.

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