Timber Development UK

Assessing the carbon-related impacts and benefits of timber in construction products and buildings

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EXECUTIVE SUMMARY

Forests and carbon

Although in some areas of the world, in particular the tropics, the amount of forest is decreasing, in many parts of the world the amount of forestry and of carbon stored in the biosphere is increasing. For Europe, over the last ten years, an average balance of 570 million tonnes of CO_2 has been added to its forestry carbon sink each year[1]. Converting land to forest results in increased soil carbon in most cases[2], but this increase cannot be taken into consideration according to the EN 15804+A2.[3]

In Europe, the amount of biogenic carbon stored in harvested wood products increases by around 40 million tonnes of CO_2 each year.

Considering carbon sequestration in timber products

Essentially, if timber is sourced from a sustainably managed forest, then the sequestered biogenic carbon stored within the product can be considered as part of the assessment. However, if timber is not sustainably harvested, it does not have the benefit of any biogenic carbon sequestration.

If sequestration is allowed, according to Table two, then the sequestered carbon is considered to enter the system when the timber is harvested and this is reported with the impact indicator, Climate change – biogenic (EN 15804+A2) or the Global Warming impact indicator (EN 15804+A1). The removal of CO_2 from the atmosphere is considered as a use of the resource, CO_2 from nature, with a GWP of -1 $kgCO_2e/kg\ CO_2$ used – this is equivalent to an emission of -1 kg CO_2.

In Module A1 (extraction), all the impacts of forestry are accounted for. This covers all the processes that are involved in producing the timber, including growing and planting of seedlings, protection (e.g. from rabbits), maintenance of the forest, for example regular thinning, the construction of any roads to enable harvesting, and the harvesting of timber itself. Carbon sequestration is also reported within Module A1 as this is the point at which the biomass enters the technosphere. If the product modules are aggregated, then sequestration is reported within Module A1-A3.

Product manufacture

Sawmills and other timber processing plants now generally use waste from processing the timber (e.g. bark, sawdust, chipped offcuts etc) as fuel for the kilns, and many use CHP plants so that they can generate electricity as well as heat.

As the product leaves the factory gate, in addition to reporting sequestration as part of module A1, the amount of sequestered carbon within the product (whatever the source of the timber) should also be reported separately in the EPD, for both the product, and any biobased packaging (unless this is less than 5% of the mass of the product or packaging respectively).

Transport of timber

Timber is often imported into the UK, but this is commonly undertaken by ship which is generally a very low carbon way of moving goods compared to road.

End of life of timber

Data from the Environment Agency's Waste Interrogator 2018[4] suggest that less than 1% of waste wood ends up in landfill. The Timber Development Uk Wood Information Sheet WIS 2-3/59[5] provides information on which types of timber product can be recovered using the different routes, and this should inform the choice of likely end-of-life routes for different timber products.

Timber end of life routes differ in the amount of time that the sequestered biogenic carbon will stay stored in the next product system if the timber is recovered – particleboard, for example, is expected to keep the sequestered carbon out of the atmosphere for 30 years or more, whereas secondary fuels, animal bedding and surfacing are expected to release all their sequestered carbon within 1 year.

It is now common for waste timber from the UK to be used for energy recovery or to be incinerated, either in the UK or overseas. Energy from waste (EfW) plants are classified as providing energy recovery or incineration based on their thermal efficiency. In the UK, EfW produces nearly 5 times more electricity than heat, and as the grid decarbonises, the avoided impacts of EfW in the UK will decrease accordingly.

For products such as preservative treated timber or panel products, combustion in an EfW in the UK or abroad is a more likely fate than recycling due to the presence of preservatives and resins. For all products sent to EfW at end of life, the impacts of combustion are included in C3 for energy recovery processes and C4 for incineration. For both energy and incineration, the avoided impacts of any heat or electricity recovered from the process can be considered in Module D. For a building assessment, it is for the building assessor to decide the fate of materials at the end-of-life.

If a building has been specifically designed for deconstruction, then it should be possible to reuse many more products and components, and to have a lower level of downcycling of materials, than if the building is a conventional design.

The RICS Professional Statement provides an EoL scenario for all timber of 75% energy recovery, 25% landfill. As described above, this default is no longer considered appropriate and is in review by the Statement's authors. Where specific data is not available, we therefore recommend the figures in table 4 are used as the default end of life routes for different timber products, based on data from the Wood Recyclers Association provided in TRADA's Wood Information Sheet 2-3/59.

Reporting at building level

If an assessment of embodied or whole life carbon is undertaken at building level, carbon sequestration, alongside all biogenic carbon emissions and removals, is considered throughout the building life cycle, and also within Module D, which should also be assessed to inform the study (see Figure 4). But if only upfront carbon (Modules A1-A5) is assessed at building level, or if upfront carbon is to be considered as a separate indicator alongside embodied carbon and/or whole life carbon (for example for an upfront carbon benchmark) then the biogenic carbon sequestered in the products used should not be included in the assessment of the upfront carbon result.

For assessments of embodied carbon, operational carbon and whole life carbon at building level, there is no need to exclude carbon sequestration, and the GWP (EN 15804+A1) or Climate Change - total results (EN 15804+A2) from EPD can be considered in reporting all modules.

Conclusion

Assessing the carbon-related impacts of timber is complex, but this paper is intended to provide a clear explanation of the approach set out in the relevant European Standards and in the RICS Professional Statement on Whole Life Carbon Assessment for the Built Environment. The storage of biogenic carbon within sustainable timber used in buildings is beneficial, as it keeps this carbon out of the atmosphere for an extended period of time. By accounting correctly for the sequestration of biogenic carbon, and its emission or transfer at end of life, this benefit can be clearly shown within an EPD, and within an Embodied or Whole life Carbon assessment of buildings or infrastructure.

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THE CARBON-RELATED IMPACTS OF TIMBER

Carbon related impacts generally

Carbon related impacts are normally measured in life cycle assessment (LCA) and environmental product declarations (EPD) using global warming potential (GWP). The GWP is a way of measuring the impacts of different gases which affect global warming and hence affect climate change. Gases which cause global warming are known as greenhouse gases (GHG) because they cause the earth to heat up in a way analogous to the way a greenhouse heats up. Solar radiation can enter the earth's atmosphere but when the planet radiates the heat it has absorbed back into the atmosphere it is at longer, infrared wavelengths that GHGs can absorb and so trap some of the heat within the atmosphere. If there are too many GHGs then global warming results. The GWP for 1 kg of a greenhouse gas is measured relative to the impact of 1 kg of carbon dioxide (CO_2) over the same time period – normally 100 years is used for EPD, but assessments over 20 and 500 years are also possible. This is because different GHGs decay in the atmosphere over different time periods and because they vary in how effective they are at absorbing energy radiated from the planet, and so they have different impacts over different time periods. The Intergovernmental Panel on Climate Change (IPCC) is the global organisation which provides regular assessments of the GWP of greenhouse gases, as part of their regular assessment reports. The most recent report published was Assessment Report 5 (AR5) published in 2014, the IPCC is expected to publish AR6 shortly.

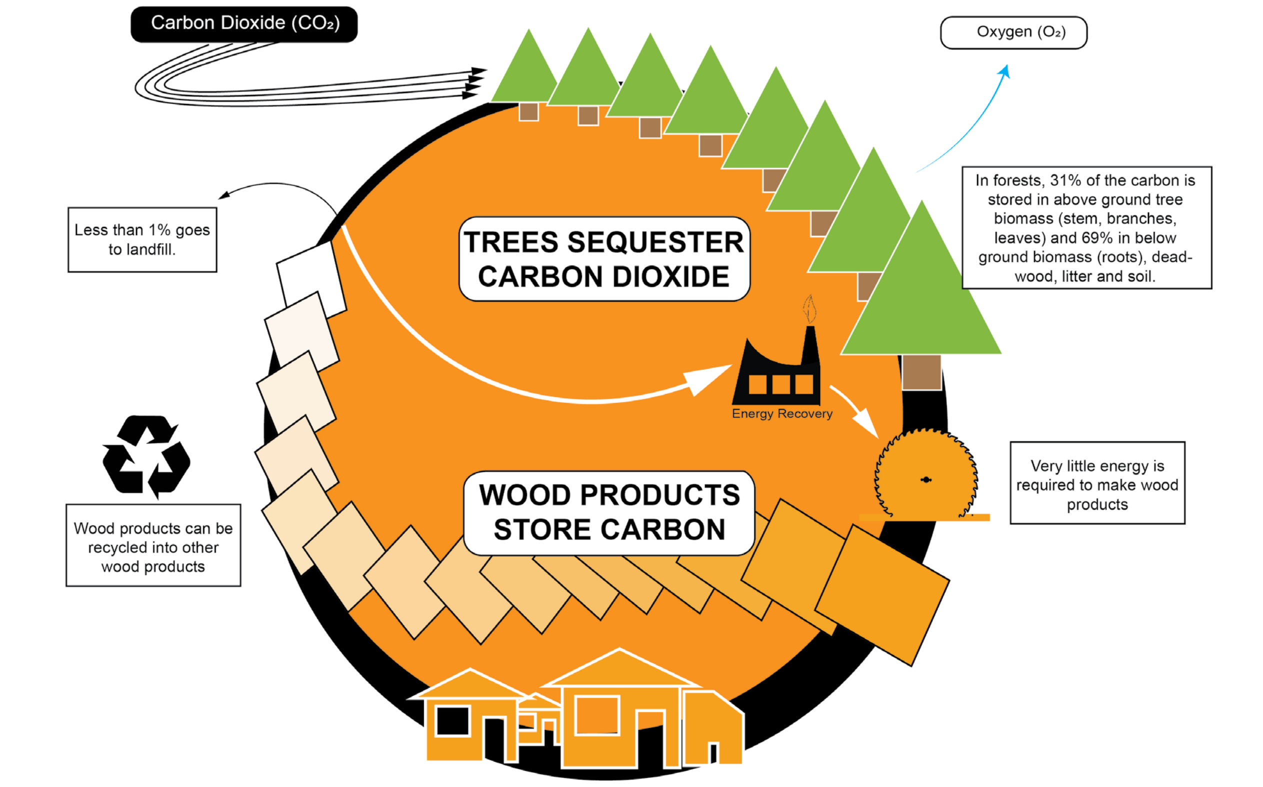
Because it is measured relative to CO_2, the GWP of CO_2 is always 1. Other greenhouse gases have higher GWP, the main ones are shown with their GWP (100 years) taken from AR5 as used in EN 15804+A2, and from AR4 (2007) as used in EN 15804+A1. The differences between AR5 and AR4 are explained by the inclusion of indirect climate change impacts in AR5 (for example, carbon monoxide is assumed to decay to carbon dioxide, so in AR5 the emission of 1 kg of carbon monoxide is assumed to lead to the indirect emission of 1.57 kg carbon dioxide. However, the differences between AR4 and AR5 are not expected to lead to significant differences in impact for most products.

Table 1: Global warming potentials (GWP) of key Greenhouse Gases over 100 years		
	EN 15804+A1 (IPCC AR4)	EN 15804+A2 (IPCC AR 5)
Greenhouse Gas	GWP (100 years)	GWP (100 years)
Carbon dioxide (CO_2)	1 kg CO_2eq	1 kg CO_2eq
Carbon monoxide (CO)	0 kg CO_2eq	1.57 kg CO_2eq
Methane (CH_4)	25 kg CO_2eq	36.75 kg CO_2eq
Nitrous oxide (N_2O)	300 kg CO_2eq	298 kg CO_2eq
Halons	<7100 kg CO_2eq	3-1750 kg CO_2eq
Hydrofluorocarbons (HFCs)	120-15000 kg CO_2eq	0-13900 kg CO_2eq
Hydrofluoroethers (HFEs)	59-15000 kg CO_2eq	2-14000 kg CO_2eq
Perfluorocarbons (PFCs)	7500-9200 kg CO_2eq	0-12300 kg CO_2eq
Sulphur hexafluoride (SF_6)	23000 kg CO_2eq	26100 kg CO_2eq

CO_2, CO and N_2O are commonly produced from the use of fossil fuels. But other processes can also cause the release of these gases and other GHGs, for example the calcination of limestone during the production of cement and lime causes an emission of CO_2, and the production of aluminium causes a process emission of SF6. Halons, HFCs and HFEs are chemicals used in fire suppression, as solvents, refrigerants or as blowing agents for foamed insulation for example. As can be seen in Table 1, they have a very wide range of impacts, so it is really important to check that any products and processes are using chemicals with low-GWP.

In addition to processes that emit GHGs, there are also processes which remove GHGs from the atmosphere. The most well-known process, and the process, which after our oceans, removes the greatest amount of carbon from the atmosphere annually is photosynthesis. In photosynthesis, plants use sunlight, CO_2 and water to produce carbohydrates which are incorporated into the plant. We call the carbon which is removed from the atmosphere and incorporated into plants (and animals, when they eat plants) biogenic carbon. In fact, the largest store of terrestrial biogenic carbon is in the soil. This is because when plants including trees lose leaves or die, the biomass is drawn into the soil to produce humus. It is estimated that 19% of the carbon in the terrestrial ecosystem is stored in plants, and 81% in the soil[6]. In all forests, tropical, temperate and boreal together, approximately 31% of the carbon is stored in above ground tree biomass (stem, branches, leaves) and 69% in below ground biomass (roots), deadwood, litter and soil.

Diagram one: Timber and the carbon cycle



Along with coastal ecosystems (e.g. mangroves[7]), forests are one of the largest and long-term stores of atmospheric carbon. Although in some areas of the world, in particular the tropics, the amount of forest is decreasing, in many parts of the world, the amount of forestry and of carbon stored in the biosphere is increasing, and for Europe, over the last ten years, an average balance of 568 million tonnes of CO_2 has been added to its forestry carbon sink each year[8]. When timber is harvested, although there is a short-term release of carbon from the decay of carbon within the root system and of some soil carbon, if the forest is sustainably managed and allowed to regrow (whether naturally or as managed replanting) then this emission is soon matched by the uptake of carbon back into the roots, tree, and soil of new trees.

Sustainable Forest Management	Types of harvesting
The Food and Agriculture Organisation of the United Nations (FAO) states the aim of sustainable forest management (SFM) is to ensure that forests supply goods and services to meet both present-day and future needs and contribute to the sustainable development of communities. Certification programmes such as Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification (PEFC), Grown in Britain (GiB) and the UK Woodland Assurance Standard (UKWAS) provide third party certification that timber is sourced from sustainably managed forests.	There are two main approaches to harvesting. In clear felling, used for the majority of softwood, an area of forestry is all harvested at the same time, restocked, and then harvested for the next rotation. This has been common on Forestry Commission land in the UK, and until recently was often based on a single species. In continuous cover, used for the majority of hardwood, an area of forest is managed by the felling of individual trees and often natural regeneration with a mix of species so that cover is always maintained. This type of forestry is necessary on steep slopes to avoid soil erosion, and allows the forest to have greater amenity and landscape value.

When deforestation occurs, and the land is cleared and used for another purpose (e.g. agriculture) then there is an emission of the soil carbon which can be considerable and which is not recoverable. The carbon which is emitted from deforestation is covered by the assessment of carbon from land use and land use change. These impacts are normally allocated to the product that caused the deforestation – so for example, if rainforest is cleared to grow palm oil, then the land use and land use change impacts would be allocated to the palm oil, not the timber. However, as the timber was not sustainably harvested, it would not have the benefit of any biogenic carbon sequestration (see below).

CARBON DEFINITIONS (source WLCN Network)

Carbon Neutral: All carbon emissions are balanced with offsets based on carbon removals or avoided emissions. (No reduction in emissions is necessary)

Net Zero: All carbon emissions are reduced in line with the Paris Agreement 1.5°C trajectory, with residual emissions offset through carbon removals.

Absolute Zero: Eliminating ALL carbon emissions without the use of offsets.

Harvesting timber allows much of the biogenic carbon sequestered in the trees to be transferred into products. Across Europe, nearly 75% of harvested timber is used for products and around 25% for energy[9]. For timber products used in construction, this means that the carbon is likely to be stored out of the atmosphere for many years[10]. In Europe, the amount of carbon stored in harvested wood products increases by around 40 million tonnes of CO_2 each year . As we increase the amount of timber used in our built environment, then countries are able to use this increase in “harvested wood products”, alongside the increase of biogenic carbon in forestry, as a benefit in their national carbon accounts which are provided as part of the Paris Agreement to track progress in reducing GHG emissions and minimising climate change to less than 1.5°C. To minimise double counting, within their national accounts, countries only count the net increase (or decrease) in carbon in their own forests and the net increase (or decrease) of harvested wood products that come from their forests (i.e. that might be used in any country).

Versions of EN 15804

EN 15804, the European standard providing the core product category rules for Environmental Product Declarations (EPD) for construction products, was first published in 2012. In 2013, EN 15804:2012+A1:2013 (EN 15804+A1) was published, providing additional detailed information on the impact assessment approach to be used.

In 2019, EN 15804:2012+A2:2019 (EN 15804+A2) was published, aligning the standard with the European Commission’s Product Environmental Footprint (PEF). This updated reporting guidelines for biogenic carbon, made Module C and D mandatory and changed the impact indicators used. EPD are now being produced using EN 15804+A2.

To allow for the transition, and the requirement for EN 15804+A1 EPD in building assessments to EN 15978 , EN 15804+A1 will remain valid in 2021 and EPD to EN 15804+A1 will be produced until the end of 2021 with a five year validity.

EN 15978-1 will be published later in 2022 and assessments using it will only use EPD to EN 15804+A2. There will be a period of transition whilst building LCA tools and building certification schemes move to use EN15978-1 and EPD to EN 15804+A2.

When forests are managed sustainably and the timber is harvested, then the carbon in the above ground biomass (the tree trunk and branches) enters the technosphere (that part of the environment which is made or modified by humans). Some of the timber is normally used for energy (in the sawmill itself or as biofuel), and in this case the biogenic carbon returns to the atmosphere. Because the biogenic carbon which has been sequestered into the timber is matched by the biogenic carbon which is released when the timber is burnt, then it is sometimes incorrectly suggested that timber is “carbon neutral” (see definitions box above). However there are still carbon emissions from the management of the forest, harvesting, the transport of the logs and the processing of the timber which are caused by the use of fossil fuels, and emissions of other GHGs from combustion, so there are carbon emissions from using timber as a fuel which are not normally offset. BEIS/DEFRA[11] estimate that the overall impact of using wood pellets (including well to tank emissions as well as combustion emissions) is 52.8 gCO_2e/kWh, and 23.3 gCO_2e/kwh for wood chip, compared to 230 gCO_2e/kWh for using natural gas – so using timber as a fuel can be considered to reduce emissions, but it cannot be considered carbon neutral.

When we assess the embodied carbon of timber used in construction products and buildings, we can track this carbon as it is removed from the atmosphere into the biosphere, and then into the technosphere when it is used within products, and through to its eventual release into the atmosphere, when it is burnt or it decays, or when it is transferred to another product system, e.g. when it is recycled, or when it returns to nature, for example after a long period in landfill (see Diagram four). The biogenic carbon that is stored in products is known as sequestered carbon.

Assessing the carbon-related impacts of timber in construction products

To assess the carbon impact of timber products, the most important question is what type of forest produced the timber. All timber used in buildings removes carbon from the atmosphere through photosynthesis, sequesters it in the cellulose and lignin in wood, and stores this biogenic carbon out of the atmosphere over the life of the building (and potentially more lifetimes if it is reused, recycled or remanufactured), releasing it back to the atmosphere or nature when the timber decays in landfill or most commonly nowadays, is burnt with energy recovery. However this biogenic carbon neutrality is only assumed when the timber is sourced in a way which does not degrade our forests, although there are different approaches to assessing this.

Essentially, if the timber is sourced from a sustainably managed forest (see table 1), then the biogenic carbon sequestration can be considered as part of the assessment. If the timber is from a native forest (defined as any forest which is not a short-term forest, degraded forests, managed forest, or forests with short-term or long-term rotations – but perhaps more easily understood as primary forest, "old-growth forest" or rainforest, with the FAO estimating that 1/3 of the world's forests are primary forest[12]), then the biogenic carbon sequestration cannot be considered as part of the assessment. For other types of forest, then it will depend on which version of EN 15804 is being used, see Table two.

Table two: Approach to carbon sequestration depending on forest type and version of EN 15804

Source of Timber: Forest Type	EN 15804+A1	EN 15804+A2
Primary Forest - naturally regenerated forests of native species where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed[13]	No sequestration allowed. Impacts reported as Biogenic carbon	No sequestration allowed. Impacts reported as LULUC carbon
Native Forest – not short-term forests, degraded forests, managed forest, or forests with short-term or long-term rotations (EN 15804+A2)	No sequestration allowed. Impacts reported as Biogenic carbon	No sequestration allowed. Impacts reported as LULUC carbon
Uncertified Forest (No Art.3.4) - forests not operating under established certification schemes for sustainable forest management AND in a country which doesn't account for Article 3.4 of the Kyoto Protocol	No sequestration allowed. Impacts reported as Biogenic carbon	Not relevant
Uncertified Forest (with Art.3.4) - forests not operating under established certification schemes for sustainable forest management AND in a country with increasing carbon pools which does account for Article 3.4 of the Kyoto Protocol	Sequestration allowed. Impacts reported as Biogenic carbon	Not relevant
Any forests in countries with increasing forest carbon pools that account for Article 3.4 of the Kyoto Protocol	Sequestration allowed. Impacts reported as Biogenic carbon	Not relevant

Non-native forest - short term forests, degraded forests, managed forest, or forests with short-term or long-term rotations (e.g. UKFS)[14]	Not relevant	Sequestration allowed. Impacts reported as Biogenic carbon
Sustainably managed and certified forest - any forests which are operating under established certification schemes for sustainable forest management (e.g. FSC, PEFC, UKWAS, GiB)	Sequestration allowed. Impacts reported as Biogenic carbon	Sequestration allowed. Impacts reported as Biogenic carbon
Reused or recycled timber (irrespective of original source)	Sequestration allowed. Impacts reported as Biogenic carbon	Sequestration allowed. Impacts reported as Biogenic carbon

Note: Chain of custody certification by bodies such as Forest Stewardship Council, Programme for the Endorsement of Forest Certification, Grown in Britain, etc, demonstrates that wood meets the requirement to originate from certified forests.

If sequestration is allowed, according to Table 2, then the sequestered carbon is considered to enter the system when the timber is harvested and is reported with the indicator, Climate change – biogenic (EN 15804+A2), within Module A1 (extraction), as this is the point at which the biomass enters the technosphere. The amount of sequestered carbon is calculated using BS EN 16449:2014 Wood and wood-based products. Calculation of the biogenic carbon content of wood and conversion to carbon dioxide. Based on the chemical make-up of cellulose and lignin, the main constituents of timber, EN 16449 states that half the dry mass of any timber is carbon, so the amount of CO_2 which has been sequestered in the product is the dry mass of timber * 0.5 * 44/12, where 44 g is the relative molar mass of CO_2 and 12 g is the relative atomic mass of carbon. When provided, moisture contents for structural timber are normally in line with BS EN 13183-1:2002 which compares the moisture in the timber to the dry mass of timber as a percentage. The dry mass of timber can be calculated by removing the mass of any water given in the moisture content. In the UK, a moisture content of 12% (dry mass basis) is commonly assumed for structural timber. An example is provided below.

Example one: Calculation of sequestered carbon content for a timber product

Most timber is provided with moisture content on a “dry mass” basis, and provides densities for the given moisture content, so if timber has a density of 400 kg/m³ with a 12% moisture content, then this means that 1m³ of the timber weighs 400 kg/m³ including 12% of the dry mass of timber as moisture within it. You can therefore find the dry mass of the timber by dividing the density at a given “dry mass” moisture content by (100% + the moisture content %) so for this example, the dry mass would be **400 / (100%+12%) = 357 kg/m³.**

The biogenic carbon content would therefore be: **357 * 0.5 = 178.5 kg Carbon**

The amount of CO_2 sequestered in 1m³ of timber would therefore be **178.5 *44/12 = 655 kg CO_2/m³, to be reported in A1.**

Whether sequestered carbon can be considered in the assessment or not, the flows of biogenic carbon need to be tracked and accounted for throughout the system. So, if timber from a primary forest is used, then no removal of CO_2 and sequestration can be reported in A1, but any sequestered carbon which is emitted or transferred over the product life cycle must be considered; for example the emission of biogenic carbon from any use as fuel within the sawmill, or the transfer of sequestered carbon to another system if the timber is recycled for use in particleboard at end-of-life.

Where sequestered carbon can be considered, then the removal of CO_2 from the atmosphere is considered as a use of the resource, CO_2, from nature, with a GWP of -1 kgCO_2e/kg CO_2 used. When sequestered carbon cannot be considered, then either a GWP of 0 is used, or the removal is set to 0.

Emissions of biogenic carbon as CO_2 have a GWP of +1 kgCO_2e/kg CO_2 emitted, with emissions of biogenic methane having a much higher GWP (+25 in EN 15804+A1 based on IPCC 4 and 36.75 in EN 15804+A2 based on IPCC 5).

For EPD according to EN 15804+A1, biogenic carbon, fossil carbon and carbon from land use change are all considered using the single indicator, Global Warming, measured in kg CO_2e using the IPCC Global Warming Potentials over a 100 year timeframe from the IPCC 4th Assessment report[15]. For EPD according to EN 15804+A2, biogenic carbon, fossil carbon and carbon from land use and land use change are reported using the separate indicators, Climate change – biogenic, Climate change – fossil and Climate change – land use and land use change (LLUC), and also as an aggregated indicator, Climate change – total. All these indicators are measured in kg CO_2e using the IPCC global warming potentials over a 100 year timeframe from the IPCC 5th Assessment report[16].

As a physical property of the biomass, this needs to be done by looking at the physical flows of sequestered carbon. For example, when a tree is harvested, the log is the main output entering the technosphere. But during forest thinning operations, short round wood might enter the system for use in OSB production – in both cases the treatment is the same. As the log or short round wood is processed, the sequestered carbon needs to be tracked in the various outputs of the sawmilling process – for example the bark, sawdust, wood chips and sawn timber. If any of these outputs leave the product system, for example the bark might be sold for use as a mulch, then the sequestered carbon contained within them will be considered as an output from the product system too, this is discussed in detail below. If any waste timber is disposed of, then the biogenic carbon should be tracked until it reaches the end of waste state (at which point it is transferred to the next, recovered, product system) or through to final disposal (e.g. incineration, landfill[17]). If any of the timber is used for energy within the product system, for example sawdust and woodchip used as a fuel for the kiln or a CHP system, then its emission of biogenic CO_2 back to nature needs to be accounted for – this will balance the sequestered carbon which entered the system. If all these biogenic flows are considered, then only flows of other GHG such as biogenic methane that arise from the sequestered carbon (e.g. from landfill of waste timber), and the sequestered carbon which is in the final product itself will remain when the timber product leaves the factory gate.

There are thus two ways of accounting for sequestered carbon in a product and reporting biogenic carbon, which should both give the same net result for A1-A3 (i.e. when A1, A2 and A3 are added together):

1. Accounting for the sequestered carbon from the point the timber enters the product system in A1 and tracking all the resulting flows of biogenic carbon in A1 to A3 till the final product is at the factory gate, or
2. Only accounting for the sequestered carbon at the factory gate in A1, based on the actual biogenic carbon content of the product.

In both cases, any other biogenic GHGs such as methane need to be tracked and accounted for within the biogenic carbon calculation.

In addition to considering the biogenic carbon flows from sequestered carbon entering the system, the assessment needs to consider all the other impacts that are relevant to the timber.

For forestry, this includes all the human related impacts, for example due to stand establishment, tending, thinning(s), harvesting, establishment and maintenance of forest roads. These impacts can be allocated (divided up) between the different products/services of forestry (e.g. logs, short round wood, amenity etc) economically, on the basis of the revenue derived from the different co-products. The carbon impacts are reported within Climate Change – fossil and Climate change – biogenic, depending on the source of energy which is used. If bioenergy is used (for example a proportion of biodiesel for the transport of the logs), then the sequestered carbon within the fuel is reported in A1 and the emission of biogenic carbon is reported in the module in which it occurs (e.g. A2 for transport of logs, A1 for forestry operations).

In addition to the biogenic carbon within the timber, there is much more carbon stored within the roots, litter and soil of the forest, and flows associated with this carbon are considered using the indicator, Climate change - LULUC. For sustainable managed forestry, particularly where timber is harvested for use in construction, with each rotation, the amount of carbon in the soil and litter is stable or increases, even though there may be a short-term release of biogenic carbon as a result of disturbance during harvesting. Any increase in this “soil carbon” over each rotation however cannot be considered within the assessment according to EN 15804+A2, although it can be reported separately within the EPD. Some forestry practices such as the extraction of slash, litter or roots particularly associated with the use of timber for bioenergy can reduce the amount of soil carbon within the forest with each rotation. Where these processes are used then the associated reduction in biogenic carbon within the forest should be considered within the indicator Climate change – LULUC.

Converting land to forest results in increased soil carbon in most cases[18], but according to EN 15804+A2, this increase cannot be taken into consideration. For all types of forestry, any decrease in soil carbon needs to be considered using the indicator, Climate change – LULUC. As with the impacts of forestry, these should be attributed to the co-products of the forest using economic allocation, see example overleaf. Converting forest land to other uses will result in an emission of soil carbon. In this case, this release of soil carbon needs to be accounted for, by allocating between the output of timber from clearing the land and the new use of the land. If the land is being cleared to build a car factory, or for agriculture for example, then the main purpose of clearing the land is to produce cars and agriculture produce, so the impact of the land use change should be allocated to the cars or agricultural produce rather than the timber produced from clearing the land.

Example two: Allocating the impacts of forestry and sawmilling to its co-products

James Jones and Sons Ltd show the typical co-products of their UK sawmills as 55% sawn timber, 30% wood chips (used in particleboard, MDF and biomass fuel), 10% sawdust (used for particleboard and wood pellets), 3% bark (used for landscaping) and 2% shavings (used for animal bedding).

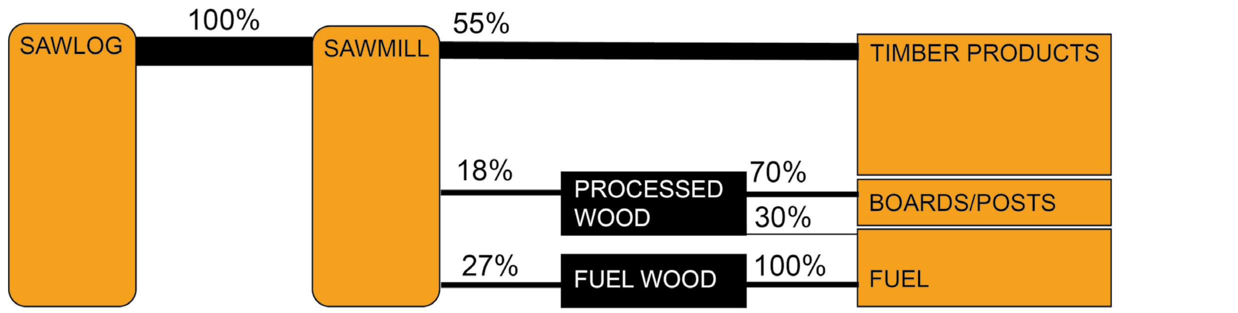
The sequestered carbon of the timber entering the sawmill will be allocated to the co-products on the basis of their physical content of sequestered carbon – if they all have the same moisture content then they will all have the same sequestered carbon/kg and the sequestered carbon will be split 55% to sawn timber, 30% to wood chip, 10% to sawdust, 3% to bark and 2% to shavings.

If, for example, only some of the products are kiln-dried using natural gas, then the impacts of the kiln can be considered separately and only allocated to the products which go through the kiln.

The impacts of forestry and the sawmilling process generally however are allocated to the co-products on the basis of their economic value (if kilning is considered separately, then all sawn timber should be considered with the value of non-kiln-dried timber to allocate the impacts of forestry and the sawmill). If the co-products are sold, then it should be simple to obtain the revenue stream per co-product. Where wood is used as fuel on-site, then these impacts stay in the system and the system impacts are just allocated between the remaining co-products. The amount of impact for each co-product is found by calculating the total revenue stream from all co-products, and then allocating to each co-product on the basis of the proportion of revenue stream.

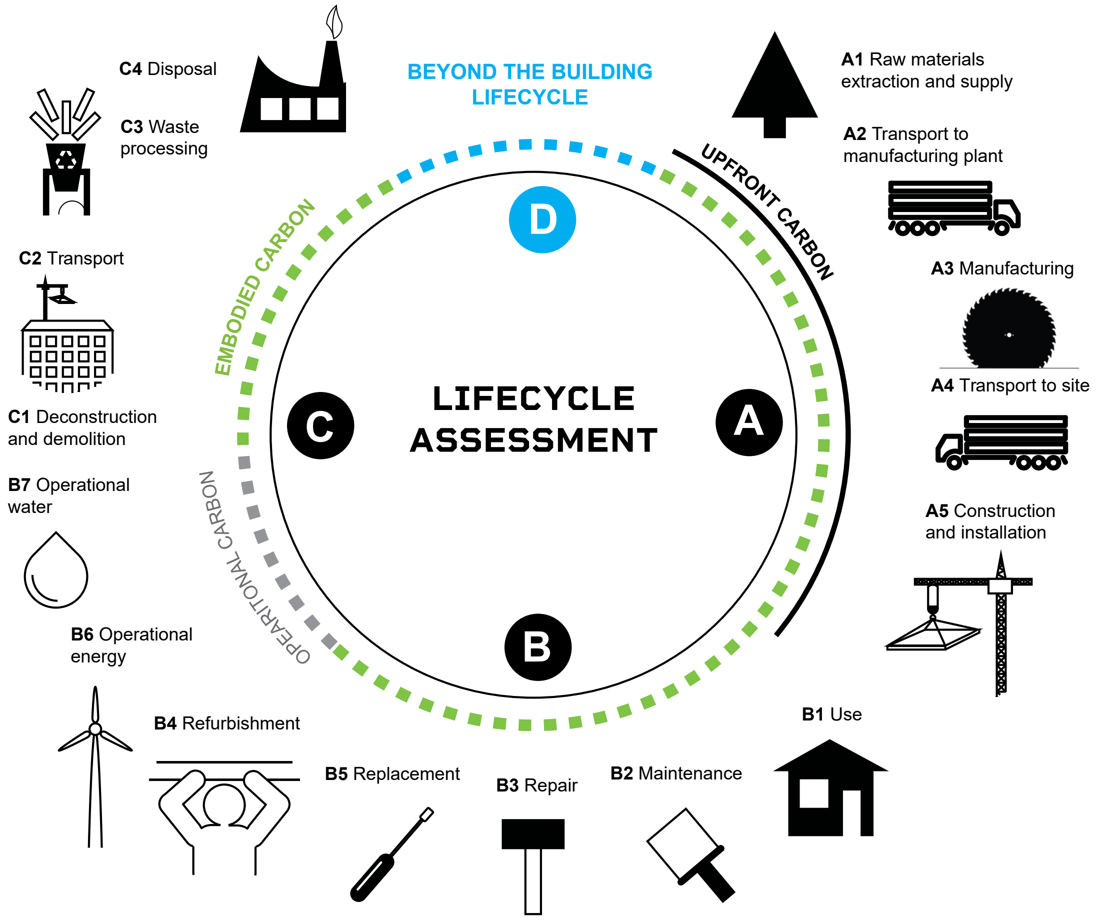
So if, for example, the sawn timber produced 70% of the total revenue of the sawmill, then 70% of the impacts of the forestry and sawmilling would be allocated to the sawn timber, and the impact per m^3 of sawn timber could be found by dividing the allocated impact by the total output of sawn timber.

Diagram two: Percentage of end-use product emerging from each process



HOW IS TIMBER ASSESSED IN EPD?

Diagram three: Whole life carbon assessment of buildings



A1-A3 PRODUCT STAGE | **A4-A5** CONSTRUCTION STAGE | **B1-B5** IN-USE STAGE |
B6-B7 OPERATIONAL CARBON | **C1-C4** END OF LIFE STAGE | **D** BEYOND THE BUILDING CYCLE

A1 – Extraction

In the A1 Module, all the impacts of forestry are accounted for. This covers all the processes that are involved in producing the timber, including growing and planting of seedlings, protection (e.g. from rabbits or deer), maintenance of the forest, for example regular thinning, the construction of any roads to enable harvesting, and the harvesting of timber itself. These impacts are normally "allocated" to the different products of forestry on the basis of economic value. Normally the production of logs is the most valuable economic activity, but income will also be derived from the thinnings for example which can be used for the production of OSB or fencing.

Based on EPD which report the impacts of A1/A2/A3 separately, the typical impact of this module for sawn timber products is around 50 $kgCO_2e/m^3$ – around half the impact of the "cradle to gate" product stage. This is because most forestry processes require fossil fuels to power vehicles and equipment, whereas sawmills (A3) increasingly use renewable fuels and energy and so have lower impacts.

We also account for the biogenic carbon sequestered in the final product in A1, as this is when this biogenic carbon enters the technosphere from nature – effectively in Year 0 of the product life. This is included as a removal of CO_2 from the atmosphere (a negative emission) to account for the sequestration of carbon dioxide into the timber – Example one above shows how this is calculated.

For engineered timber products, and panel products such as MDF or plywood, the dry mass of timber can be calculated by removing the mass of any adhesives or resins used first, and then removing the mass of any water given in the moisture content. Example three below shows how this is calculated.

EPD should provide information on the mass of the product declared in the EPD and they should also provide the material content of the product, so this should provide the adhesive/resin content of the product. This is normally given as a mass, or as the % by mass. The mass of wood can then be found by deducting the mass of adhesive/resin, or deducting the %.

Example three: Calculating sequestered carbon in a cubic metre of plywood

A plywood has a density of 480 kg/m^3 and is made up of 83% dry wood, 9% moisture by mass, 8% adhesive and hardener and <1% protective agent.

1 m^3 of this plywood therefore has 0.83*480 = 398.4 kg dry wood, and half of this is biogenic carbon (199.2 kg C). This means 730.4 kg of CO_2 (199.2*44/12) is sequestered in each cubic metre of plywood.

A2 – Transport to the factory gate

In Module A2, the transport of the outputs of the forest are taken to the sawmill or manufacturing plant. Reviewing EPD for sawn timber products where the EPD reports A1/A2/A3 separately, the impact of transport from forest to sawmill is between 6 and 19 $kgCO_2e/m^3$ of timber, generally just under 20% of the "cradle to gate" impact for the products. Although most vehicles use fossil fuels, this is low impact because generally sawmills and timber processing is located close to the forests, so transport distances are short. Where roads are built to access forests for harvesting, these impacts are included in A1.

A3 – Manufacturing

In A3, all the impacts for processing are included. For a sawmill, this will include the processing of the logs to remove bark and cut timber for drying, the drying process, which for hardwoods can often include preliminary air-drying, but for softwoods is normally just kiln-drying. Sawmills and other timber processing plants now generally use residues from processing the timber (e.g. bark, sawdust, chipped offcuts etc) as fuel for the kilns, and many use CHP plants so that they can generate electricity as well as heat. It may be cost-efficient, and environmentally preferable to use some of the timber input as fuel rather than for products, if this reduces the amount of fossil fuel/electricity needed for production. Whatever fuel is used, it is important that it is used efficiently.

Reviewing EPD for sawn timber products where the EPD reports A1/A2/A3 separately, the impact of A3 is typically around 30% of the cradle to gate impact (~30 $kgCO_2e/m^3$), but this can vary considerably depending on how much fossil fuel is used and whether the timber is kiln or air dried.

Reporting sequestered carbon at the factory gate (A3)

When the product leaves the factory gate, the amount of sequestered carbon within the product (whatever the source of the timber) should be reported separately in the EPD, for both the product, and any biobased packaging (unless this is less than 5% of the mass of the product or packaging respectively). For EN 15804+A2, this should be reported in the EPD using kg carbon per declared or functional unit, and this information is provided in addition to the reporting of the Climate Change impacts.

Once the product leaves the factory gate, the sequestered carbon continues to need to be tracked and considered in any module where the carbon is either:

- transferred to another product system (for example where the product is reused or recycled at end-of-life) or

- emitted (for example where the product is wasted and disposed of using incineration or where it decays in landfill, or where it is used to produce energy), or
- where the carbon returns to nature (for example in landfill when there is no further degradation – see below).

For timber which can account for carbon sequestration, then these impacts are reported in EPD to EN 15804+A1 with the impact category Global Warming Potential, and for EPD to EN 15804+A2 with the impact categories Climate Change – Biogenic and Climate Change – total. For timber which cannot account for sequestration, then in EN 15804+A2, these impacts arising from the sequestered carbon in the product must be reported using the indicator Climate change – LULUC.

A4 – Transport to site

This module accounts for transport to the construction site. It is an optional module in EPD but must be considered in a building life cycle assessment to EN 15978 or an assessment of Whole life carbon according to the RICS Professional Statement. Timber is often imported into the UK, but this is commonly undertaken by ship which is generally a very low carbon way of moving goods compared to road. Because timber is generally a low carbon product however, transport can be significant relative to its manufacturing impact (excluding sequestration in the product), particularly if it is transported long distances by road, but this impact is still generally low in the context of a building's impact.

Guidance on calculating the carbon impact of transport is provided by DEFRA and BEIS, "Guidance on measuring and reporting Greenhouse Gas (GHG) emissions from freight transport operations"[19], which also provides a link to the most recent GHG conversion factors. Scope 1 to 3 emissions including "well to tank" emissions should be calculated for use in embodied carbon assessments.

A5 – Construction

This module accounts for the construction process, including the use of any plant and machinery required to fix the component in place, and any waste which arises on site – which this module accounts for by including the impact of manufacturing, transport and disposing of all waste. For concrete, the use of formwork and its disposal (if not reused) is accounted for in this module.

Where site data is not available, the RICS Professional Statement recommends the use of the standard wastage rates in WRAP's Net Waste tool[20], which are given as 10% for all timber products.

C1-C4 - End-of-life scenarios for timber products

In terms of likely end of waste routes for timber products, TRADA's Wood Information Sheet WIS 2-3/59[21] provides details of its understanding of the situation in the UK for wood waste overall, based on data from the Wood Recyclers Association, DEFRA and others. This suggests that 16.6% of UK generated waste wood was not recovered; however data from the Environment Agency's Waste Interrogator 2018[22] suggest that less than 1% of waste wood ends up in landfill. Of the remaining waste, this potentially includes unreported and informal routes of disposal which may involve further processing, as well as the possibility that wood waste is included as part of 'refuse-derived fuel' that is used in either the UK or exported. It should be noted that this is a significant change from the 1990s when less than 4% of UK wood waste was recycled.

The Wood Information Sheet also provides information on which types of timber product can be recovered using the different routes, and this should inform the choice of likely end-of-life routes for different timber products. This is shown in Table three below.

All these end-of-life routes have different impacts and may avoid different processes. They also differ in the amount of time that the sequestered biogenic carbon will stay stored in the next product system if the timber is recovered – particleboard, for example, is expected to keep the sequestered carbon out of the atmosphere for 30 years or more, whereas secondary fuels, animal bedding and surfacing are expected to release all their sequestered carbon within one year.

Graph one: Showing end of life routes for UK timber

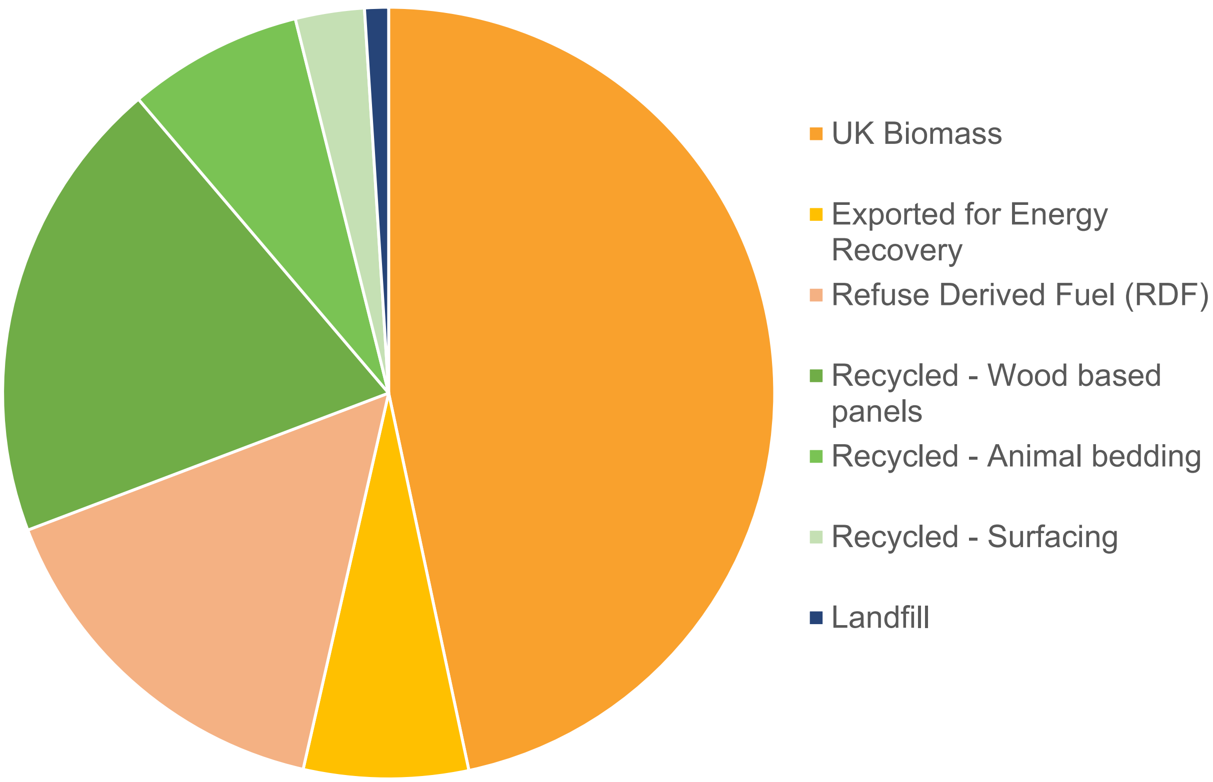


Table three: Matrix showing possible end-of-life routes for different types of EoL timber waste in the UK, based on information provided in TRADA WIS 2-3/59.

	Solid Hardwood or softwood (no preservative)	Engineered timber (e.g. glulam, LVL etc)	Wood Panel products (e.g. OSB, MDF, particleboard, plywood)	Preservative treated timber (non-hazardous)	Preservative treated timber (hazardous)*
Reuse					
Wood based panels					
Animal Bedding					
Landscaping and Equine Surfacing					
Fuel for IED Chapter 4 biomass installations					
Other biomass fuel (e.g. domestic)					
Biomass fuel for export				Small quantities	
Refuse Derived Fuel (RDF)	Residual waste only	Residual waste only	Residual waste only	Residual waste only	

* These types of timber can no longer be manufactured or used in the UK, but may arise from refurbishment or demolition of existing buildings.

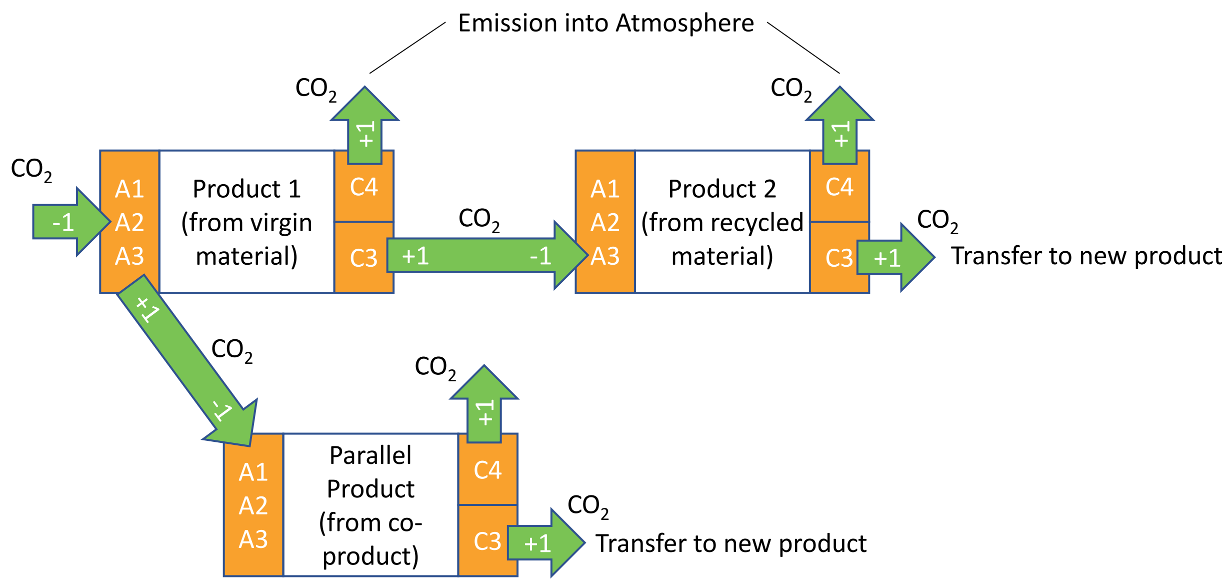
Reuse and recycling at end-of-life (Module C and D)

When any timber is recovered at the end-of-life, then its sequestered carbon is transferred to the recovered product. This is reported as an 'emission' of the sequestered carbon in C3 and as a removal of the sequestered carbon in the recovered product in Module D. Of course, the carbon is not emitted as it stays in the timber throughout the recovery process, but it is necessary to consider it as an emission to ensure:

- There is a biogenic carbon balance for the original product
- There is no double counting of the benefit of sequestration in both the original and recovered product
- That the recovered product has sequestered carbon that will balance the emission of carbon if it is burnt at the end-of-life.

When the timber leaves the building, it is assumed to be waste. Any transport and processing which is needed to allow it to reach the "end of waste state" and become a product again is reported in the Modules C1 (deconstruction and demolition), C2 (transport) and C3 (waste processing).

Diagram four: Transfer of sequestered carbon during the ongoing product cycle



Example four: Treatment of biogenic carbon for waste wood recovered for use in particleboard

Wood which is recovered for use in particleboard may be transported from the demolition site to a waste processing site for sorting and chipping, and then be transported directly to the particleboard factory for final chipping and use. Some timber may reach the "end of waste state" after sorting at the waste processing site, but in the UK it is normally after final chipping – this can be checked by looking at its legal status (waste needs waste transfer notes, products are covered by REACH legislation for example). All the impacts until it reaches the end of waste state are included in the end-of-life impacts of the original product.

Once it reaches the end of waste state, then Module D is used. Module D looks at the net output of recovered material – so if recycled wood chip has been used as an input to the process, then this input is deducted from the output of recycled wood chip in Module C. For the net output flow, Module D then looks at substitution. Sometimes the recovered product directly substitutes a primary product – for example recycled wood chip for particleboard directly substitutes virgin wood chip. If the wood is used to make a secondary fuel, then the secondary fuel may more normally substitute a fossil fuel. In this case, the "point of substitution" would be the production of energy from the fuel, and Module D would include the use of the secondary fuel and its emissions, and the avoided impacts of the same amount of energy produced by the substituted fossil fuel.

Energy recovery and incineration at end-of-life (Module C and D)

It is also common in the UK for timber to be used for energy recovery or to be incinerated. About 1 in 3 of the UK EfW plants taking recycled wood have efficiency below 60% so should be considered in C4 not C3[23]. EfW plants in the UK produce nearly five times more electricity than heat[24], and as the grid decarbonises, the avoided impacts of EfW will decrease accordingly. For products such as hazardous timber, or wood panel products, combustion in an EfW plant in the UK or abroad is a more likely fate than recycling due to the presence of preservatives and resins. For all products sent to EfW at end of life, the impacts of combustion are included in C3 for energy recovery processes and C4 for incineration. For both, the avoided impacts of any heat or electricity recovered from the process can be considered in Module D.

Landfill at end-of-life (Module C and D)

Data from the Environment Agency's Waste Interrogator 2018[25] suggests that less than 1% of waste wood ends up in landfill. Timber that does end up in landfill is expected to degrade to some extent, with a mix of aerobic and anaerobic degradation creating a mix of carbon dioxide and methane from the decay of biogenic carbon in the timber waste.

One issue about landfill is a discussion about the amount of sequestered carbon which remains in the landfill and does not degrade. For the UK, the WoodforGood EPD and LCA Datasets used work for DEFRA assessing the amount of landfill gas production from landfills to estimate the degradation of timber – this assumed that almost all of the cellulose and hemi-cellulose would decay, but the lignin in the timber would not decay after 100 years. Research in Australia however has suggested very low levels of degradation for timber in landfill. However, the latest version of EN 15804+A2 is clear that any sequestered carbon which still remains in landfill after 100 years should be considered as a transfer of biogenic CO_2 from the studied product system to nature.

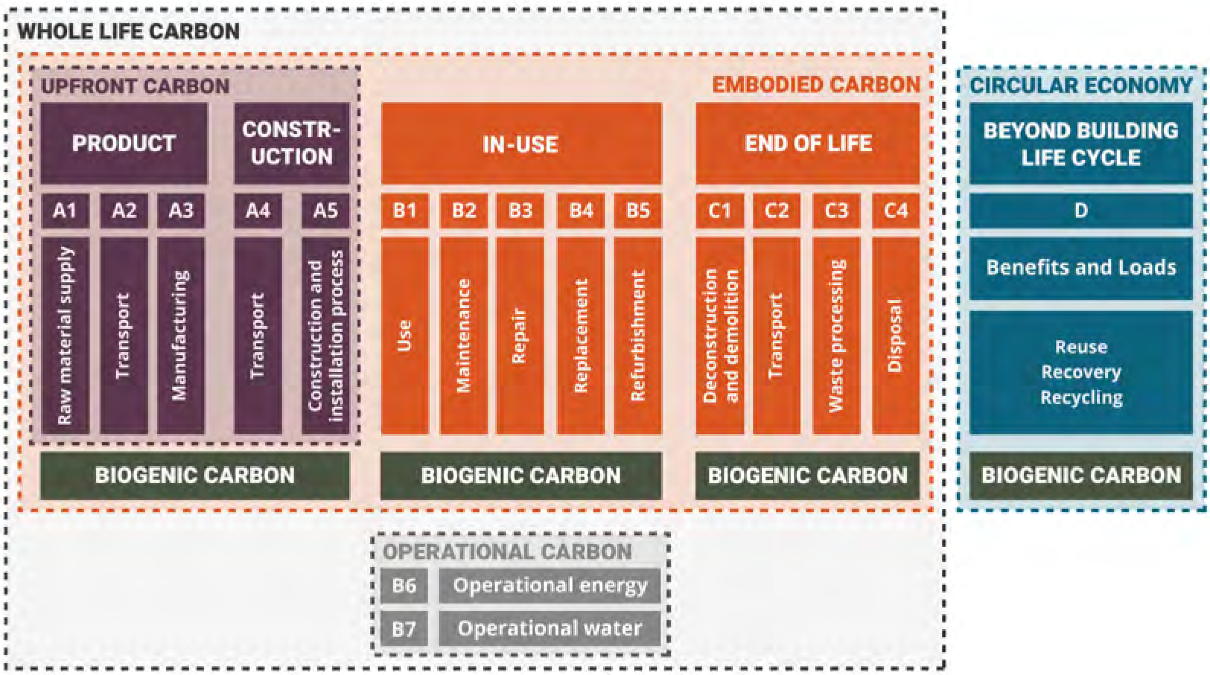
ASSESSING TIMBER AT THE BUILDING LEVEL

EN 15804 (the standard for construction product EPD) and EN 15978 (the building level environmental assessment standard) have been developed using the same framework for CEN Technical Committee 350 (TC350) so that data from EPD is formatted in a way which allows it to be used at building level. This is why EPD mention modules B5 (refurbishment), B6 (operational energy use) and B7 (operational water use) even though they are not appropriate for a single life cycle of most construction products.

Figure four shows the life cycle stages and modules used in the TC350 standards – the product stage (A1-A3), the construction stage (A4-A5), the Use Stage (B1-B7), the End-of-life Stage (C1-C4) and Module D. Overlaid on this are Upfront carbon, Embodied Carbon, Operational Carbon and Whole Life Carbon.

The RICS Professional Statement used the term “Embodied carbon to practical completion (PC-CO_2e)” to define the carbon from modules A1-A5, and added the requirement that if the assessment only considered these stages, then the biogenic carbon sequestered in the product could not be considered part of the assessment. The London Energy Transformation Initiative (LETI) provided an Embodied Carbon Primer in 2020, and this introduced the term, “Upfront carbon” for these emissions, which is now commonly used in the UK to refer to the impacts of modules A1-A5, excluding biogenic carbon sequestered in the product.

Figure four: CEN TC350 Life cycle stages and modules, overlaid by definitions of upfront, embodied, operational and whole life carbon. Image courtesy of ASBP and WLCN



If an assessment of embodied or whole life carbon is undertaken, then as shown in Figure 4, carbon sequestration, alongside all biogenic carbon emissions and removals, is considered throughout the building life cycle, and also within Module D, which should also be assessed to inform the study. But if only Upfront carbon (Modules A1-A5) is assessed, Upfront carbon is to be considered separately alongside embodied carbon and/or whole life carbon (for example for an upfront carbon benchmark) then the biogenic carbon sequestered in the products used should not be included in the assessment of the upfront carbon result. This aligns with the RICS Professional Statement which says “Carbon sequestration must only be taken into account when the following criteria are met:

1. The whole life carbon assessment of the project includes the impacts of the EoL stage [C] and
2. The timber originates from sustainable sources (certified by FSC, PEFC or equivalent).”

Although the RICS Professional Statement uses the term “carbon sequestration”, it only refers to the biogenic carbon sequestration within the installed products at practical completion. For example, within the assessment of upfront carbon, we do need to include the sequestered carbon in the wood fuel used in a sawmill alongside its emissions, and also the sequestered carbon in the timber products which are wasted in construction, alongside their end-of-life impacts. It is therefore clearer to say that all carbon sequestered within the installed product is excluded from the assessment of upfront carbon. As this is already included within the impact for A1-A3, this can be done by adding the mass of biogenic carbon sequestered in the installed product from the GWP or Climate change - total impact for A1-A5 for each biobased product. At the building level, this is shown in Example five below.

Example five: Assessment for a residential building

Table 3: Assessment of GWP/Climate change - total for a residential building using EN 15978

kgCO$_2$e/m2	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP	231	41	29	-0.6		12		154	73	17	5	10	95	14	-57
	A1-A5: 301			B1-B5: 165					B6-B7: 90		C1-C4: 124				D:-57

If the sequestered carbon within the installed products is 102 kgCO$_2$ per m², this means that the result for A1-A3 of 231 kgCO$_2$e/m² already includes the removal of 102 kg CO$_2$, so -102 kgCO$_2$e needs to be deducted from the result (which is equivalent to adding 102 kgCO$_2$).

The following should be the reported impacts for this residential building.

Upfront Carbon (excluding sequestration): 301- -102 = 403 kg CO$_2$e/m²

Embodied Carbon (including sequestration): 301+165+124 = 590 kgCO$_2$e/m²

Operational Carbon: 90 kgCO$_2$e/m²

Whole life carbon (including sequestration): 301+165+90+124 = 680 kgCO$_2$e/m²

Module D: -57 kgCO$_2$e/m²

In upfront carbon assessments using EPD to EN 15804+A2, then the biogenic carbon sequestered within the product must be provided in the EPD (if it is more than 5% of product mass). It is reported as kg of carbon rather than CO$_2$, but it is easy to convert to kg CO$_2$ by multiplying by 44/12 (the relative molar mass CO$_2$ and atomic mass of carbon). For assessments using EPD to EN 15804+A1, they have no requirement to report sequestered biogenic carbon although many do. If it is not provided in the EPD, then it should be calculated from the product mass and dry timber content as shown in Example Five above.

Biogenic carbon content	
Biogenic carbon content in product	733 kg CO$_2$ eq. / m³ = 0 kg C / m³
Biogenic carbon content in accompanying packaging	0 kg CO$_2$ eq. / m³ = 0 kg C / m³
1 kg biogenic carbon is equivalent to 44/12 kg of CO$_2$	

For assessments of embodied carbon, operational carbon and whole life carbon, then there is no need to exclude carbon sequestration and the GWP and Climate Change - total results from EPD can be considered in reporting all modules.

Assessing scenarios at building level

At building level, the information from EPD is used where this is appropriate. For example, an EPD for a German glulam may provide Module A4 (Transport) for typical transport to site in Germany, and its Module C and D (end-of-life and recovery potential) based on using the glulam for energy recovery in Germany, because this is the most common fate there. It is likely that these scenarios and impacts are not going to be directly applicable to transporting the glulam to a UK site nor for the end-of-life of glulam in the UK, where even if it is used for energy recovery, the benefits of energy recovery will be different from Germany because of the different heat and grid mix here.

For a building assessment, it is for the building assessor to decide the fate of materials at the end-of-life. In some countries with regulation, for example the Netherlands, the regulated national assessment method provides the end-of-life (EoL) scenarios that should be used for assessments. In the UK, we don't have regulation, but we do have the RICS Professional Statement on Whole Life Carbon Assessment of the Built Environment[26]. The RICS Professional Statement provides general defaults for the UK to standardise assessments, but it is still for the assessor to define the final end-of-life scenarios. It states, "The assessor should develop suitable project-specific EoL scenario(s) at a building level as well as individual components level where relevant, based on future intentions provided by the project team, precedent and current EoL practices." For example, if a building has been specifically designed for deconstruction, then it should be possible to reuse many more products and components, and to have a lower level of downcycling of materials, than if the building is a conventional design. At present there is no data in the UK on the amount of timber that is reused, however we have included information in Table 4 on the potential for reuse.

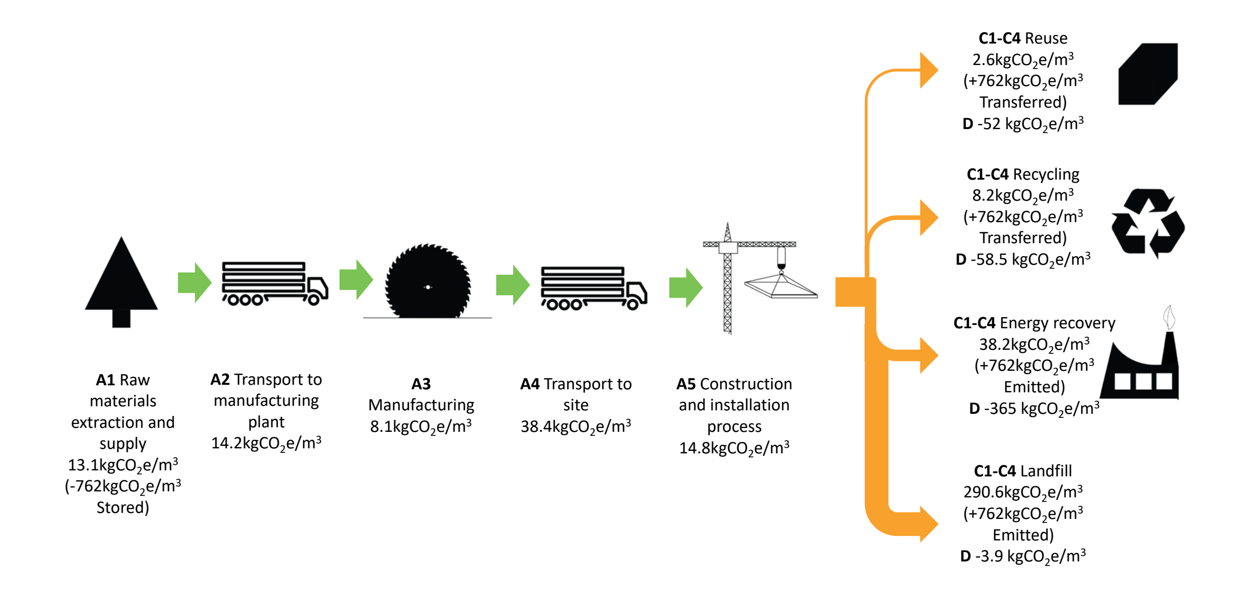
The RICS Professional Statement also states, "In the absence of specific information, scenarios on the proportion of landfilling, reuse and/or recycling each item at the EoL should be developed according to current standard practice. As a final default, if EPD don't provide relevant data, the RICS Professional Statement provided an EoL scenario for all timber of 75% energy recovery, 25% landfill. As described above, this default is no longer considered appropriate and is in review by the Statement's authors. In addition, the impact that the Professional Statement gives for landfill (2.15 kgCO_2e/kg of timber product) is for a landfill without landfill gas recovery, but in the UK (and Europe), all landfills now have to have landfill gas recovery systems in place so this figure would not be appropriate for the UK, where much of the methane released from degradation of biomass in landfill is captured and used for energy generation or as a minimum, flared producing CO_2.

Table four: End of life routes for different timber products, based on the information provided in TRADA WIS 2-3/59.

	Solid Hardwood or softwood (no preservatives or coatings)	Engineered timber (e.g. glulam, LVL etc)	Wood Panel products (e.g. OSB, MDF, articleboard, plywood)	Preservative treated and other coated timber (non-hazardous)	Preservative treated timber (hazardous)*
Recovery (C3)					
Potential for Reuse	Possible	Very High	Possible	Possible	Unlikely
Recycling for					
Wood based panels	10%	40%	0%	30%	0%
Animal Bedding and surfacing	70%	0%	0%	0%	0%
Energy Recovery	14%	59%	94%	54%	80%
Disposal (C4)					
Incineration with low energy recovery	5%	0%	5%	15%	20%
Landfill	1%	1%	1%	1%	0%

* These types of timber can no longer be manufactured or used in the UK, but may arise from refurbishment or demolition of existing buildings.

Diagram five: Life cycle of CLT shown in a Stora Enso EPD



CONCLUSION

Assessing the carbon-related impacts of timber is complex, but this paper is intended to provide a clear explanation of the approach set out in the relevant European Standards and in the RICS Professional Statement on Whole Life Carbon Assessment for the Built Environment. The storage of biogenic carbon within sustainable timber used in buildings is beneficial, as it keeps this carbon out of the atmosphere for an extended period of time. By accounting correctly for the sequestration of biogenic carbon, and its emission or transfer at end of life, this benefit can be clearly shown within an EPD, and within an Embodied or Whole Life Carbon assessment of buildings or infrastructure.

APPENDIX ONE

RELEVANT LCA STANDARDS

What are Standards?

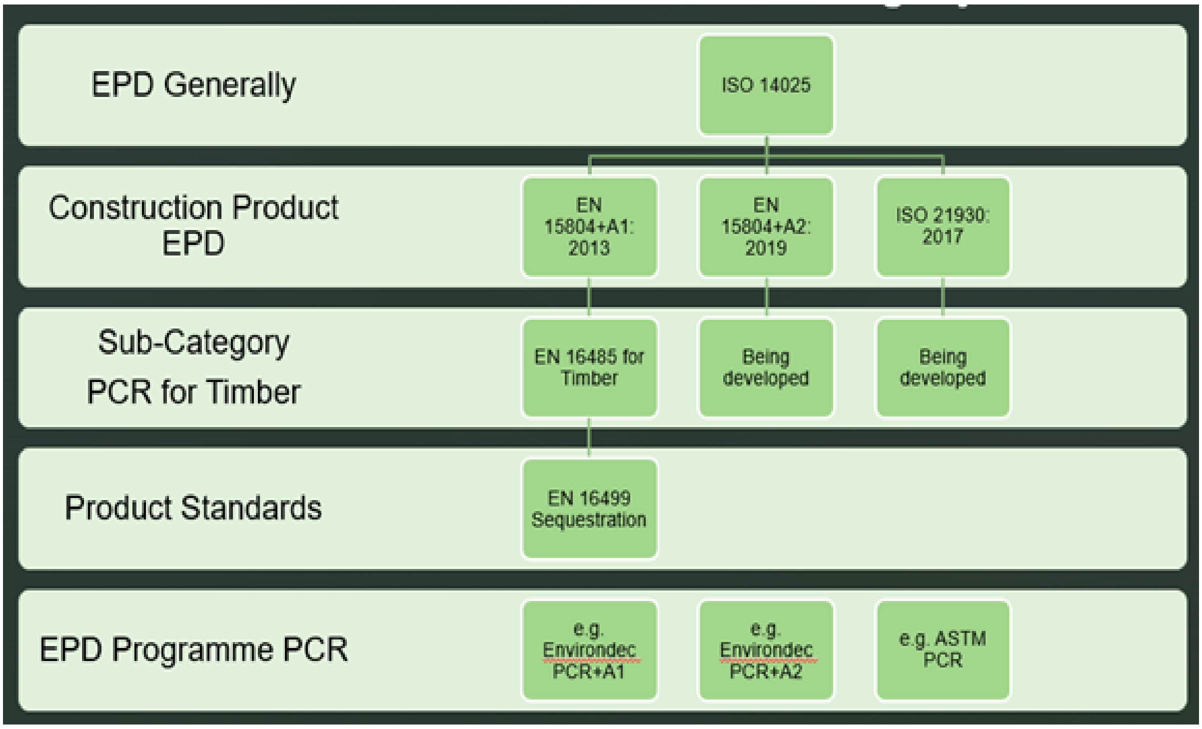
Standards are developed to provide consistent approaches in industry and regulation. International Standards are developed by the International Standards Organisation (ISO) and can be applicable globally. European Standards are developed by the European Committee for Standardization (CEN) – once a European Standard has been produced then it is a requirement that any CEN Member (e.g. all EU member states and the UK until at least the end of 2021) adopts the standard as a national standard, and if they wish to regulate in the area of the Standard that they refer to the European Standard. Some International Standards are also adopted as European Standards – these will have the prefix EN ISO. In addition to international Standards, which provide "normative" requirements, set out with the language "shall" (must do) and "should" (preferably do), there are also Technical Reports and Specifications produced by ISO and CEN, which provide informative guidance, for example in areas where there is not yet consensus.

There are also National Standards developed by National Standards Bodies (NSB). In the UK, the NSB is the British Standards Institute (BSI), which develops British Standards where there are not already ISO or European standards. NSB also adopt ISO and European Standards, which in the UK will have the prefixes BS EN ISO, BS EN or BS ISO. Other countries also have their own national standards and also adopt the European and International Standards.

All these Standards, Technical Reports and Specifications are developed in Technical Committees with expert members and liaisons which can include representatives of industry, national bodies, professionals and consumers. Standards are developed through consensus, and the wider industry and public have an opportunity to comment on proposed standards during "Enquiry", and NSB vote whether to publish the standard. Most Standards have two enquiries before publication. Only standards which receive a majority positive vote in their final enquiry go on to be published.

In the UK, BSI also develops Publicly Available Specifications (PAS) which provide a consistent, voluntary approach. They are developed by a consultant to a brief managed by a technical steering group and are also open for public consultation before publication.

Relevant standards for assessment of environmental impacts of construction products



STANDARDS MAP

Life Cycle Assessment standards: The overarching standards used for the assessment of environmental impacts of construction products are the International Standards for Life Cycle Assessment. Life cycle assessment is a way of measuring the relevant environmental impacts of a product system through its life cycle.

- BS EN ISO 14040:2006+A1:2020. Environmental management. Life cycle assessment. Principles and framework.
- BS EN ISO 14044:2006+A1:2018. Environmental management. Life cycle assessment. Requirements and guidelines.
- Standards for Environmental Product Declarations generally:
- BS EN ISO 14025:2010. Environmental labels and declarations. Type III environmental declarations. Principles and procedures.
- Standards for Environmental Product Declarations for construction products:
- ISO 21930:2017. Sustainability in buildings and civil engineering works. Core rules for environmental product declarations of construction products and services.
- BS EN 15804:2012+A1:2013. Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products.
- BS EN 15804:2012+A2:2019. Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products.
- PD CEN/TR 16970:2016. Sustainability of construction works. Guidance for the implementation of EN 15804.

Product Standards for EPD for timber products:

- BS EN 16485:2014. Round and sawn timber. Environmental Product Declarations. Product category rules for wood and wood-based products for use in construction.
- BS EN 16449:2014. Wood and wood-based products. Calculation of the biogenic carbon content of wood and conversion to carbon dioxide.

Standards for the environmental assessment of buildings and civil engineering works:

- BS EN 15978:2011. Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method. This standard is now being revised. It will remain valid until the new revision (prEN 15978-1) is adopted.
- prEN 15978-1:2021 This revised version of the standard is expected to have its first enquiry this summer.
- BS ISO 21931-1:2010. Sustainability in building construction. Framework for methods of assessment of the environmental performance of construction works. Buildings
- BS EN 17472. Sustainability of construction works. Sustainability assessment civil engineering works. Calculation methods

Professional Standards for the Whole life carbon assessment of buildings and civil engineering works

- RICS Professional Statement on Whole Life Carbon Assessment of the Built Environment

Standards for carbon and water footprinting of products:

- BS EN ISO 14046:2016. Environmental management. Water footprint. Principles, requirements and guidelines.
- BS EN ISO 14067:2018 Greenhouse gases. Carbon footprint of products. Requirements and guidelines for quantification.
- PAS 2050:2011. Specification for the assessment of the life cycle greenhouse gas emissions of goods and services.

Carbon management

- PAS 2080:2016. Carbon management in infrastructure.

ENDS NOTES

1 Forest Europe – State of Europe's Forests Report 2020, [link].

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3 Grassi, G., Fiorese, G., Pilli, R., Jonsson, K., Blujdea, V., Korosuo, A. and Vizzarri, M., Brief on the role of the forest-based bioeconomy in mitigating climate change through carbon storage and material substitution, Sanchez Lopez, J., Jasinevičius, G. and Avraamides, M. editor(s), European Commission, 2021, JRC124374.

4 Waste Data Interrogator 2018, Environmental Agency, updated March 2020, as quoted in Law, C., 'Timber and the circular economy, Timber 2020 Industry Yearbook, BM TRADA, 2020.

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10 Grassi, G., Fiorese, G., Pilli, R., Jonsson, K., Blujdea, V., Korosuo, A. and Vizzarri, M., Brief on the role of the forest-based bioeconomy in mitigating climate change through carbon storage and material substitution, Sanchez Lopez, J., Jasinevičius, G. and Avraamides, M. editor(s), European Commission, 2021, JRC124374(figure 4)

11 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005677/conversion-factors-2021-full-set-advanced-users.xlsm

12 The State of the World's Forests 2020. In brief – Forests, biodiversity and people. Rome: FAO. 2020. p. 9. ISBN 978-92-5-132707-4.

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17 In EN 15804+A2, any sequestered carbon remaining in landfill after all degradation has ceased should be considered as a transfer to nature, and reported as an emission of biogenic CO2

18 Conifer forests were planted on peat bogs in the UK in the second half of the 20th century, but concerns were raised that this was releasing the carbon stored in the peat, and this type of planting is no longer encouraged. https://www.forestresearch.gov.uk/research/peatland-afforestation-in-the-uk-and-consequences-for-carbon-storage/

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23 Source Tolvik UK Dedicated Biomass Statistics – 2019 https://www.tolvik.com/published-reports/view/uk-dedicated-biomass-statistics-2019/

24 UK Energy from Waste Statistics – 2020 - https://www.tolvik.com/wp-content/uploads/2021/05/Tolvik-UK-EfW-Statistics-2020-Report_Published-May-2021.pdf

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26 The BRE also have the IMPACT methodology which serves a similar purpose, but this document is not publicly available.

ABOUT TIMBER DEVELOPMENT UK

Timber Development UK was formed in 2021 by the merger of the Timber Trade Federation and the Timber Research and Development Association. After combining the membership of these organisations, Timber Development UK has more than 1500 members extend all the way from sawmill to specifier.

By bringing together the entire timber supply chain we aim to provide our members with the highest quality information, technical guidance and training to safely specify and design the timber structures of tomorrow, and create lower-carbon, higher quality, healthier and safer buildings using timber.

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