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THE  
HOME-GROWN  
HOMES  
PROJECT

Using Wood in  
Construction as a Significant  
Greenhouse Gas Removal  
Mechanism



Gary Newman



Dr Morwenna Spear



Simon Corbey



# CONTENTS

<b>Executive Summary</b>	<b>03</b>
<b>Introduction</b>	<b>06</b>
Net Zero Whole Life Carbon	06
Greenhouse Gas Removals	07
Greenhouse Gas Removal Systems	08
<b>Wood in Construction as a Greenhouse Gas Removal</b>	<b>10</b>
The Paris Agreement	15
The 6th Carbon Budget	16
<b>Calculating the Harvested Wood Products Carbon Pool</b>	<b>20</b>
The EU Framework for Carbon Removals and Carbon Farming	24
International Standards developed for Organisations	26
<b>Summary and Recommendations</b>	<b>28</b>
Principles for Wood in Construction Greenhouse Gas Removal Encouragement	29
<b>Conclusion</b>	<b>33</b>
<b>Appendix 1: Treatment of Biogenic Carbon Storage in Life Cycle Analysis</b>	<b>35</b>

## EXECUTIVE SUMMARY

Wood in construction (WIC) presents a significant and underutilised opportunity for greenhouse gas removal (GGR) in the UK. This paper explores how carbon stored in long-life timber buildings – when properly monitored and accounted for – can contribute meaningfully and measurably to national net-zero targets.

At present, biogenic carbon stored in buildings is addressed through life cycle assessment (LCA) frameworks designed primarily for evaluating emissions from the built environment. These frameworks, while useful for understanding embodied carbon and encouraging material substitution, are not designed to capture the long-term carbon removal benefit of bio-based materials. Specifically, whole-life carbon accounting methodologies such as Life Cycle Analysis (LCA) assume that stored carbon is ultimately released and therefore record no net benefit from storage. This approach fails to recognise the additional value of long-duration storage in wood products – value that can and should be accounted for when quantifying GGR.

Recognising this, we argue for the formal and parallel treatment of WIC as a GGR method – distinct from, but complementary to, existing embodied carbon reduction efforts. This distinction matters. By integrating WIC into the UK's GGR portfolio, and developing appropriate methodologies for monitoring, reporting and verification, the UK can access a scalable, nature-based carbon sink already supported by existing supply chains and policy goals on housing, land use and rural development.



## The report draws attention to several key insights:

### **WIC is a GGR and should be treated as such:**

The Intergovernmental Panel on Climate Change (IPCC), the UNFCCC, and the European Commission all recognise long-term storage of biogenic carbon in buildings as a form of GGR. However, the UK's current policy and reporting frameworks do not yet adequately reflect this potential.

### **Whole-life carbon (WLC) assessments are not designed to quantify GGR:**

The LCA methodologies used to regulate construction emissions – such as those underpinning the UK Net Zero Carbon Buildings Standard and RICS Whole Life Carbon Assessment Standard PS – treat biogenic carbon storage as a temporary feature with no climate mitigation credit. This leads to underestimation of WIC's true impact.

### **Failing to monitor and report WIC-GGR means the UK will undercount a critical carbon sink:**

The UK Climate Change Committee has set out ambitious targets for GGR deployment to reach net zero by 2050, forecasting the need for up to 75 MtCO<sub>2</sub>e/year in removals. As it stands, WIC is largely absent from national GGR pathways. Without appropriate monitoring and reporting systems, WIC will continue to be sidelined in both national inventories and policy frameworks, despite being potentially faster to scale than engineered alternatives.

### **The scale is non-trivial:**

Emerging studies and UK inventory data suggest that the annual inflow of timber into construction already represents a meaningful volume of removals. Wood use is already orders of magnitude greater than some early-stage engineered GGR options that are receiving substantial investment.

### **A credible monitoring and reporting system is feasible:**

The paper outlines available methodologies based on production data, housing starts, service life data, and demolition rates. This includes emerging developments relating to IPCC Tiers 2 and 3, and an ISO standard for organisations to report carbon storage in wood products. While further work is needed to refine assumptions and align with international best practices, the foundations for a robust UK-specific reporting system already exist.

The authors call for urgent recognition of wood in construction as a nationally significant GGR pathway and recommend that:

1. WIC be explicitly included in GGR policy portfolios and carbon budgets.
2. The UK develop and trial reporting systems specific to WIC-GGR, drawing from international precedents and UK inventory methodologies.
3. Funding and support for bio-based construction be broadened beyond LCA-based emissions reduction, to reflect its dual role in mitigation and carbon removal.
4. Policymakers treat WIC-GGR as a strategic climate opportunity – one that aligns with wider goals on housing, forestry, rural economies and innovation.

In short, if the UK is to meet its net-zero ambitions, it must move beyond an emissions-reduction-only mindset and fully embrace the role of carbon storage. Buildings are not just energy liabilities – they are also potential carbon assets. Unlocking this potential will require both a shift in accounting practice and a clear political will to recognise and reward the carbon stored in our built environment.

The overriding conclusion of this report is that purposeful industry and government action is required. Which should include:

- Ensuring that WIC is at the heart of UK Government's GGR and CCS policy and decision making
- Widespread industry engagement with quantification of their carbon storage contribution
- Connecting the full supply chain in reporting stored carbon, from sawmill to building client through to the use of recycled timber products.
- Connecting organisational carbon storage data with national evaluation to inform greenhouse gas removal policy
- Gathering of lifespan and material flow analysis data to support IPCC Tier 3 calculations and thereby increase the proven contribution of WIC as a GGR
- Incorporation of stored carbon in recycled timber in NIR reports to UNFCCC
- Establishing a national inventory of WIC stored carbon to help reporting and reduce the risk of double counting

The joined-up implementation of the above actions is best delivered through a national task force that is focused exclusively upon the governance, quantification and reporting of WIC as a GGR.



# INTRODUCTION

It's a relatively simple concept. When we build with bio-based materials we create a store of biogenic carbon<sup>1</sup> in the built environment. The biogenic carbon stored in a building is effectively 'locked-up'. It is carbon that has been removed from the atmosphere during plant growth and therefore carbon that would otherwise be contributing to global temperature rise. That must surely be a good thing. Some people, like the eminent climate scientist Hans Joachim Schellnhuber, go further<sup>2</sup>. Schellnhuber argues that building with bio-based materials is not only a good thing, it is an essential strategy if we are to draw down sufficient carbon to stabilise the climate, whilst creating a built environment that meets the needs of the growing global population. All of this is possible using sustainable forest management to produce timber and ensure that no diminution of the forest resource itself occurs.

However, to date, there is only very limited policy encouragement in the UK to increase the use of materials containing biogenic carbon in construction. This paper is essentially an exploration of what industry and policy makers need to do to change things.

There are two broad areas of climate policy from which this seemingly self-evident climate change mitigation solution might be encouraged: (1) inclusion of biogenic carbon in the embodied carbon assessment within net zero whole life carbon policy in the construction sector, and (2) handling the stored carbon in wood as a greenhouse gas removal (GGR) technology. Both these areas have significant policy momentum and are summarised below.

## NET ZERO WHOLE LIFE CARBON

Biogenic carbon storage can be encouraged through policies focused upon the reduction in the carbon emissions from the construction of buildings and infrastructure. This approach has significant momentum through for example the UK Net Zero Carbon Buildings Standard<sup>3</sup> launched in September 2024 which uses whole building Life Cycle Analysis (LCA) techniques and product level Environmental Product Declarations (EPD) to generate embodied carbon data and can demonstrate the potential for emissions reduction through product and material substitution. Once generated, this data is available for reporting and monitoring purposes, for example the biogenic carbon quantities from EPDs are a required input for any form of Harvested Wood Product (HWP) calculation and reporting scheme considering wood as a GGR. The focus on embodied carbon is perhaps best exemplified in the campaign to create a new section of the Building Regulations, Approved Document Z<sup>4</sup> to legislate for embodied carbon reduction, as already implemented in many European countries.

This approach to embodied carbon regulation undoubtedly has huge role to play in carbon emissions reduction but is encountering significant problems in implementation.

The problem is due mainly to the complexity of accurately reflecting constantly changing carbon emissions associated with a large number of globally sourced mineral, petrochemical and bio-based products and materials used in construction. Within this complexity, quantifying and reporting biogenic carbon storage adds a further challenge. Although it is relatively simple to calculate the quantity of stored biogenic carbon contained in a product or building, robustly accounting for the duration of storage is proving to be a difficult problem to solve. Over the nominal 100-year timeframe used in the current assessment methodology, any carbon stored in the building<sup>5</sup> is considered within life cycle assessment (LCA) methodologies to have been released back to the atmosphere in module C, the end of use stage for a building. Consequently, LCA records no beneficial impact of the carbon storage provided by the building's lifespan. The carbon associated with the product or building is the single declared carbon emission number – the Global Warming Potential over a 100-year timeframe or GWP100. The latest version of the RICS Professional Statement on Whole Life Carbon Assessment for the Built Environment<sup>6</sup> acknowledges the benefit from sequestering carbon in long-life bio-based products in buildings. Reporting biogenic carbon storage is not mandatory

<sup>1</sup> Biogenic carbon refers to carbon that is derived from biological sources and originates primarily from photosynthesis, where plants and trees absorb carbon dioxide (CO<sub>2</sub>) from the atmosphere and convert it into organic matter.

<sup>2</sup> *Buildings as a global carbon sink, 2020 & Schellnhuber's presentation at WoodBUILD 2023.*

<sup>3</sup> *The UK Net Zero Carbon Buildings Standard, 2024*

<sup>4</sup> *Approved Document Z*

<sup>5</sup> The design life of a new build house leads many to consider a building lifetime of 60 years when accounting for storage in LCA, whereas the timeframe for GWP used in LCA is 100 years. This results in the storage and the end of life emissions occurring within the 100 year window.

<sup>6</sup> *RICS Whole life carbon assessment for the built environment 2nd edition Version 3, 2024*

within the standard at present and the value must be reported separately, in addition to the conventional static assessment. While this risks the dynamic benefits being undervalued it does permit transparency in providing a value for use in HWP calculations for GGR reporting.

For completeness and because there are significant overlaps, this report will sometimes refer to this area of potential policy (and a short overview is given in Appendix A), but it is not the main concern. The reason is that much has been written and said elsewhere about embodied carbon and the failure of embodied carbon metrics and standards to effectively account for and reward the benefits of biogenic carbon storage in buildings, whereas the role of wood in construction as a greenhouse gas removal (GGR) method has received relatively little attention.

## GREENHOUSE GAS REMOVALS (GGR)

Biogenic carbon storage in the built environment can be encouraged through an area of climate science and policy focused on extracting carbon from the atmosphere and then storing that carbon for a period. Mechanisms that draw down and store atmospheric carbon are referred to as Greenhouse Gas Removals (GGRs). Wood in construction is one such GGR option, as we will explore in the following pages.

It is widely recognised that achieving the UK's legally binding target of net-zero greenhouse gas (GHG) emissions by 2050 necessitates substantial efforts both in reducing carbon emissions and in implementing carbon removals to compensate for residual emissions, which are expected to arise from sectors that are challenging or impossible to fully decarbonise. These residual emissions are expected to come from sectors such as agriculture, aviation, and heavy industry (e.g. steel and cement production), where complete decarbonisation is considered by policymakers (as well as many scientists and engineers) to be either too technologically difficult or economically unfeasible. The UK's pathway to net-zero developed by the UK Climate Change Committee (CCC) anticipates residual emissions of approximately 75 million tonnes of carbon dioxide equivalent (MtCO<sub>2</sub>e/year) by 2050. This then is the estimated total GGR required per year by 2050 to achieve net zero. Using the Government's 2050 carbon values for offsetting of £378 / tonne (central series) this would cost the taxpayer over £28 billion a year.<sup>7</sup>

### GREENHOUSE GAS REMOVAL (GGR) AND CARBON CAPTURE AND STORAGE (CCS)

At this point it is worth highlighting one area of common confusion around GGRs. A GGR is not the same thing as Carbon Capture and Storage (CCS).

CCS is concerned with capturing carbon dioxide emissions before they enter the atmosphere (e.g. from power plants) and storing them underground and is therefore an emissions reduction strategy and would be aligned to a strategy of targeting absolute zero carbon by 2050. In October 2024, Ed Miliband, the UK's Secretary of State for Energy Security and Net Zero, announced £21.7 billion support for CCS technology development over the next 25 years to deliver a forecast removal of 8.5 MtCO<sub>2</sub>e/year<sup>8</sup>.

In contrast, GGRs are concerned with removing CO<sub>2</sub> that is already in the atmosphere and storing it for a period of time. GGRs compensate for residual emissions to achieve net-zero carbon.

Wood in construction is a mechanism for GGR and not CCS. The confusion perhaps arises because some of the technology-based mechanisms used for both CCS and GGR can be very similar and because bioenergy with carbon capture and storage, known as BECCS, is both a GGR (removing carbon from the atmosphere during plant growth) and CCS (capturing the carbon before it is re-released).

<sup>7</sup> [www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-for-policy-appraisal-and-evaluation](https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-for-policy-appraisal-and-evaluation)

<sup>8</sup> Nearly £22 billion pledged for carbon capture projects, 2024

## GREENHOUSE GAS REMOVAL SYSTEMS

The Paris Agreement sets a goal to limit global average temperature increase to 'well below 2°C above pre-industrial levels', and to 'pursue efforts' to limit it to 1.5°C. This was breached in 2024, with an increase of 1.6°C above pre-industrial levels. The Royal Society state that in the UK this will require cumulative removals of 130 MtCO<sub>2</sub>e/year by 2050<sup>9</sup>. As stated earlier the CCC have suggested that annual GGR requirement to be 75 MtCO<sub>2</sub>e. Furthermore, the Royal Society state that this target demands immediate action to develop and deploy GGR technologies and practices. Many of these pools for GGR already exist, e.g. peatbogs, wood in construction, but require support to expand them.

In 2021, the UK government announced support for GGR development and demonstration through a range of UKRI innovation programmes<sup>10</sup>. The 5 areas supported were:

- management of peatlands to maximise their GHG removal potential in farmland
- enhanced rock weathering – crushing silicate rocks and spreading the particles at field trial sites on farmland

- use of biochar, a charcoal-like substance, as a viable method of carbon sequestration with testing at arable and grassland sites, a sewage disposal site, a former mine and railway embankments
- large-scale tree planting, or afforestation, to assess the most effective species and locations for carbon sequestration at sites across the UK.
- rapid scale-up of perennial bioenergy crops such as grasses (*Miscanthus*) and short rotation coppice willow.

The research is now concluded, and the results are summarised in an infographic.<sup>11</sup> A key and obvious point is that the use of biogenic materials like timber in construction was not included in this research. However, the highest authority on Climate Change mitigation policy, the UNFCCC, does consider the use of Wood in Construction (WIC)<sup>12</sup> to be a significant GGR worthy of policy consideration, and the UK Government and the CCC have commissioned work on its quantification and deployment.



<sup>9</sup> *Royal Society and Royal Academy of Engineering, Greenhouse Gas Removal, 2018*

<sup>10</sup> *UKRI 2021, Press Release, UK invests over £30million in large scale Greenhouse Gas Removal*

<sup>11</sup> *The UKRI funded GGR demonstrator projects*

<sup>12</sup> The use of the acronym WIC for Wood in Construction is viewed by the authors as shorthand for any material that contains biogenic carbon (such as hemp and sheep wool) used as a building material.



# WOOD IN CONSTRUCTION AS GREENHOUSE GAS REMOVAL

GGRs include a range of methodologies and technologies that take carbon dioxide out of the atmosphere. GGRs can be categorised as either engineered or land-based. Land-based GGRs include activities such as afforestation and peatland restoration. Engineered GGRs include technologies such as direct air carbon capture & storage (DACCS), bioenergy with carbon capture and storage (BECCS), and wood in construction (WIC). In a report by Element Energy commissioned by UK Government in October 2021<sup>13</sup>, the costs and deployment potential of engineered and land-based GGR methods were analysed to 2030 and 2050. The data for the 2030 and 2050 timeframe is summarised in the table below.

Table 1. Costs and technological readiness of different GGR options

Greenhouse Gas Removal mechanism	Technical Readiness Level (TRL)	By 2030		By 2050	
		Cost £/tCO <sub>2</sub> e	Scale MtCO <sub>2</sub> e/year	Cost £/tCO <sub>2</sub> e	Scale MtCO <sub>2</sub> e/year
<b>Land-Based GGR</b>					
Peat Restoration	9	£34	0.4	£34	1.2
Saltmarsh Restoration	7	£24	0.1	£24	0.2
Soil Carbon	8	£12	3.1	£12	3.8
Biochar	5	£72	0.3	£72	4.8
Enhanced Rock Weathering	4	£300	0.3	£288	4.5
Afforestation	9	£13	3.7	£13	18.6
<b>Engineered GGR</b>					
Direct Air Carbon Capture & Storage (DACCS)	6	£300	0.5	£130	18
BECCS Storage (BECCS) Power	7	£120	8.0	£100	26
Wood In Construction	9	Uncertain*	0.4	Uncertain*	1.5

\* The cost of swapping timber construction for existing methodologies was seen by the authors of the Element Energy report as negligible, but the uncertainty lay with the cost of incentivising a shift in industry practice through either policy or industry engagement routes

Some important points to note from Table 1 are as follows:

Firstly, Wood in Construction (WIC) is immediately deployable as a GGR. Technology Readiness Level (TRL) is a standardised system for assessing the maturity of a technology, ranging from basic research to full commercial deployment. A TRL of 9 is top of the scale and means that the technology (in this case WIC) is ready for full commercial deployment, as demonstrated by the ongoing delivery of 40,000 timber framed homes per year in the UK<sup>14</sup>. This is really an obvious point, considering how long wood has been used as a construction material, but it is worth stating that innovation in engineered wood products is already making new things possible. For example, it is increasingly possible to replace steel and concrete with engineered wood products such as cross laminated timber (CLT) and glulam

as structural materials in mid and high-rise buildings; and wood fibre insulation is increasingly being used as an alternative to mineral and petrochemical insulants.

Secondly, the cost of swapping timber construction for existing methodologies was seen by the authors of the Element Energy report as negligible, but the uncertainty (indicated in Table 1) lay with the cost of incentivising a shift in industry practice through either policy or industry engagement routes. This was supported by a Royal Society report on Greenhouse Gas Removals from 2018<sup>15</sup>, which considered that the 'transition cost to building more with timber to increase the Wood in Construction GGR to be negligible'. This was corroborated by a recent study, funded by Built by Nature<sup>16</sup>

<sup>13</sup> Greenhouse gas removal methods and their potential UK deployment, Element Energy and Centre for Ecology and Hydrology, October 2021

<sup>14</sup> NHBC data 2021

<sup>15</sup> The Royal Society and Royal Academy of Engineering, Greenhouse Gas Removal, 2018

<sup>16</sup> Understanding and Advancing Cost-effective Timber Construction

## WHAT IS TIMBER FRAME AND WHY IS CLT DIFFERENT?

When thinking about WIC it is useful to be aware of two very different building approaches for using timber.

Timber frame systems are widely used to deliver housing, schools, public buildings etc (usually 1, 2, or 3 storeys but higher is possible) with open or closed panels framed in wood, then filled with insulation, before being faced with OSB and plasterboard. Other layers are incorporated to ensure airtightness and moisture barrier effects. These lightweight panels constructed offsite in a factory can be assembled onsite, giving rapid build time, low noise and low waste, as well as exceptional energy performance. Once built and faced with brick they can be difficult to tell apart from masonry houses, leading to the unfortunate perception amongst many that the UK does not build timber framed homes unlike say North America and Scandinavia where homes are more visibly made of timber. The system is also used for schools, hotels, and some public buildings.

Cross laminated timber (CLT) is a mass timber product, because of the much higher timber content. CLT panels are assembled like large scale plywood with planks at right angles to each other in outer and middle layers, resulting in exceptional strength and rigidity – ideal for building higher-rise structures, such as the tall timber towers in Norway, Sweden, Austria and Canada. CLT has been well demonstrated in the UK in mid-rise housing developments such as Dalston Lane in London, the Cascade in Cardiff<sup>17</sup> as well as in larger schools and office buildings. Just like timber frame, the system gives rapid build time, low site noise, low waste and a highly energy efficient structure. The CLT panels are lighter than concrete and steel systems used in equivalent mid-rise structures reducing the weight on sensitive sites and decreasing depth of foundations, further reducing concrete consumption and associated carbon emissions.



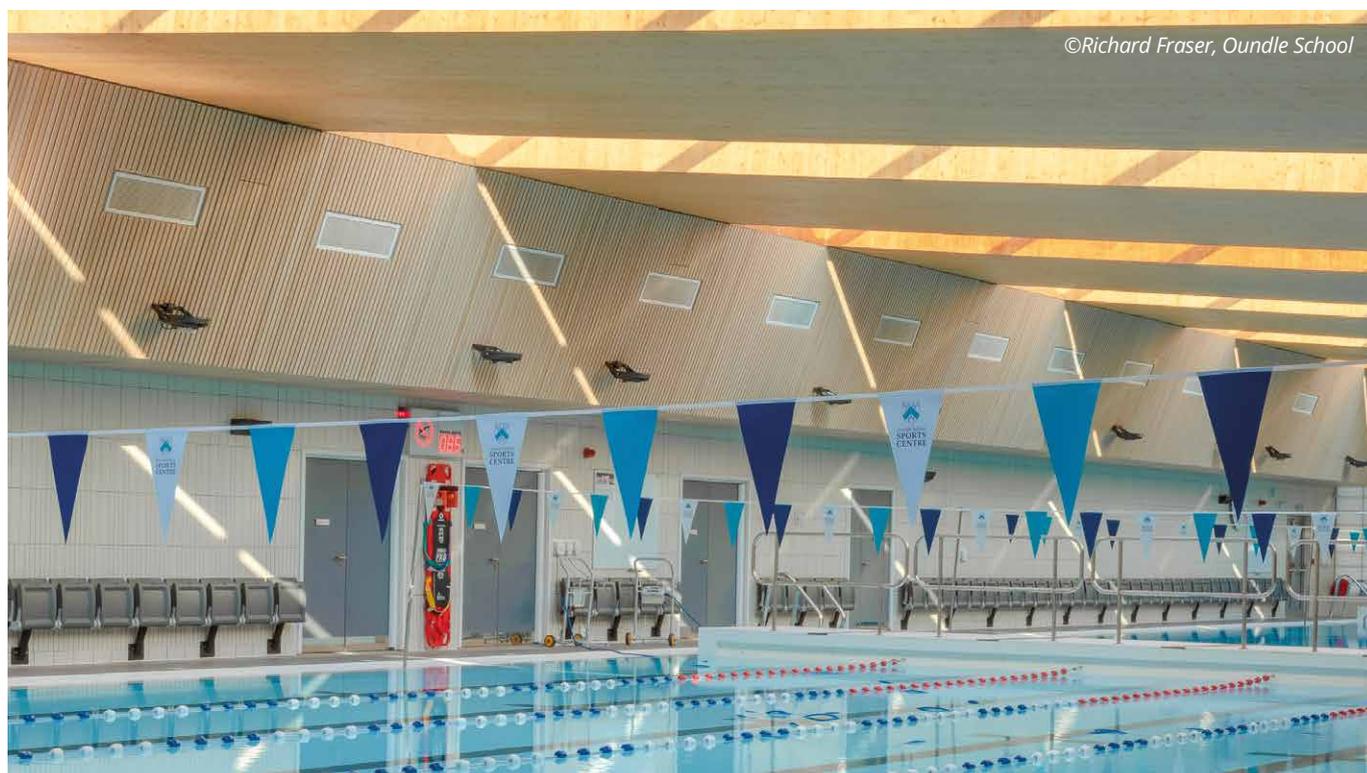
<sup>17</sup> [Building to seven storeys with CLT](#)

Thirdly, the scale of deployment considered possible by 2030 was assumed to be 0.4 MtCO<sub>2</sub>e/year and 1.5 MtCO<sub>2</sub>e/year by 2050<sup>18</sup>. This is consequential considering that the CCC have predicted the need for GGR at a level of 75 MtCO<sub>2</sub>e/year by 2050. However, according to another report on the policy options for GGR by Vivid Economics commissioned by the UK Government in 2019, the scale of Wood in Construction as a GGR could be as high as 5 MtCO<sub>2</sub>e/year by 2050<sup>19</sup>. Importantly, the Element Energy report excluded the use of imported construction timber, which accounts for approximately 85% of the structural sawnwood timber used in construction. So only home-grown timber was considered as eligible for inclusion as GGR. The exclusion of imported timber is an important consideration, the reasons for which will be explored later in the report.

In 2019, the CCC commissioned the BioComposites Centre to study the potential of WIC to inform future policy development<sup>20</sup>. This study used a model of housing stock and projected building rates, alongside historic demolition rates, to calculate the changes in biogenic carbon stock in housing within the UK. The model assumed houses conformed to combinations of six house archetypes which had been used to generate individual materials profiles to consider embodied and biogenic carbon. The archetypes focused on structural elements only (excluding windows,

doors and other joinery elements), so not all timber was considered. The timber quantities in the models were assumed to be in the longest service life category reflecting the building lifespan. Demolition rates in the UK are relatively low – typically 4-10% of the new build rate. Consequently, each year's house building activity gives rise to a significant increase in stored biogenic carbon of between 1.0 to 1.3 MtCO<sub>2</sub>e/year<sup>21</sup>. Unlike the Element Energy report, the BioComposites Centre report considered both home-grown and imported timber.

However, the 1.0 to 1.3 MtCO<sub>2</sub>e/year value is the increase in stored carbon from new build houses only. Other structures built with wood include non-residential (estimated at between 0.5 and 2.3 MtCO<sub>2</sub>e/year by 2050 in the BioComposites Centre report), as well as the conversion and extension of structures, or remodelling interior studwork. Although up-to-date market data is limited, we know from data on total strength graded timber consumption (imports and UK produced) and an analysis of new build housing (number, size and build method), that as much as 85% of homegrown structural timber flows into construction markets other than new build housing<sup>22</sup>. Therefore, the scale of the increase in the carbon store is likely to be considerably higher than can be indicated from modelling new build housing stock alone.



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<sup>18</sup> These are midpoints in ranges. By 2030 from 0.2 to 0.6 MtCO<sub>2</sub>e/year and by 2050 0.9 to 2.8 MtCO<sub>2</sub>e/year

<sup>19</sup> *Vivid Economics for BEIS, Greenhouse Gas Removal (GGR) policy options, 2019*

<sup>20</sup> *Wood in Construction in the UK: An Analysis of Carbon Abatement Potential, 2019*

<sup>21</sup> This represents the range of the different scenarios that were modelled.

<sup>22</sup> *Timbertrends Market Utilisation Report, 2015*



The Cascade, Cardiff - Credit Eurban

Another way to consider the potential scale of WIC as a GGR is to look down the other end of the telescope, from the perspective of the manufacture of wood-based construction products that are used within the structure and fabric of buildings. There are three product categories not currently manufactured at any scale in the UK, but which could feasibly be produced in Wales within the next 5 years, given suitable policy incentives. The examples in Table 2 assume plants of medium capacity by European standards and would require a sawlog input of less than 10% of the current Welsh harvest. This scale of new log demand would influence the current market flows of sawlogs and may divert some wood away from other low value shorter life uses such as energy, but in the opinion of the authors of this report, would be unlikely to lead to the significant disruption of other timber users' businesses.

Table 2. Carbon storage potential for manufacture of different wood products

Product	Output Capacity (m <sup>3</sup> /year)	Carbon Storage in products (MtCO <sub>2</sub> /year)	Assumptions
Wood fibre insulation	75,000	0.012	Average density of 100 kg/m <sup>3</sup> (mid-way between the rigid board and the flexible batt) at 12% MC
CLT	90,000	0.073	Density of 500kg/m <sup>3</sup> and a MC of 12%
Glulam	30,000	0.024	Density of 500kg/m <sup>3</sup> and a MC of 12%
<b>TOTAL</b>		<b>0.109</b>	

An increase in biogenic carbon storage delivered by wood in construction from these three hypothetical modest scale plants alone would provide an additional 10% on top of the current value declared in the UK's National Inventory Report (NIR) to the UNFCCC, 1.1 MtCO<sub>2</sub>e. Thus, investment in new wood products for construction purposes, made from home-grown timber, could be a rapid way to boost greenhouse gas removals in the UK.

Another way to look at the opportunity is by considering the demand for timber in the structure and fabric of UK housing. If the UK house building commitment of the current administration of 300,000 homes/year<sup>23</sup> was met with modern timber frame using home-grown C16 timber, home-grown OSB and insulated with wood fibre insulation from a new UK factory, then the WIC GGR would be 6.4 MtCO<sub>2</sub>e/year<sup>24</sup>. This figure only includes wood used in the structure and external fabric, and excludes timber joinery elements considered by RICS<sup>25</sup> to have a lifespan less than 35 years.

As of January 16, 2025, the price of carbon in the United Kingdom Emissions Trading Scheme was £32.57 tCO<sub>2</sub>e. If a WIC as a GGR scheme was operational in the UK, this carbon price could provide an additional revenue of over £200 million in housing, or £2.8 million into Welsh social housing. This represents a significant opportunity to offset

hard to abate emissions and provide significant co-benefits for social housing, forest industries, land based GGRs through afforestation, as well as many other potential ecosystem services associated with trees.

In summary, WIC is widely accepted to be a GGR method. In contrast to other engineered GGRs, it is market ready and relatively low cost. The scale of the WIC GGR is a little difficult to pin down, but it is clearly significant, which explains its inclusion in the UNFCCC policy sphere and in IPCC technical guidance. There are emerging policies in the UK to encourage greater use of timber (e.g. UK government's Timber in Construction Roadmap 2025<sup>26</sup>, Welsh Timber Industrial Strategy consultation<sup>27</sup>) but real regulatory drivers and fiscal incentives are largely absent. In fact, the only use of wood that currently carries a financial incentive is burning for energy, which in general, is the least climate beneficial of all the markets for wood.

So, if WIC is indeed more than just a good idea, how can it be incentivised? Is it best done through the carrot or the stick? Is it better to use compulsion through regulatory policy or fiscal incentives or both? At this point in the WIC as a GGR story, it is necessary to provide some background on the Paris Agreement, and the UK's contribution to climate change mitigation.

<sup>23</sup> *The current UK government's plan to build more homes*

<sup>24</sup> Taken from an excel model developed by the authors which can be made available upon request to Woodknowledge Wales

<sup>25</sup> *Construction element service lives taken from the Whole Life Carbon Assessment for the Built Environment, RICS, July 2024*

<sup>26</sup> *UK Governments Timber in Construction Roadmap*

<sup>27</sup> *At the time of writing, Wales first Timber Industrial Strategy consultation is closed and publication is expected in July 2025*

## THE PARIS AGREEMENT

As Climate Change is a global challenge it requires a global response. This response is being led by the United Nations through the Framework Convention on Climate Change (UNFCCC) which was established at the Rio Earth Summit in 1992. The expressed aim of the UNFCCC is to stabilise greenhouse gas concentrations *"at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system and within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner."*

The UNFCCC leads the process of developing a coordinated global response to climate change through regular meetings known as Conference of the Parties (COP) which now involve almost every country in the World. The two most consequential conferences were held in Kyoto in 1997 and Paris in 2015. As a direct result of the COP processes, there are now country specific targets with countries required to submit to UNFCCC ever more ambitious climate action plans every 5 years. These plans are known as Nationally Determined Contributions (NDCs).

The Intergovernmental Panel on Climate Change (IPCC) is the overarching scientific authority on climate change. The IPCC publishes reports summarising climate science, providing guidelines for GHG inventories and advises policymakers with scientific evidence. The IPCC provides the science, and the UNFCCC turns that science into global climate policy. The UNFCCC drives action, while the IPCC provides the knowledge to support it. They work together to guide countries in tackling climate change.

To deliver on the commitment made by signing the Paris Agreement, the UK has legislated for net zero greenhouse gas emissions by 2050. Net zero is now a legally binding commitment. The CCC are the UK government's independent advisors on tackling climate change and were established in 2008 under the Climate Change Act. The CCC are responsible for advising on UK Government policies and for setting the UK's legally binding carbon budgets.

These budgets limit the total amount of greenhouse gases the UK can emit over a five-year period to ensure the UK meets its long-term climate targets. These budgets are shown in the following table.

Table 3. UK Carbon Budgets and their target emission reductions

Carbon Budget	Target Reduction (MtCO <sub>2</sub> e) (limit emissions to...)	Target Reduction (%) (compared to 1990)
1st (2008 -2012)	3,018	
2nd (2013 – 2017)	2,782	31% reduction by 2020
3rd (2018 – 2022)	2,544	37% reduction by 2025
4th (2023 – 2027)	1,950	51% reduction by 2025
5th (2028 – 2032)	1,725	57% reduction by 2030
6th (2033 – 2037)	1,201	78% reduction by 2035
7th (2038 – 2042)	Yet to be defined	

The collection and reporting of data that underpins UKs greenhouse gas monitoring and reporting is the responsibility UK Government's Department for Energy Security and Net Zero (DESNZ).



## THE PARIS AGREEMENT AND THE UK'S QUANTIFICATION AND REPORTING PROCESS

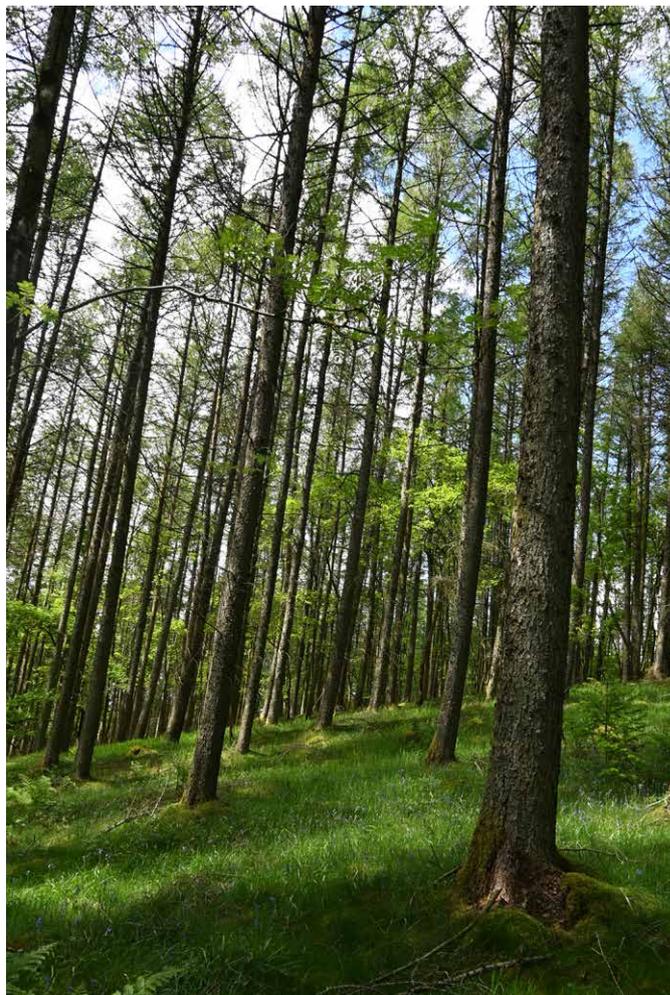
The UK Government reports progress on meeting net zero to the UNFCCC through the National Inventory Reports (NIRs) which are submitted annually. The NIRs report actual recorded greenhouse gas emissions. They are based upon data from the UK Greenhouse Gas Inventory (GHGI). NIRs enable the monitoring of progress against the forecast reductions declared in the Nationally Determined Contributions (NDCs). A further layer of detail is that for the harvested wood products carbon storage, the UK GHGI draws upon forestry data supplied by Forest Research (a UK Government research agency).

The NDC for the UK and NI was submitted in 2020 and updated in 2022<sup>28</sup> and covers the period 2021 to 2030. The sectors included in the NDC follow IPCC guidelines and include energy, transport, industry, agriculture and land use and land use change and forestry (LULUCF). Harvested wood products (HWPs) have been a recognised carbon pool in LULUCF reporting since the IPCC 2006 guidelines. It is therefore important to note that the UK is already calculating and reporting a carbon removal from HWP within the NIR. However, while this provides visibility at a macro level, there is little consideration at the sector or micro level, and WIC contribution is potentially overlooked.

## THE 6TH CARBON BUDGET

The CCC's 6th Carbon Budget (which runs from 2033 to 2037) is the first carbon budget to report the potential of GGRs<sup>29</sup> in general and WIC as a GGR in particular. In fact, a special GGR report was prepared to support the 6th Carbon Budget, whereas to date there have been no engineered GGRs reported other than a small WIC GGR reported as part of LULUCF. This makes the CCC's 6th Carbon Budget good news for those who are championing the greater use of wood and other biogenic construction products. However, the budget period doesn't begin until 2033 and the CCC has taken a relatively cautious approach to the expected contribution from WIC, as can be demonstrated by some key statements extracted from the 6th Carbon Budget GGR report, explored below.

- The estimate of the WIC GGR not accounted for in LULUCF by the report was 0.4 MtCO<sub>2</sub>e/year by 2050<sup>30</sup> – that is in 25 years time. Compare this estimate with the carbon storage potential of 0.109 MtCO<sub>2</sub>e/year from three theoretical but modest capacity engineered wood product plants shown in Table 2. Or indeed, compared with 6.4 MtCO<sub>2</sub>e/year if we build all new UK homes using timber rich approaches.
- The CCC state that no additional costs are associated with achieving the predicted WIC GGR. This means that the CCC recognise that the WIC GGR is free or at least very low cost, but the CCC seem not to have envisaged approaches that may drive rapid scaling.



<sup>28</sup> *United Kingdom of Great Britain and Northern Ireland's Nationally Determined Contribution, 2022*

<sup>29</sup> *The 6th Carbon Budget, Greenhouse Gas Removals, 2020*

<sup>30</sup> The WIC 'not accounted for in LULUCF' is used to calculate only the 'additional' wood used through a WIC policy that has not already been reported in the NIR based on forest data. In the 6th Carbon Budget a value of 1.0 MtCO<sub>2</sub>e was assumed to be reported in LULUCF through to 2050.

- The CCC state that only wood sourced from UK forests is considered. On the upside, this should provide a driver for the use of home-grown timber in construction which has significant social, economic and environmental co-benefits. On the other hand, it limits the current scale of the GGR that can be delivered in the near term, due to the UK's current heavy reliance on imported timber.
- The proportion of timber frame houses is forecast by the CCC to rise from 28% to 40% by 2050. This seems unambitious considering the growth of the use of timber frame in Wales and Scotland. The growth is particularly strong in social housing where Welsh Government is beginning to encourage the use of timber through fiscal and regulatory levers associated with the social housing standards<sup>31</sup> and through the funding mechanism<sup>32</sup> which currently provides a 10% uplift for the use of advanced timber frame and the use of home-grown timber.
- Engineered wood products remain a minor contributor (the scenario used 5% of mid-rise housing, which is typically dominated by steel frame and concrete). Again, this seems unambitious. The UK demand for engineered wood products could change almost overnight with the introduction of policy incentives, which may only need to be light touch given the competitive price and performance of wood products.

## WHAT IS LULUCF?

LULUCF (Land Use, Land-Use Change, and Forestry) is a sector in greenhouse gas (GHG) inventories that accounts for carbon emissions and removals related to land use. It is a key category in climate reporting under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The LULUCF forest carbon pools reported in the NIR include above ground biomass (e.g. trees), below ground biomass, biogenic litter, deadwood and soil organic carbon, and importantly stocks of harvested wood products (HWP).

In terms of Wales, the proportion of the WIC GGR that is allocated as achieved by Wales simplistically follows the timber harvest volumes, rather than the actual use of home-grown timber in Welsh construction. This follows the logic of LULUCF reporting and the reliance on macro forestry production and market data but fails to correctly allocate the benefit to Wales of building with home-grown timber. It is an example where HWP calculations can be used to consider specific issues and answer policy questions, if a suitable method is agreed. Additionally, the use of the IPCC Tier 1 half-life methodology will fail to capture the benefit of a shift to increase the use of homegrown timber in long-life construction applications, as the half-life is static not dynamic. An Austrian example investigated how half-lives alter year by year with shift between commodities produced across the economy<sup>33</sup>.

The CCC can foresee high emitting sectors paying for GGRs<sup>34</sup>. This then might open the possibility of private sector bodies effectively providing a fiscal incentive to fund the use of wood in construction. It can be envisaged that companies such as Ryan Air, Cargill or Tata Steel to give but three hypothetical examples, could fund the greater use of wood in construction. This might seem far-fetched but in the case of tree planting as a GGR it is already happening, since the introduction of the Woodland Carbon Code 14 years ago in 2011. It should be noted that the Woodland Carbon Code methodology assumes that all the carbon sequestered by the tree is released upon harvest. There is therefore no risk of double counting the carbon in the WIC GGR calculation.



<sup>31</sup> *The standards for Welsh social housing are described in the Welsh Development Quality Requirements (WDQR)*

<sup>32</sup> *The funding mechanism is the Social Housing Grant (SHG)*

<sup>33</sup> *Braun et al. (2016) Apparent half-life dynamics of HWPs in Austria*

<sup>34</sup> *Policies for the Sixth Carbon Budget and Net Zero, CCC, 2020*

In summary, the UNFCCC and the Paris Agreement represent a truly remarkable exercise in global cooperation but has required the creation of an extremely complicated process to enable good governance. The opportunity for WIC as a GGR is clearly recognised and valued by the CCC and by UK Government. Through the Paris Agreement reporting process the WIC GGR is at least partially accounted for. But are we missing opportunities? The need to create order has spawned a process that only a limited number of government employees, supported by a limited number of academics, understands.

This report seeks to peel-back the layers of the WIC as a GGR onion. In so doing it is hoped that more organisations (such as processors, manufacturers, contractors and building clients) will be able to better understand how the system works and participate in both quantifying the contribution of their activities, as well as in influencing a significantly more ambitious approach to the use of wood and other biogenic materials in construction. It is also critically important to understand what reporting systems need to be in place to enable WIC to become a more significant GGR and therefore of increased interest to policy makers. Such systems may include a registry to record the GGR on a project or sector or business level, chain of custody to provide evidence of origin, along with market data to provide greater granularity on timber construction product uses and carbon storage duration. To unpick this a bit more, it's necessary to understand how the HWP carbon pool is currently calculated.

## THE WOODLAND CARBON CODE

The Woodland Carbon Code (WCC) is the UK's voluntary carbon standard for woodland creation projects that remove carbon dioxide (CO<sub>2</sub>) from the atmosphere. It provides a framework for measuring, verifying, and trading woodland carbon credits, helping businesses and landowners contribute to the UK's net-zero targets. The WCC can provide a potential template for future schemes targeting wood in construction. WCC projects must follow strict rules to ensure additional CO<sub>2</sub> removal through tree planting. Carbon capture is independently verified by accredited bodies. Landowners earn carbon credits and businesses can buy carbon units to offset emissions as part of their net-zero strategies.





# CALCULATING THE HARVESTED WOOD PRODUCTS (HWP) CARBON POOL

The carbon cycle of a timber producing forest is complemented by the transfer of carbon in harvested timber into wood products. Sustainable forest management practices typically maintain stable carbon levels in the forest, but the store of carbon in harvested wood products (HWP) changes over time depending on timber markets, service life and end of life strategies, such as recycling. All wood products offer storage for varied lengths of time. Timber in the fabric of buildings provides multi-decadal storage, whilst biomass for energy may be released back to atmosphere within a few months of harvest.

To quantify the change in the HWP carbon pool size, it is necessary to calculate the quantity of carbon entering and exiting this pool. It is important to remember it is not only the total size of the HWP pool that is important, it is the increase in pool size, or rate of growth of the pool, that really matters. Thus, the quantity entering the carbon pool, and the quantity leaving the carbon pool in a given year must be known.

This is where things can get fiendishly complicated. Fortunately, as we have touched on, the IPCC provides a framework of different approaches and calculation methods for estimating these changes in HWP carbon pools<sup>35</sup>. This then enables countries to quantify the contribution of HWP in their national greenhouse gas inventories and in their reporting to UNFCCC as part of their Paris Agreement commitments. Individual countries can choose an approach and calculation method that best reflects their data availability and national circumstances.

The four main IPCC approaches are shown in the explainer box on the next page. The UK has adopted the Production Approach. This means that the UK has decided to only include carbon stored from home-grown timber in the HWP calculation. The stated reason for this is to avoid the risk of double counting carbon when the UK's NIR is combined with other Annex 1 countries at UNFCCC level, because timber grown elsewhere will be counted elsewhere. This decision will have a profound implication for the scale of WIC as a GGR in the UK, and for the market dynamics that would underpin growth or otherwise as a GGR. If a carbon compensation mechanism for WIC as a GGR could be introduced, then the incentive for UK companies to invest processing home-grown timber and manufacturing of wood-based construction products such as wood fibre insulation, CLT and glulam could be substantial.



<sup>35</sup> IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 12 Harvested Wood Products. Rutter S, Matthews R.M, Lundblad M., Sato A and Hassan R.A. Published IPCC, Switzerland; 2006 IPCC Guidelines for National Greenhouse Gas Inventories

## IPCC APPROACHES FOR ESTIMATING HWP CARBON POOLS

The IPCC allows for different methods based on data availability and national circumstances:

### Production Approach:

- Accounts for carbon in HWPs produced from domestic harvests only.

### Stock-Change Approach:

- Measures changes in carbon stocks in HWPs used within a country's boundaries.
- Includes imports and excludes exports.

### Atmospheric-Flow Approach:

- Estimates emissions at the time of harvest, including imports from other countries. For example, imported wood for bioenergy would be an emission for the importing country.
- Does not account for delayed carbon release in HWPs.

### Simple Decay Approach:

- Estimates emissions at the time of harvest, for wood produced domestically.
- Does not account for delayed carbon release in HWPs.

The existence of these four approaches affirms that each one has its own relevance, depending on the context and the policy question that is being addressed. The production approach is used at UNFCCC level for NIRs. The stock change approach is useful when considering domestic policy, for example the effect of legislation to promote WIC, or trends in national wood consumption into long and medium life product groups for GGR.

At this point it's important to state that recycled wood used in construction should be considered as a GGR. Regardless of the origin of the timber in the first life, recycled products such as wood based panels or recycled glulam and CLT provide a new lifespan in the building. Circular approaches are essential part of optimising the carbon benefit of the wood value chain<sup>36</sup>. Recycling ensures that the carbon storage duration is extended into the next product life and there is limited risk of double counting.

The IPCC also provides three different methods for estimating Harvested Wood Product (HWP) carbon pool size. These methods describe the number crunching options. The methods are characterised by increasing levels of data requirement but also offer increasing accuracy of the calculated value through use of better data and more complex models. In practice, the Tier 1 method, based on three half-life values for broad categories of wood product, shown in Table 4, has been seen as the most attainable and has become most widely used internationally. However, it is known to lead to underestimation of pool size in many cases<sup>37</sup>.



<sup>36</sup> *Circular wood use can accelerate global decarbonisation but requires cross-sectoral coordination, 2023*

<sup>37</sup> *The benefits of circular economy approaches in the wood panels industry on the magnitude of harvested wood products (HWP) carbon storage, 2023*

## IPCC METHODOLOGIES FOR HWP POOL CALCULATIONS

### Tier 1 (Basic Approach)

- **Method:** Uses default IPCC values for decay rates, known as half-lives, and carbon conversion factors.
- **Data:** Can be done with three simple categories of wood product that are commonly reported in international statistics (e.g., FAO forestry data) for HWP production, trade, and consumption.
- **Decay Model:** First-order decay (FOD) model with default half-lives:
  - Sawnwood: 35 years
  - Wood panels: 25 years
  - Paper products: 2 years
- **Carbon Pool Approach:** Typically applies the Production Approach but can be applied to stock change approach.
- **Best For:** Countries with limited national data or small forestry sectors.

### Tier 2 (Intermediate Approach)

- **Method:** Uses country-specific data to improve the accuracy of half-life values but still applies the first-order decay model.
- **Data:** Uses sub-categories such as semi-finished products to refine the lifespan estimates within the three product categories, e.g. joinery, pallets and structural timber would be within sawnwood. Incorporates semi-finished product quantity data, domestic HWP lifetimes, and refined decay rates.
- **Decay Model:** first order decay, but adjusting the half-life values.
- **Carbon Pool Approach:** Can refine the Production and the Stock-Change Approaches.
- **Best For:** Countries with more detailed wood products sector statistics and the ability to track national HWP use and service life.

### Tier 3 (Advanced Approach)

- **Method:** Uses detailed national models and country-specific parameters. Several options for method refinement are possible.
- **Data:** Incorporates comprehensive national statistics, industry-specific decay rates, and detailed product tracking.
- **Decay Model:** Can use FOD, but other models such as Weibull, gaussian, Rayleigh and logistic functions are possible. Also possible to use the 'flux data method', i.e. without a model, if product disposal data is sufficiently good to give real end of life data in place of modelled values.
- **Carbon Pool Approach:** Both the Production and the Stock Change Approach. Often applies custom decay models.
- **Best For:** Countries with sophisticated forestry, wood product and carbon tracking systems, coupled with detailed market split information (e.g., EU, US, Canada).

Progress towards achieving the commitment outlined in the UK's NDC is monitored using data in the annually submitted National Inventory Reports (NIR). The HWP contribution is currently calculated for the UK using the IPCC Tier 1 approach with three IPCC default half-lives<sup>38</sup> as shown in the Table 4 below.

Table 4. Default half-lives for the three IPCC product categories

Product Categories	IPCC Half-Life
Sawnwood	35 years
Wood-based panels	25 years
Pulp and Paper	2 years

The sawnwood category includes all uses for sawnwood, ranging from graded structural timber, pallets and garden products down to very short life items. A half-life of 35

years therefore represents the profile across all these uses. Similarly, the 2-year half-life for pulp and paper represents the mix of long life (e.g. books) and short lifespan (e.g. toilet tissue) products.

These half-lives are used in the UK's forest carbon accounting model known as CARBINE operated by Forest Research. The UK national greenhouse gas inventory (GHGI) draws on the data used in the CARBINE model to report HWP carbon pools in the UK's NIR in the section that deals with land use, land use change and forestry (LULUCF). However, when considering WIC as a GGR, a half-life of 35 years may be a significant underestimation of the period of carbon storage, particularly for wood products used in the structure and fabric of buildings. Also, the 25-year half-life for wood-based panels underestimates the period of use of oriented strand board (OSB) within timber-framed systems.

## ORIENTED STRAND BOARD (OSB) AND TIMBER FRAME CONSTRUCTION

Oriented strand board (OSB) is a wood-based panel used to provide rigidity (racking resistance) in timber frame construction. OSB is formed from precision cut strands of timber. The strands are aligned parallel to the load direction of the panel and aligned perpendicular to this in the central layer of the sandwich. This orthogonal alignment gives high rigidity and structural performance, akin to plywood, while also keeping the strength of the timber in its longitudinal direction. The wide panel area is ideal for the wall, floor and roof cassettes formed using strength graded timber for timber framed structures. The strands can be cut from smaller diameter logs, i.e. not competing with sawnwood. The UK has mills already producing OSB entirely from home-grown timber, and capacity is set to further increase with investment at

Kronospan (expected to be operational by 2027). This means that when considering GGR and the ability to manufacture timber frame from home-grown timber, the OSB currently contributes more home-grown material to the house than the sawn timber.



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Using this approach, the UK's most recent NIR reported the HWP storage component to be an increase of 2.139 MtCO<sub>2</sub>e/year. This then is the calculated annual increase in the store of carbon from home-grown timber in sawnwood, wood-based panels and paper. To emphasise this point; by including HWPs in the UK's Paris Agreement reporting means that the use of home-grown wood in construction as a GGR, is at least to some extent accounted for in the UK's net zero carbon balance sheet.

To substantially and purposefully grow WIC as a GGR, incentives will be needed. Such incentives (whether driven by regulation or financial mechanisms such as carbon offsetting) need to be managed within an appropriate governance framework for monitoring, reporting and verification. Such a framework has come into force in the European Union and provides further insights into what needs to be done in the UK to support the growth of WIC as a GGR.

<sup>38</sup> A half-life is the time it takes for half the carbon to be released. So over 35 years 1kg of stored carbon becomes 0.5kg, and over 70 years 0.25kg, and so on.

# THE EU FRAMEWORK FOR CARBON REMOVALS AND CARBON FARMING

In December 2024 a new European Union certification framework for carbon removals came into force – known as Carbon Removals and Carbon Farming (CRCF). This framework covers permanent carbon removals (such as DACCS and BECCS), carbon farming (such as afforestation and improved soil management) and carbon storage in products (such as the use of wood and other biogenic materials in construction). This framework covers both GGRs and CCS approaches and is designed to be used for the certification of both regulatory incentives for carbon removal as well as for carbon compensation mechanisms or offsetting. This means that the same carbon removals principles apply whether WIC is being encouraged and reported through government policy levers, or through a private sector offsetting mechanism.

To ensure the effectiveness of carbon removal activities, the CRCF Regulation has 4-key elements: quantification, additionality, long-term storage and sustainability. These elements could help to provide the basis for a roadmap for policy makers and industry for the development of the necessary reporting mechanisms for WIC as a GGR.

## Quantification

It is highly likely that the quantity data for wood in construction carbon storage would be obtained from the biogenic carbon reported in Environmental Product Declarations (EPDs) for the building products. The data to quantify the biogenic carbon storage within a construction product can be derived from an EPD. The quantity data for products used within a build can then be combined with biogenic carbon data from independently verified EPDs. This then is a key point of overlap between policies associated with embodied carbon reduction in construction and Greenhouse Gas Removals.

## Additionality

The additionality requirement is a key criterion in carbon offsetting and carbon removal certification. It ensures that carbon reduction or removal projects provide genuine climate benefits that would not have occurred without the financial support from carbon markets or regulatory incentives.

Key features of additionality include:

- The carbon removal activity must go beyond business as usual. This means that the removal must go beyond what is legally required or what would typically happen

under existing policies, industry standards, or economic conditions. The ability to prove “going beyond business as usual” requires an understanding of the baseline condition. In the UK we almost certainly do not collect sufficient data to know what our baseline condition is. Furthermore, going beyond business as usual in standard modern lightweight timber frame may be hard to prove if the consideration is upon a single dwelling. Alternatively, if a policy is introduced that doubles the effective market for timber frame, then lightweight timber frame may pass the additionality test, when consideration is upon a sector (e.g. social housing), or defined geographic region (e.g. Wales).

- The project must demonstrate that carbon credit revenues are necessary for viability. If the project would still occur without carbon finance, then that project effectively fails the additionality test. Proving whether timber was chosen for a project based upon a financial incentive is very difficult. Again, this may be easier to prove with macro sector data than it is for an individual project. There is considerable risk with financial additionality in that it may skew decision making, away from a more holistic consideration of all issues, towards a consideration of carbon alone.
- The additional carbon removals must not come at the cost of other environmental goals (e.g., biodiversity loss, water depletion).

In short, additionality really matters. Additionality criteria help avoid double counting and prevent credits from being issued for removals that are already legally required. They ensure real climate impact and builds trust in voluntary and compliance carbon markets.

Additionality is also something of a thorny issue. To ease the path for proving additionality and reducing the risk of non-compliance with a future scheme, it may be better to do something that wouldn't otherwise make sense – such as to plant a species of tree that grows fast but has no market value. Or to give an example more relevant to WIC, to build low rise houses with CLT which uses far more timber and is more expensive than modern timber frame and therefore arguably ill-advised from both an economic and sustainability perspective. A further challenge with additionality is related to government regulation or fiscal incentives. If the Welsh Government provides financial support or regulatory compulsion to use more home-grown timber in its social housing programme, does this mean that these homes then fail the additionality test? This seems to set up a counter-productive catch-22.

## Duration of storage

The EU framework seeks to ensure that the certified carbon is stored securely over an extended period. That period can be short term over decades, such as biogenic products used in construction, where a requirement is that storage is longer than 35 years, medium term over centuries such as biochar and reforestation or permanent, i.e. over millennia such as DACCS. In the case of construction there is an absolute requirement in EU CRCF that storage is longer than 35 years. A 35-year period is being used as both the IPCC's half-life for sawnwood in the harvested wood product calculation in LULULCF and the period of storage necessary to qualify as a GGR in the EU's CRCF framework

The period of storage will have a significant influence over the monetary value of a carbon removal as well as the risk of reversal. Short term storage requires robust processes for the ongoing monitoring of storage and for managing the risk of early reversal of storage. In the WIC case, default values for certain products are available, for example in the RICS whole life carbon assessment methodology, building components and fit out elements are assigned typical lifespans. The focus on product level calculation permits this approach to be used to assign the quantity of timber that will be present in the building for longer than the 35-year threshold to be certified under the EU CRCF framework.

## Sustainability

The EU framework seeks to ensure that additional removals don't come at the cost of other environmental goals (e.g., biodiversity loss, water depletion). In the land management options, as well as the wood in construction case, it would be expected that sustainable forest management practices are observed. This then puts considerable responsibility on the timber construction value chain (from forest to building) to account fully for, and make transparent, the environmental impact of the use of wood in construction. Chain of custody schemes already exist and will come into play to validate this criterion when certifying carbon storage. In addition, the current UK Timber Regulation (UKTR), and its mirror EU Timber Regulation (EUTR) all contribute to tracing this information on sustainable resource use.

## THE UK TIMBER REGULATIONS

The United Kingdom Timber Regulations (UKTR), which came into force on January 1, 2021, are domestic legislation that mirrors the EU Timber Regulations (EUTR), aiming to prevent illegal logging and promote sustainable forestry by ensuring timber and timber products placed on the UK market are legally sourced. EUTR is soon to be replaced by EUDR, which tightens the focus on avoiding deforestation, and imposes additional data requirements. Although the EUDR will not be applicable in the UK, it is likely to drive the demand/technology for improved traceability of materials.

Within CRCF, the EU are committing to create a registry for carbon removals by 2029. This will lead to transparency and full traceability of certified units within certification schemes. A UK registry would also be required to ensure transparency and avoidance of double counting.

However, there are some open questions related to the fact that the CRCF framework is not tied to the UNFCCC carbon reporting system established under the Paris Agreement. It is unclear how double counting can be avoided for WIC that has been traded in an offset mechanism, as it should not then be reported as a GGR in the UK's NIR to meet the UK's NDC commitment. Furthermore, the CRCF framework may not be restricted to only reporting carbon in home-grown timber, and mechanisms could be introduced that only require the timber to have come from sustainably managed forests. This suggests that it might be possible for home-grown WIC to count as a GGR within national carbon accounting and reporting, whereas imported WIC could be traded in a compensation mechanism within the CRCF framework.



# INTERNATIONAL STANDARDS DEVELOPED FOR ORGANISATIONS

## ISO 13391 Greenhouse gas dynamics

A newly developed standard from ISO brings a new approach to quantifying carbon storage. The ISO 13391 standard has three parts, which together address the greenhouse gas dynamics of wood and wood-based products. The first part (ISO 13391-1) quantifies value chain emissions (similar to an LCA, embodied carbon) as well as giving a method to calculate the stored biogenic carbon within HWP. The second part considers forest carbon balance, and the third part addresses displacement – where wood products are used in place of higher embodied carbon products resulting in a reduction in emissions. All of these aspects can be reported together to give the greenhouse gas dynamics of an organisation's products – regardless of their location in the wood products value chain.

It is the HWP calculations in part 1 of the standard that are of greatest relevance to WIC as a GGR. The standard has brought the concepts from IPCC methodology into the space where it can be used and applied by organisations to quantify their own carbon storage effects. This overcomes the product centred method used by LCA,

which tends to result in the time dimension of carbon storage being deemed too complex to quantify (see explainer box). If ISO 13391-1 is used, then the storage duration effect of wood construction products entering the pool can be evaluated – a key metric of interest when making policy decisions, or when demonstrating the benefit of adopting a timber-based option to deliver GGR.

Within the HWP carbon calculations in ISO 13391-1, the approach mirrors that of the IPCC methodology for national HWP carbon storage, i.e. the change in size of the HWP pool achieved by the organisation's outputs is calculated, rather than the carbon stored at a product level. In common with the IPCC method, there are three tiers for the calculation, with Tier 1 using default data relating to the IPCC default half-lives, and Tier 2 and 3 using increasingly precise data relating to the specific activities of the organisation and the destination of their wood products, e.g. service life and recycling rate. Thus, the standard presents an option for considering the carbon storage benefit of the organisation's activity, and the principles could then be used when considering delivery of stored carbon in WIC at a regional level.

## LIFE CYCLE ASSESSMENT, EMBODIED AND BIOGENIC CARBON

The field of life cycle assessment (LCA) is well established, with several standards addressing products including biobased materials or construction materials as well as guidance for making calculations for whole buildings. While LCA addresses many different environmental indicators, including ecotoxicity, water quality, air quality etc, the field that is most relevant here is embodied carbon or global warming potential (GWP). The embodied carbon is also considered within carbon footprints, a closely related metric.

The embodied carbon, or GWP, of manufacturing, using and disposing of a material is the radiative forcing<sup>39</sup> effect on the atmosphere resulting from all the emissions at each stage in the product's life. It can be calculated from cradle to gate, but increasingly is considered right through from cradle to grave. However, when a material is made using wood, the wood itself

contains carbon, which is considered to have been taken out of the atmosphere while the tree grew, so is referred to as biogenic carbon.

In an LCA conducted under EN 15804 the biogenic carbon will be declared as negative (i.e. removed from the atmosphere) at the start, and then released to the atmosphere at the end of life – it is assumed the material is burnt or oxidised in disposal. The two numbers are always reported separately, but the net effect over the whole product life for the biogenic carbon is zero. In a carbon footprint, the footprint is defined as the embodied carbon minus the biogenic carbon, i.e. the storage benefit is considered to reduce the emissions. These two approaches have been well debated over many years, but differences persist. The topic of LCA and consideration of biogenic carbon in a related field – dynamic LCA – are discussed further in Appendix A.

<sup>39</sup> Radiative forcing is the change in the Earth's energy balance resulting from alterations in factors like greenhouse gas concentrations, aerosols, land use, solar irradiance, and volcanic activity, which can lead to either warming (positive forcing) or cooling (negative forcing)

The method in all three tiers handles products of every expected lifespan because of the HWP pool method, so no age restriction is applied to exclude short life products. Importantly the Tier 2 method allows the organisation to determine appropriate half-lives for their specific products, so one focus of effort has been improving the half-life data for timber and wood panels in construction. Tier 3 allows other mathematical functions to be used, not a first order decay or half-life method. Functions such as the Gaussian, Gamma and Chi-squared distribution are much more accurate in modelling pool size, because they use a distributed approach to address product service lives, showing an increase relative to half-life data<sup>40</sup>. The ability to include carbon storage resulting from recycling is another benefit, for example when considering the way that the circular economy prolongs carbon storage effects and thus increases the size of the HWP pool.

### RECYCLING TIMBER AND EXTENDING STORAGE

The wood products sector was an early adopter of recycling, with both the paper industry and the wood-based panels sector fully engaged with recycling during the 1990s. The benefit of reusing timber in a new product such as particleboard is the potential to extend the duration of carbon storage. On the one hand, several medium life span applications can add together to achieve a reasonably long storage period, but on the other hand if structural timber at end of building life is recycled into particleboard for flooring, then a second full length building lifespan can be achieved. An additional benefit is that the recycled material is considered to be a domestically sourced product, thus the origin of the timber does not alter whether or not carbon storage can be calculated or certified. In the IPCC production approach for national inventory reports, a wood panel with 90% recycled timber and 10% domestic should be counted as 100% entering the HWP pool. In the ISO 13391-1 method, the whole production by that organisation, including recycled content, should be counted as storage.

The longer biogenic carbon can be stored out of the atmosphere, the more benefit it provides. It is therefore better – not just for the circular economy but for global warming – to extend the life of biobased products, and to reuse and recycle them at end of life, rather than use them for energy recovery or dispose of them with incineration.

If biogenic materials are to be a key solution to creating and maintaining a built environment whilst staying within global carbon limits, quantification of the carbon storage effects is essential. It is clear from consideration of the new EU CRCF framework and the emerging ISO standard, that a lot of work has been done to address this issue from different perspectives, answering subtly different needs of different parties. These tools are now available to meet the needs of policy makers or an emerging GGR sector. However, further thought and development are required before the biogenic materials used within the construction sector will be fully recognised as a GGR, or able to benefit from a policy or fiscal mechanism associated with driving greater uptake to achieve GGR targets.



<sup>40</sup> *A distributed approach to accounting for carbon in wood products, 2009*

# SUMMARY AND RECOMMENDATIONS

Determining how much biogenic carbon resides in a piece of wood is relatively simple. Whereas proving that a piece of wood is contributing to climate change mitigation as a GGR is anything but. Table 5 attempts to summarise key features of some of the approaches that have been mentioned. Protocols need to be developed to enable a much better understanding of the origin and quantity of wood being used in construction and for what purpose, to enable more accurate reporting, to avoid double counting and to manage risks.

As policies emerge over the coming decade, they will need to go hand in hand with more accurate modelling to avoid over and under reporting. There could be a strong case made for use of the IPCC methodology, or the ISO 13391-1 approach to HWP modelling when reviewing the impact of policies intending to achieve GHG reduction through GGR in WIC. For example, the sub-categorisation of sawnwood into

semi-finished products such as graded structural timber, joinery timber, pallets and garden products, each with a better estimate of lifespan to permit a Tier 2 calculation, or even an improved method for modelling service lives (e.g. a shift to alternative mathematical functions within a Tier 3 model). Only with better quality data for the contribution of WIC will the effect of the supportive policies be detectable. The continued use of assumed split and default half-lives will not detect a shift in WIC delivery. Furthermore, if only home-grown timber can qualify then a chain of custody system is required.

However, it is widely reported that we are now amid the critical decade for climate action, if we are to stay below 2.0°C. Therefore, we should not wait for the full development of standards and frameworks before taking action to increase the wood in construction GGR. What can be done today?

Table 5. Overview of similarities and differences across different systems for quantifying biogenic carbon or GGR through WIC.

Trait	IPCC	EU CRCF	LCA and EPD	ISO 13391	Carbon credits and carbon finance
Who for	Countries to send NIRs to UNFCCC	Organisations and others	Organisations	Organisations	Organisations
Pool or product	HWP Pool	Construction Product	Construction Product	HWP pool	Construction Product
Restrictions	Only homegrown timber	Only products over 35 years lifespan	No carbon storage benefit in GWP100	The organisation's product mix	Additionality
Approach	Production (also Stock change)	--	--	Production or Stock change	--
Quantification of biogenic carbon	Model using first order decay (FOD) Or model using other functions Or use primary data	Excludes (i.e. subtracts) embodied C	Determined at A3 and shown as loss at C3	Model using FOD Or model using other functions Or use primary data	Based on EPD biogenic C values
Additionality	N/A	Only the quantity above baseline	N/A	N/A	Most schemes only the quantity above baseline
Duration	Flux of pool allows all durations to be handled	Over 35 years	N/A (Few cases exceed 100 year time horizon)	Flux of pool allows all durations to be handled	Varies with scheme
Sustainable forest management	Yes	Yes	N/A	Yes	Varies with scheme

# PRINCIPLES FOR WIC GGR ENCOURAGEMENT

Encouraging the use of wood in construction as a GGR strategy undoubtedly requires a holistic approach that addresses the full value chain from forest to building. Below are some potential policy levers to drive growth in timber-based construction while maximising its carbon storage benefits. Some of these are already happening to a greater or lesser extent across the UK.

## Financial Incentives & Market Mechanisms

Provide direct subsidies for low-carbon buildings that use timber instead of steel and concrete, such as Germany's "Wood Construction Bonus" which rewards timber-based structures. Offer tax deductions or lower VAT rates for buildings with a high proportion of timber which could apply to Cross-Laminated Timber (CLT), Glulam, and mass timber projects.

Introduce carbon credits for long-term carbon storage in buildings. Examples of this are being pioneered by Aureus Earth<sup>41</sup>, and Timber Finance<sup>42</sup>, but progress is slow as it's proving difficult to monetise the biogenic carbon stored in buildings in a way that is legally robust, low risk, avoids double counting and can pass the additionality test.

## CASE STUDY – AUREUS EARTH

Aureus Earth's primary offering is carbon asset-backed securities (CABS), a carbon-based financing mechanism for developers. Aureus Earth provides funding for buildings based on the amount of carbon sequestered and reduced using mass timber and other biogenic materials. Initially, Aureus Earth's focus was leveraging carbon credits to reduce the green premium associated with mass timber construction. In 2022 the company, in partnership with the University of Washington, completed the first mass timber carbon credit project globally.

However, the company needed to pivot away from carbon credits due to the downturn in the voluntary offset market, which has caused venture capital funds to disappear. Consequently, Aureus Earth CABS offering resembles a more traditional real estate investment with a carbon focus.

Aureus Earth states that they are now avoiding offsets for the following reasons:

- The financial equation does not align. Offsets do not generate sufficient revenue to effectively incentivize mass timber construction and lower the green premium.
- There are challenges in navigating additionality in construction projects.
- Too slow to market.
- Too many competing standards organizations.
- The offset market has crashed in the US and lost almost all credibility. The big "issuers" have had scandals and participants are getting sued.
- The above has caused all VC money to disappear. Offset is now a bad word in the US.



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<sup>41</sup> Aureus Earth

<sup>42</sup> The Timber Finance Initiative

## CASE STUDY – THE TIMBER FINANCE INITIATIVE

Based in Switzerland, Timber Finance has developed a methodology for Mass Timber Construction which quantifies and monetises construction stored carbon under the Verra Standard<sup>[1]</sup>. The methodology also accounts for the co-benefits of avoiding emissions associated with concrete and steel. They have recently launched a pilot phase for the DACH region and will finalize the methodology with a project portfolio of approximately 20 buildings spread across Switzerland, Germany and Austria. Once the methodology is approved by Verra, an ICROA<sup>[2]</sup> standard, they will look to develop regional adaptations of the methodology and create an offering for other markets globally.

## Reform building regulation, standards and policies

- Mandate timber in public sector building by requiring government-funded buildings (schools, offices, public buildings, healthcare, social housing) to use a minimum percentage of timber and harvested wood products. In France, 50% timber in new public buildings has been mandated since 2022. Japan have had a “Wood First” law and urban timber policies since 2010 promoting and prioritising the use of wood in public buildings. Sweden prioritises the use of timber in public buildings.
  - Modernise Building regulations to support timber. For example, in Canada the National Building Code was updated in 2020 to support the use of mass timber enabling increased height limits. In the UK we need to revisit the post-Grenfell fire and safety regulations that currently restrict the use of combustible materials in the external fabric of residential buildings over 18m.
  - Include whole-life carbon assessments in construction policy and fast track the introduction of embodied carbon regulations into the UK Building Regulations (Approved Document Z). Sweden have set embodied carbon limits for all public buildings and many other countries have introduced embodied carbon legislation including Denmark and France and certain US states.
- Doing things differently from the norm inevitably increases the cost of construction due to the insurance industry’s understandable response to change and unfamiliarity. The timber industry is delivering on its responsibility to address insurance concerns through publications such as the ASBP’s Mass Timber Insurance Playbook<sup>43</sup>. Timber framed housing is increasingly widely accepted, not only in Scotland where it makes up over 90% of new build housing, but also Wales and England. However, there is evidence of the need for a similar publication for low rise standard timber frame construction, particularly for when biogenic insulation or timber cladding is used. There is also potential role for government to underwrite a degree of risk in a similar way to the approach used for housing vulnerable to flooding that would otherwise be uninsurable – this is known as FloodRE<sup>44</sup>. It may also be possible to insure all public buildings and social homes under a single all-encompassing insurance policy reducing risks and costs for all parties to secure the acknowledged climate benefits from timber in construction.
  - Fire testing and the availability of fire certificates and test data is critical for enabling the golden thread of information called for by the Building Safety Act. Currently too much of this information is withheld or challenging to acquire by project teams, adding complexity, cost, and time to projects. This is a materially agnostic challenge but also an opportunity for timber and wood-based products as a concerted testing programme with public data disclosure could support the wider migration from higher emission materials to timber and wood-based products, as championed by Austria and Germany within dataholz.eu. <https://www.dataholz.eu/>

<sup>[1]</sup> ICROA is the International Carbon Reduction and Offset Alliance is an industry body that sets best practices for carbon offsetting and greenhouse gas (GHG) reduction programs

<sup>[2]</sup> Verra

<sup>43</sup> Mass Timber Insurance Playbook, ASBP

<sup>44</sup> FloodRE is a reinsurance scheme established by the UK government and the insurance industry under the Flood Reinsurance Scheme Regulations 2015 and became operational in April 2016



## Strengthening domestic timber supply chains

- Expand sustainable forestry & woodland creation, through policy and grant incentives. This is largely already being done across the UK, although increasing forest area is meeting much regulatory and public opposition.
- Develop and enhance the circular economy for timber, driving an increased use of recycled timber in wood-based panels, and incentivising reuse of structural timber to extend carbon storage<sup>45</sup>.
- Encourage cascading use of timber, favouring the use of timber for longer life products on first life but recognising and rewarding the complex and valuable web of wood products including OSB and wood panels in construction<sup>46</sup>.
- Offer capital grants for timber processing and manufacturing facilities of engineered wood products such as glulam, CLT and wood fibre insulation to reduce reliance on imports, increase national resilience, create distributed and long-term UK jobs, and lower emissions from transportation.

## Industry Training

- Educate architects, engineers & developers by expanding training programs on timber engineering and construction. Work within the construction sector to consider skills provision for timber frame construction and offsite construction systems is underway through the Timber in Construction Roadmap working groups in partnership with STA, TDUK, BWF and CITB.

## Research & Innovation Support

- Increase R&D funding into the use of innovative and traditional timber products in all forms of construction with particular focus on addressing the regulatory and risk industry barriers to rapid adoption of the use of biogenic materials.
- There is a public perception challenge around forestry practices and cutting trees down to build buildings that needs to be addressed to support a national drive towards timber in construction. This could readily and positively be addressed through a social media campaign with outreach at schools and community events.



<sup>45</sup> [Circular wood use can accelerate global decarbonisation but requires cross-sectoral coordination, 2023](#)

<sup>46</sup> [Developments in the Recycling of Wood and Wood Fibre in the UK: A Review, 2025](#)

# CONCLUSION

Using wood in the built environment to increase carbon storage within the UK's greenhouse gas removal plans, is significant and market ready. The cost associated with sending the required market signals to increase the scale of wood use would seem very low cost – particularly when it is set against the recent UK commitment to unproven CCS technology of £21.7 billion (delivering a forecast removal of 8.5 MtCO<sub>2</sub>e/year). UK housing alone could deliver a GGR of 6.4 MtCO<sub>2</sub>e/year with the widespread adoption of timber rich timber frame construction of a similar specification to that being pioneered by a collaboration of 23 social landlords in Wales in a housing project known as Tai ar y Cyd<sup>47</sup>.

Drawing upon policies from across the globe to support the increased use of wood in construction, government mandates seem to work best for public buildings (e.g. France and Japan), carbon pricing and subsidies can boost private timber construction (e.g. Germany, Canada) and government financial support for R&D and production of engineered wood products can help long-term sector growth (e.g. Austria, Sweden).

Whilst such policies are critical to increasing the use of wood in construction, they do not in themselves enable the robust quantification and reporting of WIC as a GGR in a way that provides tangible value to UK Government. Improved quantification and reporting allows visibility and certainty, contributing to the government's legally binding commitment to meet net zero by 2050.

The IPCC methods, the EU Carbon Removals and Carbon Farming regulation and the ISO13391 series provides the framework to understand the quantification and reporting systems necessary to ensure the robust development of WIC as a GGR. It is now essential that national governments, devolved administrations and industry bodies put the necessary governance, quantification and reporting mechanisms in place.

The overriding conclusion of this report is that purposeful industry and government action is required. Which should include:

- Ensuring that WIC is at the heart of UK Government's GGR and CCS policy and decision making
- Widespread industry engagement with quantification of their carbon storage contribution
- Connecting the full supply chain in reporting stored carbon, from sawmill to building client through to the use of recycled timber products.
- Connecting organisational carbon storage data with national evaluation to inform greenhouse gas removal policy
- Gathering of lifespan and material flow analysis data to support IPCC Tier 3 calculations and thereby increase the proven contribution of WIC as a GGR
- Incorporation of stored carbon in recycled timber in NIR reports to UNFCCC
- Establishing a national inventory of WIC stored carbon to help reporting and reduce the risk of double counting

The joined-up implementation of the above actions is best delivered through a national task force that is focused exclusively upon the governance, quantification and reporting of WIC as a GGR.

<sup>47</sup> *The Welsh collaborative social housing project known as Tai ar y Cyd is a collaboration between 23 social landlords to roll out a standardised timber rich build system to AECB CarbonLite and Passivhaus standards*



# APPENDIX 1

## TREATMENT OF BIOGENIC CARBON STORAGE IN LIFE CYCLE ANALYSIS

Several of the methods in this document utilise data from life cycle assessment (LCA), so a short introduction is needed, in order to highlight how biogenic carbon is treated in this well-established field. LCA was developed to allow the environmental impact of a product or process to be calculated objectively, and one metric is the embodied carbon or global warming potential (GWP). It became obvious that two different schools of thought existed when it came to considering the biogenic carbon within this context, as exemplified by the current difference between a carbon footprint and an LCA. In the carbon footprint, it is possible to deduct the carbon stored in the wood or bio-based material (which has been taken out of the atmosphere) from the embodied carbon (or emissions that occur during manufacture and use of the product). This reduces the carbon footprint, appearing to give credit to the use of the timber item. In an LCA it was decided that while biogenic carbon was relevant, it should always be reported separately – enabling transparency when reporting the emissions and the biogenic storage effect.

EPDs that comply with EN 15804+A2 are required to report their total climate change impacts split into fossil,

biogenic<sup>48</sup> and Land Use, Land Use Change and Forestry (LULUC) carbon for each module. EPDs that comply with EN 15804+A2 are also required to report modules C (End of Life) and D (next life). The end-of-life scenarios provided in EPDs must always be checked to ensure they align with the defaults, as end-of-life routes for biomass vary considerably in different countries, as do the incinerator efficiencies in energy recovery. If the scenario is not aligned, modules C and D must be generated using the reported biogenic carbon content and the default scenarios.

However, in the LCA approach it was deemed necessary to balance the system boundary, and for the end of product life, to consider the return of the biogenic carbon to the atmosphere. This leads to the declaration of a negative value for the biogenic carbon at start of product life (in category A3, under EN 15804) but for this carbon to be declared as a positive value at the end of life in category C3 (see Figure A1). As a result the two values cancel each other out, giving rise to the 'minus 1 / plus 1' effect. It means that an LCA will yield a net storage effect of zero regardless of the quantity of wood used or the duration of storage.

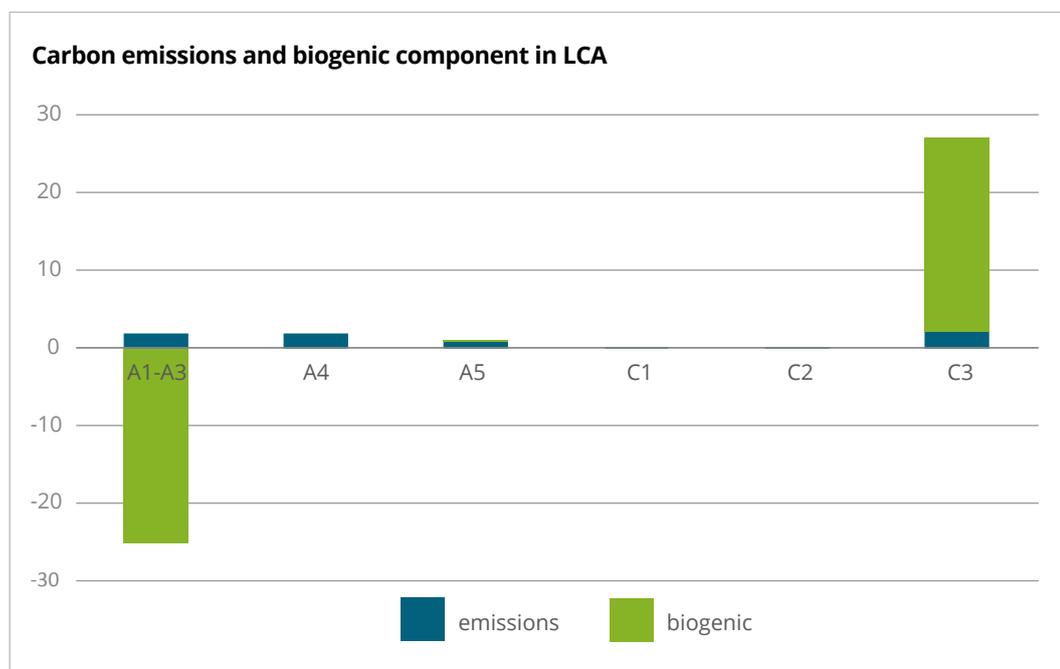


Figure A1 Schematic for a typical wood product LCA, showing the declaration of negative emissions (i.e. biogenic carbon storage) in class A1-A3, and emission of that stored carbon at end of product life in category C3, i.e. the -1/+1 effect.

<sup>48</sup> The mass of sequestered carbon is reported as 'kg carbon' (not CO<sub>2</sub>). The mass of carbon can be converted to the mass of CO<sub>2</sub> by multiplying by 44/12 (relative atomic mass of carbon = 12; relative atomic mass of oxygen = 16).

Time is not a consideration within conventional LCA. However, ignoring duration effects in considering biogenic carbon means that conventional LCA is ill-equipped to handle the temporal nature of carbon storage. As a result, the benefit of extending the storage cannot be captured. In addition, the storage action is not a flux of carbon, but causes a flux, relating to changes in the sizes of carbon pools. This makes it more similar to the approach used in considering forest carbon pools (e.g. in IPCC LULUCF reporting) than the metrics that are typically handled by LCA.

However, LCA researchers have attempted to handle the time dependent nature of biogenic carbon through development of dynamic LCA approaches. This additional research into dynamic LCA has led to several methods. Each one attempts to quantify, or account for, the passing of time between the storage at the start of product life, and the

emission of a pulse of CO<sub>2</sub> at the end of product life. It is the effect of the delay that is quantified, not the storage. The quantity of carbon emitted in the pulse can be discounted by a factor, to represent the duration effect. In some cases this is a linear relationship, while other methods have used curved functions.

For the linear approach, longer carbon storage leads to a larger credit for the delayed emission (Figure A2), leading to a reduction in the value of carbon emitted at the end of the product life. This method is included in the ILCD Handbook<sup>49</sup> and PAS 2050 methods – although both systems suggest that this is an optional calculation, not a required one. The RICS Whole Life Carbon Assessment method (2nd Edition, 2023) takes a similar approach – allowing biogenic carbon reporting to be optional.

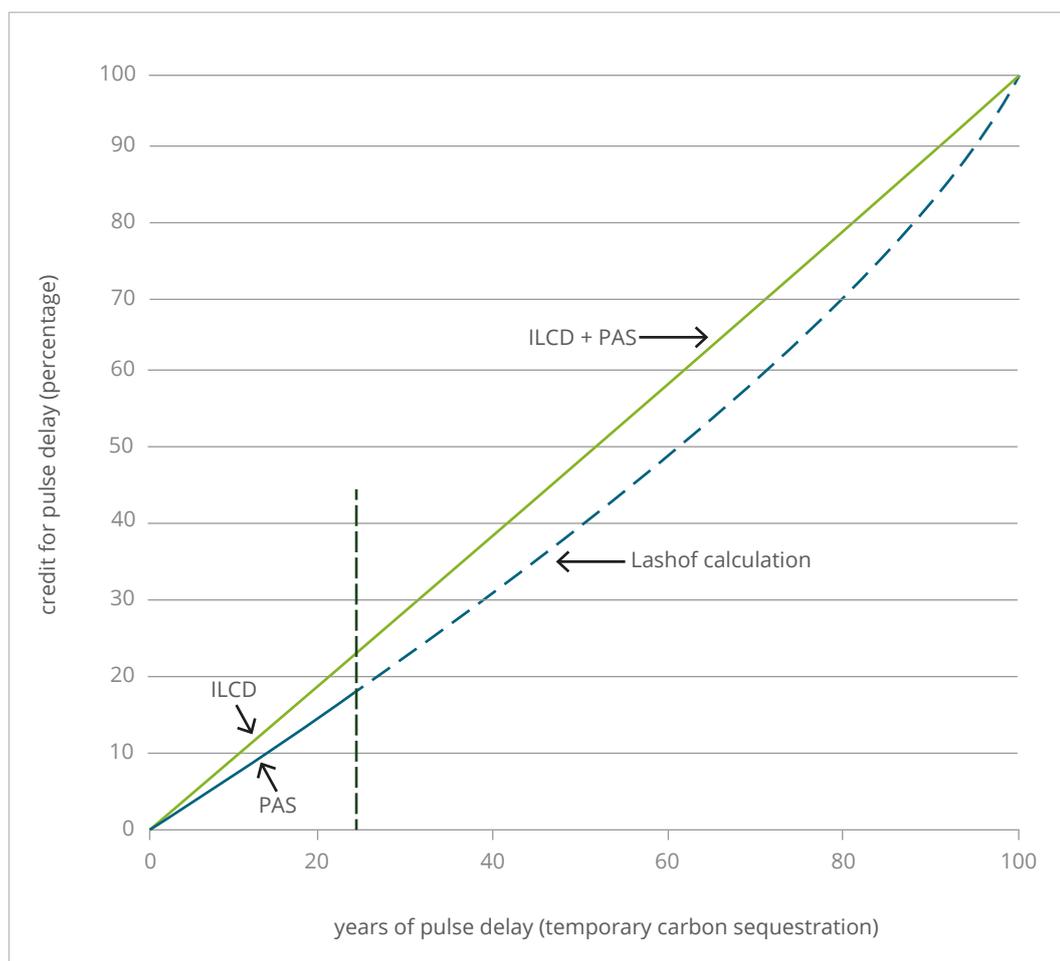


Figure A2. Credit for delaying the pulse of carbon emitted at end of product life, as used in ILCD handbook (linear) and PAS 2050 (follows Lashof until year 25 then linear). Image source Vogtlander et al. (2014) *Int'l Life Cycle Assess* 19:13-23.

<sup>49</sup> European Commission (2010) International Reference Life Cycle Data (ILCD) System Handbook – General Guide to Life Cycle Assessment – Detailed Guidance. Publications Office of the EU.

In other systems, such as the Lashof method, the radiative forcing effect of the carbon that is not emitted is accounted for, and a curved function is used to adjust the quantity by which the emission is reduced in the future time period (Figure A3). The longer storage may be proportionally larger than shorter storage as the avoided radiative forcing effect increases the further into the future the delayed emission occurs. A similar approach has been mandated by the French for carbon storage in buildings since 2021, but uses a 50 year reference period (not 100 years).

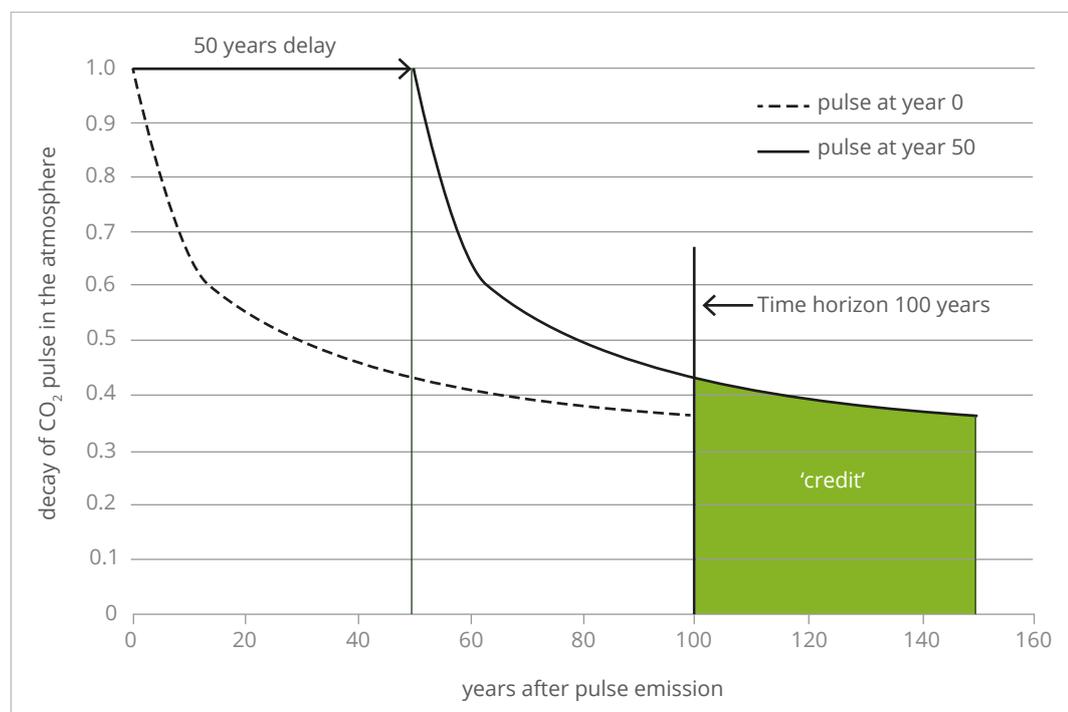


Figure A3. The sliding time window used to determine the credit for delaying emission beyond the 100 year time horizon in Lashof method. The curve shows decay of a CO<sub>2</sub> pulse in the atmosphere. Image source: Vogtlander et al. (2014) *Int J Life Cycle Assess* 19:13-23.

Dynamic LCA was demonstrated by Clift and Brandao in 2008, and by Levasseur et al. (2010)<sup>50</sup>. It is closely related to the Lashof method. A popular method in the same field is the GWPbio method, where characterisation factors are used, based on impulse response functions. The method was developed to characterise the temporary storage of carbon with rapid re-release when used for bioenergy, but more recently has been demonstrated in multi-component models such as wood products and wood waste into recycling and bioenergy. It is worth noting that there is still a lack of consensus regarding the methodologies for dynamic accounting of carbon flows for use in LCA studies.

Two different LCA-based methods for considering time in association with biogenic carbon are shown in the case study box. Much remains unclear, with up to 15 different methods having been proposed and compared by different authors – and preferences between them partly relating to context (Garcia et al. 2019)<sup>51</sup>.

In summary, while there are several positives arising from the various dynamic LCA methods, they don't directly quantify the GGR effect. However, the benefit of widespread adoption of LCA is the availability of numerical data. LCA does lead to the quantity of biogenic carbon within products being available within Environmental Product Declarations (EPDs). It is possible to use this within quantification of the pool size – for example if seeking to model the stocks of stored carbon entering a given wood products pool relating to a single company's product(s). Given that market data are available, either at company level or at national level this inflow of HWP carbon to the pool is relatively straightforward to estimate.

<sup>50</sup> Levasseur, A., Lesage, P., Margni, M., Deschênes, L., Samson, R., 2010. Considering time in LCA: dynamic LCA and its application to global warming impact assessments. *Environ. Sci. Technol.* 44, 3169–3174.

<sup>51</sup> Garcia et al. (2019) Accounting for biogenic carbon and end-of-life allocation in life cycle assessment of multi-output wood cascade systems. *Journal of Cleaner Production* 275: 122795.

## CASE STUDY BOX

**PAS 2050:2011** allows the benefits of permanent and/or temporary carbon storage to be accounted for, for a period of up to 100 years from manufacture to the point of incineration or recovery (whichever is earlier), weighted by the number of years out of 100 that biogenic carbon is stored and the percentage of the biogenic carbon that is stored. Carbon footprints calculated according to PAS 2050:2011 can deduct the calculated impact of carbon storage from the total GHG impact over the life cycle of the built asset. It should be noted that the PAS 2050 method does not show any greater benefit if biomass is reused or recycled at the end of life, rather than combusted with possible energy recovery. For a building with a 60-year required service life, whatever the fate of the timber at end of life, 60% of the carbon sequestered within the building over 60 years could be claimed as the calculated benefit of carbon storage over the 100-year period used by PAS 2050.

**Dynamic LCA in France** The French Regulation of building-related carbon emissions<sup>52</sup> requires both the reporting of biogenic carbon storage (in kg carbon/m<sup>2</sup> floor area), and the use of the dynamic approach to calculating the overall carbon impact of the building. Simplified weighting factors are provided<sup>53</sup> based on IPCC radiative forcing, to be applied to net emissions or removals in each of the 50 years studied. This shows the relative impact, assuming an emission in Year 0 has 100% impact and an emission in Year 100 has no impact. This means that emissions and removals that occur earlier in the asset life cycle have greater weighting in the overall impact than those that occur later in the life cycle. The model is linear, unlike the more complex curved functions used in other dynamic LCA methods. The approach only provides weighting factors for the first 50 years of an asset's life, as the French Regulation uses an RSP of 50 years. It does not allow longer life cycles, or the benefit of reuse or recycling at the end of an RSP of 60 years to be considered. It is expected that the revision of EN 16485:2013, the CEN c-PCR for timber, will provide weighting factors for up to 100 years from construction, which could then be used to calculate the benefit of carbon storage and reuse, and recovery of biomass at end of life, to be calculated over the full life cycle of the asset.

<sup>52</sup> in the Arrêté of 4th August 2021 (Ministère de la transition écologique, 2021)

<sup>53</sup> 'les coefficients de pondération' provided in Article 11 of the Arrêté



**Woodknowledge Wales Limited**  
22 Cathedral Road, Cardiff, CF11 9LJ

