Carbon capture and storage – the natural way

Morwenna Spear (BioComposites Centre, Bangor University), **Andrew Norton**, (Renuables Ltd) and **Callum Hill** (JCH Industrial Ecology Ltd)

It is now beyond any reasonable doubt that the release of CO_2 into the atmosphere, strongly linked to economic activity, is leading to climate change in its many manifestations, with serious impacts on planet, society and the economy.

Decarbonisation of economic activities such as manufacturing and construction is the only answer; and various governments around the world have put in place strategies to pursue a low-carbon pathway. The UK Government was the first major economy to put in place zero carbon laws, with the stated intention to bring all greenhouse gas emissions to net zero by 2050. But how will this be achieved?

Part of the strategy is to balance any emissions by removing an equivalent amount of greenhouse gases from the atmosphere, by planting trees or using technology like carbon capture and storage (CCS). A huge investment would be required in CCS technologies and there is a notable lack of any serious plans to build CCS infrastructure at the present time.

By contrast, planting trees requires a much smaller investment, as well as providing additional ecosystem benefits, such as rainwater interception and providing natural habitat. Apart from the obvious carbon sequestration provided by the trees, economic benefits can also be realised if the trees are harvested sustainably and the harvested wood products are used in long-life applications, such as buildings. The investment in forestry will pay for itself; this is not the case for CCS.

The role of timber in climate change mitigation

The use of timber in construction provides climate change mitigation due to the storage of carbon derived from atmospheric carbon dioxide in the timber. There are also other advantages because most timber products have a lower embodied energy (and carbon footprint) compared with the same functional unit made from non-biogenic materials, such as steel or concrete. In addition, the inherent energy that is stored in the timber can be recovered from the material through burning, often substituting fossil fuel equivalents, when no further recycling can be achieved. Depending on the circumstances, the re-use of timber in other products (cascading) may provide further benefits.

A 2018 report of the potential climate change mitigation benefits of using timber in construction in the UK was published by the Committee on Climate Change - Wood in Construction in the UK: An Analysis of Carbon Abatement Potential. This study, undertaken by the Bangor University BioComposites Centre, JCH Industrial Ecology and Renuables Ltd, used very conservative assumptions. The effect of replacing brick and block masonry structures with timber frame was investigated, but the same foundations were included, even though the timber frame was lighter. Even using these assumptions, the advantages of using timber-rich structures were readily apparent.

CO_2 reduction by using timber in construction

By considering houses with either brick and block, or timber framed construction methods, and quantifying the embodied carbon and the stored sequestered carbon of each, the team were able to model the effect on the housing sector.

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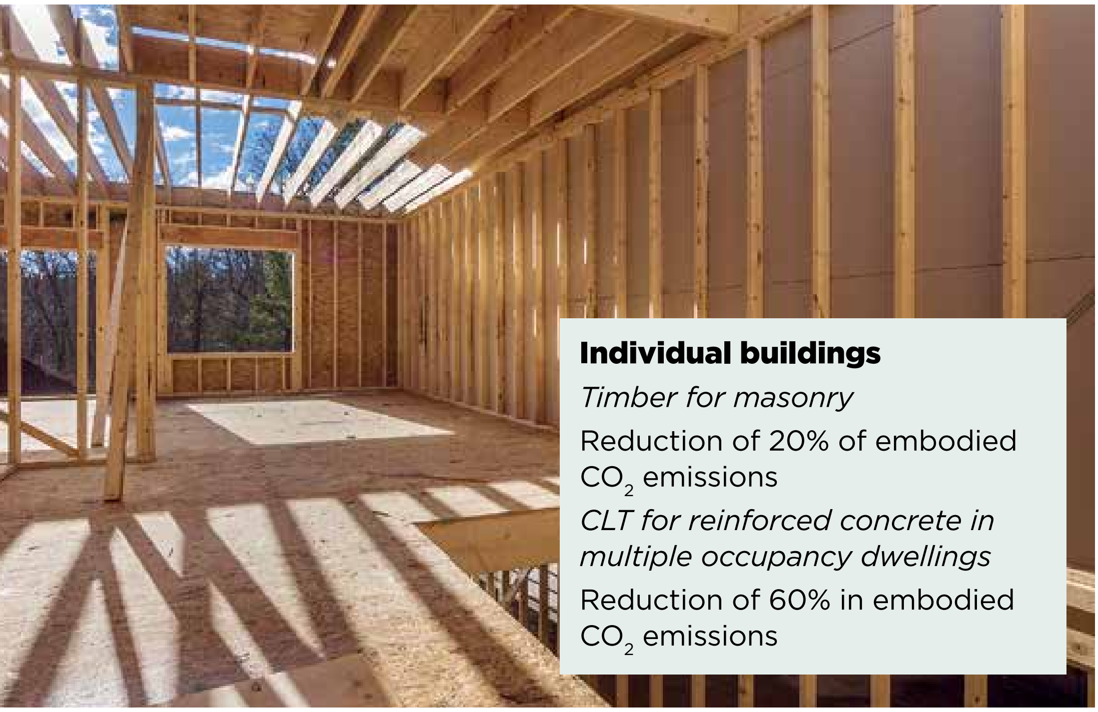
270,000 new homes by 2050

If using timber frame instead of other materials

Emissions reduction: MINUS 0.08 – 1 Mt CO_2eq / year

+ carbon storage in timber fabric of 1 – 1.3 Mt CO_2eq/year



Individual buildings

Timber for masonry

Reduction of 20% of embodied CO_2 emissions

CLT for reinforced concrete in multiple occupancy dwellings

Reduction of 60% in embodied CO_2 emissions

When looking ahead to a potential 270,000 new build homes per year by 2050, it was calculated that this substitution would deliver an annual reduction in carbon emissions of at least 0.8-1.0 Mt carbon dioxide equivalents (CO_2e) per year. This was simply by substituting timber structures for methods that use higher embodied energy and embodied carbon building materials. In addition, the carbon storage in the fabric of the timber buildings amounted to an additional 1.0-1.3 Mt CO_2e, per annum.

For individual buildings, the substitution of timber for masonry resulted in the reduction in embodied CO2 emissions by about 20%, whereas using CLT (cross laminated timber) instead of reinforced concrete for construction of multiple occupancy dwellings led to a massive 60% decrease in embodied CO2 emissions. Most importantly, these climate change mitigation benefits can be realised with almost zero abatement costs, because recent UK studies have shown that costs of timber frame and masonry are now similar, and that CLT is nearing cost parity with concrete or steel systems.

As the CCC report hinted, huge further reductions in carbon emissions are possible with only simple changes in building designs, to move the current vernacular away from brick and block for small buildings and steel and concrete for larger ones. Timber can provide a powerful alternative in reducing the construction sector's footprint, here and now. This can be done without the need for a decarbonised electricity grid or investment in CCS technologies, meaning that these technologies can yield additional carbon reductions in future. However, this can only be realised if the benefits of this low energy requiring and carbon storing material, timber, are recognised by policy and commercial venture and promoted as such.

Availability of homegrown timber

The study also considered timber availability within the UK. Total volumes of softwood sawlogs were found to be sufficient to support timber frame construction using homegrown timber. This can be achieved if the timber frame housing sector designs structures to use C16 timber, or if higher grades become available through revision of grading practices for homegrown timbers such as pine and larch. It was found that a significant volume of the stored sequestered carbon was derived from wood-based panels used in the timber frame houses, ie oriented strand board and particleboard within walls and floors. From the point of view of reporting these benefits are attributable to the national carbon accounts, and it was estimated that it was possible to source 86-92% of the timber construction material within the UK.

Although the majority of timber requirements for the UK construction sector could be met by homegrown timber, it must be recognised that markets already exist for much of this timber; albeit often with shorter product lifetimes. Any timber shortfall must consequently be met by imports, for which no credit is currently given in the UK carbon accounts. Given the pitifully low levels of planting in England, Wales and Northern Ireland last year, there will have to be a massive shift in policy in order to get anywhere near the required planting targets. Declaring a Climate Emergency is one thing, but now is the time to take action.

Tree planting to support decarbonisation of construction sector

Decarbonising is a massive challenge for the UK construction sector, but the timber industry is more than capable of helping to meet that challenge. As part of the strategy, it will be necessary to have a massive increase in new planting. Confor have stated that 40,000 hectares of new woodland needs to be planted every year to make a substantial contribution to carbon reduction and as much as 260,000 hectares a year to achieve a zero carbon Britain. We have recently seen a substantial commitment to tree planting included in the March 2020 budget.

Are we just temporarily storing carbon in wood?

One final point needs to be made. A criticism sometimes levelled at the use of timber in construction is that the carbon might be in storage now, but one day it will be back in the atmosphere. Aren't we just 'kicking the can down the road' - creating a problem for future generations? In fact, it can be shown by modelling that carbon stored in long life products (such a buildings) will be held in the built environment carbon pool for a long time. It will take time before the built environment carbon pool reaches equilibrium (the quantity of carbon exiting the pool equals the quantity entering). Depending on the assumptions used, this point of equilibrium will not be reached for 100-150 years, even without considering the additional storage duration when timber cascades into secondary lives through reuse or recycling.