# 7 Materials

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## Scale Jumping to Regenerative Material

> In the current pursuit of low carbon buildings … can all roads lead to timber?
>
> (Brown 2020)

All roads may appear to lead to timber as the solution in the current carbon/climate agenda, it is not however a silver bullet.

- timber has to be from a sustainable source, ideally local;
- there needs to be a sound sustainable forestry supply chain with capacity and capability;
- landfilling timber at end of life may have a greater impact than using other higher embodied carbon materials;
- the above requires carbon design for deconstruction and a circular economy;
- core materials (steel concrete) will still have a place and will therefore need their own decarbonization agendas and transformations.

## Past Damage to Scotland's Flow Country

Flow Country in northern Scotland is the largest European expanse of blanket bog, covering 4,000 km$^2$. It was severely damaged between 1979 and 1987 through misguided planting of non-native conifer forests (cash crops) for construction and other industries, and in the process thousands of miles of newly dug ditches damaged natural drainage patterns. The trees dried out the peat, changing the habitat and destroying its value for birds and other wildlife. Only now, some 40 years later, is a multi-million pound 'back to nature' project working to remove the conifer trees and to restore the biodiversity of the natural peatlands that are also efficient carbon sinks.

Conifer cash cropping in all probability continues worldwide, illustrating the need for a responsible approach to construction materials. Up to 40% of all carbon from wood used in building construction has come through irresponsible timber practices, such as those described in the Flow Country, removing an important natural CO2 balancing mechanism from the ecosystem.

## Socially Just Materials

Health and its social impact on humans have emerged as vital criteria for materials used within the built environment alongside environmental and planetary health. It includes health and planetary impact and

social justice considerations, in relation to material extraction, manufacture, storage and transportation, and construction, whether in use, adapted for reuse, or undergoing final demolition and disposal. Transparency and verification is offered through such platforms as Declare/Living Building Challenge. However, although expanding, these considerations occupy only a small niche area of sustainable buildings. It is therefore important to expand and to scale jump the use of red list and precautionary principles from within regenerative standards (LBC, Well), applying them to all projects irrespective of standards. Some examples are the Material Schedule approaches from developers British Land and contractors Baxall (UK).

## Carbon

If we are to achieve carbon targets (net zero) in line with Paris and other IPCC reports, we have to rapidly remove embodied carbon from both new built environments and from the refurbishment of the existing building stock. This can only be achieved through using bio-based materials, in particular organic materials that have sequestered carbon during their growth.
The Cuerden Valley Park Visitor Centre, Lancashire, (Fig.1.1.10), the first building designed and constructed in the UK in accordance with the Living Building Challenge, demonstrates that it is possible to construct without the use of cement or concrete products. Application of bio-based materials in compliance with the Living Building Challenge Red List (ILFI), depicted in the Circular Economy butterfly diagram, mean that all materials used on the project have a future life through the natural (composting) or technical (reusing, repurposing) waste streams.

**Figure 1.1.10.** *Cuerden Valley Park Visitor Center (Credit: M. Brown).*

In 2013, Chris Magwood referred to embodied carbon as the carbon elephant in the room (Magwood): "hardly anybody was accounting for this significant amount of emissions. Instead, all the focus was on making buildings more energy efficient. While efficiency is important, reductions in material emissions are immediate and therefore more impactful in reducing atmospheric carbon concentration now, rather than in the future"

## Upfront carbon

Whilst we continue to use the language of embodied carbon, it maintains a level of mystery and misunderstanding, along with a 'this-is-too-difficult' attitude, a mask behind which we hide our inactivity.
Milne, G. (2013) commented that EE is the energy consumed by all of the processes associated with the production of a building, from the mining and processing of natural resources to manufacturing, transport and delivery of the finished product. Embodied energy does not include the operation and disposal of the building material, which would be considered in a life cycle approach. Embodied energy is the 'upstream' or 'front-end' component of the life-cycle impact of a home.

## Considering the Blue Economy in New Material Production

The blue economy is an economic model responding to the basic needs of everyone and everything with nature-inspired innovations with multiple benefits. Created by Gunter Pauli, in 2004, the model places nature at the centre of the economy. Jobs and social capital are provided while producing more with less resources. Physics and biology drive solutions, and only necessary needs are met with no excess production and no waste: encouraging biodiversity and diversity and discouraging industrial standardization. Companies are also diverse with no monopolies. Gravity is the main energy source, and solar is the second renewable energy. Water is the main solvent with simple chemical compounds and non-toxic catalysts (Pauli, 2004).
The model and vision are based on the premise of natural resilience. Nature has overcome and will continue to overcome disasters with beautiful and unexpected solutions (Weizsäcker and Wijkman, 2018). Innovation is the norm, because nature is constantly changing. The economic model is turned on its head starting from sufficiency and growing to abundance. Economies of scope include natural innovations that have several benefits for the common good. Nature is the starting point. All components are biodegradable over time.
The 21 Principles of the Blue Economy consider nature, society, physics, biology, and joy and happiness (Weizsäcker and Wijkman, 2018), among others. Only local materials are used in blue economy products. Sustainable business evolves with local resources, culture and tradition bringing resilience in challenging times, identity, and joy in periods of abundance. Natural systems are non-linear, connected and evolving towards symbiosis. Natural elements of clean water, clean air and fertile soil are abundant and free. Risks are motivators for innovations and when risks are shared by everyone, problems turn into opportunities (Pauli, 2004; Weizsäcker and Wijkman, 2018).
Self-healing concrete is a restorative material. Payne *et al*. developed a biomimetic self-healing concrete as part of the Resilient Materials for Life Program (RM4L). The concrete mixture contains bacteria spores in isolated microencapsulations throughout the concrete. The bacteria react with the calcium carbonate growth medium that precipitates CACO3 in a chemically expansive reaction, filling the crack (Payne *et al.,* 2019).

Scale jumping in this sense is utilizing the natural chemical reactions between bacteria and calcium carbonate in concrete at a microbiotic and microscopic scale applied to a mesoscale item such as a concrete building, or bridge structure or the like. The philosophy and integration of elements working simultaneously throughout each scale is discussed in great detail in (Bejtullahu and Morishita-Steffen, 2020).