The Environmental Impact of the Construction Sector in the EU

Today, the construction sector in the EU is responsible for about 1/2 of all the extracted materials and energy demand, and about 1/3 of all water consumption, waste and CO2 emissions, which are primarily associated with the production of steel and cement. About 90% of existing EU buildings will still be in use in 2050, but 75% of them are currently energy-inefficient. At the same time, EU's infrastructural elements are ageing and will soon need to be replaced. Hence, the room for improvement is enormous and the time for the transition is ripe. Considering the major environmental footprint of the sector, EU's 2050 carbon neutrality goals simply won't be achievable without a sustainable and circular built environment. Through a Circular Economy (CE), the environmental impact of EU construction can be significantly reduced and the sector turned it into an active contributor to both adaptation and mitigation efforts against climate change (CC). As shown by a recent IDB report, CC can be mitigated by circular approaches such as designing construction projects to act as carbon sinks, increasing the use of renewable energy, biobased and upcycled material, via circular waste management practices, etc. This way, the built environment can simultaneously become more resilient and durable by i.a. adopting context-specific solutions to limit their exposure and vulnerability to the effects of CC.

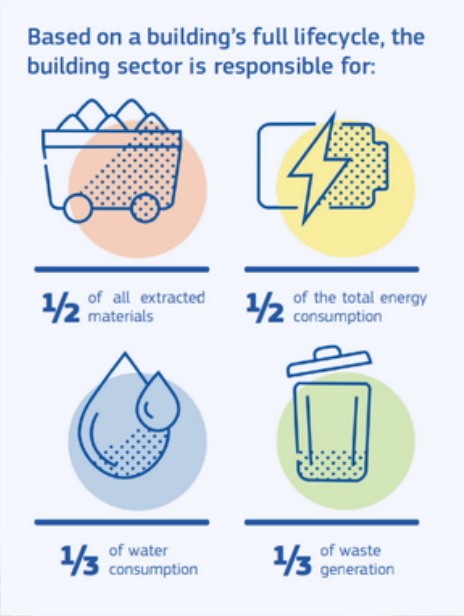

Figure 1: European Commission. (2021). Level(s), What's in it for construction companies and contractors, manufacturers, asset managers, facilities managers, and occupants? - Retrieved Nov. 17, 2022 from source

The Challenges to Green(er) Buildings & Infrastructures

TThe construction sector heavily contributes to climate change as being very resource- and carbon-intensive along the whole value chain of buildings and infrastructures, which typically have very long lifespans. If we account for all (in)direct emissions during both construction and usage phases, buildings alone cause +35% of EU emissions and +40% of its primary energy consumption.

Additionally, 15% of building materials are currently wasted in the construction phase, causing additional emissions. Environmental policies have traditionally aimed at enhancing energy efficiency and renewable energies in the use phase of buildings, while neglecting material efficiency in construction. This focus however fails to tackle the considerable emissions associated with the materials and construction processes. Referred to as 'embodied carbon', the latter are indeed estimated to be responsible for minimum 10-20% of the construction-related emissions within the EU, representing a real challenge for decarbonisation in the built environment.

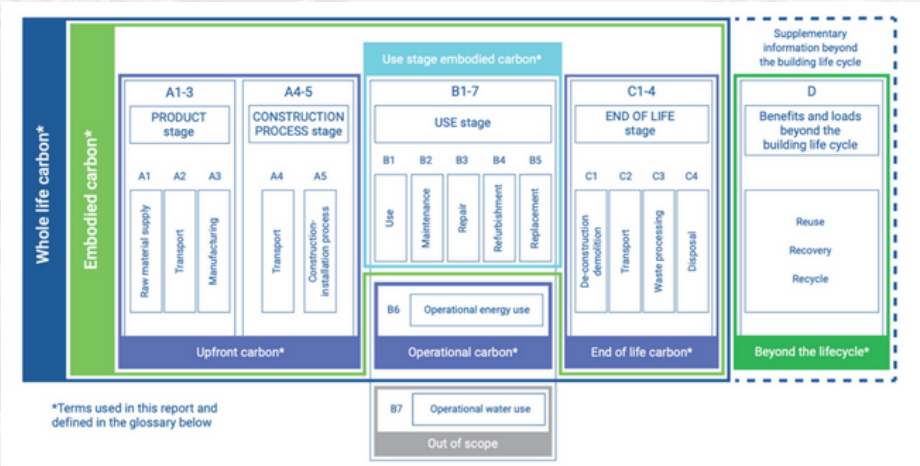

Figure 2: Lifecycle stages or modules defined in the widely-adopted European standard EN 15978. World Green Building Council. (2019). Bringing embodied carbon upfront.

The climate benefits of a Circular Construction Sector

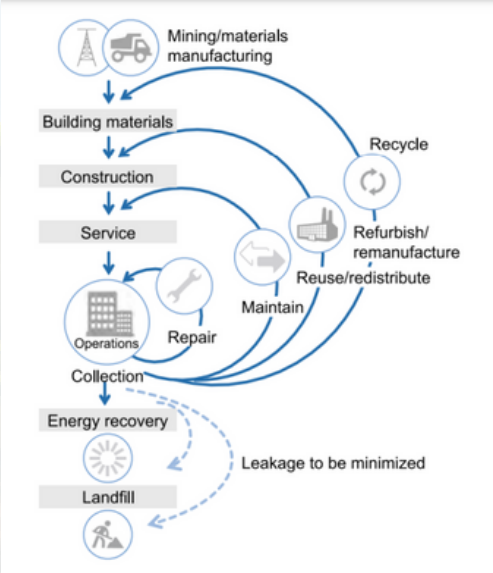

Figure 3: Breene, K. (2016). Can the circular economy transform the world's number one consumer of raw materials?. Retrieved Nov. 17, 2022 from source

The CE shows a pathway to ensure an efficient and sufficient use of ever scarcer resources and to reduce the emissions generated by buildings and infrastructures across their entire lifecycle. *Circularity in the built environment can be defined as developing, using and reusing buildings, construction components or products and materials, areas, and infrastructure without unnecessarily depleting natural resources, polluting the living environment and affecting ecosystems, while simultaneously maximising the value of the building or infrastructure's design, operation, and deconstruction over time (ECESP, 2021)*.

Initiatives such as design for durability, repair and disassembly, the use of renewable and bio-based building materials, circular business models as well as high-quality reuse and recycling, collectively have a huge potential in tackling CC and reducing resources demand in the EU. For example, the use of biobased construction material that is renewable in a relatively short time frame removes GHGs from the air during growth as opposed to most currently employed construction materials such as steel and cement, whose production is highly carbon-intensive. Reuse of traditional construction materials is also paramount like in the case of steel, which is currently a major contributor to CC but is also 100% recyclable and retains most of its original properties when reused.

According to The Circularity Gap Report 2022, resource-efficient construction can lead to 3.45 Gt emissions saving and 4.05 Gt material usage saving, majorly contributing to emissions reduction on the path to carbon neutrality. Data collected by TNO also shows a potential 40% emissions reduction in infrastructure thanks to more efficient use of energy and materials, lifespan expansion, increased re-usage rates, and the consistent deployment of innovative materials, products, and processes. This represents a very promising avenue for green infrastructures, which are often demolished before the end of their technical lifespan for functional reasons, resulting in avoidable waste and pollution.

Other than contributing to the welfare of people, planet and animals in the short- and long-term, CE in general and circular construction in particular also bear considerable economic advantages. As an example, 74% of construction and demolition waste today is already reused across Europe. However, most recovered materials are downcycled for backfilling operations. This is not only the least environmentally-sound waste treatment option from a circular economy perspective, but it also represents a missed opportunity from a financial point of view due to the consequently high loss of value of the vast amount of discarded resources.

Circular construction solutions for climate change mitigation

Circular construction solutions are already emerging across the EU and along the whole value chain, showing how a systemic change can only be achieved through a truly holistic approach to collaboration and innovation. We present here some exemplary case studies, one from each value chain segment: building passports, circular buildings, platforms, public procurement, secondary raw materials, and standards.

The availability of accurate data is an important initial step for the circular transition. **Building passports** track the journeys of the various construction products, components, and materials, fostering high-value reuse at all levels. Originally Dutch and now operating in 5 EU countries, **Madaster** is the first platform for a standardised, web-based generation and registration of construction materials and products. The platform retains a detailed inventory of all materials, components and products used of a construction project, including environmental impact and residual material value, with the possibility to update each material passport over time while keeping a history of all changes made.

Buildings can be designed to become future reservoirs for construction materials through e.g. modular construction, design for disassembly and reusable structural elements. For example, the new building of the Austrian print house **Gugler*** (Cradle to Cradle® Gold Product Standard certified) was designed based on CE principles with a focus on reusability. 95 % of the materials in the building can be reused in case of future demolition and 43% of all used materials are already recycled, sourced either from the company's products or other sources of materials.

C**ircular platforms** can offer multiple services including e.g. awareness and knowledge sharing, matchmaking, databases for public procurement. **Restado.de** is an example of a marketplace matching construction materials coming from demolition or oversupply with the demand in new construction projects. Restado's mission is to extend products' lifecycle by enabling their reuse. Their audience is represented mainly by craftsmen, smaller construction companies, and private DIY.

Particularly for infrastructure, the public sector regularly mobilises considerable investments, offering unique chances to foster circularity through **public procurement**. This is the case of the first **Dutch Circular Viaduct**, 95% of which can be regularly reused and readapted thanks to its modular design. Opened in Jan. 2019 and dismantled successfully nine months later, the infrastructure has been supported by the Dutch Government and has spawned innovations also in public procurement. The project was developed via a partnership of different public actors and local companies transparently sharing know-how and experimenting together to foster the development of innovative solutions.

The insights from this 'Open Learning Environment' in turn inspired the development of a SBIR (Strategic Business Innovation Research) tender to challenge entrepreneurs to develop new circular infrastructure solutions adoptable by Rijkswaterstaat as a launching customer.

The employment of **secondary raw materials** is essential for a truly circular construction sector. The resident community **Cambium** (now part of the H2020 project HOUSEFUL) was founded in 2014 with the aim to transform a former military barrack into an economic, social and ecological village, where to implement sustainable agriculture techniques and circular building technologies. Solutions include: separating wastewater to turn it into usable resources together with other organic waste, converting organic solid waste into biogas for use in the buildings, and processing the liquid organic-waste component via a vertical plant treatment unit to produce fertiliser for agricultural use.

Standards, protocols and regulations all play an active role in limiting the impact of the construction sector on CC. The German **DGNB** (German Sustainable Building Council) is an international knowledge platform with 1,500 members who has developed the world's most advanced sustainable building certification system. The certification accounts for various circularity aspects, such as life cycle assessment, the conscious choice of construction products with regard to their composition and origin, as well as the ease of recovery and recycling. By providing bonuses for applying circular solutions, the certification enables unique assessments and measurements of circularity within the built environment. Bonus points also exist to incentivise the development of new solutions in a progressive way. These bonuses are included across all system applications, including new construction, buildings in use, renovation and deconstruction projects.

Circular Construction: The Way Forward

The time to implement circularity in the EU's built environment is now. But what is needed to accelerate the transition? A number of approaches already show high potential for success, particularly with regards to **increased standardisation, modularity and adaptability of constructions to optimise durability, reuse and disassembly**. Other than generating considerably less waste, maximising resource value throughout the construction lifecycle represents a profitable avenue for switching to circular construction. This change will need to be enabled through increased information flows between all relevant stakeholders in the form of **improved access to material, product and construction quality information**, and wide recognition of existing standards and certifications, including via regulations. Shifting from materials with high levels of embodied carbon like steel and concrete to **bio-based materials** like wood will also further circularity along the value chain. Furthermore, **reverse logistics** approaches such as take-back systems coupled with sorting and collection methods for construction material, are similarly promising. The reclamation of valuable resources will however become economically viable when adopted as a golden standard by the whole sector. For this, **circular public procurement** is crucial.

The above mentioned approaches should be supported via appropriate regulations. An **integrated EU framework of regulations** to i.a. mandate materials reuse, increase public procurement, support existing green construction standards, enhance transparency and data availability, and raise overall awareness of circular solutions in the market will aid in maximising the economic advantages for the broader sector. Devising **incentives** for climate neutral and circular construction will create a level playing field, and help prioritise value-retention waste management processes (upcycling vs. downcycling). Furthermore, the introduction of **standards for impact assessment methodologies** across the EU construction value chain can represent a solution to drive circularity on a large-scale, combined with the widespread deployment of digital product passports as a tool for accurate impact calculations.

Figure 4: 'Aeres Hogeschool Almere, The Netherlands. Photo by BlueMonque Creatives

The regulatory momentum in the EU is already growing, creating considerable opportunities to speed up the transition in a sector that is already part of several key initiatives (European Green Deal, the new Circular Economy Action Plan, Fit for 55 package, etc).

The upcoming EU Renovation Wave for the retrofitting of existing buildings and the forecasted growth of urban areas create a window of opportunity for implementing future-proof solutions. Additionally, the **Energy Performance of Buildings Directive** (EPBD) is currently being revised and would greatly foster energy retrofits by requiring all EU buildings to be carbon neutral by 2050. Other opportunities will come from the implementation of the **EU's Strategy for a Sustainable Built Environment**, e.g. new rules and requirements for more durable, repairable and recyclable construction products and materials. The revision of the **Construction Products Regulation** is equally crucial to deliver harmonised, accessible and accurate data on construction products, and therefore meet the measurement and reporting requirements for embodied carbon set by the EPBD. A further **push for decarbonising construction** is also upcoming from the revisions of the Effort Sharing Regulation (ESR) and new Emission Trading System (ETS), following the Fit for 55 emission reduction goals. Finally, in 2023 the revision of the **Waste Framework Directive** is expected to impact EU recycling and reuse practices for construction waste.

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