



## Policy briefing

# Materials 'passporting': Rethinking building construction and renovation for a circular economy

**The building sector is one of the most resource-intensive sectors in Europe<sup>1</sup>, accounting for approximately half of all extracted materials, half of total energy consumption, one third of water consumption and one third of waste generation.**

Research carried out by the Ellen MacArthur Foundation<sup>2</sup> has estimated that, in Europe, 10 to 15 per cent of materials are wasted during the construction process alone, and more than 50 per cent of the materials arising from demolition are sent to landfill<sup>3</sup>. Construction materials, such as steel, are often undamaged in service, and could be re-used much more than they are. With forward-thinking design, more value could also be derived from buildings, as, for example, some commercial buildings are designed to last 100 years, while most buildings don't last that long and are on average replaced much sooner<sup>4</sup>.

This briefing note, for both policymakers and businesses, makes the case for how building materials can be better monitored and managed for greater sustainability, especially through the wider use of materials 'passporting' in buildings to facilitate this. It also outlines how passporting can be complementary to other approaches already being developed and deployed, and it suggests how to overcome barriers to wider adoption.

*"There is a profound need to understand what products are used in the building and retrofit industry and how they contribute to a climate fit for life. Energy efficient products, materials which have a sustainable supply chain and goods classified as low carbon alternatives are available, and contractors and architects must be supported to make a better choice."*

**Geanne van Arkel, Head of Sustainability, Interface EMEA**

## 1. What is the current situation?

### 1.1. Existing tools and approaches

Considerable work has already been done on voluntary building rating schemes, with approaches like **Leadership in Energy and Environmental Design (LEED)**<sup>5</sup>, the **Building Research Establishment Environmental Assessment Method (BREEAM)**<sup>6</sup> and **DGNB**<sup>7</sup> already in the marketplace. These tools have been instrumental in redefining the scope of green or sustainable buildings beyond energy use and associated carbon emissions, to include life cycle considerations such as the environmental impacts of materials used, as well as the health impacts for occupants.

Despite this, these tools are still only used on a small percentage of the building stock, and still do not fully consider approaches that keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life (the circular economy). The tools in question have instead mainly been concerned with master planning and building design.

Newer approaches such as **Level(s)**<sup>8</sup> introduce an assessment methodology for life cycle sustainability rather than identifying the individual components of a building or those products used during renovation. Launched by the European Commission, this sustainable building assessment framework evaluates performance in six areas: climate change, resources (including resource efficiency and the use of circular material life cycles), water, health, resilience and costs, and looks throughout the whole life cycle of building projects from manufacturing to end of life. It is a key policy tool of the EU Circular Economy package.

Existing **Energy Performance Certificates**<sup>9</sup> only cover in-use energy consumption, but are relevant to consideration of materials as they also include



recommendations for energy improvements in the building.

## 1.2. Driving a more circular approach through materials passporting

Materials passporting is a complementary approach that can build on existing building-level assessment tools, and perhaps more importantly, help to drive changes towards a more circular and low-carbon approach to construction and renovation.

### What is materials passporting?

Materials passports are publicly accessible electronic registers of the component materials, products or product systems used in the construction and/or renovation of buildings. They are designed to ensure that building components can be identified, recovered or removed sustainably for reuse or recycling, and safely, when changes are being made (addressing for example, toxicity). The passports can also be a platform for future regulation, to ensure that materials used in construction and renovation have low embodied carbon and low toxicity, and do not create a future waste problem.

Materials passports are meant to support, rather than replace, existing approaches such as Building Information Modelling (BIM) and Environmental Product Declarations (EPDs). They seek to describe practically how the residual value of materials can be recovered, instead of, for example, listing their composition.

A form of material passport already exists: the Environmental Product Declaration (EPD), which is referenced by the building certification systems aforementioned (LEED, BREEAM etc.) and supports whole building life cycle assessments encouraged by Level(s). The EPD is a type of environmental declaration developed in accordance with standard ISO 14025 on environmental labels and declarations which provides verified, objective and detailed information about the life cycle environmental impact of a product. EPDs include a description of product components and the materials that they are made from and indicate the environmental footprint of the product in relevant impact categories. Well-established EPD operators for the building sector include **IBU EPD programme**<sup>10</sup> in Germany, **EPD-Norge**<sup>11</sup> in Norway and the **INIES database**<sup>12</sup> in France. At the EU level, a group of EPD operators, industrial associations and other stakeholders of the construction sector have created an association called the **ECO Platform**<sup>13</sup> which works to develop EPDs, enhance harmonisation and enable their use in all European and international markets. Currently, EPDs are insufficiently used as part of the materials selection process – an issue that needs to be resolved if materials passports are to successfully evolve and integrate into the

decision-making process.

Other norms and methods pertaining to building materials include the **REACH**<sup>14</sup> legislation, which governs the use of chemicals/chemical products, and the international **Greenhouse Gas (GHG) Protocol**<sup>15</sup> which, as part of its consideration of value chain (Scope 3) emissions, has developed methods to assess an organisation's emissions arising from construction, waste and other sectors. In addition, the EU has considered developing wider guidance<sup>16</sup> on **Extended Producer Responsibility** (making manufacturers and suppliers responsible for end-of-life products, such as batteries), including for the construction sector through the EN15804 standard<sup>17</sup>.

As far as the building sector is concerned, there is a need to centralise the information provided by these different tools in order to properly inform decision-making through describing the full circular economy value across the building cycle and track individual products or components of buildings through their installation, use and re-use, re-purposing or disposal.

On a practical level, the materials passport could be accompanied by a building dismantling manual, so that contractors can scan a QR code (or use other technologies with similar functionality) and get guidance on how to deal with the systems, products or components when renovating a building. The passport information would provide advice on how to re-use or remove products sustainably and safely. One example of such a product is **DSM-Niaga's** reversible glue<sup>18</sup>. This is applied today in carpets to enable easy recovery of different material layers after use.

*“A digital materials passport for buildings should be accompanied by a Dismantling Manual, so that everyone can access information about the kind of materials used in products and buildings, and how to dismantle them. As there are currently so many ‘unknowns’ in buildings, such transparency would make retrofit a lot easier, and help to drive innovation in the market to use safer, healthier, non-toxic materials.”*

**Lukas Hoex, Manager Strategic Growth, DSM-Niaga**

The **Buildings As Material Banks (BAMB)**<sup>19</sup> project is developing and integrating tools that will enable the shift to sustainable buildings through the use of materials passports and reversible building design. BAMB is also investigating new circular business models and their implementation. A Materials Passports Platform has been developed that allows users to identify potential value throughout the building cycle, from planning and construction through occupancy, repairs, renovations, repurposing and decommissioning, thus providing a ‘one-stop-shop’ describing circular economy value across the cycle and the continuous capacity to track component and materials quality.

In the **Netherlands**, the Madaster Foundation<sup>20</sup> has been trialling the **Madaster materials passport**, which contains a variety of information on the quality and origin of materials as well as their embodied carbon used in buildings and their current location. The newest building of Liander in Duiven in the Netherlands is one of the first buildings in the world with a materials passport. The material balance of the building was updated in various phases of the construction process. The Madaster Foundation created an online 'library'

platform, which provides the framework and technology to give materials an identity. Anyone can consult the platform, from estate agents to city officials to citizens who want to understand more about the house that they may be about to buy.

## 2. What is the value and potential for wider use of materials passporting?

More and more businesses are identifying the huge

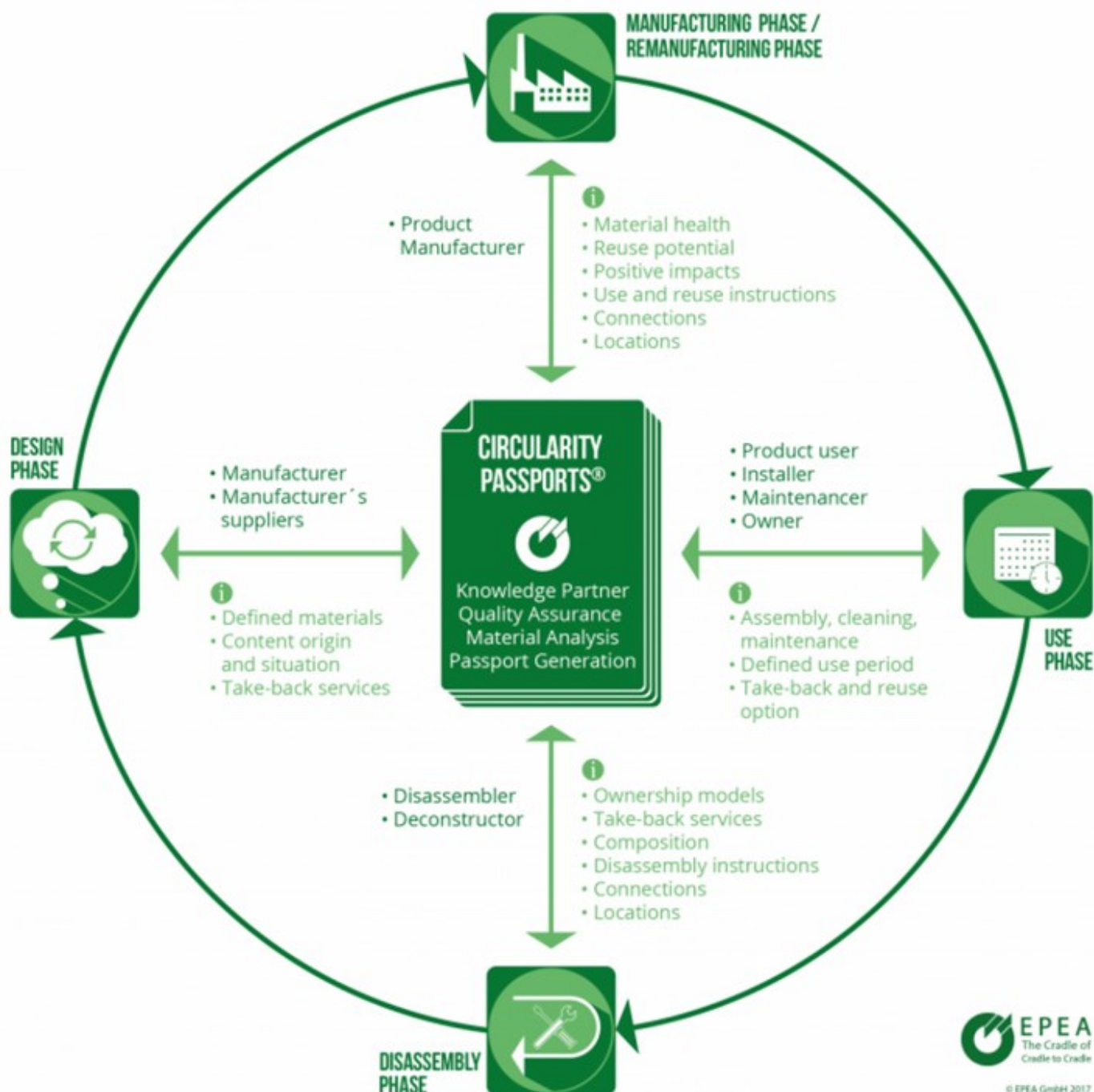


Figure 1: The Circularity Passport System, showing how products can be tracked through different phases of their utilisation. (Source: EPEA<sup>21</sup>)



potential for approaches to address waste problems, improve energy efficiency and generally contribute to business sustainability. When interviewed, several members of The Prince of Wales's Corporate Leaders Group (CLG) were very supportive of the introduction of materials passporting and instruction manuals for dismantling (as evidenced in the report, *Renovation roadmap: Making Europe's homes fit for the 21st century*<sup>22</sup>). The previous CLG business conversation 'European industry in the 21st century: New models for resource productivity'<sup>23</sup> also showcased companies that were redesigning value chains and products to use fewer materials which last longer, choosing innovative bio-based materials over fossil-fuel-based materials, and circling waste back into production processes.

Businesses interviewed, particularly those whose products or materials are used in building construction and renovation, support taking a longer-term view, to avoid increasing the carbon footprint of the building through use of carbon-intensive materials or products, to monitor toxicity levels (emitted by chemicals used in products), or to not add to the waste stream when the building is renovated again in future.

## 2.1. Importance to sustainability

The use of materials passports helps ensure that the renovation of buildings does not create more CO<sub>2</sub> than is saved in their use and can also encourage the use of building materials that sequester CO<sub>2</sub>. Corporate Leaders Group members would like to see full low-carbon renovation, not just in-use carbon emissions reductions.

The renewable materials company **Stora Enso** is working to provide renewable alternatives such as Cross Laminated Timber (CLT) and Laminated Veneer Lumber (LVL) for building materials such as concrete and steel with the aim of lowering levels of CO<sub>2</sub> emissions embodied in construction products. To do so, they have released comprehensive open source building systems manuals on how to build multi-storey houses from CLT and LVL. The company has also introduced Lineo™, which is made from versatile wood-based raw material lignin and can replace oil-based phenolic components in a range of materials, for example, resins for plywood, oriented strand board (OSB), and LVL.

Modular carpet manufacturer **Interface** has developed a prototype carpet tile with a negative carbon footprint (based on a life cycle assessment) of minus two kilograms of CO<sub>2</sub> equivalent per square meter through incorporating natural, plant-derived carbon throughout the tile, commercially available today through the CircuitBac Green backing<sup>24</sup>. Interface also offers a glueless installation to enhance both reuse and recycling and is working with local partners on increasing reuse, thus contributing to more circularity.

Enhanced reuse of building materials facilitated by materials passports would reduce premature demolition and building vacancy caused by their initially mono-functional nature.

Improved knowledge about the products, components and systems from the building design stage throughout construction and building renovation also helps to deliver safer and healthier indoor environments, with less use of potentially toxic compounds. It also enables more resource-efficient construction. For example, it is estimated that, in the UK alone, steel use in commercial buildings exceeds the safety requirements of the Eurocodes by a factor of 2<sup>4</sup>.

City leaders are also recognising the role that materials passporting can play in taking action on the Sustainable Development Goals (SDGs). Reducing materials waste and creating safe materials loops could substantially contribute to the better management and efficient use of natural resources, reduce the adverse environmental impact of cities and combat climate change<sup>25</sup>. These outcomes can be read as direct contributions toward the realisation of SDG 11, SDG 12 and SDG 13.

## 2.2. Key barriers to overcome

Why is this not happening already? Today's policies have not adapted quickly enough to embody the possibilities that passporting presents nor to incentivise the reuse and recycling of materials and documentation of data about a building's impact. The Buildings As Materials Banks (BAMB) project has identified key barriers to possible adoption. These include:

- a fragmented policy framework and conflicting energy and environment policy measures
- supply chain barriers (a lack of standardised data across the value chain of the product/building, linear construction industry models and lack of a business model framework)
- awareness and perception barriers (perception that reversible design solutions entail high financial costs, low awareness among the general public).

There can also be perceived risks associated with reused and recycled materials and policy barriers to reusing secondary materials as shown in a previous CLG business conversation.<sup>23</sup>

Addressing all of these barriers will take concerted effort from the supply chain for individual products, the construction and demolition sector, regulators and policymakers, and decision-makers at local and national level. Public procurement of buildings and renovation has as strong role to play in driving change.

Key opportunities do exist, however, to overcome these challenges and implement key structures and principles to underpin future adoption. These include the EU Circular Economy package where specific goals and guidance should be developed for the construction sector. Such an approach should consider GHG Protocol Scope 3 emissions and the future role for Extended Producer Responsibility in the sector.

Further, improved inventories of products can be linked to Building Information Modelling (BIM), which is being developed further as a tool used in the design phase of buildings but also in their construction, management (including renovation) and deconstruction. Even if only on a voluntary basis, this would help the construction and renovation supply chain to make more informed decisions on the components/products they use.

### 3. Key takeaways

CLG companies whose materials are used in building construction and renovation are very supportive of materials passporting, for example through EPDs brought together in a database for the construction sector and instruction manuals for dismantling or removing products. This would ensure that current

building renovations and new constructions are informed by the composition of the materials being used, and that architects and builders are also informed on how to remove or re-use these products in future renovations.

In order to manage the growing problem of construction waste, materials passporting should ideally be implemented sooner rather than later. Knowing the full life cycle of how a product will be used in the building is key to closing the loop.

In order to be most effective, buildings legislation needs to be better integrated. Issues such as in-use energy and sustainability performance, embodied energy (and other resources) and materials use and reuse need to be linked to ensure that in fixing one problem, other problems are not created in their place. The EU Circular Economy package could present one opportunity to do this for Europe. By improving access to objective information and knowledge on building materials, material passporting also supports the ability of EU Member States to encourage low-carbon and circular solutions.

## The Prince of Wales's Corporate Leaders Group

The Prince of Wales's Corporate Leaders Group (CLG) brings together executives from a cross-section of European industry to accelerate progress towards a low carbon, sustainable economy. Through cross-fertilisation of ideas and influential conversations with policymakers and peers, the CLG advocates forward-looking solutions that build a resilient and prosperous future.

The CLG is convened by the University of Cambridge Institute for Sustainability Leadership (CISL).

The CLG is a founding member of the We Mean Business coalition.

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