CBCI
Circular Bio-based Construction Industry

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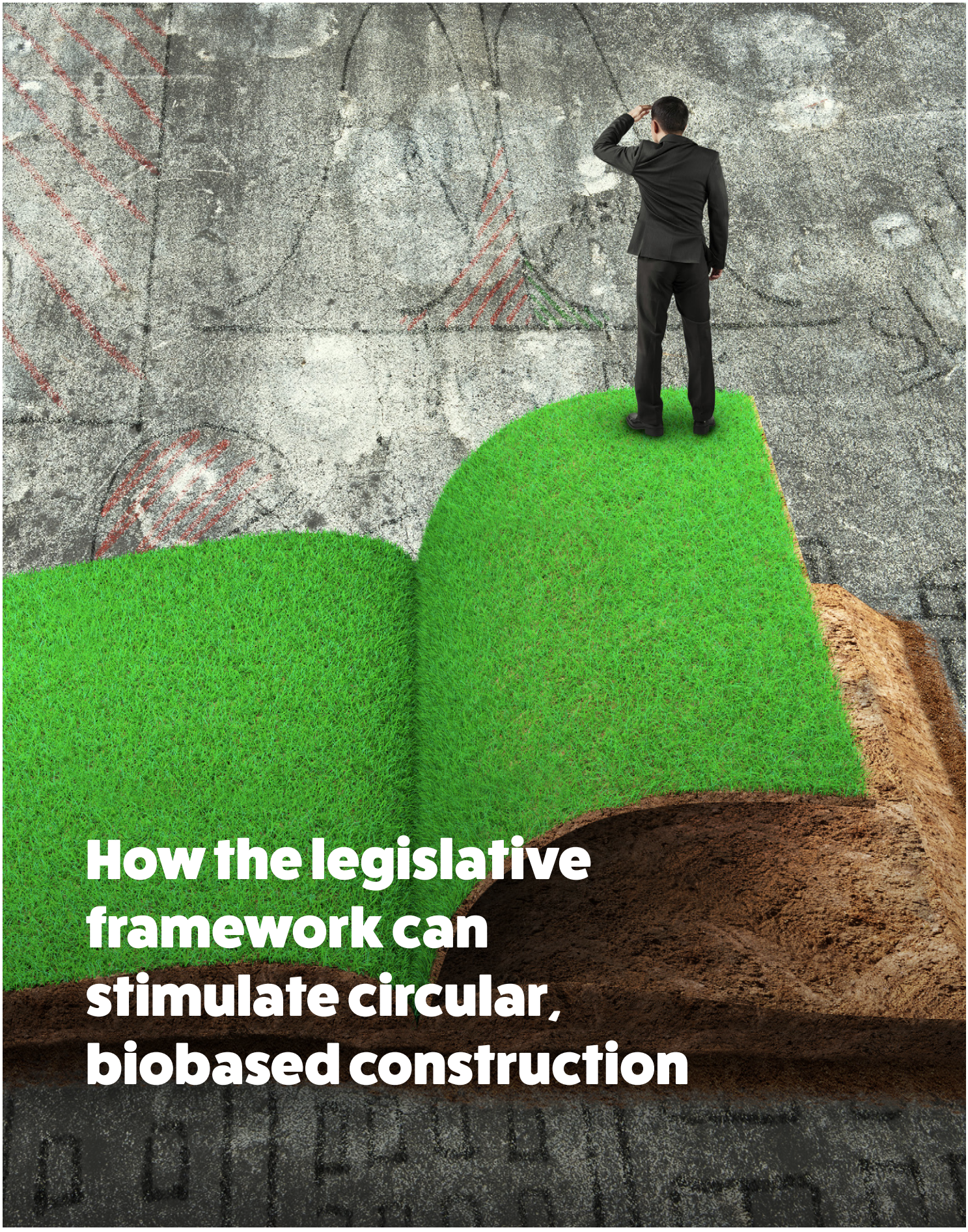

How the legislative framework can stimulate circular, biobased construction

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Context

Following the signature of the Paris Climate Agreement, governments developed policy to limit the anticipated warming of the climate. For the construction industry, this mostly involves economic use of raw materials and reducing power consumption in the production and use of buildings.

In order to achieve the goals of the Paris Agreement, a different perspective on the economic model arose: the circular economy as a counterpart to the current linear economy. Legislation and regulations follow up on this development, but only recently so. A lot has been put into motion. In this white paper, we set out the developments in legislation and regulations for a circular construction industry. One of the developments is a greater role for renewable materials and products in that future economy.

This white paper answers various questions:

- What legislation and regulations are important to scale up circular, bio-based construction?
- What lessons can be drawn from the difference in approach between the countries involved?
- How much of a barrier does legislation and regulation really pose?
- How flexible is legislation and regulation in view of function change?
- How much room does legislation and regulation offer for stimulating circular, bio-based construction?

LIVING LAB KU LEUVEN

KU Leuven, Ghent, Belgium
The Living Lab KU Leuven concerns a housing project in the city of Ghent (Belgium). One of the goals of this CBCI Living Lab is to realise a prototype for the renovation of terraced houses in urban innovation projects based on circular, bio-based and industrial construction principles. The developed concept addresses three challenges. Firstly, the operational and demonstrable energy performance upgrade of the existing building stock. With the concept, specific existing homes are renovated to meet the EU's EPC-A objectives for 2050. Secondly, solving the first problem will avoid a new problem at the end of the lifespan of that solution by taking into account the availability of raw materials. The Living Lab is a materials database for future related projects but was also built with materials from existing materials databases, demonstrating that the ambitions for the end of the lifespan of the new concept are achievable today. Thirdly, the concept entails 'design for adaptability' in addition to 'design for disassembly', by using a modular system that allows for modification throughout the lifespan of the concept. In addition to these project-transcending aspects, disassembly and flexibility are equally important from a project perspective. The prototype building will be present at the technology campus in Ghent for a limited time, around ten years. It will then be reconstructed elsewhere and used as a home.

In order to design and build the CBCI Living Lab Ghent, a team was formed with KU Leuven as principal and expert in sustainable design. Support by CBCI experts and prototyping partners as well as a consortium of contractors has led to a unique result. First and foremost, the circular character and use of bio-based materials are of importance when it comes to legislation and regulation. In addition, the temporary character, relocation and change of function are at least equally relevant.

LIVING LAB EMERGIS

Emergis, Kloetinge, Netherlands
The Living Lab Emergis concerns an extension of an outpatient centre for adults of the GGZ (mental healthcare) clinic of healthcare organisation Emergis in Kloetinge, Zeeland (NL). The project was subdivided into two parts. The first part concerns the renovation and new construction of the existing fixed building section. The second concerns the new construction of bio-based, circular and dismountable units.
The goal of this Living Lab is to renovate in a circular fashion using bio-based materials and to accommodate the clinic's clients in an environment that is as natural as possible. A new entrance will be built and the façade and roof will be renovated. The portable cabins, which have been there for over twenty years, will be replaced by new construction. Based on the current trends at GGZ, the centre requires a more permanent solution.

The starting point for the new building is connectable units that can be used for different functions, can be replaced as easily as possible as a unit and can be manufactured industrially. In addition, they will make use of bio-based materials as much as possible. As a healthcare institution, it is important for Emergis to be able to deploy both existing and new real estate as flexibly as possible. Both in terms of functionality and availability, with a quality improvement relative to the current real estate. The key for Emergis is to be able to organise optimal care for its clients in a safe environment. The daily dynamics and complexity of healthcare demand a great deal of flexibility, which is at odds with the long-term organisation of circular and bio-based real estate. Emergis is still in the process of developing a (scalable) circular, bio-based real estate strategy.

Two white papers have appeared in the CBCI project in the past:

- Five building blocks for successful circular, bio-based construction initiatives
- Circular and bio-based ambitions in construction projects; an integral approach of the tendering process

This white paper is about legislation and regulations, as producers, contractors, building owners and developers often see this as an obstacle to the wider adoption of circular, bio-based construction.

Legislation and regulation and circular, bio-based construction in the '2 Seas region'

Legislation and regulations do not materialise from thin air, but are rather the result of social, political and business interests. Two important aspects can be distinguished in the 2 Seas region in the context of scaling up circular, bio-based construction:

- The difference between countries due to culture and political background. Learning from the different approaches between countries can eventually lead to an improvement.
- Legislation and regulations offer some freedom of movement. In the execution, there is always some flexibility when it comes to interpretation. This freedom and flexibility can facilitate developments. In addition, there is a risk of unintended barriers getting in the way of new developments. Both sides have been analysed.

Ad 1. Organisation of legislation and regulation and governance culture

Laws and the associated rules exist to provide certainty, offer safety and protect citizens against arbitrariness. This paper specifically addresses legislation and regulations in the area of circular construction, particularly the handling of raw materials, construction permits and energy consumption.

Time aspect
Overarching legislation and regulation within Europe is organised by the European Union (EU), including the United Kingdom (UK) in its pre-Brexit form. The EU is pursuing policies on sustainability and raw material scarcity, partly based on the importance of high self-sufficiency for Europe. Member states then elaborate the EU policy in their own legislation and regulations. The position of the UK is not yet completely clear but remains along the same lines for now.

An example of overarching European legislation is the European Green Deal for climate neutrality in 2050, with consequences for all European subsidy programmes[1]. The transition to a circular economy plays an important role in this regard.

Green Deal roadmap, Source: Committee of Regions

[1]Fetting 2020

The translation of European policy into national policy is subject to 'delay'. The transition from linear to circular, from non-renewable to renewable materials and from traditionally to industrially produced, touches many aspects that need to be laid down in legislation and regulations. This takes time and a transition period with ambiguity, experimentation and pushing the margins and borders of legislation and regulations is inevitable. We are currently in that transition phase.

Types of laws and regulations
We distinguish various types of legislation and regulations that lay down prerequisites for this transition. Governments can deploy a very wide range of legislation and regulations such as laws, permits and taxes; stimulus schemes such as government funds and subsidies; and mandatory norms such as standards, labels and certificates. This is where the nature of legislation and regulation comes in. With what intention and purpose was it created? Promoting or punishing, guiding or anticipating, prescriptive and descriptive, binding or optional?

Governance culture
The nature of legislation and regulations is related to the national and regional governance culture. The main differences between participating countries are:

- France has a top-down governance culture;
- So does Flanders, though it is also subject to a complex federal governance culture with great autonomy for individual regions.
- The UK consists of countries and districts with a fair amount of autonomy within an overarching administrative structure;
- The Netherlands, on the other hand, has proportional representation with many parties. The Netherlands follows the developments of the market and provides little guidance.

Ad 2. The relationship between legislation and regulation, and application level

When it comes to circular and bio-based materials, it involves differences in:

- Scale levels from regions, cities, districts, building, component, product to material;
- Material streams Source of the materials and cultivation, processing, production, transport, implementation, use, reuse and administration;
- Functionalities related to material streams and scale levels, in application and use and change of application and use relative to use, value retention and lifecycles;
- Stakeholders legislators, principals, designers, producers, experts, consumers, etc.

'Regulation and circularity' is related to the following factors: time, function, scale level and stakeholders. Functions will change due to end of life or use cycle. Depending on the scale level, functions may change over time: urban structures will change less rapidly than the interior of a building. The scale level also determines whether other stakeholders are involved in the change of function and thereby the type of regulation relative to this change of function.

The changeability of functions at various scale levels demands adaptability and flexibility. Creative and 'outside-the-box' thinking helps parties such as building owners, builders and property developers in recognising and optimally capitalising on opportunities for change of function. At what scale level are changes necessary? What other function is the best match for this building?

'Regulation and circularity' relate to organisation as follows:

- abstraction levels and levels of organising and governance
- building level and use and lifecycles
- adaptability and flexibility

Depending on the scale level, we can distinguish various types of legislation and regulation that are more or less normative or determinative. The table below indicates the relationship between levels of organisation and governance, the type of legislation and regulation and scale levels. The horizontal axis represents the different scale levels with Europe as the highest scale level and material as the smallest. The vertical axis represents a hierarchical depiction of the levels of organisation and governance with the type of legislation and regulation from ambition to certificate. The higher in the hierarchy, the more a certain type is normative or determinative.

A strategy steers towards a certain development and result in the very long term. This becomes more concrete in a vision document and policy measure, where laws can be developed as regulating and, for example, funds as stimulating preconditions. Stimulating or regulating says something about the nature of the legislation and regulation. The nature of the legislation and regulations is indicated by abbreviations in brackets: prescriptive (p), guiding (gu), generally valid (gv) or specific (s).

The table shows that not all types of legislation and regulation occur at every scale level. Certificates, for example, are limited to scale levels of material through building and only affect those. Strategies, agendas, visions and policy measures affect a much larger portion of scale levels. Without legislation and regulation at a higher level, combined with legislation and regulation at a lower level, a transition is impossible.

	ABSTRACTION LEVEL						
LEGISLATION AND REGULATION TYPE	Europe	Country	Region	City	Building	Component / product	Material
Ambition (gu)							
Strategy (gu)			Region Agenda (gu)				
Vision & Policy measure (v) and (gv)							
Laws (p) (gv)			Structure vision / structure plan	Zoning plan	Permits		
Taxes (p) and (gv)							
Funds (gu)							
Green Deals & Pact (gu)							
Insurance (s)							
Subsidies (gu)							
Funding (s)							
Norms (s)							
Standards (s)							
Labels (s)							
Certificates (s)							

The impact of the material transition is extensive. Of all materials, around 60% is used in the built environment[2]. If part of or all materials in the built environment must be made of bio-based or renewable materials, this requires a reorganisation of material streams and with that potentially a change in the use of land. As such, this says something about laying down spatial functions at the regional and national level in legislation, zoning plans, structure visions and structure plans. For the application of bio-based materials in the built environment (building, component and material level), construction permits and standards are important, among other things. A sole focus on adapting legislation and regulations at the building and material level without attention to changes at the urban and regional level will eventually block the transition.

[2]Ohl et al. 2008; Wackernagel & Rees 1996

Legislation and regulations for circular, bio-based construction in practice

Wide-ranging interviews about opportunities and obstacles based on desk research (2020/21) with 20 front-runners in the countries of the 2 Seas region and interviews and workshops with stakeholders have provided a more in-depth practical picture. This was translated into recommendations.
The following themes came out on top as the most relevant:

- The position of legislation and regulations relative to political ambitions;
- Legislation: construction permit/environmental permit;
- reuse of materials, products and buildings;
- definitions: circular and bio-based (products);
- technical specifications.

A The position of legislation and regulations relative to political ambitions, specific insights

From desk research
The literature review demonstrates the existence of many policy initiatives for more sustainable and circular construction both at the EU level and at the national and regional level.

The same applies to the bio-based industry: bio-based raw materials and products are receiving more and more attention. Development of the industry and the framework is progressing. But the European Green Deal remains vague. There is little emphasis on the role of bio-based materials in construction. The representation of bio-based products in circular construction initiatives remains limited. Initiatives to promote the bio-based industry rarely contain the application area of the construction industry.

There are interesting examples where circular construction and application of bio-based products go hand in hand. In Flanders, Vlaanderen Circulair supports various initiatives (case studies, product development) for bio-based solutions in their call for a circular economy. In the Netherlands, the use of bio-based products is explicitly stated in the circular economy and construction policy papers. It is part of the policy proposals being developed by the CB'23 platform. And parties including the government collaborate in order to stimulate bio-based construction in the City Deal.

In France, the RE2020 (see box) took effect, which is expected to boost circular, bio-based construction. In the UK, the 'Circular Package' (CEP) is the framework addressing waste and circularity. It is a largely decentralised approach, resulting in policy differences between the four countries of Wales, England, Scotland and Northern Ireland. However, they do all encapsulate the core objective of addressing climate change and becoming more circular.

RE2020 (Régelementation environmentale 2020), France

This scheme sets minimum greenhouse gas emission requirements for new buildings throughout their life cycle.
Specifically, two types of requirements will be set, calculated on the basis of Life Cycle Assessments (LCAs), expressed in m2 of floor space per year:

- requirements for greenhouse gas emissions associated with energy consumption. More efficient and less carbon-intense energy solutions will be encouraged, such as hybrid gas solutions and heat pumps;
- requirements for greenhouse gas emissions associated with construction materials and equipment, throughout their lifecycle. According to the E+C experiment, between 60 and 90% of the carbon footprint of new buildings is related to the construction and demolition phase. The goal is to calculate emissions across the entire lifecycle of a building (50 years) as realistically as possible. Footprint thresholds are established, which increase in stages. A new development is that a Dynamic Life Cycle Assessment approach is used to improve the use of materials for the temporary storage of carbon (wood, for example).

Potential actions:
- Ensure proper representation of the bio-based construction product industry for these interests to be weighed in at the political level (both bio-based industry and circular economy).
- Make a deeper analysis of the best examples of policy that integrate and spread both elements (circular & bio-based) in the construction industry.

Green Deals and Open Calls for European subsidies, for example, seem like interesting instruments for involving parties in further steps.

From interviews and workshops
The most striking observation from the interviews is that the 20 interviewed front-runners 'simply' apply circularity. No concrete issues were reported in relation to legislation and regulation. Problems are also hardly ever reported to relevant hotlines or services.
The front-runners make explicit choices such as Cradle to Cradle (C2C), working according to The Natural Step, building with wood, 'no waste' or building with a certain bio-based material (lime hemp). All principles that fall within the framework of circular construction. These front-runners took the very fact that highly circular ambitions are barely regulated as an opportunity in their projects.

"The building code allows for circular construction by omitting it."
Licensing Authority Middelburg

Nevertheless, such minimal regulation and the absence of clear guidelines and descriptions can be considered a barrier for scaling. Lacking guidelines can become an 'excuse' for not doing or not having to do anything. Or for not experimenting. Another important observation is that an incentive to ramp up investments into circular and bio-based construction is missing due to the absence of a framework.

In France, interviewees indicated that the market has been set into motion with the application of materials with a lower CO_2- footprint (including bio-based materials) due to the introduction of the RE2020. Builders are now more inclined to consider circular and bio-based solutions. Manufacturers and traders of construction material are responding accordingly.

"Political primacy over interpretation of rules. More is possible than appears at first sight. A lot depends on the official who interprets and applies."
Entrepreneur Baarland (Zeeland)

Legislation and regulations are not an obstacle, but they can occasionally be a hindrance to the execution of circular building projects. The real bottleneck, however, is often hard to pin down, as the interviews and discussions showed. Some do experience the lack of guidelines for the reuse of materials. Waste regulations can also give rise to discussions, especially if national borders are crossed. In addition, reuse often lacks guarantees and quality labels, which makes scaling up more difficult.

"Experiments (subsidies) are necessary to demonstrate the possibilities, to test practical experience and to show what the market can solve on its own. Only then does the legislator get involved."
Construction lawyer RVO

In Belgium, legislation and regulations are approached differently. In Flanders, regulations are turned to more quickly because the market fails to address it itself.

"With cars, it was done sooner! A push for progress. Is the opposite of what was done (and successfully so). Consider the Porter hypothesis: strictness stimulates innovation. Requirements must be raised."
PhD researcher Hasselt University

Minimum regulations maintained by lobby
Established parties- those that have a large market share - are usually inclined to defend their position. After all, it involves large investments into a certain product and a certain production method. These 'large players' impede the transformation from a linear to a circular economy. The transformation itself is becoming less of a discussion item, but the pace is not. This reduces both the European and national political ambition[3], which in turn affects the formulation of legislation and regulations appropriate for a circular economy.

"The construction industry is also involved at the European level so that the solutions are not overly ambitious. The industry is being pushed out of the market."*
PhD researcher Hasselt University

[3]Jonas Voorter
*Industry refers to innovative small players.

National Environment Databases such as NMD, Totem and INIES and the green Building Councils (GBC) explicitly support the interests of the construction industry at large by measuring and comparing the environmental performance of buildings. They are committed to an equal playing field for all construction materials. The GBCs want to promote the circular economy in this way.

Advocating for the interests of innovative 'small players' is difficult because their clout and level of organisation are too low relative to established players. But rather than being a specific issue confronting bio-based/circular players, this is a general issue for all innovative companies.

Circular front-runners in the construction industry, such as the Living Labs and the studied projects, meet various criteria of circularity with their higher ambitions. Players in the market can thus meet the circularity demand. The (technical) knowledge is there. Jonas Voorter and Pieter Stroo are convinced that the market will change by including Best Available Technology (BAT) in regulation.

Jan Willem Groot (NMD) indicates that bio-based materials by and large score well when it comes to their environmental performance. This is demonstrated based on a Lifecycle analysis (LCA) published in an EPD (Environmental Product Declaration). However, making an LCA is time- and cost-intensive.
The interviews and workshops reveal the following important issues:
- A generally applied basic framework for legislation and regulation in the area of circular construction is missing while policy intended to stimulate it does exist. As a result, the policy remains in the ether.
- This poses a difficulty to enforcers as it remains unclear what needs to be enforced. This leaves room for interpretation.
- Innovative companies and smaller players in the current market have limited room to invest into the requirements imposed onto companies by the government.

From the Living Labs
A temporary construction permit was obtained for the Living Lab. The university's facilities department insisted on this for two reasons. Experience shows that temporary permits for construction specifically at the technology campus in Ghent have a better chance to succeed than permanent permits. Secondly, the location of the Living Lab is reserved for a new academy building that will be constructed as of 2030. The research group thus aspires to relocate the dismountable Living Lab to a different location in the city and have it reused as a real home.
To allow for the consideration of all possibilities, a discussion with a representative of the city planning department of Ghent was set up prior to submitting the building permit. The following aspects were discussed in particular:
- By analogy with the temporary court in Amsterdam, can we get a split permit for the building and the location?
- In the case of scaling: is it possible to obtain multiple scenarios of the same design (e.g. including future extensions)?

The conversation with the city planning department revealed that no legislation currently exists to allow for both scenarios. Firstly, applicable legislation may differ from one location to the next and so may the rules that the building itself must comply with if it is relocated or the same version is built in several locations. Secondly, permits map what has been built in which location. If a permit were granted for multiple scenarios, the city planning department would never have an up-to-date view of what has been built and what has not.

Emergis' experience with policy, legislation and regulations
In the preparation, licensing and execution phases, no obstacles have arisen from municipal policy. On the other hand, no policies promoting the use of bio-based or circular materials exist. When clarifying the project, the municipality did respond with enthusiasm. In order to grant the permit, they are investigating whether the project fits within current legislation and regulations. The project specifically focuses on the application of bio-based materials and aims for future flexibility. The application of recycled wood is limited to the construction of the new entrance, junction gate and the façade finish of the units. When it comes to these elements of the building, legislation and regulations posed no barriers for granting the permit.

The basic principle for enabling the future flexibility of the building is the construction of linked units around a standalone corridor. This means that each unit and the hallway must be sufficiently strong even without the construction around it. This is a logical consequence of the concept rather than a real statutory or regulatory requirement.

B Legislation: construction permit/environmental permit, specific insights

From desk research
Current legislation in the regions does not seem to pose a barrier. However, various aspects complicate the process of making circular, bio-based buildings appealing to builders who work according to present-day economic models. This involves the definition of waste: when is something considered a construction product and when is it mere waste? Lack of familiarity with the technical features of construction materials may complicate the process of obtaining a construction permit as well.

New legislation aimed at promoting a circular, bio-based economy may miss its mark due to complex requirements. Such as managing the environmental performance of a building. In order to ensure that circular buildings (built with bio-based materials) can capitalise on their largely favourable environmental performance score, they must possess an Environmental Product Declaration (EPD). These are costly investments for manufacturers who are often small players. Without EPD, designers and principals do not select them. As a result, the legislation fails on its objective to improve the environmental impact of a building.

The desk research found the following barriers in legislation and regulations that inhibit the scaling of the construction industry in a true circular economy:

- Fiscal legislation High taxes on labour render labour-intensive circular activities expensive; the social costs of (raw) materials are insufficiently factored into market prices.
- Statutory ownership rules In a circular economy, the number of rental and lease constructions will grow. This demands clear rules about legal ownership and rules with regards to tracking and tracing the functionality of products, components and buildings.
- Financial framework Rental and purchase rules cause depreciation without residual value, while the residual product still represents economic value. Banks are currently lacking suitable models to account for this.
- Insurance Insurers are still finding it difficult to estimate the risks of circular, bio-based construction materials and construction concepts.

Potential actions that emerged:

- Stimulating circular, bio-based construction in the legislative framework, e.g. by promoting circular, bio-based construction through permits.
- Creating more insight and knowledge on the environmental impact of bio-based materials.
- Stimulating companies to work on standardised environmental impact data for their products (EPDs) or to unite in order to create them at the industry or product level.
- Offering support to companies in order to simplify the creation of EPDs.
- Driving the development of current LCA methods in order to correctly calculate the benefits of bio-based construction products such as carbon capture and renewability.

From interviews and workshops
Workshops and interviews reveal that it is proving difficult for bio-based materials to become established on the regular market for construction materials. After all, it tends to be a displacement market. In addition, these materials are not being prescribed because they are less known to those who create rules and schemes, or they are noted as an alternative in calculation tools or application forms.

Of course, circular, bio-based materials will have to meet certain standards and specifications. This relates to primary and secondary materials. But this tends to be financially infeasible in the development phase or early start-up:
It is financially difficult for innovative manufacturers to keep their certificates up to date because certification needs to be renewed for every improvement in production or change of composition.

It was also mentioned that differences in regulations and certification to meet legal requirements between European countries are causing unnecessary costs.

New legislation and regulations for CO_2-neutral Construction
More and more countries are looking at how the CO_2 footprint can be used as a control tool. France is currently leading the way in that regard. The RER2020 took effect on 1 January 2020 and sets requirements for the maximum CO_2 footprint per floor area. That footprint is adjusted downward over the years, for new buildings at first.
CO_2 recording is interesting for bio-based materials. In the Netherlands, a discussion is ongoing about whether and how such CO_2 recording can be included in regulations. It will probably become a part of the MPG calculation. The discussion will continue in 2022.

From the Living Labs
KU Leuven's experience with legislation

Scaling of the concept clashes with a specific aspect of the city of Ghent's regional regulations. To prevent existing family homes from being divided into student rooms and maintain the limited stock of large family homes, it is not allowed to split existing homes into separate units in Ghent. So-called semi-detached homes are allowed but they must be designed as such from the start. This is diametrically opposed to the Flemish policy of preventing further encroachment on empty land in Flanders. This policy indirectly steers towards densification of the existing urban fabric. The Living Lab does have this potential, but will not be able to exploit it during its lifetime given the city's current legislation.

Because the Living Lab is being built on the technology campus of KU Leuven, it is subject to the laws and regulations of public buildings despite it being a prototype for a single-family home. It should be noted, however, that stricter rules apply to multi-family dwellings, even though they should be feasible with the adaptable and divisible building concept. Although this was a research project, it was not possible to obtain a waiver so as not to have to comply with the rules specific to public buildings. However, the law does provide for a scenario in which certain rules do not have to be met, namely if the building is very limited in size. Unfortunately, the small Living Lab was still too large. This has various consequences, especially when it comes to rules around accessibility and fire safety.

[4]Koster et al, 2020

C Reuse of materials, products and buildings

From desk research
Two matters are of particular importance for legislation and regulations when it comes to the future reuse of materials in construction:

- Waste legislation
- Ownership

Waste legislation
In the definition of circularity and materials, it is key for materials not to be wasted. Material cannot be waste for it to carry value for a sustainable environment. In the current situation, however, there is a difference between the definition of waste and material: in policy, legislation, standards, etc.

Waste legislation carries several limitations that make circularity more difficult, such as:

- Waste is not considered a raw material: waste legislation (currently) hinders the collection and cross-border transportation of waste for circular use;
- Limitation of trade in secondary waste: the European Waste Shipment Regulation (currently) inhibits international trade in valuable secondary waste;
- Competition policy: competition policy can be at odds with cooperation between companies for the optimal use of each other's residual flows.

Met aanvullend en soms ander beleid kunnen overheden de
With additional and sometimes different policies, governments can better promote the transition to the circular economy. For example, it is clear that the term waste needs to be dealt with differently. The starting point should be that the concept of waste must be defined broadly, with the understanding that there has to be a justification for labelling something as waste. More specifically, the designation of a certain material as waste is in principle not justified if that material can and will be used for a certain purpose and does not burden the holder.

Ownership
CBCI's first white paper states that ownership should best be kept as simple as possible[4], because according to legislation and regulations, whoever owns the land also owns what is on it. In addition, an element that is (too much) fixed to a building, automatically becomes part of that building. This makes constructions with, for example, product as a service extremely complex legally.
An example of how ownership could be handled in a circular economy is the circular façade (see page 16).

VMRG (Dutch façade industry organisation) took the initiative to achieve a circular façade economy in collaboration with colleague industry organisations VGK (synthetics), NBvT (wood), VHS (locks and hinges) and VRN (glass). The reuse of façade products and raw materials is maximised and value destruction minimised. Since 2018, it is possible for the façade builder to retain ownership of the façade via a long-term lease, which enables the leasing of a façade and thus its reuse. In 2020, an exploratory study commissioned by the Dutch cabinet "Circular Façade Economy" was completed. The Ministries of Infrastructure and Water Management and of the Interior and Kingdom Relations will lay down the objectives, agreements and activities for 2030 in a chain agreement with the industries.
In the exploration of the circular façade economy, four legal points of attention were identified in relation to circularity in construction. Some solutions are available within current legislation, but they do not always facilitate circularity optimally, especially in the change from ownership to use: the façade as a service.

The issues identified in 2020 are:
1. Changing performance requirements
2. Copyrights of architects in the event of 'form changes'
3. Split of façade under procurement law
4. Separation of building elements is difficult

EXAMPLE Alkondor (2021)
Together with TU-Delft, industry organisation VMRG and other partners, Alkonder Hengelo developed the concept of the integral, circular façade 'as a service'. In this model, a façade is sold to the owner with a service contract, or Alkondor can retain ownership of the façade and its exploitation. The motto of the as-a-service model is 'no more than usual': over the entire life cycle, the costs for the client cannot exceed those of a traditional real estate operation. One failure factor so far has been financing (e.g. risk in case of bankruptcy). Alternative solutions include collaborating with other suppliers that can acquire the contract from one of the partners or collaborating with multiple banks to spread the risk. In addition, a circular façade is not determined by ownership but rather by the service that the product provides. It is merely a means.

Accession

The legal term 'accession' appears to be an important (limiting) factor. Accession means that real estate is owned by the owner of the ground that holds the building. There are two ways to change this: right of superficies and emphyteusis.

The right of superficies gives the superficies holder ownership right for the circular product in question. An important limitation does apply: the object for which the right of superficies is established must be sufficiently independent. It is unclear when this is the case and whether the right of superficies can be used to solve the problem of component formation.
In addition to the right of superficies, there is the option of establishing emphyteusis. This right gives the right holder the authority to hold and use real estate that belongs to someone else. It is therefore a usufruct and not an ownership right.
In the case of a circular façade, this means that the façade supplier, as a superficies holder, receives a right of superficies for the façade and leases the façade to the emphyteusis holder (the building/landowner).

From interviews and workshops

The deployment of reused materials that were harvested from previous projects and have been deployed in a first (or multiple) application(s), is still confronted with limitations. This is due to the question when a material remains a construction material or is legally considered to be waste. This can throw up a barrier because waste is often prohibited from being reused. Legislation and regulations are overly geared to risk prevention and as a result many solutions are prescribed in detail. Working with performance standards (instead of detailed solutions) could be one approach.

If you set requirements for equivalence of products and do so on the basis of calculations and assumptions that are 5-6 years old, there is a chance that someone will want a new calculation. They might want to know what has changed about the material in the past years and what new insights exist with regards to its environmental impact.

Sometimes, reuse simply is not very sensible. Rules can be relaxed or their sensibility reconsidered. When reusing second-hand material (what is currently allowed and possible?), we assign value to residual material in new construction. But perhaps legislation will change in such a way that products and components that can be reused right now, will no longer qualify in the future?

One opportunity would be to work with two permits. One permit for the building itself and another for the location. The practical benefit would be that compliance with the regulatory change is not necessary and the building remains approved. Should it be relocated and comply with the new location, it will be allowed to go there. As such, the building is considered a separate product.

"For the granting of (construction) permits, ownership does not matter. The only question is whether you meet the requirements."
Licensor

"This is a specific aspect. Lease and rental have nothing to do with the circular idea. They don't require a circular philosophy at their root."
lawyer RVO

The interviews and workshops reveal that ownership poses a lot of issues. They are associated with costs as well as guarantees. Principals find it complicated. A participant will often see a circular ambition shatter due to the lack of a conclusion about ownership.
You are confronted with rules of accession. As a producer or supplier, you lose ownership of your product as soon as it becomes the property of the new owner of the building. How does this relate to leasing or product as a service? What does it mean when you, as an owner, want or have to take something back after a while? What about financing? You are confronted with a lot of collateral. Accession therefore proves to be very difficult (legally) to realise in practice.

In the Netherlands, CB'23 is working on the design of future reuse as well. Its report is expected mid 2022. There too, the difficulties around waste, reuse and quality and product liability come up as unresolved issues.

Belgium works with a movable property registry which eliminates the issue of accession rules for producers listed in that registry. There are systems such as tracimat/blockchain and materials decree that have yet to be fully applied. It has been suggested to work with a circular construction producer registry[5].

France is working on a system where the producer retains responsibility for their product, the Responsabilité Elargie du Producteur (REP). But its implementation in construction turns out to be complex; it was scheduled to take effect in 2022 but was postponed to 2023[6].

Recommendations and opportunities
- Rules for waste in relation to construction materials in a circular economy need to be revised at the European level.
- Product equivalence can be applied more often. This does require clear rules for demonstrating such equivalence.
- Legislation and regulations are overly geared towards risk prevention. As a result, many solutions are prescribed in great detail. One solution in this regard could be to work with performance standards.
- We must try to equalise the playing field between circular, bio-based and traditional materials. For example, one could buy traditional concrete blocks that cost x, lime hemp blocks that cost y, and a subsidy could ensure that the cost of using them is the same.
- Attention to fair pricing. Implement an environment tax on materials. Results in price increases (which is less desirable).

From the Living Labs
Emergis' experience with ownership
Rather than changing ownership, the Outpatient Centre Emergis project opted for a traditional form of ownership. The user, Emergis, becomes and remains the owner of the building because this fits Emergis' need for flexibility. Emergis wants to be able to respond to changing healthcare needs and is also best positioned to do so as an expert in this area. The latter does involve a change in how the real estate is considered, as it becomes secondary to the current healthcare need rather than healthcare being adapted to the available real estate.

[5] https://www.circubuild.be/nl/nieuws/wet-uit-tijd-van-napoleon-staat-transitie-naar-circulair-bouwen-in-de-weg/
[6] https://www.ademe.fr/expertises/dechets/elements-contexte/filieres-a-responsabilite-elargie-producteurs-rep

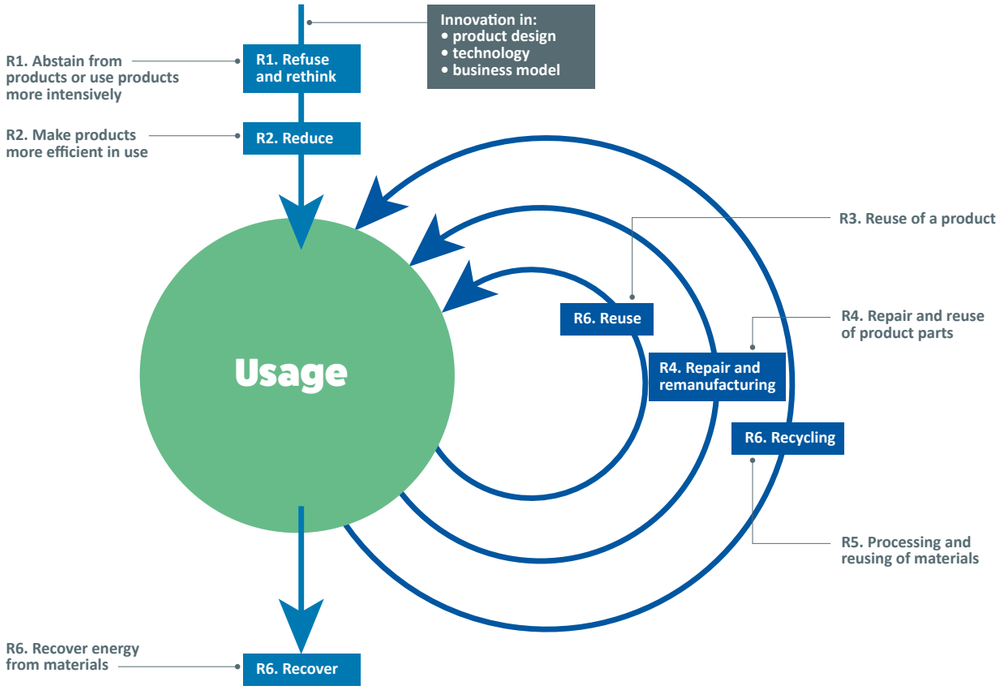
D Definities: circular and bio-based (products)

From desk research
Circular economy is a widespread term that currently lacks consensus. This means that the definition of circular economy depends on the context. Generally speaking, circular economy refers to the economic model that, contrary to the linear economy (take-make-use-dispose) aims to avoid waste and make the use of resources more efficient. However, many different definitions can be found in the literature.

Such definition may relate to:
- Sustainability and the three pillars environment, social and financial;
- Economic processes;
- Systems;
- Social value creation;
- Technical aspects related to the R strategies (see figure);
- Waste management.

In addition, different contexts are found within the definitions.

R-ladder with strategies of circularity



Bron: PBL

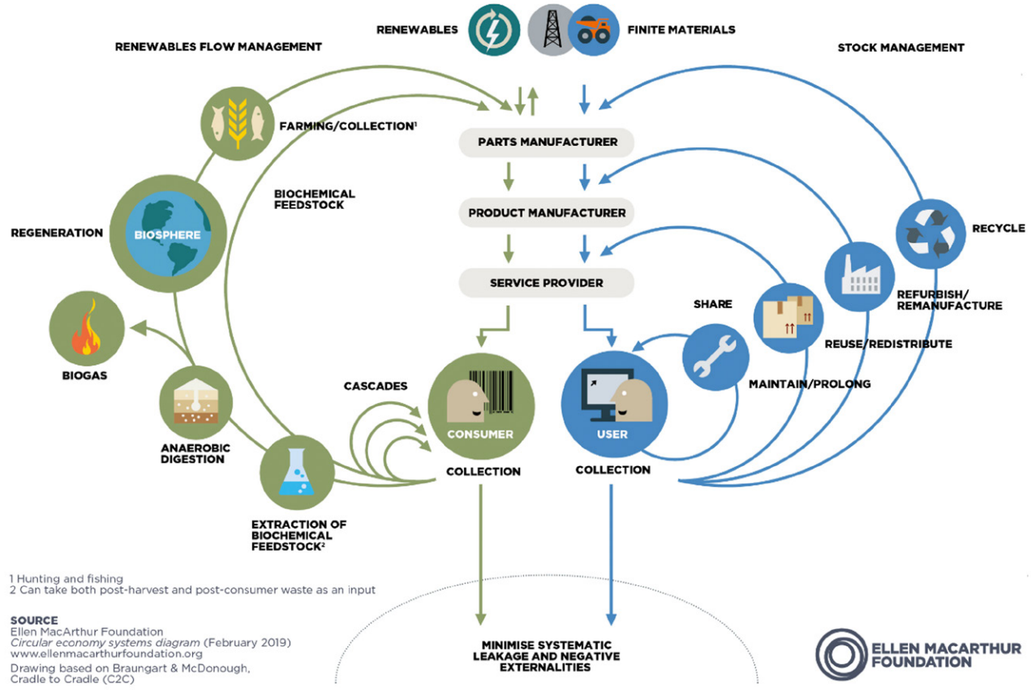
Understanding the concept of circular economy is important, but there is more. It is also relevant to understand that it entails a measurable concept. Various measurement methods have been developed for the various contexts where the circular economy has been applied. Nevertheless, consensus about a single measurement method for the concept is still lacking.

What is circular economy in the context of the built environment?
As mentioned earlier, the same term can be interpreted in different contexts. This context concerns the built environment. Various concepts emerge when it comes to the circular economy. These concepts include:

Regeneration of natural systems	Optimisation of resources
Reduction of raw material consumption	Processing of construction and demolition waste
Reduction of waste production	Highest utility with highest value
Lifespan extension	Recyclability
Solution to atmospheric issues	Implementation of goals for sustainable development
Increase of social value	Control of finite reserves
Application of the R strategies	Waste management
Retention of sustainability pillars	Retention of economic value

The aforementioned terms contain important words, such as value, sustainability, raw materials, finite reserves, construction waste, demolition waste, innovation, reduction, extension, application, retention, optimisation, execution, control and management. These words help formulate an overarching definition for circular economy in the context of the built environment that is generally accepted.

The Ellen MacArthur Foundation's definition is used as a basis for further exploration:
"An economy that is restorative and regenerative by design and aims to keep products, components and materials at their highest utility and value at all times while distinguishing between technical and biological cycles."



How is circular construction measured?
Measurable values are desirable for legislation and regulation. Different stakeholders in the construction industry developed measurement frameworks of circular economy for buildings. However, no generally accepted term for circular economy in the built environment exists as of yet. As such, each framework has a different measurement approach.
This also means that each framework takes different indicators into consideration that align with that specific definition of circular economy. They each have their own methodology for measuring those indicators, eventually allowing them to measure the degree of circularity of their project (based on those indicators and their own ambitions). Once consensus is reached about the definition of circular economy in the built environment, a standardised framework can be developed. Guiding questions in this context are:

- What indicators are very well-defined? Are they aligned with our definition, ambitions and context?
- Which indicators differ between assessment methods? Which ones are not as well-defined? Or is a clear measurement method lacking altogether?
- How can these indicators and measurements be implemented into procurement? Two tracks: individual indicators with goals and working towards a total score.

From interviews and workshops
A multitude of definitions exists and even more variables (34) about how to proceed with measurement. TU Eindhoven's Eduardo Lopez investigated this, in addition to the activities with the Dutch platform CB23. It is clear that circular as a term is still in development, both nationally and at the European level.

The workshop with the K&I network concluded that (prescribing) an exact definition should be left out in view of the lack of clarity and discussions, leaving room for the market to make its own interpretation. Rather than 'prescribe': make it as concrete as possible so I just have to apply it.

Thierry Laquitaine (AEW) has a different viewpoint. It is the very lacking of the definition and missing of a single responsible party or organisation for applying the definition that causes fragmentation, ambiguity and inhibition of the transition. We get bogged down in technical solutions (formulas, labels and IT programmes) that calculate circularity, whereas what we need is a change of culture.

The definition issue contains a contradiction between clarity and flexibility. This seems to be related to the contradiction between project-oriented work (inherent in the construction culture, where flexibility is convenient), versus long-term strategic thinking. The latter is done by real estate investors and production companies who are in need of clarity in order to make targeted investments.

E Technical specifications

Primary materials and reused materials differ in terms of ownership and lifespan. The question in this paragraph is what has been agreed upon with regards to

- standardisation
- environmental impact, EPD
- certification
- labels

From desk research, interviews and workshops
Standardisation
Standards are important for the acceptance of materials and products in construction, especially when scaling is involved. After all, a standard provides certainly for an applier and also for legislators and regulators. A standard should offer a solid foundation for consumer trust in the quality and safety of the offered products. A European standard is the most desirable because it eliminates any issues with cross-border trade and export traffic.
What standards exist around circular, bio-based materials? Although wood and wood-based materials are largely standardised, this is not the case for other bio-based materials. As it stands, only two standards exist for materials that are not based on wood.

- Standard 1: EN 14063 series: Heat-insulation materials and products- In-situ moulded expanded lightweight clay products (LWA)
- Standard 2: EN 15101 series: Thermal insulation products for buildings- In-situ moulded loose-fill cellulose (LFCI) products

Contrary to the wood standards, these two standards only describe testing methods for assessing the intrinsic properties of the materials without setting quantitative/minimum requirements. Because the properties of products of organic origin may change depending on the seasons/years, it would be relevant to indicate a minimum target value in order to assure product consistency.

The European Assessment Document (EAD) complements the European standards. It includes the documentation of the procedures and criteria that the European Organisation for Technical Assessment (EOTA) deems applicable for the assessment of the performance of a construction product based on its properties. Most materials that are not based on wood are described in four EADs. They all pertain to insulation products made of plant-based and animal-based fibres, both factory-made and fitted on the construction site, consisting of grass, flax, hemp, jute/sisal, paper, recycled paper, cotton fibres, untreated wood chips, sheep's wool and cork. But again, when those EADs describe test methods for determining the performance of the product, they do not state any quantified requirements.

An improvement could be to set a minimum required level to ensure the consistency of the product. The minimum required performance level may differ for each product.

Products tested according to the EAD are covered by the European Technical Assessment (ETA) that provides information on the indicated performance. It is not mandatory to test all aspects of performance stated in the EAD. For the properties that were not tested, the ETA only states the following: 'No performance established'.

The technical documents must also state a minimum value of the most important plant-based or animal-based fibres and their sustainability potential (recycling and compostability). ETAs issued after 1 July 2013 are valid indefinitely. The question remains how the manufacturer of bio-based products can reassure the user and guarantee that the product will perform consistently regardless of variations over the seasons/years.

At the national level, the French national organisation for the regulation of insulation materials (ACERMI) has drafted two documents that can serve as a foundation for the development of a more suitable EAD:

- The document 'Référentiel Produit n°11 (2014)'. This document lists all properties that can be certified for insulation materials based on plant-based or animal-based fibres. It contains a list of European standards, the type and number of required samples and test conditions. More importantly, part of this document offers information about the characterisations that can be executed at the factory in order to validate the continuity of the performance over time. The document provides information about how frequently the manufacturer is required to perform the tests in order to obtain certification.
- The document 'Cahiers du CSTB 2928, 375 (2002)'. In this document, various classes are established to sort the insulation materials and determine what application they were made for. The materials are classified based on five property categories: mechanical properties, dimensional stability, behaviour under water, cohesion of the material and water vapour permeability. In each phase, the materials are assigned a score from one to five depending on the results obtained according to European standards or tests invented by the ACERMI organisation. Depending on the results, the user knows whether the insulation material can be used for roof, wall and/or floor applications. A lot of standardisation work remains to create transparent standards for various bio-based construction products. Standards make it possible to set the bar and communicate clearly about the technical performance of products. If standards are missing for certain product types or exclude the use of bio-based materials, it is important to create fitting standards.

Because standards act at the European level, no conflict between countries and regions exists. As such, it is not considered to be a bottleneck. The following bottlenecks do occur, however:

- Lacking numbers and a minimum level of bio-based content makes it difficult to determine what is bio-based and what is not.
- A lack of substantiated descriptions of material properties.
- No mandatory testing of all requirements or testing frequency.

Standards are, of course, merely a means to communicate and set agreements about performance and testing methods, while it is up to the manufacturer to 'prove' that their product fits the purpose. If a standard exists, it can be used; if not, there are various options at the European and national level for substantiating technical performance on the one hand and the continuous quality of the production process and products on the other. It seems that typical manufacturers of bio-based materials:

- lack sufficient awareness of the current framework or have difficulty finding their way around.
- are not very keen on using the current possibilities to substantiate technical performance (because of costs, organisational problems, priorities, etc.).

Together with hundreds of contractors, the French group CODEM (acronym for sustainable construction and eco-material innovation) performed a study into the use of bio-based materials[7]. The five main factors that obstruct the acceptance of bio-based materials are summarised in the following table:

	STAKEHOLDERS	
Obstacles	**Contracting authority**	**Craftsmen and contractors**
Lack of knowledge Lack of training Lack of feedback	'For 45% of companies, the lack of knowledge of biobased materials by project owners is a major obstacle to their use. 'Little appeal for comfort improvement due to hygroscopic characteristics of bio-based materials.	For 1/3 of companies the use of biobased materials causes difficulties (availability, implementation, supply). Recommendations are needed to support sales and implementation. Lack of training.
Regulatory and normative		Prejudices about the risks of fire and mould growth. Advantages of comfort by the hygroscopic behaviour or the phase shift are few included in technical documents.
Structure of the sector		Craftsmen fear difficulties in their supply.
Prices	'Difficulty in reasoning in terms of overall cost (maintenance, upkeep) penalises biobased materials, which have a higher purchase price.	80% of companies estimate an additional cost for the purchase or implementation of biobased materials.
Lack of prescribing		In 74% of cases, the use of biobased materials is the result of a request by the client and not a spontaneous proposal by the companies.

[7]CODEM, Guide de renovation de paroi à l'aide de matériaux bio-sourcés, 2020

Steering for environmental impact: Environmental Product Declarations (EPD)

Legislation and regulations in construction are increasingly based on an Environmental Product Declaration (EPD). These EPDs are made in compliance with the European standard (EN 15804). An EPD is a public summary of a Life Cycle Analysis (LCA) that states the environmental impacts of the materials. One important example of environmental impact is climate change. In addition, EPDs offer insight into production, transport and what happens to the product after the usage phase. EPDs can be found in various (national) databases.

When it comes to LCA analyses, the handling of circular materials and products remains in its infancy. How to deal with the implementation of recycled materials into production? No sound scenarios or default values have been developed as of yet. But for the 'end of lifecycle' as well, it begs the question how the released material is best treated. Currently, it often remains more beneficial to burn the material instead of recycling it. As such, one is still being rewarded to destroy material that would still be usable. That is why there will be a lot of research and potential changes to the calculation method of the LCA in the near future. In addition, the European Committee (EC) is working to make the EPD more transparent for the consumer, beyond construction products alone. To that end, the EC has introduced the Product Environmental Footprint (PEF).

Another problem for scaling the use of mostly bio-based and innovative materials is the fact that only few of these materials and products have been included in the database (B: Totem, F: INIES, NL: NMD and UK: various databases).

This is due to the following reasons:

- Small production companies often tend to prefer putting their investment into marketing rather than an LCA calculation because the money can only be spent once.
- The importance of an LCA calculation is often underestimated. In order to determine the environmental performance of a building (e.g. MPG in the Netherlands), data from national databases is used. An LCA is required in order to be included in that database. If the product is not listed, it is not found and therefore rarely selected.
- Producers often work internationally and are not inclined to invest in national versions (especially in the Netherlands and France, requirements often differ from European standards).

France is expected to catch up due to the RE2020 as the calculation of the CO_2 footprint is based on the LCAs from INIES. The government is also going to encourage the inclusion of LCAs in INIES, for example, by making data in the system available to all companies (CSTB info).

In the Netherlands, the data from the NMD is used in tenders and construction permits. And products included in the NMD also generate fiscal benefits. This encourages companies to make LCAs and EPDs.

Certification

We draw the following conclusions for certification from the literature review:

- Just like with standards, no minimum has been established for bio-based content or for testing all specifications.
- Certificates are granted based on a single assessment or test and are valid indefinitely. It guarantees the production process but does not offer any guarantees for material composition or minimum performance.
- There is no uniform certification system at the EU and national level. A European system of certification deserves recommendation.
- Because certificates are generally quite expensive, certification inhibits innovation and the development of new products. This seems to be a barrier for investment, especially for smaller and new companies. On the other hand, these certifications may stimulate the commercialisation of a product. That is why small companies should receive more financial support in order to execute these tests.
- Products without certification are much more difficult to sell and thus include into selection processes and criteria.
- In order to obtain the necessary proof of the quality and specifications of products, material suppliers must meet specific procurement requirements. Because no standards exist, buyers develop their own set of requirements and assessment criteria, which results in additional tension (and lack of alignment) for both material suppliers and buyers themselves.
- In the Netherlands, certificates remain mostly private initiatives (except KOMO) while in other countries public parties initiate these certificates (which results in a more objective approach).
- At the moment, most manufacturers use standards that are not general and/or not representative for the actual circumstances, e.g. for the assessment of materials based on fungal growth. Most manufacturers use either the ISO 846 (2019) method A, which was intended for plastic, or EN 15101-1 (2019) Annex F standards, created to test loose-fill cellulose. Adequate certification for fungal growth is vital for technical reasons as well as to improve trust in bio-based materials among users.
- No clear standards were chosen to assess the durability of the material. According to manufacturers, the bio-based materials have a minimum lifespan that matches the lifecycle of the building, around 50-60 years. However, the stereotype that bio-based materials are not resistant and

will not last long pertains. To break through these clichés, it is key to establish a series of standards and criteria that can validate the potential of these materials. This list could be drafted based on pre-existing European standards for conventional material, such as dimensional stability (EN 1604), water absorption (EN 1609) or resistance to parallel traction (EN 1608). Other tests, such as those developed by ACERMI in their 'Cahiers du CSTB 2928, 375 (2002)' could act as an example (thickness recovery after compression, thickness loss after water spray). Many different studies by academic and research centres can also act as an example for the creation of adequate standards that would stimulate trust in bio-based materials among users. Long-term studies into bio-based materials in the field must be encouraged to feed the discussion.

Potential actions:

- Allow producers to organise themselves and give rise to an unambiguous offering with a certain quality.
- Equalise testing and certification across borders to ensure that tests within Europe only have to be performed once. For this purpose, align with existing schemes at the national and European level. This will also make the validation of testing methods more efficient and easier.
- Develop frameworks, standards, testing methods or certifications wherever they are missing for circular, bio-based materials and products.
- Encourage and train producers and suppliers to maintain sound technical documentation and monitoring reports of projects executed with bio-based materials. This simplifies communication about the performance of bio-based materials.

Labels

For legislation and regulation, it is good to keep in mind that labels are generally private (and national) initiatives. The success and credibility of a label is mostly the result of marketing efforts and not necessarily a quality guarantee.

Only 'new' products get a label whereas no labels exist for previously used products which are suitable for reuse. This makes it difficult to encourage reuse and inhibits the use and control of (re)use of materials.

In Belgium (Flanders), the Netherlands and England, no independent bio-based label is available. France has the BioSourcé label.

FSC, PEFC, Cradle to Cradle and natureplus have a wide international reach and are considered to be more of a 'standard'. These specific labels find their way into some (public) tender requirements.

An overview of current environmental and bio-based labels with the associated criteria can be found in the practical guide of CBCI.

From the Living Labs

Experiences of KU Leuven

The following technical aspects seem interesting:

- regulations for fire resistance and fire reaction class;
- availability of certification;
- Reuse versus technical performance requirements that change too rapidly.

As stated above, the Living Lab must comply with fire safety and prevention legislation applicable to public buildings. Because the test home is built on the technology campus, it will be used as a public building and thus has to meet applicable regulations. This does not inhibit future reuse.
At the material level, many bio-based products fail to achieve the required fire reaction class which means they cannot be used. The range of applicable bio-based materials with the right fire safety properties was limited, making it more difficult to compete with traditional materials. At the component level, effective fire resistance tests are required that result in certification, allowing for a certain wall, floor or roof constructions to be applied. Because many bio-based construction materials remain in their infancy and fire resistance tests are very expensive, the required certification cannot be obtained for many new materials, although the material could be able to deliver the required performance.

Fire safety and certification in general also affected the team when considering their options for the reuse of input materials. Twenty percent of materials used in the building had to be sourced from recycling streams. For example, for the wooden ring beams in the floor above ground level, the possibility of using reused GLULAM beams was considered. A supplier of beams had been found but the material characteristics of the available materials were not available. As such, the stability engineer had no choice but to make a conservative calculation, assuming the least favourable material characteristics. This naturally resulted in very large beam sections that simply would not fit into the construction. The option of reuse for structural elements was quickly abandoned. As a second option, a batch of wooden façade cladding was considered for reuse. Once again, certification was an issue. The fire reaction class was unknown and so the material could not be used despite the fact that all technical requirements were being met.
A final example demonstrates that legislation changes too quickly at times, in this case it became more strict, thereby eliminating the option of reuse. This was the case for the roof windows in the building. A supplier of refurbished Velux roof windows was found in the Netherlands. Fitting windows were found, including screens and ventilation grilles. However, dynamic ventilation grilles were needed to comply with BEN legislation (Almost-Energy-Neutral) for homes. Those have only recently entered the market, in 2016. As such, the maximum age of the Velux windows is five years. If legislation becomes increasingly strict, products that remain in a perfect state but no longer meet the renewed legislation, cannot be used.

Conclusions and recommendations

Policy
- Europe has a guiding role from a climate perspective, but often remains unknown at the national level.
- Better alignment between European policy and national and regional legislation and regulation is required. This missing alignment causes the development and policy framework for steering and enforcement to stagnate.
- Good alignment between national and regional legislation and regulations is needed to (1) better organise spatial functions in relation to material, product and component flows, and (2) for uniform preconditions regarding the (re) use of materials, products and building components.
- Regional developments in policy must stimulate the circular and bio-based economy.

Legislation and regulations
- Legislation and regulations do not, in fact, pose any barriers.
- Legislation and regulations can, however, stimulate the evolution towards a circular construction economy. Investors are very sensitive to it which encourages producers and builders to adopt circular construction. Creation of a profitable business model for companies.
- European legislation and regulations are leading; countries adopt them to varying degrees but eventually it does happen.
- Flexible and circular use of buildings, components, products and materials requires legislation and regulations that facilitate change rather than stopping it. Monitoring with tracking and tracing of functions and functionalities in relation to location and time is key in this regard.

Reuse
- Waste legislation inhibits future reuse. Legislation needs to be adapted to the circular economy and equalised across borders.
- Quality guarantees are yet to be developed, equivalence statements can offer a solution.
- Ownership as a service is a means rather than an end when it comes to circularity and change of function of a building, component or product. It is about how the service is organised in relation to quality and time in terms of circularity and change of function.
- Ownership as a service, e.g. ‘façade as a service’, is legally possible already but its application is limited by a lack of suitable financial services.

Definitions
- The lack of a fixed definition and framework poses an obstacle.
- However, a project always leaves ‘room’ for circularity to be implemented. In a transition where much is unknown and uncertain, practical experiences form an important part of the final definitions.

Technical specifications
- Standards are necessary as a reference for scaling. This requires broad awareness of the standards with the same preconditions and characteristics in all countries. It is important to validate continuity of performance in relation to time and to look closely at the relationship between use and required characteristics. Viewing testing methods from the circular, bio-based perspective.
- Environmental declarations promote communication and transparency about the environmental impact of materials, products and building components. To make this method of communication work for entrants to the mainstream market, it is important to fund research to substantiate an EPD (Environmental Product Declaration) in the transition phase.
- Labels help policy makers but tend not to be assessed and validated neutrally and centrally. As such, they do not automatically offer a quality guarantee. In addition, labels aimed at new products inhibit reuse of existing products.

Certificates
- It is important to facilitate certification in order to have a certificate available for a larger group of new, circular and bio-based products.

Reflection legislation, regulations and CBCI

In conclusion, we reflect on this white paper from two perspectives:
- In relation to the characteristics of circularity and legislation and regulations: what aspects are missing in the understanding of the transition to a circular built environment?
- In relation to the above: what is a potential approach for developing future legislation and regulations?

As indicated in table 1, circularity is determined by differences in:
- Scale levels From regions, cities, districts, building, component and product to material.
- Material streams Acquisition and cultivation, processing, production, transport, implementation, use, reuse and administration.
- Functionalities Related to material and scale levels, in application and use and change of application and use relative to use and lifecycles.
- Stakeholders Legislators, principals, designers, producers, experts, consumers, etc.

In relation to the characteristics of circularity and legislation and regulations: what aspects are missing in the understanding of the transition to a circular built environment?

Looking at various types of legislation and regulations and various abstraction levels, we see the following:

THEME 1
Stimulating or regulating impact monitoring

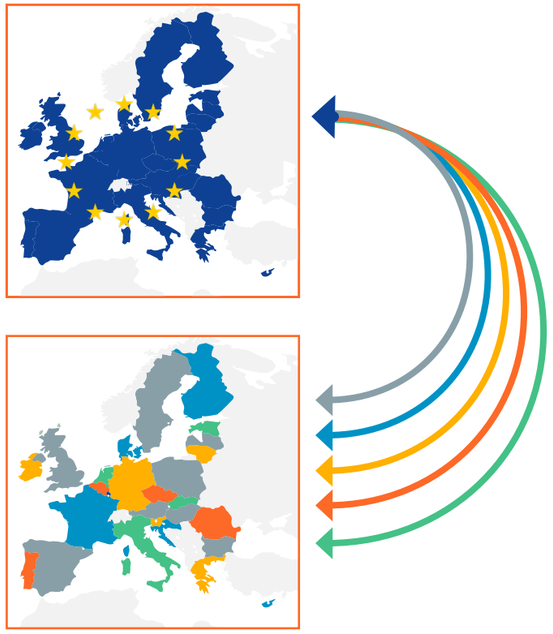
Legislation and regulations give a lot of attention to stimulating circularity and the application of bio-based materials. This translates into ambitions, funds, green deals, subsidies and financing in part. In addition to investments into the former, we see an ambitious focus on legislation at the European level as well[8]. To a lesser degree, European legislation exists with respect to CO_2-neutral construction, definitions and standards alignment and waste tax. This must be translated into national legislation and regulations within the 2Seas regions.

This makes a case for:
1) Monitoring whether national legislation and regulations bear the intended effect.

The European Green Deal does not always fit within existing legislation and regulations of member states. Monitoring will allow for bottlenecks to be mapped so that legislation and regulations can be adapted accordingly.

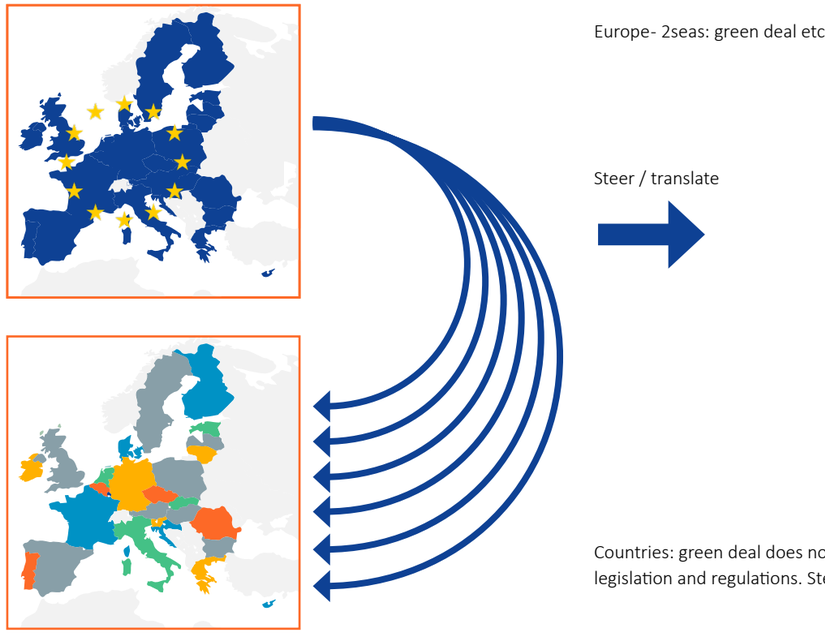
2) Steering more explicitly towards the linking and translation of European and national legislation and regulations.

Theme 1, is circularity achievable?



1) monitoring the effect of stimulation on national legislation and regulations

Theme 1, is circularity achievable?



2) more explicit emphasis on the linking/translating of European and national legislation and regulations.

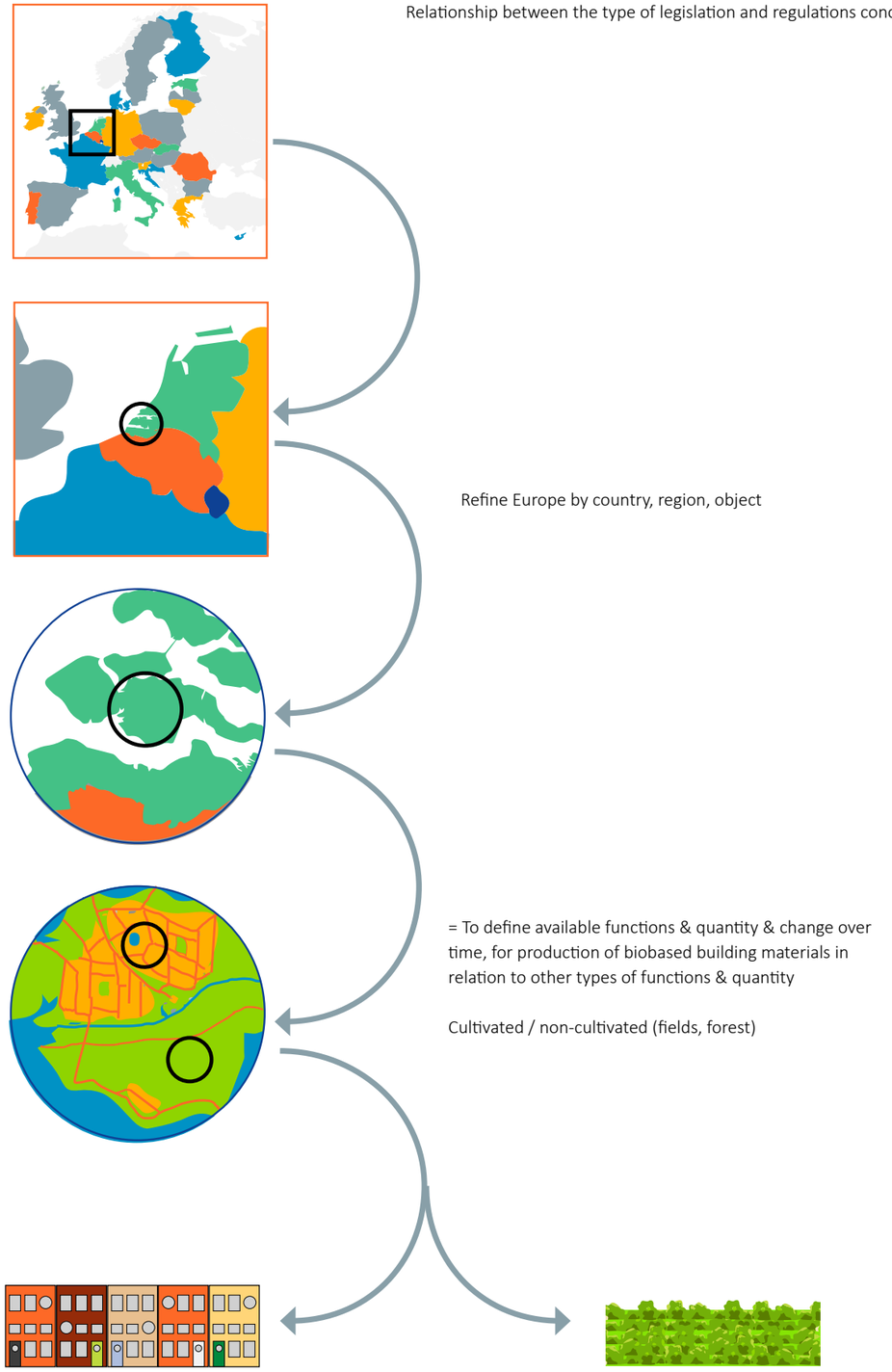
[8]Climate Law

THEME 2
Necessity for alignment between European regions

Looking at the cross-regional impact of circularity, two important aspects catch the eye.
Of all materials being used, around 60% is used in the built environment[9]. Considering the size of the material streams and the shift towards the use of more bio-based materials, alignment is necessary when it comes to assigning land with respect to the various functions: residential, work, recreation, agriculture. Agricultural land gains a new function: growing construction materials in addition to food cultivation and livestock farming. This demands legislation and regulations with regards to forestation and cultivation and reforestation/ recovery conditions in relation to the quality of spatial planning and biodiversity in the specific (geographic and cultural) context. Which, in turn, demands agreements about the redistribution of spatial functionalities and spatial planning in all its aspects (including ownership, financing, valuation), not just at the national level (with exchange between regions) but especially within Europe. France has a lot more agricultural land available than Flanders and the Netherlands, for example, especially relative to the population and need for construction material. Another important aspect involves legislation pertaining to the availability and exchange of renewable materials and reused materials, products and components and/ or buildings. Exchange between shrinking and growing regions can provide a closed cycle (balanced). Another implication is that alignment at the European and national level directly affects the preconditions in terms of spatial planning at the city and district level, including the translation to zoning plans, permits, material passports, certification and standards.

This makes a case for an explicit alignment of legislation and regulations between the European regions in terms of:

Spatial planning: establishing what parts of the country are suitable (type, quality, surface area, percentage and geographic location) and available for the production of bio-based (construction) materials in relation to: 1) the other necessary parts of the country for other functions (living, working, agriculture and horticulture, recreation, etc.) and 2) the possibilities with regards to changing these functions.



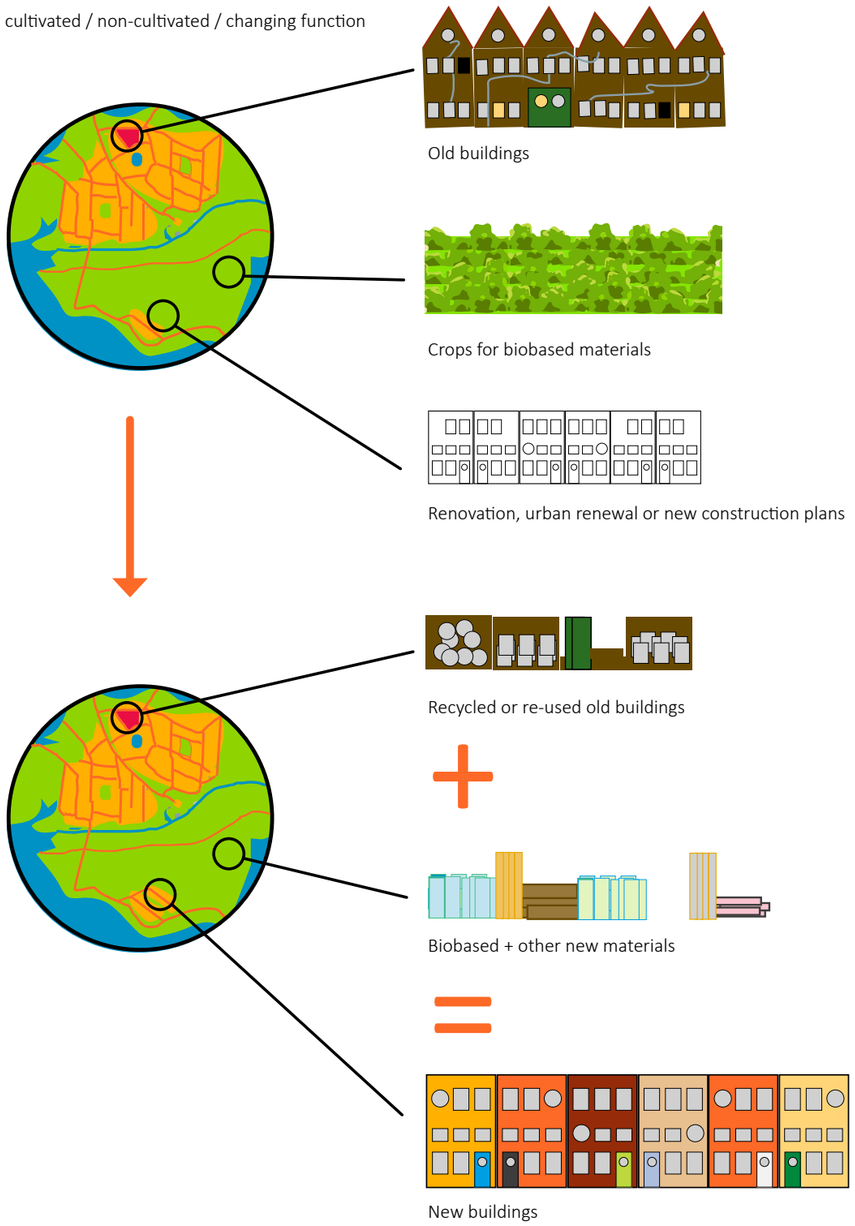
[9]Ohl et al. 2008; Wackernagel & Rees 1996

Material flows (establishing the available quantity, type and quality of the supply (materials, products, components)) for bio-based (construction) materials, in relation to: 1) the demand (quantity, type and quality), and 2) the location and duration of use in both situations (supply and demand).

Theme 2

The recording of available functions & quantity & change over time for the production of biobased building materials in relation to other types of functions & quantity & change over time

cultivated / non-cultivated / changing function



THEME 3
djustment in relation to change of function and flexibility

An important aspect is the legislation and regulations with regards to change of function at the city and building level through the component, product and material level. After all, an entirely circular situation allows for parts of cities or entire or parts of buildings to change function and location over time. This means that legislation and regulations do not need to facilitate, guarantee and organise the static or real estate situation but rather that legislation and regulations are required for dynamic or moveable assets in the built environment. This development has not or barely materialised. Examples of flexible housing to learn from are portocabins, containers, trailers and tents. This different approach also touches legislation and regulations pertaining to, for example, ownership, assets and tax, and applies to the component and product level such as, for example, construction elements (prefab columns, beams), façades (prefab window frames, cladding, etc.), installations (heat pumps, solar panels, installation boxes, etc.). Interchangeability of these components also demands a different type of sometimes more flexible legislation and regulations regarding certification, equivalence, ownership, etc.

This makes a case for a reconsideration of especially zoning plans and building decrees, construction permits and certifications in relation to change of function at the area, building and component level.

What is a potential approach for developing future legislation and regulations?
A potential approach is determined by the insight that the future cannot be predicted but that functions and functionalities will change. If we want to be as prudent as possible with what we design and build- as sustainably as possible with as little waste as possible and as much reuse as possible- then we will have to facilitate change of functions and functionalities. Legislation and regulations will not, as is currently often the case, be geared towards facilitating the stable situation (functions and functionalities) but rather changes in the situation (functions and functionalities).

John Habraken developed this perspective back in the 60s and 70s in view of Open Building. He linked the organisation of and decision making around the physical (building) elements to the organisation of the process and the parties (designing and executing decision making about the use of the various scale levels such that elements of region or city – depending on their service lifespan – can be replaced and/or reused) (1). This was elaborated on by Stewart Brand in the 80s/90s[10] and linked, among other things, to the service and lifecycles (designing and building in such a way that the various scale levels or elements of a building – depending on their service lifespan – can be replaced and/or reused) (2). The third step in this development is that of Industrial Flexible Dismountable Construction[11], Smart Construction[12] and Design for Disassembly[13] of the 90s/00s, where scaling is linked to the circular aspects of physical and organisational flexibility (3).

For the framework of legislation and regulations, it would be interesting to combine the scale levels of Brand's Layers (Figure 2, Brand 1994) and the organisability in Open Construction (Figure 1. Habraken 1961 – see reference list) at the regional, city and building level. A third aspect is who or what organisation is required for the type of adaptability and flexibility (Figure 3). Next, we can look at the required type of legislation and regulations in relation to the necessity and urgency of adaptation – flexibility required to facilitate the change in functionalities

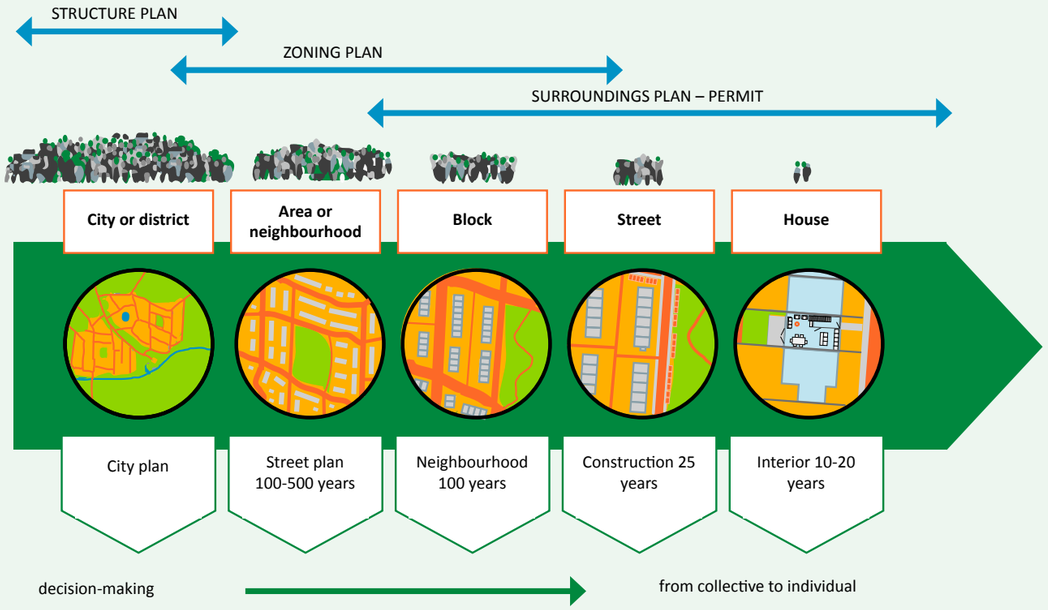


Figure 1: organisation of decision-making in relation to the organisation of scale levels- derived from J. Habraken (1961)

[10]Brand 1994
[11]Brand et al. 1999, Vos 2007
[12]Lichtenberg 2005
[13] Durmicevic 2006

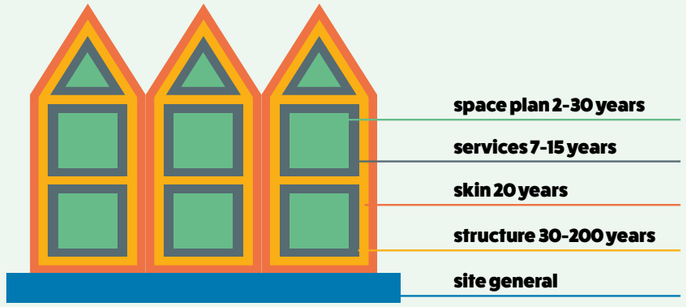


Figure 2: organisation of technical systems of a building in relation to the lifespan of those systems – derived from S. Brand (1994)

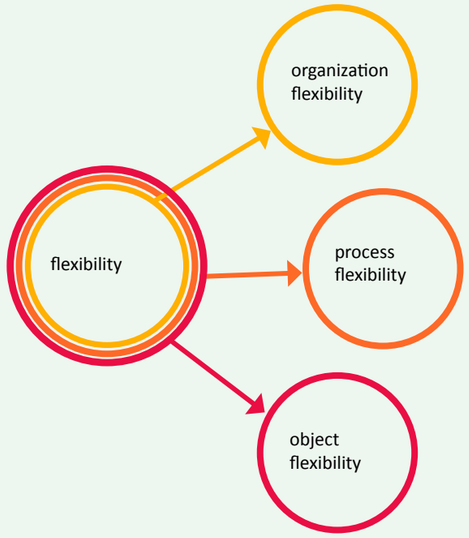


Figure 3: organisation of the flexibility type – derived from Geraerds 1996

Step 1 is to determine what existing legislation and regulations are effective and necessary at what scale level in order to achieve the goal: the way it is now (a), how to change it in steps (b) and then to adjust (c). It will sometimes turn out that certain legislation and regulations are not necessary or can be taken care of at a later stage or at a lower abstraction level. Both the Habraken and Brand models connect the factor of time to the type of scale level and the lifespan and service lifespan, from the city and district level (100-300 years) to the structure of a building (30-300 years) and interior (1 day - 1 month). It is interesting to see at what scale level certain regulations are or are not necessary to organise the change of function. It will sometimes turn out that certain legislation and regulations are not necessary or at a later stage, e.g. by organising matters at a small scale level. On the other hand, the establishment of preconditions in zoning plans or at the structure level is highly effective to organise circularity at the regional level where it is all about an integral approach of building-related aspects, spatial planning, material streams, biodiversity, etc, as stated under the first aspect in this reflection.

At the building level, the possibility of a change of function is important in terms of regulations, as is the reuse of both the spatial aspects (change of function on site, change of location of the function) and the material aspects (change of function and/or change of location of the main supporting structure, façade and roof, installations, etc.). Regulation in relation to the aspects and criteria of traceability and the recording of properties, safety and health in relation to the time factor are also of importance.

The third aspect flexibility has three different types: 1) organisational flexibility; 2) process flexibility; and 3) object flexibility

- Organisational flexibility is the degree to which an organisation is able to adequately respond to the environmental requirements. This type of flexibility may pertain to both the organisation of the client/user and the constructing organisation[14]. In addition, there is an external influence on flexibility – preconditional flexibility. This is flexibility in relation to legislation and regulations and comes from organisations that are involved and/or responsible for the public preconditions, e.g. health, safety and the environment.
- Process flexibility refers to flexibility in the decision-making process. For example, the decision-making process that plays out within organisations and pertains to the primary production process or the core business. Process flexibility also pertains to
- the development process of buildings.. From initiative and design to execution and administration[15]. Process flexibility comes in many forms, each relating to legislation and regulations in a different way:
    - Programme flexibility: The room in the programme for adjustment of the plan to developments that arise during preparation.
    - Approval flexibility: The room in the system of government approval for adjustment of the plan to developments that arise during preparation.
    - Design flexibility: Keeping possibilities open as much as possible for further elaboration of the plan through an adjusted and phased decision-making structure.
    - Realisation flexibility: The ability to adjust the setup during the actual realisation of the building to arising developments.
    - Execution flexibility: A certain degree of room for the executing companies with regards to the execution method, including the choice of materials and products.
    - User flexibility: The ability to adjust the way in which the building is used to arising developments during the administration phase;
- Object flexibility is changeability of and/or by the product. If the hospital is considered as the product, object flexibility is the changeability of the building itself during its realisation and after delivery[16], both architecturally and in terms of installation engineering at the building or construction component level[17]. According to Geraedts (1996), the following four flexibility types are part of the spatial element:
    - Flexibility of use is the ability to use rooms for other functions. Certain rooms can be designed and set up such that they can be used for various functions or in various ways.
    - Layout flexibility or parcelling flexibility is the ability to change the spatial layout inside a building. Anything covered by the term ‘renovation’ will be easier as more layout flexibility exists.
    - Extension flexibility makes it possible to add rooms in suitable locations. This is often referred to as external flexibility. Extension flexibility offers the best possibilities in situations where existing functions are added to or entirely new functions are added.
    - Elimination flexibility: When certain functions are toned down or terminated, it is recommended to be able to materially eliminate the spaces or (installation) functions. This avoids partial vacancy and loss of capital. It must be possible to eliminate functions without severe interventions to the entire building.

[14]Volberda, 2008
[15]Geraedts, 1996
[16]Stienstra, 2004
[17]Geraedts, 2001

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