BAMB
BUILDINGS AS MATERIAL BANKS

FRAMEWORK FOR POLICIES, REGULATIONS AND STANDARDS

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Vision without action is merely a dream. Action without vision just passes the time. Vision with action can change the world.

Joel A. Barker

1 INTRODUCTION

BAMB´s mission is to enable the shift to a circular building sector, thereby reducing waste, retaining value for materials in the system and slowing down the use of resources to a rate that meets the capacity of the planet. The EU, as well as many national, regional and local governments, see the advantages and need for a circular economy and understand that the environmental and financial gains associated with a circular economy are in the best interest of society.

Policies, standards and regulations will have a crucial impact on the applicability of dynamic and circular building design. For example, in terms of circular business model development, such instruments all have a bearing on value creation. Governments and regulators have the potential to be influencing forces in all phases of a building's lifecycle. In addition, public authorities can take a key role as early adopters and leaders in embedding and normalising circularity.

Circular built environment: a built environment designed according to Reversible Building principles, is with a design and construction strategy that has the ambition to realise buildings whose parts follow material loops and facilitate building alterations and support changing user needs.

Emphasising the ability of buildings and their components to return to an earlier state, this strategy strives for high resource productivity.

It includes a spatial dimension, in which a building can be efficiently refurbished, as well as a technical dimension, wherein a building's components can be disassembled and used again or deconstructed and recycled or biodegraded.

The transition to a dynamic and circular built environment[1] requires both action and vision. This transition will need systemic changes, boosting opportunities and eliminating barriers, going beyond technical innovation. The Framework for

[1] https://www.bamb2020.eu/topics/common-language/reversible-building-building-design/

Policies, Regulations and Standards provides a roadmap for changes which will allow the transformation of the industry to circular principles, through a set of recommendations to guide policy-makers.

Circular value network: The circular value network of a building is the set of interrelated activities performed by companies of a specific industry to maintain or increase the social, financial or environmental value of that building and its parts.

Throughout the BAMB project, the impact of current policies, standards and legislation on the implementation of circular and dynamic buildings has been considered and analysed. The Framework for Policies, Regulations and Standards is the culmination of a series of tasks under the heading *Standards and Regulations for reverse logistics and circular value chains in buildings*, as well as work carried out in the development of the State of the Art report on Policies and Regulations, which provided an analysis of current policies and regulations related to the circular built environment. Research has been undertaken at different policy levels (from EU, through national and subnational, to local) and for different links in the circular value network[2], and the results have been collated and analysed. This work, along with interactions with different stakeholders and policy platforms, has led to the development of this Framework for Policies, Standards and Regulations, which contains recommendations for the future development of policies, standards and legislation that will better favour the applicability of dynamic and circular building design.
Following the introduction, the methodology for developing the Framework is presented, explaining the tasks which have contributed to the understanding of current policy instruments. This is followed by four sections which summarise and develop conclusions based on work carried out during the course of the project in the following areas:

- State of the Art – a review of current policies and regulations at the EU level, at the national level in Sweden, Belgium, Portugal and the UK, and at sub-national level in Ronneby Municipality (Sweden), the Brussels Capital Region and the Flemish Region (Belgium).
- Interactions with other platforms and policy bodies – the project has collaborated and participated in events with many platforms and policy bodies throughout the duration of the project. Intelligence on policy and regulation gained during these interactions has been captured to form part of the framework and its recommendations.
- Impact Assessments – in-depth analyses of five current or past policies/ regulations to identify success factors and barriers to the uptake of circular building principles. Policies examined were at the national or sub-national level:
    - the Swedish Environmental Objectives (1999, 2009),
    - the Site Waste Management Plan Regulations (2008) in the UK, which have now been repealed,

[2] https://www.bamb2020.eu/topics/common-language/circular-value-network/

- the circular economy programme adopted in the Brussels region of Belgium - Programme Régional en Economie Circulaire (PREC) (2016-2020),
- Tracimat (2018), a demolition inventory system for certifying the quality of construction and demolition waste in the Flanders Region of Belgium,
- Incorporação de 5% de materials reciclados (2011), a procurement tool requiring a percentage of recycled materials to be used in the construction of public buildings in Portugal.

- Best Practices – a review of a range of (often emerging) mechanisms considered to have direct relevance to the desired BAMB Systemic Changes, to be innovative and to promote a change towards Circular Economy thinking. Best practices were drawn from around the world and included the Act for the Promotion of Long Life Quality Housing (2009) in Japan, Be.Circular (PREC) in the Brussels region of Belgium and the Public Procurement Rules of the Rijkwaterstaat (the Ministry of Infrastructure and Water Management) in the Netherlands.

The final section brings together the conclusions drawn from the four areas above and provides a set of recommendations for the future development of policies, standards and regulations which will better favour the applicability of dynamic and circular building design.

2 METHODOLOGY

The research in policies, standards and regulations was divided into four sections (see Section 1):

- State of the Art,
- Interactions with EU and other platforms,
- Impact assessments
- Best practices.

These four areas were selected to provide a breadth and depth of research to identify a range of success factors, as well as barriers and opportunities, from current policies, standards and regulations (see Figure 1 below). Additionally, the best practices would allow new or developing trends to be uncovered.

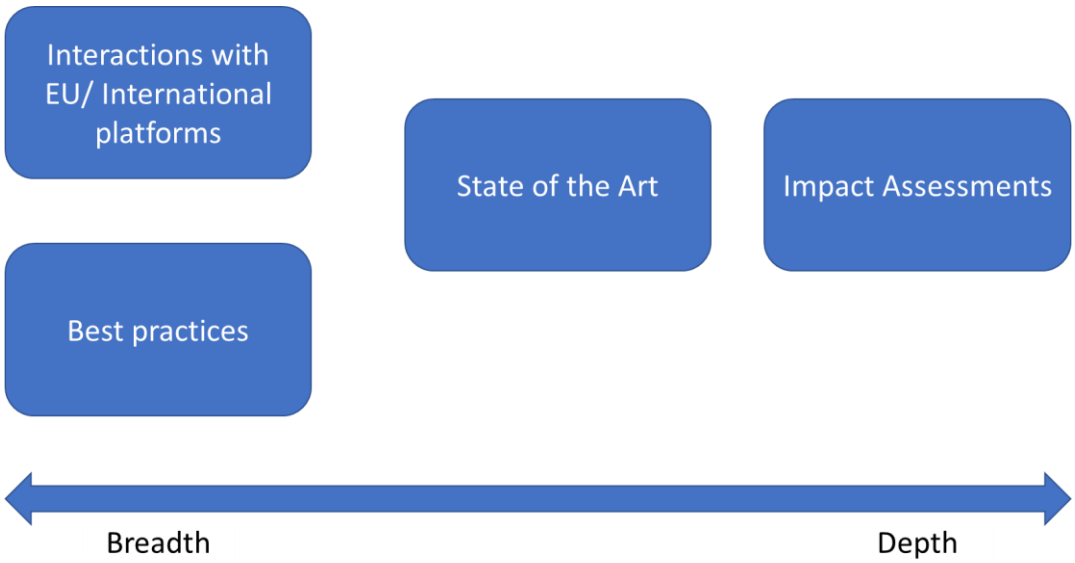

Figure 1: The approach to ensuring breadth and depth of research for the framework

To allow effective analysis of the various policy instruments, it was first necessary to narrow the geographical scope to be investigated through the State of the Art and Impact Assessments. This was necessary to take account of language barriers and knowledge of the policy structures in place in the countries to be selected. In addition to broadly applicable EU level regulations, four countries were identified based on pilot locations and the geographical activity of the involved BAMB partners in order to sufficiently narrow the scope for an in-depth analysis at the local and national levels, and to take account of language barriers for analysis.

The geographical limitation is shown in Figure 2 below:

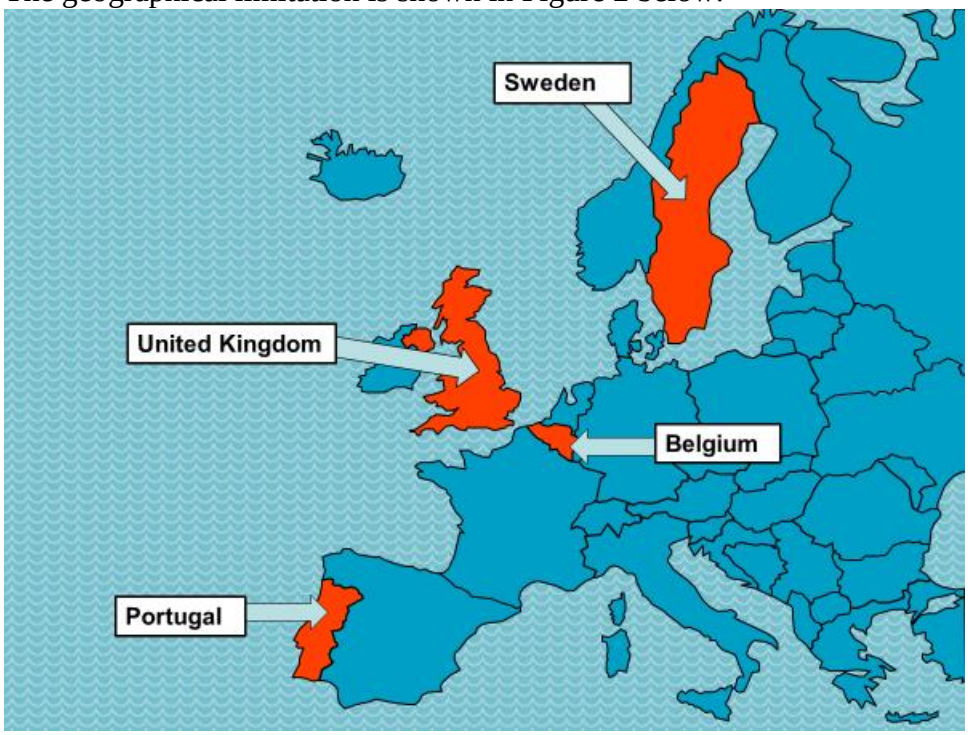

Figure 2: The geographical limitation for the State of the Art and Impact Assessments

For interactions with EU and international platforms, and for the gathering and analysis of best practices, no geographical limitations were set.

State of the Art

The State of the Art chapter presented in Section 3 summarises and updates the policy content of the full State of the Art report (D1), published by the BAMB consortium in 2017.

The State of the Art report collated information on all relevant current policies, standards and regulations in the European Union, Belgium, Portugal, Sweden and the United Kingdom. In addition, policies and regulations at sub-national level in Ronneby Municipality (Sweden) and the Brussels Capital Region and Flemish Region (Belgium) were considered. The policies were then analysed for the potential opportunities and barriers to dynamic and circular building design.

For this Framework, the full State of the Art report was reviewed to identify any significant changes or new polices arising since the report was submitted. It was then further analysed to provide a synthesis of the current status, to identify opportunities and to provide recommendations for existing and future policies.

Review of collaborations with EU and international platforms

Throughout the BAMB project, the consortium has established and maintained links with a number of platforms, both European and international, related to the built environment sector and/ or aligned to circular economy principles.

For the development of Section 4, all collaborations were collated and summarised. They were then analysed to identify the lessons learned and to draw conclusions on policy instruments and opportunities and current direction of travel related to circular and dynamic building design.

Impact Assessments

Five policies were selected for a detailed impact assessment (IA) to provide insight into the design of policies and standards and to allow the identification of success factors (and barriers) to successful policy design and implementation which could be harnessed to support the implementation of the BAMB vision. Policies were chosen from the long list developed from the State of the Art report, having been prioritised according to a set of selection criteria. The full methodology for selection is give in Section 5.

The five policies represent a range of policy and regulation mechanisms: national framework, procurement legislation, industry regulation, sub-national programme and sub-national industry certification system. All were chosen for their applicability to the BAMB vision and to the built environment.

The detailed IA for each policy was summarised in Section 5, barriers and opportunities for the move to a dynamic and circular built environment were identified. The full impact assessments are provided in Appendix A.

Best practices

Throughout the project, BAMB partners have gathered examples of best practice from around the world which illustrate behaviours and mechanisms which would support the move to a dynamic and circular built environment. These were collated and scored against a set of criteria to identify those which would be further researched and included in this paper. (A detailed methodology is provided in Section 6).

The 16 selected best practices were analysed in detail to provide a detailed assessment of their alignment to BAMB systemic changes, their circular economy impact and their level of innovation. A summary of each of the best practices is provided in Section 6, along with recommendations for adoption or adaption.

The role of the Special Interest Group

A stakeholder network has been developed alongside the project to disseminate information from the project and to enable collaborative work with interested parties. Members are drawn from across the built environment industry area, as well as policy and research. Within the stakeholder network, the Special Interest Group (SIG) on Policies and Standards has over 240 members from 28 countries. The most represented countries are the UK, Belgium and the Netherlands.

Members of the SIG have participated in discussions on policy, standards and regulation throughout the project and have proved a valuable source of expertise and information, providing feedback on research into policy and regulation and examples of best practice.

The Framework report

The broad range of research and analysis carried out in the field of policy and regulation has been brought together in this Framework report. The Framework identifies success factors for policy and regulation which have the potential to overcome existing barriers, and exploiting emerging opportunities, as well as highlighting current regulations and policies which could support the transformation to dynamic and circular building design. In addition, gaps in policy have been identified and recommendations developed for future polices and regulations to facilitate the transition towards a circular built environment.

3 REVIEW OF STATE-OF-THE-ART ON POLICIES AND STANDARDS

3.1 Methodology

This state-of-the-art analysis has the objective to provide an overview of the current policy instruments that are considered to have relevance in relation to promoting, or possibly hindering, the adoption of circular economy opportunities in the built environment. The analysis has been done on the European level, as well as on the national level for 4 Member States (Belgium, Portugal, Sweden and UK) and 3 sub-national entities (Ronneby Municipality; Brussels Capital Region and Flemish Region). The geographic scope has been defined based on geographic dispersal, as well as the access to information (including linguistic barriers) – and thus limited to the partner countries of the BAMB project.

A policy matrix has been developed to identify the different types of existing policy mechanisms and legislation (legal instruments, financial instruments, public investment, raising awareness) for different policy levels (EU, national, sub-national) across the value chain. This matrix has enabled mapping the existing policies linked to circular and dynamic building and further refining the scope.

Based on the mapping of existing policies, a State-of-the-art Report on Policies and Standards was drafted at the end of 2016, paying attention to summarize identified policies and instruments' content, as well as the opportunities and barriers that they present for the adoption of the BAMB tools and the shift to a circular building sector.

To get broader feedback on the initial conclusions and trends illustrated within the 2016 report, a workshop was conducted in January 2017 with the BAMB Stakeholder Network Special Interest Group on Policies and Standards. Information was also exchanged with the European Regional Development Fund (ERDF) project "Le Bâti Bruxellois, Source de nouveaux Matériaux"[3] (BBSM) research team with regards to the investigated policies and standards, in order to guarantee complementarity of the research and avoid duplication.

Since January 2017, some policies related to the built environment and/or circular economy have been evolving and new policy instruments and standards have been introduced. Below is a list of the most relevant policy developments and updates identified:

- The revised *Waste Framework Directive* (2018/2008/98/EC) clarifies the definition and use of construction and demolition waste for back filling, as well as increasing the focus on waste prevention.

[3] https://www.bbsm.brussels/en/home/

- The *EU Construction and Demolition Waste Protocol and Guidelines* has been launched with the overall aim to increase confidence in the construction and demolition waste management process and the trust in the quality of construction and demolition recycled materials.
- The communication from the European Commission on *Resource efficient opportunities in the building sector* has led to the development of *Level(s)*, a voluntary reporting framework to improve the sustainability of buildings and a transition towards a circular economy within the building sector.
- An ISO Standard "*ISO / CD 20887 Design for Disassembly and Adaptability of Buildings*" is under development.
- The European Commission's communication on *The implementation of the circular economy package: options to address the interface between chemical, product and waste legislation* explores the four most critical issues identified in the way the legislation on chemicals, products and waste work together and how these are hampering the development of a circular economy.
- The Brussels-Capital Region drafted a strategy for reducing the environmental impact of existing buildings by supporting the energy efficient and sustainable refurbishment of the Region's building stock.
- Within the Flemish regulation VLAREMA, a new acceptance and processing policy for producers of recycled aggregates came into force in August 2018. From this point, all producers of recycled aggregates shall differentiate between materials with high and low environmental risk.

The conclusions and recommendations presented in this chapter build on the State-of-the-Art analysis, while considering these new developments. In addition, though extending beyond the defined geographical scope, findings from the BAMB pilot projects have been a source of input.

3.2 Conclusions

Energy performance

From the different policy instruments relevant to promoting, or possibly hindering, the adoption of circular economy opportunities in the built environment, the binding legislations mainly focus on energy performance and construction and demolition waste management.

This results from the transposition by Member States of the requirements of the revised *Energy Performance of Buildings Directive* (2010/31/EU) into their legislation. The effective level of requirements depends on the Member State and the (sub-) national context.

Even within sustainable building and circular economy policy instruments, energy remains a key focus point. For example, the *Flagship Initiative 4: "Resource Efficient Europe,"* of the EC's *Europe 202010-year Strategy*, supports the shift towards a low carbon economy,

increasing the use of renewable energy sources, modernizing the EU's transport sector and promoting energy efficiency.

Waste and materials

As with energy, waste regulation results from the transposition of the requirements of the *Waste Framework Directive* (2018/2008/98/EC) by Member States at the national and sub-national level. While the Scottish government, for example, has developed a Zero Waste Plan, and the Flemish government has set up a Regulation on recycled aggregates, Portuguese waste management is not yet defined and implemented as in other EU countries.

Although in the last revision of the *Waste Framework Directive* more emphasis is put on waste prevention, the major focus of current initiatives remains on waste management, recycling and improving the uptake of secondary raw materials. This is amongst other things supported by the *EU Construction and Demolition Waste Protocol and Guidelines*, *EU guidelines for the waste audits before the demolition and renovation works of buildings*, and the objectives of the *European Innovation Partnership on Raw Materials*.

Hazardous materials

The use of substances in construction products which have a negative impact on human health and/or the environment might not only have a negative impact through their 1st life-cycle but will also hamper their future reuse and high quality recycling. The regulation concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) aims to ensure a high level of protection for human health and the environment.

Furthermore, the European Commission's communication on *The implementation of the circular economy package: options to address the interface between chemical, product and waste legislation* aims to prevent hazardous chemicals from entering the material cycle as well as staying in the material cycle through recycling.

In addition, a transparent communication on the content declaration as well as the use of Materials Passport would support the identification of potential hazardous substances in the future for which no clear information is available today. This will facilitate the identification and decision making for safe reuse and recovery in the future.

Voluntary instruments

Policy instruments aiming to promote waste prevention and reuse – meeting the circular economy objectives such as 'designing out waste and pollution' and 'keeping products and materials in use at their highest utility and value at all times' –are mostly voluntary.

Similarly, most policy instruments supporting sustainable building design and construction, comprising building materials' (environmental) assessment, are voluntary instruments. For a long time, these instruments have been developed at national or sub-national level. Private certification schemes have also demonstrated having a positive impact on sustainable building design. Based on this positive impact and as a result of the *Communication from the Commission to the European Parliament, the Council, the European Economic and Social*

Committee and the Committee of the Regions on Resource efficiency opportunities in the building sector, a voluntary reporting framework to improve the sustainability of buildings has been developed at the European level: Level(s). Using existing standards, this voluntary framework provides a common EU approach to the assessment of the environmental performance in the built environment based on life-cycle thinking and a circular economy approach.

Complex supply chain

The building sector is characterized by a complex and multi-disciplinary supply chain, which is reflected by the wide range of policies impacting it. It is important to assess the impact of (future) policies on the different links of the value network. The *Construction Products Regulations* e.g. offers a common language and harmonized rules that could allow for reprocessed, recycled and reused materials to be widely exchanged by providing confidence in their performance and quality. However, obliging the CE marking for all reclaimed construction products could, depending on the type of construction product, have a contradictory effect and even distort existing second-hand markets, as a result of the complexity of the process and the resulting cost. It is therefore crucial to systematically investigate the potential barriers and opportunities for the different links of the value network.

3.2.1 Barriers

The current complexity of legislative frameworks, and the fragmentation of policies over the different policy levels, may lead to a lack of integration of the different policies and in some cases could result in contradicting policy mechanisms.

It could be argued that a key barrier comes from energy efficiency policies across Europe. The prioritization of energy efficiency and the high energy performance of buildings may unintentionally result in building designs and materials which do not lend themselves to deconstruction and reuse. It is not the high performance itself that could hamper the adoption of dynamic and circular building design, but the choice of construction techniques and materials to achieve the required performance. For example, in seeking to create an airtight connection between building elements to improve energy efficiency, connecting materials may be used which make it difficult to deconstruct and reuse the parts. The BAMB Reversible Building Design work package has developed a Reversible Building Design Protocol including connections to enable resource efficient repair, re-use and recovery of building materials, products and components such as floors, windows, ventilation systems and internal walls.

Furthermore, the definitions provided by the *EU Waste Framework* seem to lack clarity. As a result, high recovery rates recorded in many countries may correspond to down cycling of stony fraction used for road foundation, which is far from the objective and strategy of buildings as material banks as understood within BAMB.

An additional barrier can be seen in the fact that until recently many of the existing policies and instruments have been developed from a linear viewpoint, which does not take into consideration the potential reality of a circular built environment. For example, current urban regulations and building permits are based on a linear and static vision of buildings which

may impede changes and transformations supported by reversible design and materials recovery. This was illustrated in the BAMB pilot in Brussels, the Circular Retrofit Lab, which experienced difficulties when applying for a building permit. All changes to the building are required to pass through a separate permit procedure, each taking up to nine months, as current permit rules do not allow for reversibility and adaptation.

Similarly, some financial incentives require complete ownership of buildings, which may be contradictory to new business plans and ownership models within a circular built environment. Moreover, the implementation of new circular business models such as 'products as a service' are hampered by the lack of clarity regarding legal and judicial aspects and the responsibilities and liabilities that are related to these new ways of working.

Although a life-cycle approach is recognised more and more as being essential to support the transition towards a circular economy, currently used life-cycle assessment methods within the European built environment, such as prescribed by the CEN TC 350 and PEF, are still based on a linear vision. Both methods consider potential (net) environmental benefits or impacts resulting from recycling, energy recover and reuse of building products. However, there is a lack of methodological support regarding the assessment of buildings that are designed to be transformed easily and building components that have the potential to be used again multiple times in the same building or other applications. Further in this section, we give some insights how the BAMB project explored the refinement of the LCA methodology, to tackle these methodological issues.

At the moment of writing this report, the standard EN15804 (building product level) is still under amendment process and plans are undertaken to revise the standard EN15978 (building level). For both standards the alignment with the PEF methodology has been demanded by DG Environment. However, there is still no consensus on how to tackle the end-of-life allocation issue, as CEN TC 350 and PEF methodologies differ greatly on that point. The current CEN TC 350 standards incorporate a cut-off approach moving potential benefits related to (multiple) reuse outside of the system boundaries. Within the PEF approach the system is expanded to incorporate future benefits related to reuse (of a product) but, this is more labour intensive regarding data inventory, and lack clear guidelines on building level.

The lack of companies and stakeholders' knowledge and awareness has also been identified as an important issue with regards to the implementation of effective resource and waste management, as well as the adoption and use of Materials Passports and Reversible Building Design tools.

3.2.2 Opportunities

Although the lack of clear definitions is seen as a potential barrier, the EU Waste Directive also offers an opportunity to support the transition towards a circular building economy. The Directive introduces the "polluter pays principle" leading to Landfill Taxes in several countries. The increasing cost of landfill provides an economic driver for alternative solutions, such as reversible building design, which avoid end-of-life waste. Furthermore, the *Waste Framework Directive* (2015/2012/2008/98/EC) has been revised in 2018, increasing

the focus on waste prevention and minimum requirements for Extended Product Responsibility (EPR). The revised document promotes repair and reuse and a transition towards sustainable production and consumption models. Further clarification of the current definitions, as well as the definition of clear reuse targets, could help to increase the quality level of the recovered, reused and recycled materials.

Such an integrated approach is also essential if we want to avoid today's energy efficiency actions hampering tomorrow's recovery of valuable materials. The *Energy Efficiency Directive*'s (2012/27/EU) requirement to refurbish 3% of public building stock per year offers the incredible opportunity to do things better and to respond to a variety of challenges in a sustainable and effective manner.

Emerging initiatives such as *Level(s)* and the ISO standard *ISO / CD 20887 Design for Disassembly and Adaptability of Buildings* (see also Chapter 6) are emphasising the importance of design and more specifically design for disassembly and adaptability. Amongst other things, these initiatives are promoting the extension of the service life of the building as a whole, either by facilitating the continuation of the intended use or through possible future changes in use; as well as facilitating the future circular use of building elements, components and parts that make up a building's material bank. They provide design principles and emphasise the importance of assessing the performance across additional areas, such as future reuse potential, reclaimed content contribution to reduced embodied carbon, and adaptability to change use and/or capacity. In addition, there is a need of environmental and circularity benchmarks; target performance values with which (future) buildings should comply.

Resource efficiency is hindered by inadequate business-to-business information on what substances and materials products contain. Such information is needed to know how products can be repaired, remanufactured or recycled, and if the presence of certain chemicals can constitute technical or health barriers that prevent recycling. To tackle this issue the *EC Communication* on the *Options to address the interface between chemical, product and waste legislation* has been drafted. This increasing awareness of the need to provide clear information on material and product characteristics to support resource productivity is fully in line with the objectives and developments of the BAMB Materials Passports.

More recently a new wave of circular policy development is underway. *The Circular Economy Package* (EU), the *Circular Economy Strategy* (Scotland), the *Regional Program for Circular Economy* (Brussels Capital Region), etc. have been adopted. All of these instruments identify construction and demolition waste and the building sector as essential pillars to address. However, it is noted that the role of design of buildings and building products has not been addressed.

This provides a significant opportunity to reframe sustainable building policies and instruments to allow for a circular approach. While the wealth of data provided through the existing voluntary programmes, plans, strategies and tools will feed into BAMB's tools and support carrying out circular and dynamic buildings; the BAMB tools will also serve as interesting input to further strengthen existing mechanisms and enable their adaptation and better implementation within a circular built environment.

3.2.3 Recommendations

The recommendations that can be drawn from the State-of-the-art Analysis can be subdivided in 3 categories: general recommendations and a new policy vision, the extension of existing policies, and adaptations of existing policies.

General recommendations and a new policy vision

3.2.3.1 Overcoming fragmentation

One of the main barriers that has been identified is the fragmentation of the policies over the different policy levels as well as between the different policy domains. This leads to a lack of integration which in some cases leads to contradicting and conflicting policies. Therefore, an inclusive policy approach that tackles the fragmentation of policies between different policy 'silos' and between different policy levels is necessary.

A clear direction and an integrated and homogeneous approach should be provided on the higher policy levels (European and Member State). However, these policies should enable, if not support, innovation on a sub-national and local level. In Sweden for example, building regulations are defined on a national level which doesn't allow municipalities to enforce a more ambitious and circular local regulation for construction and buildings. The 'Permit to do' [4] - a French law, enables providing certain deviation possibilities regarding urban development regulations to support innovation - providing a 'permit to do' instead of a 'permit to build.' In some European member states, such as Belgium and the Netherlands, Living Labs provide an interesting way of how innovation and experiments are possible within a regulated domain.
Furthermore, linking the requirements regarding energy performance of buildings to other requirements such as the environmental impact of buildings, resource effectiveness of buildings and reversible building design, could enable a more integrated vision on the importance of design of buildings (and products) on sustainable resource use – energy and non-energy related. For example, the recently developed BBCA low carbon building certification in France which has an emphasis on the total carbon impact, including material/embodied aspects[5].

3.2.3.2 Health impacts

In addition, it is important to align strategies to (re)use resources in a responsible way with health strategies in which the selection of building materials and the design of the building improve the quality of indoor as well as exterior environment, instead of deteriorating it. Through reuse of buildings and building components, the manufacturing of new building products and the extraction of primary resources and avoided, and by doing so also potential harmful emissions to air, water and soil. However, an important attention point, is the potential risk on indoor air quality by reusing old building products that were made in a time

[4] L'article 88 de la loi LCAP du 7 juillet 2016 « Permis de faire » Le décret n° 2017-1044 du 10 mai 2017
[5] https://www.certivea.fr/offres/label-bbca-batiment-bas-carbone#

where toxicology and law enforcement (cf. REACH) was not as far as today. Hence, the importance of historic data on reclaimed building products, e.g. through Materials Passports.

3.2.3.3 Cost

Reversible building solutions are often perceived as too expensive compared to the conventional solutions, which have been optimised over decades. This reflects a short-term perspective, in which the financial investment cost is considered a principal decision criterion, not looking at potential financial gains and the individual or societal added value that circular and reversible building solutions could deliver over their entire service life. Having a great impact on the environment and society, a new policy approach is needed for the current building industry, one which integrates external environmental and societal costs as well as a long-term perspective.

The internalization of external costs should be an inherent part of (public) procurement processes. One of the best practices case studies which can be referred to in this context is for example the case of the procurement process developed by Rijkswaterstaat - the Dutch executive governmental organization responsible for the design, construction, management and maintenance of the main infrastructure facilities in the Netherlands.

3.2.3.4 Extension of existing policies

Existing hard laws on energy performance, waste management and construction product regulations offer the opportunity to address certain aspects supporting the implementation of dynamic and reversible buildings. Extending these policy instruments by integrating Materials Passports and Reversible Building Design principles would enable the development of an integrated approach regarding climate change, energy, environmental and economic issues.

It is noted that in some countries, 50% to 65% of all national global warming emissions are directly related to material related processes[6]. According to Ecofys and Circle Economy, current climate change mitigation actions mainly focus on energy efficiency, renewable energy and reduced deforestation, which equates to a reduction of 13 billion tonnes of CO_2e in 2030. However, 26 billion tonnes of CO_2e is needed to meet the Paris agreement target of reducing global temperature increase to 1.5°C. Policy (but also market and civil) actions supporting circular economy measure could, according to Ecofys and Circle Economy, cover half of the gap to meet the Paris agreement.

3.2.3.5 Energy Efficiency Directive

The *Energy Efficiency Directive* (2012/27/EU) revised in December 2018, requires the establishment of a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private (article 4),the annual renovation of 3% of public buildings owned and occupied by National central governments (Article 5), public procurement focusing on high energy performance of

[6] https://www.ovam.be/link-tussen-materielenbeleid-en-klimaatbeleid

buildings (Article 6) and the reduction of embodied energy (Article 7). The articles 6 and 7 should be further developed as one article focusing on the high resource performance of buildings and integrating energy efficiency, resource productivity and the reduction of the environmental impact.

3.2.3.6 Emissions Trading System

Further concerning the prominence of energy and emissions targets in existing policies, it is interesting to note a missed opportunity to target the construction sector specifically in order to reach the EU's greenhouse gas emissions and energy efficiency targets. Construction is not an industry specifically targeted by the Emissions Trading System, but when looking at the figures for GHG attributed to construction (40%) in Europe, it seems necessary to set clear and specific targets for the sector. As power and heat generation are already targeted by the ETS system, emissions targets specific to construction products manufacturing and construction processes could facilitate greater accountability and coherency across environmental policies. Furthermore, we have to acknowledge the limits of the EU ETS system, as it is currently susceptible to 'carbon leakage', in which some businesses transfer production activities to other countries with laxer or no emission constraints and may lead to even bigger amount of global greenhouse gas emissions. However, most of the building product manufacturing industries are characterised by local businesses – this is especially the case for stony materials – which are easier to regulate and control.

Moreover, there is an opportunity to link circular buildings with decarbonisation. Metrics could be set to acknowledge the carbon credit linked to dynamic and circular building design, which could then contribute to decarbonisation goals and tools by recognising CO_{2e} savings. The BAMB Circular Building Assessment method supports the environment net benefit evaluation of circular building scenarios against linear, business as usual, design choices.

3.2.3.7 Construction Product Regulation (CPR) and Environmental Product Declarations (EPD)

More information is required on the composition of materials and their impact on health as well as on the characteristics of building materials and products in regard to their potential for resource recovery and reuse. Different initiatives such as the *Construction Product Regulation (CPR)* and *Environmental Product Declarations (EPD)* provide information on material and product characteristics. A construction product covered by a harmonized standard (or a European Technical Assessment) according to the CPR, must have a performance declaration and be CE marked to be sold. EPD is an independently verified and registered document that communicates transparent and comparable information about the life-cycle environmental impact of products. However, the information required by CPR and EPD is currently insufficient to support effective resource recovery and reuse. A standardized and harmonized data set (required data content and data format) providing this information is required to build on and complement these existing initiatives, enabling producers to extend the information they provide for these existing initiatives with valuable information to support the transition towards continuous loops and a circular built environment. The *Construction Product Regulation* requirement 7 'Sustainable use of natural resources' could e.g. be further

developed to embrace a Buildings As Materials Bank vision[7] supporting the transition towards a circular economy in the building sector. Further on, one aim of the CPR is to improve the free movement of construction products within EU but a Member States may not unilaterally introduce complementary national regulation, even if they consider shortcomings or gaps in the harmonized standards. One such example is to make more far-reaching demands through national legislation than the CPR on accounting for the chemical content of construction products. Such regulation may affect the ability to sell building products and thus constitute trade barriers.[8]

Furthermore, in addition to providing clear information on the material/product composition and its potential for future recovery through circular end-of-life options, it is also crucial to have information on the product's use life. Enhancing the traceability and data collection of the life cycle(s) of materials/products in a structured database could enable defining the recovery value and effective end-of-life options.

Through the revised *Waste Framework Directive* (2018/2008/98/EC) the European Commission aims to increase the focus on waste prevention and minimum requirements for Extended Product Responsibility (EPR) by promoting repair and reuse and a transition towards sustainable production and consumption models. To do so, some of the recommendations drafted in the *EU Construction and Demolition Waste Protocol and Guidelines* could be extended.

- The implementation of pre-demolition waste audits could be extended to pre-development audits in a first stage. In a second stage, the use of Circular Building Assessment tools, such as the one developed within the BAMB project, could enable to define a clear view of the reuse potential on building / product and material level, eliminating the need for future audits. This, however, requires a shift from end-of-life waste management to early design waste prevention and resource management.
- The enforcement of traceability along the waste chain could be extended towards a traceability of all products and materials along their different life-cycles based on the use of digital sets of information stored in structured database as described above. For example, QR codes and RFID tagging could be used to access information on materials, toxicity, manufacturer and history of building elements to support their reuse.
- Town planning comprising the development of recycling plants in urban areas should also incorporate development of stockpiling and refurbishment facilities to support the reuse and continuous loops of materials and products.
- The quality management of secondary raw materials should be extended to the quality management of reclaimed and refurbished materials and products. The use of digital sets of information such as Materials Passports will facilitate the quality management of the re-claimed products of the future.

[7] https://www.bamb2020.eu/topics/blueprint/vision/

[8] Judgment of the Court (Tenth Chamber) of 16 October 2014 — European Commission v Federal Republic of Germany Case C-100/13.

- An open market for recycled content facilitated by public procurement should be extended to an open market for reused and refurbished materials and products and incentives for their use considered.
-

3.2.3.8 Towards a standardized framework

Different circular framework programmes are embracing the built environment as one of the main pillars to be addressed. Most of them lack clear objectives regarding the metrics to be reached as well as quantitative decision making and assessment / measuring tools that enable supporting the implementation and the monitoring of resource productivity. The adoption of Materials Passports, Reversible Building Design and Circular Building Assessment tools, such as developed in BAMB, enable meeting this gap.

However, it is important that a standardised framework, comparable to the Energy Performance of Buildings Regulation, is set up to guarantee a common language and assessment method that provides a clear direction to the sector in the different Member States. The integration of the BAMB tools (Reversible Building Design and Circular Building Assessment Tools) within the further development of existing sustainability schemes such as *Level(s)* could enable providing such a framework. This could permit the integration of different environmental aspects comprising energy efficiency, resource productivity and sustainable building in one integrated and coherent approach.

Furthermore, besides quantitative measuring tools, the circular framework programmes should integrate policy action that supports awareness and knowledge development of the different stakeholders of the value network with regards to the different aspects characterising the innovations of a dynamic and circular built environment through tools[9], training and raising awareness regarding Reversible Building Design, Circular Building Assessments and indicators, business models, etc. In addition, policymakers can stimulate circular niche activities through, for example, supporting living labs and lighthouse projects.

3.2.3.9 Adaptation of existing policies

In 2005, the EU published its strategy on the *Sustainable Use of Natural Resources* (COM(2005)670). This emphasised the importance of sustainable production and consumption for the prosperity of Europe and included considerations of the application of Life Cycle thinking to policy. However, the existing life-cycle assessment tools are built on a linear vision of the building industry which at best incorporates recycling. The concept of multiple cycles of reuse as defined within the BAMB project is not adequately considered neither in the current frameworks nor in the end of life options. It is therefore essential to

[9]More initiatives such as *The Circulator* which is a project funded by EIT Raw Materials aimed at supporting aspiring entrepreneurs in making conscious **strategic choices regarding the sustainability of their business model** and value proposition and BMIX (http://vlaanderen-circulair.be/bmix/index.php).

review the current life-cycle assessment frameworks by integrating a vision of circularity and extending the end-of-life options.

The implementation of circular economy and reversible building solutions will necessitate the adaptation of local building legislations where they are acting as a barrier. For example, according to the Dutch building codes and law, the leasing of a façade system was judicially not possible because it is a structural part of the building. The Dutch Association of Metal Window and Façade Producers, VMRG, developed a contract based on emphyteusis (the right to a long-term lease) which enables the producer to remain the owner of the façade system and implement a "Product as a service" business model within the existing judicial structure. Building codes and regulations are developed based on the static character of the current built environment, which hampers the ease of transformation of buildings, as well as the implementation of circular building solutions linked to circular business models such as product as a service models. Adaptations to current legislation are needed to enable new models of ownership. Similar responsibilities and liabilities corresponding to these innovative and circular building solutions need to be defined to support the transition.

Furthermore, current building codes such as the Eurocodes are also developed with a static built environment in mind. The disassembly of buildings, systems and products might require an alternative approach to meet the required structural performance.

4 REVIEW OF COLLABORATIONS WITH EU AND INTERNATIONAL PLATFORMS

4.1 Methodology

Over the course of the project interactions and collaborations have been set up with different types of public bodies in different European countries as well as with European and International policy platforms. These interactions have enabled to, on the one hand, learn from current developments in the field of policy and standards related to circular economy in the built environment and, on the other hand, share and discuss the concepts and output developed within the Buildings as Material Banks project.

The set-up of the Special Interest Group on *Policies and Standards* has furthermore enabled to exchange with a broader group of interested stakeholders on the different aspects related to policies affecting the transition towards a circular economy. The outcomes produced by the BAMB project in the development towards the drafting of the Framework for policies and standards have also been shared and discussed within this Special Interest Group. For example, a workshop has been organized to discuss the State-of-the art document, in which current policies have been described as well as the barriers and opportunities they present regarding a circular and dynamic built environment.

This chapter will summarize the different interactions that have taken place as well as the lessons learned that could be drawn.

4.2 Description of the platforms and interactions

4.2.1 CEN TC350 working group 3

CEN/TC350 is responsible for the development of horizontal standardized methods for the assessment of the sustainability aspects of new and existing construction works (buildings and civil engineering works), including horizontal core rules for the development of environmental product declaration of construction products (EPD).

Working group 3 (building product level) is focusing on the alignment between EN 15804 and PEF Guide on several LCA aspects, divided in several task groups:

- Definition of functional unit
- System boundaries – carbon offsets
- Additional environmental impact categories + methods
- Common life cycle inventory nomenclature for ease of data transfer
- Fossil and biogenic carbon emissions and removals
- Carbon storage and delayed emissions
- data quality requirements

- System boundaries - Modelling of (net) environmental benefits/loads regarding reuse, recycling and energy recovery (cf. Module D vs. Circular Footprint Formula among others)

The BAMB consortium has been following the activities of the last task group to better understand the discrepancy between CEN and PEF approaches. This has enabled the BAMB project team to develop, within the framework of the development of the Circular Building Assessment tool a refined and circular approach to determine environmental impact of (reversible) buildings. Both CEN and PEF approaches were further refined, in order to:

- Determine environmental impact profiles of building products reused in different buildings and building solutions
- Determine environmental impact profiles of reversible buildings (or designs) that are potentially transformed (in an easy way)
- Parameterise of environmental impacts for all possible End-of-Life scenarios of buildings and their components, considering multiple reuse cycles within the same building or other (building) applications
- Facilitate automation of environmental impact calculation within to-be-developed circular buildings assessment tool(s)
- Stimulate future and current circularity (i.e. recycling of materials and reuse of building components in the beginning and at the end of its life cycle). Specifically, for the PEF approach, the market-based procedure for allocation of environmental impacts relating to circularity, has been further refined for a 'reclaimed products' market.

In order to meet the vision in which buildings really acts as material banks, further testing of the developed approaches is required and also data characterization related to the reuse of different types of materials and products.

Whilst calculation of environmental impact is an important tool in checking proposed solutions, the methodological discussions should not be a distraction to taking action to move from linear towards more circular solutions. For this reason, the BAMB Circular Building Assessment focuses on comparing environmental impact of circular & dynamic building scenarios to a 'business as usual' baseline scenario for a specific asset (at system or building level).

4.2.2 One Planet Network

The One Planet Network has been formed to implement the 10-Year Framework of Programmes on Sustainable Consumption and Production, which supports the global shift to SCP and the achievement of SDG 12 (responsible consumption and production). It is a multi-stakeholder partnership for sustainable development, generating collective impact through its six programmes amongst which "Sustainable building and construction".

The Sustainable Buildings and Construction Programme (SBC) aims to, amongst other things, improve the knowledge of sustainable construction, support and mainstream sustainable building solutions and foster enabling frameworks to implement SBC policies.

As a member of the SCB programme, the BAMB project has been actively collaborating with the SBC programmes on different levels. The BAMB project has been exchanging and sharing knowledge and good practices and participating on the development of cooperation networks through: the participation to two webinars, the organization of the joint event on circular economy in the built environment and digitalisation with the One Planet Network, sharing of best practices based on the BAMB pilot Projects, linking circular building business models to tourism infrastructure within the Sustainable Tourism Programme.

The main lessons learned from the cooperation with the One Planet Network can be summarized as follow:

1) A wide, diverse range of stakeholders have to be involved in the transition towards a circular and dynamic built environment. This will require to raise awareness, educate and provide the right tools for these different stakeholders to engage them in the transition.
2) A circular and dynamic built environment offers some short and long term advantages. It is important to acknowledge the incentives and communicate these to the right stakeholders using their own language to enable them to disrupt the routine and habits that are directing their ways of working.
3) A transition towards a circular economy requires stakeholders, companies and governments to engage in a long term vision.
4) Transparency, communication and collaboration between the different stakeholders are key:
    - Clear and open communication between the stakeholders is required to meet the objectives together.
    - Sharing information between the different stakeholders within a project and even between different projects enables to develop circular and dynamic solutions and foster reuse
    - Open source and open access data is required to enable decision making towards circular and dynamic building development for new construction and refurbishment
5) Reliable and consistent data is essential to support the decision making
6) Digitalisation is an important enabler in the transition towards a circular economy. It is supporting the required data gathering and access. Furthermore, it enables to simplify and speed up assessments resulting in tangible tools and time efficiency in the decision making process.

7) Concrete implementation, projects and collaboration are needed to support the transition, enable to provide concrete input in order to support the points developed above.

4.2.3 Ellen McArthur Circular Economy 100 platform

The Circular Economy 100 brings together members from across the economy to provide unique opportunities for multi-stakeholder collaboration. Member groups include corporates, governments and cities, academic institutions, emerging innovators, small and medium sized enterprises (SMEs) and affiliates. A number of BAMB partners are members, including BRE, BAM, IBM, EPEA and Brussels Environment. The programme is designed to advance understanding of the circular economy, build organisational capacity, and exploit networking opportunities across business, government and cities, and academic institutions. The twice-yearly CE100 Acceleration Workshops and Annual Summit are held around Europe/USA and London respectively.
Although the focus is not built environment, there is a built environment cluster and there have been several built environment projects and publications.

Another important area is the link to cities where there is a growing membership of policy makers joining a dedicated work stream focused on 'circular cities'. There is likely to be a growing emphasis on how to make the buildings and city infrastructure transition to a circular economy, which is also where some of the learning and outputs from BAMB project could be applicable.

The main lessons learned:

Although the focus of CE100 is pan sector, rather than built environment focused, there are opportunities to develop projects and guidance with other members that contribute to knowledge in this space. BAMB has been publicised on multiple occasions via this programme, including a BRE (CE100 member) presentation at an acceleration workshop, inclusion in a case studies report, and a recent video produced with EMF and distributed via the thinkDIF virtual conference 2018[10][11].

BAMB can offer support to built environment members of CE100, and also those members who have large real estate portfolios. This would need to be carefully targeted, simple to communicate and packaged in a visually attractive way (in keeping with CE100/EMF approach to dissemination). Some areas to target could include health & wellbeing benefits of Material Passports, Impacts measurable via the Circular Building Assessment, Social value insights derived from Mostar (and possibly Amsterdam project), and value/ business modelling conclusions.

[10] https://www.youtube.com/watch?v=o2hyMZ0oA3w&feature=youtu.be
[11] https://www.bamb2020.eu/news/dif-2018/

4.2.4 Resource Efficient Use of Mixed Wastes project: Improving management of construction and demolition waste

The *Resource efficient use of mixed wastes project* consists of a study ordered by DG Environment. The study aimed to investigate the current CDW management situation in EU Member States, identifying obstacles to recycling and deficiencies that could lead to non-compliance with EU waste legislation. Good practices in terms of creating conditions for increasing CDW recycling and for improving the quality of recycling and recovery were identified and a set of recommendations to address potential barriers formulated. Success stories of efficient CDW management were showcased and the credibility of official CDW statistics was assessed

The BAMB project participated in the seminar presenting the preliminary findings of the study as well as to the latter reviewing. It also contributed to the EU stakeholder workshop to validate and expand upon initial conclusions and recommendations of the study.

The study identified some important barriers which have led to the formulation of key recommendations. The lack of reliable and consistent data on waste production and management in many countries is a major barrier to improve the waste management and identify different resource recovery end of life options for these streams. This is also one of the major findings of the impact assessments in chapter 5. Furthermore, the statistics on recycling do not consider reuse and thus the waste that has been prevented is not given value. Finally, backfilling was identified as a major barrier to high quality recycling.

Based on this study and the conclusions from the EU stakeholder workshop, some key recommendations were developed.

1. Measure to manage – better and more detailed data collection
2. Target waste prevention – targets, reuse buildings, procurement incentives, avoid hazardous materials
3. Refocus on reuse – promote reuse above recycling, industry takeback schemes, mandatory pre-demolition audits, use of BIM
4. Keep it clean – improved source segregation, selective demolition
5. Remove the backfilling barrier – promote higher value recycling through redefining backfilling and excluding from 70% recovery target
6. Products, not waste – develop more End of Waste Criteria
7. GPP: lead by example – set green public procurement criteria to promote reduce/reuse, better data capture
8. Enforce to reinforce – bigger penalties for infringement, minimum resourcing levels for enforcement activities, rollout of EDOC (electronic duty of care)
9. Continuous and holistic improvement – self assessment using a maturity matrix approach, pan policy approach needed
10. Promote eco-design & design for deconstruction to enable better reuse

The final report was published recently[12] and expands the rationale and possible implementation of these recommendations, along with other information, such as high level impact evaluation of certain intervention and further detail on best practices around the EU (with a focus on resource efficiency rather than circular economy).

4.2.5 EC Communication on Resource efficiency opportunities in the building sector – Level(s)

The general objective of this initiative is to reduce the environmental impact of buildings by improving the overall resource efficiency and, as a consequence, to improve the related competitiveness of construction businesses. This identified the need for a common EU approach to the assessment of the environmental performance of buildings: a 'common framework of core indicators', rigorous enough to drive improvement in performance and allow for comparison between buildings. Different studies have been conducted to meet the objectives of the communication and provide a concrete framework providing a flexible system of indicators that can be incorporated into new and existing assessment schemes or be used on their own by a diverse range of stakeholders, including public authorities, design teams and property investors: Level(s).

The BAMB consortium has been following the work developed within the context of the EC communication on *Resource efficiency opportunities in the building sector* as well as the developments of the voluntary sustainability assessment scheme Level(s). Furthermore, the BAMB consortium has been actively contributing to, amongst other things, the consultation to the Identification of macro-objectives for the resource efficiency of EU buildings and exchanging with DG Environment, DG Growth and JRC on the development of the BAMB outputs that have been identified as valuable to support the further development of levels.

The main lessons learned can be summarized as follow:

The common language and the integrated approach on sustainable building, which is defined on a European level and can be applied in different member states, provides a clear direction on which the building sector and industry can rely on. It is therefore also required by the sector to where possible further develop and built on this framework instead of developing additional and maybe contradictory initiatives.

The consultation and involvement of the stakeholders for the development of the macro-objectives as well as for the testing of the framework result in a time consuming process. However, this process is crucial to raise awareness, to enable the sector to take ownership of the framework and to foster a large scale uptake.

4.2.6 OVAM – Circular Flanders

Circular Flanders is an initiative from OVAM (the Flemish governmental service responsible for policies regarding waste, materials and soil decontamination) that aims to provide a hub and inspiration for the circular economy in Flanders. It is built on a partnership of governments, companies, civil society and knowledge institutes that take action together.

[12] http://ec.europa.eu/environment/waste/studies/pdf/CDW_Final_Report.pdf

In order to streamline policy-relevant research within the framework of the circular economy in Flanders, the Circular Economy Support Center was created within Circular Flanders.

The BAMB consortium is collaborating with Circular Flanders on the further development of the reburg.world website which provides an inspiring vision for how an imaginary circular city 'Reburg' could really work. The BAMB consortium provided input for the "buildings as material banks" layer of the website, illustrating the challenges and insights regarding circular economy within the built environment based on the blueprint developed within BAMB and presented from the point of view of different types of stakeholders.

Circular Flanders is developing some interesting initiatives to engage stakeholders in the transition towards a circular and dynamic built environment.

A first initiative to mention is the organization of open calls for innovative project proposals to support circular economy within the themes 'Circular city and businesses' and 'Circular procurement'. Already, for two years in a row, building related projects are the most popular.

A second initiative is the launch of a Green Deal 'Circular Construction' at the beginning of 2019, to bring different profit and non-profit organisations together to learn from each other and to engage them in initiatives supporting a circular economy within the built environment. A Green Deal on 'Circular Procurement' was already launched in 2017.

A third initiative is the launch of a Living Labs on 'Circular Construction' in 2019 with a major objective to support a near-future policy framework for the transition in the construction sector to a circular economy, based on (real-time) experiment and applied research.

Finally, through the website of Circular Flanders different tools are provided to support stakeholders to develop circular economy activities, amongst which some tools supporting the creation of circular business models.

4.2.7 I.C.L.E.I

ICLEI – the International Council for Local Environmental Initiatives – is the global network of 1,500+ cities, towns and regions committed to building a sustainable future. Through joint action, peer learning, and strong partnerships between civil society, business leaders and all levels of government the ICLEI aims to accelerate local sustainable development and make real change on the ground. Local and regional governments across the ICLEI network work alongside a diverse team of global experts shaping policy and sparking action in support of sustainable urban development.

The BAMB project has been interacting with the I.C.L.E.I on the topic of Sustainable and Circular Public Procurement. As a result of this cooperation the Procura + manual and case studies developed by I.C.L.E.I have also been analysed within the best practice section.

The lessons learned from the interaction with the I.C.L.E.I can be summarized as follows.

1) Public procurement can be playing a crucial role in the transition towards a circular and sustainable built environment. It accounts for approximately 20% of Europe's

GDP and enables to provide the sector with a clear direction to follow. Public authorities' purchasing decisions impact millions of people through the supply chain. Sustainable procurement is about using public spending to achieve social and environmental objectives, and to strategically use the public sector's economic power to catalyse innovation in the private sector.

2) Sustainable and circular public procurement embraces more than the integration of sustainable or circular indicators and specifications within the tender dossier. An innovative and participatory approach relying on sharing of information and mutual learning is essential in all stages of the procurement process to meet the objectives.

4.2.8 DG GROW's Thematic Group 3 'Sustainable use of natural resources'

To follow up the framework Construction 2020 of the Communication on "Strategy for the sustainable competitiveness of the construction sector and its enterprises" (COM (2012) 433 final), a High Level Tripartite Strategic Forum and 5 *Thematic Groups* gathering relevant stakeholders have been set up. These thematic groups are discussing and defining actions for the implementation of the Construction 2020 strategy.

Thematic Group 3 (TG3) "*Sustainable use of natural resources*" is focusing on the environmental performance of buildings and the valorisation of Construction and Demolition Waste.

The BAMB project has been following to the work of the TG3 and has been actively contributing to developments regarding the thinking process and preparation of the guidelines for Design for Deconstruction.

This collaboration has pointed out the complexity of developing policy instruments that are built on a consensus and thus accepted by a broad range of stakeholders. This participatory approach is a time consuming process. However, this participatory approach is an essential process. It enables to:

1) Raise awareness and provide the stakeholders with innovative information and knowledge on different aspects related to the topic through expert presentations, which supports the decision making process in a constructive way;
2) Learn from the barriers and opportunities that are encountered by different stakeholders and develop solutions to overcome and/or built on these;
3) Develop policy instruments that are understood, supported and taken up by the market.

4.2.9 GLOBE-EU

Globe EU is an international non-profit association that, within the European Parliament, serves as a platform for discussing European Commission policy proposals and for

coordinating political action among like-minded legislators in the European Parliament and at member state level that believe in sustainability, resource efficiency, Corporate Social Responsibility and environmental management.

It seeks to facilitate structured discussions between Members of the European Parliament, Commission officials, specialists, and a diversity of stakeholders through high-level round tables, workshops and conferences.

The BAMB project has been actively involved in the preparation of the pre-conference to the official opening of the EU's Green Week 2018 "Green Cities for a Greener Future" hosted by GLOBE EU.

The lessons learned from the preparation work with GLOBE EU can be summarized as follows.

1) Presence of hazardous waste in construction is often underestimated
2) Many materials that can be reclaimed have no market: existing building codes and standards often act as an impediment to reusing waste materials
3) CDW is evenly divided between construction, demolition, and refurbishment. It is estimated that within the hotel sector important refurbishments are occurring every seven or ten years, which is leading to large quantities of waste
4) Public Procurement is an important mechanism to integrate environmental impact and reward reduced and positive impact
5) Countries in which waste management policies have high requirements and these requirements are enforced show higher levels of recycling.
6) Already existing initiatives that can be scaled-up (for new and refurbished buildings): material passports, reversible building design, circular building assessments, data sharing, online platforms, green public procurement

4.2.10 World Circular Economy Forum

The World Circular Economy Forum is a yearly event that presents the world's best circular economy solutions and brings together over 1,000 key thinkers and doers from around the world. Stakeholders from very different back grounds have been supporting the discussions by presenting their vision.

The main conclusions that could be drawn from the 2017 event can be summarized as follows:

- The internalization of external costs is seen as essential to support the transition towards a systemic shift. This would also enable to avoid that countries that are currently in the development process would follow the path that has been used by

developing countries in which the development was coupled with an increased footprint which would then be reduced.

- Different stakeholders have been supporting a transition from taxation on work to taxation on materials so that we would "paying for labour to save materials instead of paying for materials to save labour"
- Policies need to support the upscaling to foster the systemic change. It is essential to work on policies at all different parts of the value network
- Cities play a major role in the transition towards a circular economy. Therefore 'circular' policies need to be implemented on a city level supporting adapted financial mechanisms. Furthermore, mechanisms need to be developed to measure the systemic transition.
- Different cities have been presenting the strategy they have been implementing to support the transition towards a circular built environment. For all cities a multi-stakeholder approach has been identified as crucial as well as raising awareness through best practices. Furthermore, the city of Amsterdam follow the strategy to experiment and learn by doing to support the development of policy recommendations.
- The transition towards a circular economy will lead to new professions and new job requirements but will also affect existing jobs, it is important to support the transition for the jobs that are being lost or will have to evolve.
- Public procurement accounts for 20% of GDP and plays therefore an essential role in supporting the transition towards a circular economy.

BAMB was represented at WCEF in Japan in 2018, with a workshop organized by EASME, to highlight the work done to date and to talk with European and Asian participants about potential collaboration and exploitation in the future. The BAMB table was well attended for each of the three networking sessions and several interesting leads were developed for follow up. A further workshop where new (started in summer 2018) Horizon 2020 projects, relating to Circular Economy, were discussed was also useful in identifying activities where BAMB outputs/knowledge could be used to help advance the R&D. A project called HOUSEFUL[13] has particular relevance in this context.

4.2.11 Global Initiative for Resource Efficient Cities (GI-REC) and ACR +

GI-REC is a cooperation platform offered by UN Environment to connect many different institutions that are using systems approaches (specifically urban metabolism and morphology approaches) towards building low-carbon, resilient, and resource efficient cities.

[13] http://houseful.eu/

Brussels being one of the partner cities of this cooperation platform, a collaboration has been developed within the framework of the development of macro level indicators for circular economy. The contribution within this framework has led to a report that will be published by the end of 2018.

ACR+, the Association of Cities and Regions for sustainable Resource management, is an international network of cities and regions sharing the aim of promoting a sustainable resource management and accelerating the transition towards a circular economy on their territories and beyond.

Circular economy calling for cooperation between all actors, ACR+ is open to other key players in the field of material resource management such as NGOS, academic institutions, consultancy or private organisations.

Brussels Environment being a member of ACR+ has enabled the BAMB project to interact with ACR+ on different projects such as FISSAC, RE4 and the H2020 Support Mechanism and to actively participate to ACR+ activities.

These initiatives and interactions have enabled to identify the needs for multi-stakeholder approach and how the tools developed within BAMB can support the different stakeholders and cities in the systemic shift.

4.2.12 Ministry of the Environment of Finland, Ministry of Environment and Food of Denmark, Ministry of Infrastructure and the Environment of the Netherlands, Ministère de la Transition écologique et solidaire (France)

The BAMB project has been in contact with different public authorities and Ministries of Environment from different European countries exchanging on the challenges different member states are facing with regards to the transition towards a circular economy in the built environment. Information has been shared on the current developments, tools and strategies.

- A participatory approach that involves all the stakeholders in the definition of the objectives as well as the roadmap to achieve them is important to support a systemic shift
- By defining clear objectives governments are providing a clear direction to the sector
- The different instruments developed within the BAMB project are if interest to different public authorities since they enable to assess a positive impact in a quantifiable way

4.3 Conclusions

The interactions with the different policy platforms over the course of the BAMB project enabled the BAMB consortium to identify a shift from waste management and recycling to resource management including reuse. This transition is a slowly process as is the process of policy development for a complex sector such as the built environment. The large number of

stakeholders and the size of the value network leads to a time consuming process in the development of policy instrument that is acceptable for all.

However, experiments are identified as interesting enablers to learn by doing and to support policy developments based on concrete facts and lessons learned. In addition, they enable to support a multi-stakeholder approach and provide some best practices which can help to raise awareness. Policy makers can play an important role to facilitate experiments, as well as frontrunner and niche activities, to support upscaling.

Public procurement has also been identified as an essential policy instrument to support the development of sustainable innovation and a transition towards a circular economy. Furthermore, the enforcement of regulation is an essential leverage to reduce the use of virgin resources and the production of construction and demolition waste.

5 SUMMARY OF THE IMPACT ASSESSMENTS

5.1 Methodology

The policies to be selected for Impact Assessment were drawn from those considered in the State of the Art report (see Section 3) and were restricted to the four countries identified: Belgium, Portugal, Sweden and the UK. Given the number of policies and standards contained in the report, it was considered beyond the scope of the BAMB project to conduct an impact assessment on the majority of items included. It was therefore agreed to conduct a prioritisation exercise on all policies and standards in the report, to identify which would be likely to have the greatest influence on the BAMB project and methodology. A common methodology was used by all partners involved.

For the first selection, scoring was based on:

- Level of use/influence of the policy/ regulation
- Direct applicability to circular economy and built environment (either positive or negative)
- Relevance to BAMB

The highest scoring policies were then subjected to a further sift, where availability of supporting data and ease of impact evaluation were assessed and scored. A snapshot of the prioritisation matrix for the UK is shown in Figure 3 below:

Prioritisation matrix for policy/ legislation
Work package 5, Action 3

Policy ↓	Country/ Region ↓	Level of use/ influence	Direct applicability to circular economy and built environment (either positive or negative)	Relevance to BAMB/ built environment	Total for first prioritisation	materials passports reversible building design wastes reduction data management circular building business models	Availability of supporting data	Ease of impact evaluation	TOTAL SCORE
		0-3	0-4	0-4			0-2	0-2	
Environmental Protection Act (1990)	UK	3	1	0	4				
Climate Change Act (2008)	UK	3	0	0	3				
Environment Act (1995)	UK	3	1	0	4				
Planning and Energy Act (2008)	UK	3	0	1	4				
Building Act (1984)	UK	3	1	1	5				

Figure 3: A snapshot of the prioritisation matrix for selection of the UK regulation to be the subject of the Impact Assessment

Through this process, a total of 5 current policy actions were selected and were subject to an Impact Assessment:

- Site Waste Management Plan Regulations (2008) (UK)
- Swedish Environmental Objectives (1999, 2009) (Sweden)

- Programme Régional en Economie Circulaire (PREC) (2016-2020) (Brussels-Capital Region, Belgium)
- Tracimat (Flanders Region, Belgium)
- Incorporação de 5% de materiais reciclados (2011) (Portugal)

The geographic spread of the policies is shown on the map in Figure 4 below:

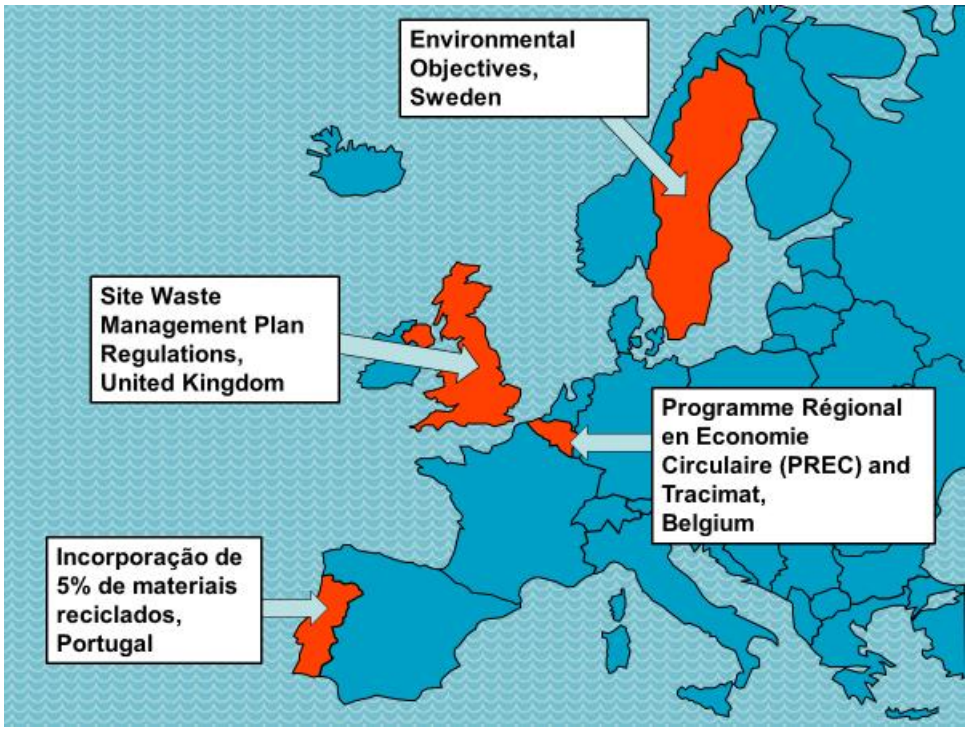

Figure 4: The geographic locations of the policies and regulations examined in the Impact Assessment

The policy actions provide a mixture of levels (both national and regional), and consist of a broad policy framework (Swedish Environmental Objectives), a circular economy policy framework (PREC), sector specific measures (Site Waste Management Plan Regulations and Tracimat), and procurement regulations (Incorporação de 5% de Materiais Reciclados).

The Impact Assessment methodology was developed by BRE and drew on a range of best practices, including the framework Magenta Book, the Impact Assessment manual provided by the UK Government for the evaluation of policies and regulations. Step by step guidance was provided for the project partners conducting the Impact Assessments (IAs) and an outline framework developed to ensure a level of consistency across the IAs.

Whilst the methodology used for the Swedish Impact Assessment was purely qualitative, a mix of quantitative and qualitative data was used in the other assessments. Given the lack of a suitable control group (counterfactual) for sufficient comparison of conditions 'before' vs. 'after' policy implementation, a holistic and objective approach was developed, including multiple perspectives to strengthen the validity of the evaluation. In this way, the causal relationship between policy and outcomes could be more clearly established.

The full Impact Assessments are provided in Appendix A.

It should be noted that both Tracimat and the PREC are also included in chapter 6 (Best Practices) where they are considered from the perspective of new approaches to implementing circular economy practices.

5.2 Site Waste Management Plan Regulations (2008)

The Site Waste Management Plan (SWMP) Regulations were a set of regulations introduced in the UK to address two issues:

- the illegal dumping of waste (fly-tipping) - in 2007/08, there were an estimated 1.28 million fly-tipping incidents, with 7% as identified as construction, demolition and excavation waste
- construction resource efficiency - in 2008, the amount of construction, demolition and excavation waste generated in England was 101 million tonnes, and of this, 12.55 million tonnes was landfilled.

The Regulations required SWMPs to be developed for construction projects over £300,000 (equivalent to approximately €339,000) in project value. According to the Regulations, SWMPs should be undertaken prior to the commencement of the project, with a forecast of waste generated and how it would be managed. The plan should be updated regularly throughout the project to provide information on how much waste was actually generated and how it was being managed, with a review undertaken after the close of the project. For construction projects over the value of £500,000 (equivalent to approximately €565,000), a more detailed SWMP was required. The Regulations put duties on the client and principal (main) contractor.

Prior to this there was a Voluntary Code of Practice for SWMPs, which was recommended for projects over £200,000 (equivalent to approximately €226,000) in value, which was adopted mainly by the larger contractors.

The Regulations were repealed in December 2013 as part of the English Government's 'Red Tape Challenge' as they were viewed as 'not fit for purpose'. However, many businesses continue to undertake SWMPs and they are also a requirement in sustainability building standards such as BREEAM, as well as through some local authority planning and client requirements.

5.2.1 Conclusions of the Impact Assessment

It was concluded that the Site Waste Management Plan Regulations (2008) were clear in their two-fold objectives of decreasing illegal waste and increasing construction resource efficiency. However, there were a range of issues which were identified as contributing to an overall lack of effectiveness of the Regulations and which eventually led to their repeal.

Barriers

One of the weaknesses in the SWMP Regulations identified by the impact assessment was the lack of engagement with the client and designer stakeholder groups. It was reported that client organisations were not generally interested or involved in the SWMPs and it was left to contractors to write and implement the plans. Indeed, many clients did not sign their part of the declaration. This lack of engagement at the design phase resulted in the SWMPs being considered too late in the construction process to have maximum impact. A further barrier was noted in the naming of the plans: Site Waste Management Plan was considered too open to misunderstanding as being site based, and therefore focused on the actions of the contractor.
There was little data gathered and published regarding specific costs and savings attributed to the different activities associated with the introduction of the SWMPs. This was also considered to be a barrier to the effective implementation of the regulations, as the financial burden (or gain) to businesses of the SWMPs was unclear. Indeed, research suggested that although realised savings on larger projects outweighed the negative cost impacts, the opposite was true for smaller projects.

A lack of consistency in approach by different local authorities was also identified in the impact assessment as influencing the implementation of the regulations. Survey results showed that there was a significant lack of awareness of the SWMP Regulations amongst local authority planning, building control and waste management officers, with different local authorities administering the SWMPs in different ways. This was found to lead to a high risk of inaction, confusion and inconsistency, and in the most extreme cases, property owners and contractors could find that neighbouring properties on which they were working were subject to different procedures as they were in different local authorities.[14]

Another barrier to the effectiveness of the regulations was identified as being lack of a clear ‘owner’ for the regulations. Regulations were not effectively enforced, and it was noted that there was no clear consensus as to which agency would be responsible for driving through and enforcing the regulations, nor a plan for how this would be achieved.

In addition, there were many types of projects, such as small scale construction and refurbishment, which fell under the threshold limit of £300K. These smaller projects were perceived to be the key contributors to illegal activity, and hence one of the objectives – to reduce fly tipping – would be less impacted as a result of their exclusion.

Implementation on affected projects was also variable in quality and rigour. For example, the objective to identify waste reduction measures could be as simple as a statement of intent. In addition, the robustness of waste forecasting and monitoring was not systematically checked, and the level of detail required, from a compliance basis, quite low.

Generally, there was an upward trend in the amount of construction and demolition waste diverted from landfill from 2008. However, the data is inconclusive on the cause and no discernible pattern was identified for when the Regulations were in place or not. This indicates there were contributing factors such as rising costs of landfill, improved waste

[14] Shiers et al (2014)

infrastructure and recovery routes and better segregation of waste on site. Factors for the increase of excavation waste being landfilled include a change in Permitting Regulations, a number of major infrastructure projects and the need for this type of material to fill landfill voids.

Opportunities

The SWMP Regulations were preceded by a voluntary code of practice for SWMPs. Drivers for their use included client demand, rising costs of waste disposal and inclusion in the BREEAM scheme. A number of impact evaluations were undertaken with varying results on the costs and benefits derived. Users of, both voluntary and mandatory, SWMPs generally considered that cost savings were made, but exact quantification was difficult as there were multiple factors to consider, including improved corporate image, corporate social responsibility, increased tendering success, better management and quality systems and better site conditions. Conversely, concerns were voiced that they had become a tick box exercise, general awareness of waste gains had been made and advances in material manufacture, waste processing and design had overtaken the SWMP ambitions. Ultimately, there was an official consultation (Consultation documents and responses for the Regulations and their repeal) managed by the government which demonstrated 75% of respondents supporting mandatory SWMPs. Despite this support, the regulations were repealed.

Once the regulations were in place, assistance was provided to companies, which was considered to be effective. These included awareness raising events, guidance and a set of templates. The regulations were also considered by some to have helped as an administrative tool, keeping all waste requirements (including those found in Duty of Care legislation) in one central document.

The SWMP Regulations were thought to have improved waste performance, particularly for larger contractor companies, through providing a greater understanding of waste arising, how it is managed and the cost of it, combined with a framework to enable change. Surveys have shown that many companies benefitted from the introduction of SWMPs including through increased cost savings and profitability, better legal compliance, reduced environmental impact, integration with existing environmental policies, and better health and safety and working practices. Particularly highlighted are the environmental benefits and ensuring compliance with waste legislation.

Another element of the SWMPs which emerged from the impact assessment was the usefulness of the data forecasts and data collected, along with the consistency of waste reporting. It was also noted that SWMPs provided a means to discuss waste management with the client, becoming part of the pre-contract discussions and ‘provided a formal structure and some ‘weight’ to activities that were already occurring’. Increased transparency in waste costs led to more informed decisions and enabled the commercial part of the business to take a greater interest. Additionally, placing a requirement to implement a SWMP encouraged innovation within the industry, such as developing new methods for recovering aggregates or developing take back schemes, and drove improvements in the subcontractor supply chain but did not significantly affect methods of construction.

The positive outcomes of the SWMPs is evidenced by their continuation in use, particularly by the larger contractors and via building assessment schemes such as BREEAM, although they are combined with other site issues such as energy and water, as 'Resource Management Plans'[15].

Prior to, during and post SWMP regulations, BRE provided a tool called SMARTWaste which was revised to provide automatic compliance with SWMP through following the steps in the online process. Use of this tool increased dramatically during the years of SWMP regulation. Other tools, by the Environment Agency and WRAP, were also developed to support those needing to comply with the legislation. As a result, a repository of waste data was collected and used to prioritise actions to reduce, reuse and recycle construction waste. For example, WRAP produced many guidance reports, case studies and commitments (such as 'halving waste to landfill') and transitioned from SWMPs to voluntary Resource Management Plans. BRE continues to provide support for SWMPs via Smartsite[16] and collects data from around 1000 live sites every year. This data is used to develop benchmarks which are further used to set the threshold levels for achieving waste minimisation credits in BREEAM.

5.3 Swedish Environmental Objectives (1999, 2009)

In 1999, the Riksdag (the Swedish Parliament) adopted a number of environmental quality objectives to provide a broad policy structure for environmental action. The objectives were further refined in 2009, and a three-tier system put in place, which consists of:

- A generational goal:
  > *to hand over a society in which the major environmental problems in Sweden have been solved for the next generation, without increasing environmental and health problems outside Sweden's borders.*
- 16 Environmental Quality Objectives, which describe the goal for a range of environmental aspects (e.g. *A good built environment: cities, towns and other built-up areas must provide a good, healthy living environment and contribute to a good regional and global environment. Natural and cultural assets must be protected and developed. Buildings and amenities must be located and designed in accordance with sound environmental principles and in such a way as to promote sustainable management of land, water and other resources.*
- Milestone targets set out the changes in society needed to achieve the environmental quality objectives and the generational goal (e.g. *no net emissions of Greenhouse Gases by 2045).*[17]

[15] https://www.breeam.com/NC2018/#10_waste/wst01_nc_a.htm%3FTocPath%3D10.0%2520Waste%7C_____1

[16] https://www.bresmartsite.com/products/smartwaste/

[17] http://www.swedishepa.se/Environmental-objectives-and-cooperation/Swedens-environmental-objectives/The-environmental-objectives-system/

The three objectives most relevant to the BAMB project are:

- Reduced climate impact
- A good built environment
- A non-toxic environment

The environmental objectives are followed up on a regular basis, with annual reports to the Government as a basis for the Budget Bill. An in-depth evaluation of environmental action and the prospects of reaching the objectives is performed once every parliamentary term. The evaluation aims to address whether existing policy instruments are sufficient, or if adjustments and new measures are needed in order to achieve the objectives.

A number of government agencies are responsible for following up and evaluating specific environmental quality objectives.

5.3.1 Conclusions of the Impact Assessment

The Swedish Environmental Objectives system has been in place for almost 20 years. It has evolved during this time and is regularly evaluated. The impact assessment concluded that there are many elements of the system which are considered positive (including its visionary nature, the clarity with which the direction of travel is expressed, and the way that it brings environmental ambitions together in one place). However, there are also concerns that most of the objectives will not be met on time (Naturvårdsverket, 2017) and that they are not ambitious enough to reach the goals of the Environmental Objectives system. However, the Impact Assessment identified that the system clearly promotes circular economy aspects and that the circular economy is a central part of the generational goal and objectives.

Barriers

One of the barriers for success of the Objectives System was concluded to be that objectives themselves are visionary but the system does not contain any solutions for the problems that need to be tackled. Government departments are expected to develop their own solutions to the objectives and milestones. Whilst the system therefore creates pressure for the agencies concerned to identify and propose solutions, the solutions are not necessarily sufficiently ambitious to meet the objectives.

In terms of working towards a circular economy, the impact assessment found a barrier to be that material loops are considered in terms of a waste issue rather than design. Also, it was noted that a range of different perspectives on circular material loops are in place which reduces the potential impact.

The complexity of some of the objectives was also considered to be a negative. For example, in the case of Good Built Environment the topic is so broad that the objective remains visionary rather than a clear goal.

From the perspective of civil society, the objectives system is not a mandatory framework, so stakeholders including commercial businesses have no requirement to buy in to the objectives

and no concrete targets. It was considered that better communication of the objectives system and more mandatory targets would be needed to get business on board.

The impact assessment identified that the system needs to be closely monitored and evaluated, but that this is considered to be a risk as the resources required for evaluation could be diverted away from delivery. One way which could be used to reduce this risk is by structuring the evaluation, and that resources will be identified, so it can be used to plan and implement actions.

It was considered that a more prescriptive approach and clearer guidance towards circular practices in the building sector, as well as reinforcement from the government to agencies about the significance of sustainability issues in the building sector in reaching the objectives, would support the case for implementation. It was also noted that the milestone for reducing waste and increasing the recycling from building and demolition waste was seen as a non-typical milestone for the objectives system, as it is the concrete implementation of EU waste legislation at the national level. This milestone was considered to lack the emphasis on quality that is more usual, instead focusing on quantity. It was noted in the impact assessment that there has been some controversy around how this goal should be calculated. The interviewees describe an uncertainty around if this milestone has affected the recycling rates or prevented waste from the building sector in any significant way.

Opportunities

The objectives system was found to demonstrate a long-term commitment, providing leadership from the government, but also, as there is broad cross-party consensus, a clear direction of travel which will remain stable regardless of the political party in power. That stability was considered to allow businesses to understand where policy is heading (e.g. in the development of building regulations). The system is also considered to place the environment high up the agenda.
The adaptability of the objectives system was considered to be a strength, with the system reviewed every few years. Although it was also noted that the negative of this is that this can make the system more difficult to implement and time-consuming to keep up to date with changes.

The system was considered to force agencies to work together and cooperate around sustainability issues and the system encourages collaboration between government agencies and also with other stakeholders. Dialogue, for example with the construction industry, includes workshops on waste sorting and circularity, developing guidance for the industry.

By allowing the agencies involved to identify solutions to the objectives, milestones and descriptions in the Environmental Objectives system, the agencies have a large degree of autonomy. (However, as noted above, this can also create a barrier to achieving the objectives, as the solutions may not be sufficiently ambitious.)
These agencies then in turn are part of shaping the playing field for the building sector in Sweden. The degree to which the Environmental Objectives system is mandatory and prescribed to be at the forefront of the specific agencies work seems to have influence on how

much the Environmental Objectives system has influence over initiatives taken and the development of rules and regulations. Here it seems important that the agencies' governmental instructions correlate with the Environmental Objectives system.

With respect to circular economy ambitions, the objectives build on the loops and cycles that have been discussed in Sweden since the 70s. Overall, it was considered that the focus on circular aspects are a central part of the generational goal and the objectives, with the system clearly relating to circular economy aspects in general, and to some extent towards the building sector. Emphasis is on toxic free loops as well as waste reduction and recycling.

The impact assessment found that it is considered that the focus of the environmental objectives and the circular economy are very similar. Circular economy adds a financial aspect to the traditional Swedish way of striving for loops, and the interviewees emphasised the importance of not losing the qualitative aspects of what is used and reused, e.g. chemical content. It was identified that it is not only about the amount of material recycled, but also about content, keeping track of the dangerous substances, not spreading them and making sure they are phased out of the cycles in the long run. They also mention the gain of doing things "right" from the beginning, designing for a circular economy, thinking long term, not just one more cycle.

There have been initiatives in the last few years, stemming partly from the Environmental Objectives, which indicate a movement in the direction of more focus on building and material information (e.g. LCA, Building logs etc.), design for deconstruction and oversights of the building regulation with regard to more modern building regulations including health and sustainability issues. Thus, it seems that the current version of the Environmental Objectives system does further development in a more circular direction.

It was not considered that the environmental objectives system would be suitable for upscaling to the EU level, as would be too complex and complicated to get multiple governments to agree to the objectives and likely that they would be watered down. Nevertheless, the generational goal "to hand over a society in which the major environmental problems in Sweden have been solved for the next generation, without increasing environmental and health problems outside Sweden's borders" should be the basis of every environmental/sustainability policy program of EU and its member states.

5.4 Tracimat

Construction and demolition waste (CDW) originates from demolition of buildings and construction works, as well as during construction and breakdown of roads and pavements. When the stony fraction of this CDW is processed by the crusher, 'recycled aggregates' are produced. These aggregates originate from the mechanical processing of inorganic material from construction works (VLAREMA, art. 1.2.1).

When buildings are demolished, new materials are created that are eligible for reuse or recycling. Their field of application is, to a large extent, determined by their purity. Thanks to selective demolition, pure fractions are collected on site. To stimulate the practice of selective

demolition, Tracimat (TRACIng MATerials), a voluntary supply chain tracing system, was set up.

Tracimat is a non-profit neutral construction and demolition waste (CDW) management organisation that will certify the selective demolition process by issuing a "certificate of selective demolition" for demolition waste that has been selectively collected and subsequently gone through a tracing system, thereby assuring the processing company of the quality of the recycled demolition waste.

In Flanders, if the CDW is accompanied by a "certificate of selective demolition" the processor can accept the demolition waste as "low environmental risk material" (LERM) and can therefore process it separately from waste streams with a high environmental risk (HERM).

Tracimat initially focuses on the stony fraction, which in terms of weight by far represents the greatest portion of the CDW in Flanders and Belgium. The processor of the stony fraction of the waste, i.e. the crusher, produces 'recycled aggregates'. Tracimat traces selectively collected stony demolition waste from its point of origin down to the crusher, thereby requiring distinguishing between LERM and HERM at the time of acceptance and assuring the crusher of the environmental quality of the input demolition waste. Where possible, the organisation's field of activity will be expanded in the future to include other types of CDW materials, e.g. timber waste.

Tracimat is legally incorporated into the Flemish environmental regulation VLAREMA for Sustainable Management of Material Cycles and Waste, implemented in the Flemish Materials Decree. Tracimat operates in feedback with the Common Regulation for Recycled Aggregates, allowing it to trace construction and demolition materials down to the crusher.

A new acceptance and processing policy (LERM vs HERM) for producers of recycled aggregates came into force in August 2018. From this point, all producers of recycled aggregates should differentiate between materials with high and low environmental risk.

5.4.1 Conclusions of the Impact Assessment

Barriers

Very little data is available on the production and quality of recycled aggregates. Currently producers of recycled aggregates do not keep data. Due to this lack of data, it is difficult to quantify the impact Tracimat can achieve through the new acceptance policy (LERM versus HERM) for producers of recycled aggregates.

The lack of trust between stakeholders within the building value network was identified as one of the main obstacles of a circular economy within a built environment. A good example is given by the current lack of trust in the quality of recycled aggregates. The Impact assessment concluded that the introduction of the new acceptance policy (LERM versus HERM) for producers of recycled aggregates will ensure a certain level of quality of LERM and by doing so is an important step to increase trust between demolition contractors, crushers, manufacturers and building clients.

The introduction of Tracimat would in practice mean an additional cost for the contractor (and therefore the building client/owner), whilst also ensuring that legal obligations are complied with. Tracimat should therefore provide an added value in the monitoring of demolition sites and the enforcement of the legal obligations. However, to make the system self-regulating, it was identified that the additional cost of following the Tracimat procedures must at least be compensated by the price difference between LERM and HERM, which currently depends upon market conditions. Market forces in turn are partly determined by the confidence of the crushing firms in the tracing system and the enforcement of the legislation on LERM and HERM.

The impact assessment also noted that it is usually impossible to ensure in an economical way that no more disturbing substances are present in the stony fraction of the waste. The question therefore is: which pollutants will be accepted by the Tracimat management organization and in what quantity? The amount of disturbing substances still present in the stony fraction will depend on the recommendations of the expert and the choices made by the contractor in the execution of the demolition works.

It was also noted that crushing companies will need to reorganize at the crushing site, as they will have to make the distinction between LERM and HERM for the incoming stony fraction. This will provide a social benefit but at an economic cost.

The impact assessment identified that the success of Tracimat could be hindered by non-alignment of regulation in bordering areas. The fact that a huge amount of stony waste originates from the Brussels Capital Region, where Tracimat currently has no authority, is a risk for the actual application of tracing and certifying selective demolition waste practices. It is expected that some Walloon crushing firms (situated in the south of the Brussels Capital Region) would benefit from the implementation of the new acceptance and processing policy (LERM vs HERM) in Flanders, because there is no incentive yet to separate LERM and HERM in the Walloon region. Policy alignment between the three Belgian regions is therefore recommended. Similar experiences have been acquired during the implementation of the Energy Performance of Building Directive (EPBD) in the early 2000. Each Belgian region has enforced different policy rules (e.g. other energy performance thresholds) leading to regionalised building practices, with EPB advisors, architectural and engineering firms specialised in regional regulation. Even though EPBD policy measures have been (better) aligned within Belgium over the last years, this regional specialisation is still active. It is unclear what the effect on the economy of de-regionalisation would be.

Opportunities

The main purpose of Tracimat is to enhance the quality of recycled aggregates, in order to be used for high value recycling applications. The introduction of Tracimat can ensure that legal obligations are met, such as the obligation to draw up a waste demolition and asbestos inventory and the mandatory removal of hazardous substances. This improvement is required by law today, but is not applied to its full potential yet. It is estimated that for only 1 in 10 demolition works where a demolition inventory is mandatory, the inventory is actually

present. For the asbestos inventory this is the case for 1 in 20 demolition works. Moreover, hazardous waste is not always disposed of separately (e.g. fluorescent lamps).

The new acceptance policy (LERM versus HERM) for producers of recycled aggregates is designed to ensure a certain level of quality of LERM. The increased trust resulting from this, might influence the current barriers for high quality applications of recycled aggregates. In general, it was concluded that there is a huge opportunity for improvement in the upcycling potential. However, the market demand needs to follow, in order to upscale alternative applications, to replace decreasing demand for construction of new roads.

Historically, the lack of enforcement of the waste demolition inventory and asbestos inventory regulations has resulted in a large percentage of actors ignoring the requirements. The implementation of the Tracimat supply chain tracing system aims to provide an added value in the monitoring of demolition sites and the enforcement of the legal obligations. The higher purpose of Tracimat is to enhance the quality of recycled aggregates for high value recycling and therefore to create purer waste streams with a greater upcycling potential. This objective is primarily supported by recent changes made within the Flemish environmental regulation for sustainable management of material cycles and waste (cf. VLAREMA) and the new acceptance policy measure of August 2018 (cf. LERM vs. HERM). Both policy measures will lead to development and better monitoring of waste management plans for all demolition works requiring an environmental permit.

The Impact Assessment identified several social impact opportunities in terms of employment and training, alongside new jobs for the management organisation of Tracimat itself for development of the system, as well as training, inspection and evaluation.

The lack of up-to-date and reliable data on the production and quality of recycled aggregates currently leads to failure to understand the current situation and to monitor the effectiveness of regulations on that aspect of CDW. The implementation of the Tracimat system is considered to provide an opportunity to gather such data. The proper collection and analysis of data could lead to the development of the Tracimat management organization as a knowledge center, who can share experiences and know how. This could result in the availability of very useful databases with figures about the quantities and applications of CDW originating from demolition of buildings and construction works. The expansion to other types of waste materials than stony fraction (such as timber waste and electronic waste) is currently being investigated by the Tracimat management organization. Where possible, the organisation's field of activity will be expanded in the future.

5.5 Programme Régional en Economie Circulaire (PREC) (2016-2020)

The Brussels Capital Region’s Programme Régional en Economie Circulaire (PREC) (2016-2020) aspires to make a structural transformation of the Brussels’ economy, transforming it into not only a circular economy but a low-carbon one, which creates employment and added value while respecting the environment and quality of life of Brussels’ inhabitants. It defines the circular economy as an economic system of exchange and production, which, at all

moments in the lifecycle of products (goods and services), aims to increase the efficiency of the use of resources and drastically reduce their waste, reduce the environmental impact of products, and develop the well-being of individuals. The Program has 3 general objectives: transform environmental objectives into economic opportunities, anchor the Brussels' economy in Brussels to produce locally when possible, and contribute to the creation of jobs. To achieve these general objectives, 111 measures have been outlined across 4 strategic areas – transversal measures, sectoral measures, territorial measures, and governance measures. By 2019, the PREC aims to provide a complete support package for this transition, including but not limited to:

- Subsidies
- Economic aid for businesses
- Access to loans and other regional incentives for circular investments
- Evaluation of jobs to be created
- Training
- 50% of relevant public procurements are to contain clauses for circularity

The measures and approach of the PREC are inspired by a study commissioned and published by Brussels Environment in 2015 on the urban metabolism of the region, its flux, actors, activities and possible routes for resource optimisation. The study was led by EcoRes, ICEDD, and BATir (ULB). Using figures and statistics, this study illustrated the importance of the construction sector for the Brussels Capital Region to transition towards a circular economy. According to the study, construction is responsible for 20% of resources coming into Brussels, it produces a large amount of waste (34% of the region's non-household waste), and is the largest stock (84% of the total mass) of materials in the region (EcoRes et al., 2015). Recognizing the necessity of tackling this sector to achieve Brussels' circular objectives, the PREC announces a series of specific sectoral measures for construction, including a measure to put into place a monitoring tool for the sector and its evolution. To do this, it is foreseen to rely on data from no one source but various sources, and to then harmonize the data to come to a complete illustration of the sector.

5.5.1 Conclusions of the Impact Assessment

The Impact Assessment for the PREC looked at past policies related to data collection on construction and demolition waste and their impact on data collection for circularity objectives, in particular the PREC.

The European Commission has identified the lack of data on construction and demolition waste in general, as well as on the quality and the quantity of specific waste streams, as an important issue for qualitative waste management and the transition towards a circular economy in the built environment.

Based on the role given to data in the development of the PREC through the urban metabolism study, as well as the importance given to developing indicators for monitoring the sector as the Brussels region works to transition to a circular economy, the impact assessment

identified success or fail factors regarding data collection for waste policy which can be extended to recommendations in circular contexts.

The different laws that have been assessed build upon one another.

Barriers and Opportunities

The Ordinance of 91' concerning the prevention of waste develops a reporting obligation for hazardous waste that could be extended to other types of waste. This enabled extending the reporting obligation to construction and demolition waste and the obligation to recycle debris (stony fraction construction and demolition waste) with the aim to achieve 70% recycling of construction and demolition waste as stated in the 1995 law relative to the mandatory recycling of certain construction and demolition waste. Furthermore, the 1997 law on the waste registry defines the required maintenance of a waste registry enabling the control and monitoring of infractions.

Initially, the ordinance of '91 aimed to allow assessing quantities and waste flows and to facilitate planning. However, these objectives have been adapted along the way for different reasons:

- The accuracy of data and difficulties to extrapolate statistics
- The lack of resources required for the administration to verify the quality of the data and to process and analyse the data

As a result, the data cannot be used to monitor the flows and types of construction and demolition waste and their potential recycling and reuse. Therefore, the data within the registry cannot be used to assess the current situation and to fix realistic circularity targets.

The laws mentioned above have been brought together with 8 additional laws on waste management into the 2016 Law on waste management, (implemented since 01/01/2018). This law aims to simplify the administrative burden for the actors and administration, and to extend the list of actors targeted by the reporting obligations, incorporating the waste producers, in order to make sure that the whole supply chain is covered. Furthermore, the law will enable improving the traceability of the waste. However, no adaptation/extension has been foreseen to enable using the gathered data for monitoring or planning.

The importance of accurate data that can support the monitoring and definition of circularity targets is identified by different members of the Brussels administration for environmental management (Brussels Environment, previously IBGE). However, the administrative burden is also acknowledged for the different actors who have to provide, collect, process and analyse the information. To accept this burden, the data provided must offer a clear added value. This means that the following all must be aligned: the objectives of the data collection, the clarity of the data requested to meet those objectives, the different stakeholders that need to be involved, and the adequate financial and HR means.

It is noted that the SMARTWaste system, highlighted in the Site Waste Management Plan IA above, does not impose the same level of administrative burden for data gathering. Data

gathered through SMARTWaste was used in the *Resource Efficient Use of Mixed Wastes: Improving Management of construction and demolition waste* (2017) commissioned by the European Union. [18]

An idea was proposed to possibly imagine a multi-step process towards more complete data. The sector is shifting to a data focus for various aspects of its activities (BIM, MPs). In the long-term, policy makers can capitalize on that data for policy purposes as well. Nevertheless, in the short/middle-term, we can continue to try to make effective circular policies relying on alternative, less broadly applied methods (qualitative and quantitative) and/or incentive schemes. One of these alternatives is the conduction of punctual studies and surveys defining the materials flows for the built environment.

5.6 Incorporação de 5% de Materiais Reciclados (2011)

Prior to 2008, there was no specific policy or framework for CDW in Portugal. In 2008, a CDW framework was implemented in response to European legislation. This was further updated as part of the review of the national waste management legal framework in 2011 (D.L. 73/2011). For the first time, a measure of green public procurement was introduced, which stipulated that "at least 5% of recycled materials or materials containing recycled components, should be incorporated in public construction works, regarding the total amount of raw materials used in public construction works".

From this point, the measure was to be included in public tenders, being integrated in the design stage and verified during the construction stage of public buildings.

The measure is one of a number of green public procurement measures in place in the public sector in Portugal, which are designed so that public authorities provide an example for private corporations.

The policy is under the umbrella Environment Agency, Portugal's environment ministry.

5.6.1 Conclusions of the Impact Assessment

To date, there is no official indicator or study to evidence if the 5% required target has been achieved and therefore it is impossible to know how successful this policy has been. Indeed, in 2016 the Environmental Agency surveyed the public construction industry, not to assess/measure the percentage of recycled material, but to gain information on the level of understanding of recycled materials by the different actors involved. This study identified that the regulation did not contain a definition of recycled materials or materials containing recycled components. The Environmental Agency published a clarification in July 2016 (Circular 01/2016/DRES-DFEMR, APA[19]) with information to clarify non-compliance.

Primary research conducted by BAMB partners for the Impact Assessment has concluded that there is a lack of awareness, technical information and monitoring across the industry in

[18] https://publications.europa.eu/en/publication-detail/-/publication/78e42e6c-d8a6-11e7-a506-01aa75ed71a1/language-en

[19] http://www.apambiente.pt/_zdata/Politicas/Residuos/Circulares/Circular_1_2016.pdf

Portugal, with nearly 30% of respondents saying that they did not know about the existence of the measure. For those who were aware and for whom the legislation was applicable, 52% of respondents admitted that they did not comply. They identified main barriers as the lack of verification, control and demand by public organisations (ultimate responsible by the projects), lack of will and lack of technical knowledge. Only 5% identified the target as a measure that is difficult to implement

Barriers

As part of the Impact Assessment, a stakeholder consultation exercise and a survey were conducted which identified a number of barriers to the successful implementation of this green public procurement measure:

There is no enforcement of the regulation by the public institutions. Indeed, there is a lack of ownership of the measure and without a regulatory body for construction and demolition waste, no department takes responsibility for ensuring that the relevant construction firms adhere to the regulation, or ensures that the requirement that has been written in to contracts has been applied to the projects. This is considered to be a contributory factor to the low awareness rate of the policy and the apparent lack of engagement.

Lack of awareness was also concluded to be a serious barrier to implementation. This extends to local authorities and government departments, who, as the customers for public construction projects, would be well placed to enforce the requirement for recycled materials to be included in projects. Indeed, the general lack of awareness was identified as extending across the entire supply chain and all stakeholders.

The impact assessment identified a lack of data as a serious barrier. Currently, the Portuguese government does not know the extent to which recycled materials are being used within public construction projects and the regulation is being complied with. High quality data would allow the impact of the measure to be quantified and benefits to be captured and communicated to stakeholders. The impact assessment has also identified a lack of technical knowledge by industry professionals over how to measure and monitor the 5% targets themselves.

Environmental topics/subjects are still not widely considered by designers, architects and engineers and it is unclear where the responsibility across design teams for the implementation of this measure lies.

The cost of implementation was also considered to be a barrier. The construction industry in Portugal in 2017 mainly consists of micro, small and medium companies (98.2%[20]) that represent 66.2% of total value of the public contracts. These companies have a lack of capacity to respond to and include new requirements in their processes.

Opportunities

Several key opportunities for better implementation of the *Incorporação de 5% de Materiais Reciclados* were identified by the Impact Assessment. In particular, it was noted that the

[20]http://www.impic.pt/impic/assets/misc/relatorios_dados_estatisticos/Relatorio_Anual_ContratosPublicos_2017.pdf

legislation is currently being reviewed and this provides a window of opportunity to make changes to the measure which would support its success. These could include:

- Identification of an 'owner' for the measure who would be responsible for measuring, monitoring and reporting on its implementation.
- More effective communication of the requirement to use 5% recycled materials. Communication of the measure across the supply chain and all stakeholders would ensure that awareness was raised and would encourage its take-up. Additionally, case studies demonstrating the benefits of the measures could be developed which would support the implementation of the measure.
- Requirements for monitoring, which would allow better understanding of the level to which the measure is being implemented and its impacts.
- Setting clear objectives for the measure. This would provide a strong message for the construction industry and enable advantages to be identified and communicated more effectively.

The impact assessment identified that there are opportunities to enforce the measure through engaging local authorities. They can act as ambassadors for the use of recycled content in construction, both as customers and inspectors, using the planning permission process during design stage.

It was noted in the impact assessment that one of the drivers for implementing this measure has been when the construction projects are using a certification process (such as BREEAM or LEED) or when they are receiving international funds.

5.7 Conclusions and recommendations

There are a number of conclusions which can be drawn from the Impact Assessments regarding the critical success factors of policy regulation.

Data

From the Impact Assessments, it was noted that an important critical success factor for a policy is the quality and quantity of data available. This has an effect on the impact of the policy in a number of ways:

- High quality data is required for the meaningful definition and monitoring of targets. As identified in both the Site Waste Management Plan IA and the PREC, without high quality data, it is impossible to know if the policy or regulation is achieving what it set out to achieve and to adapt targets as required.
- The data required needs to be well-defined and standardised to maximise its value and allow for effective benchmarking and monitoring, as identified in the Site Waste Management Plan IA.
- Stakeholders need to understand the objectives of data collection, and what added value that data provides. Gathering and supplying data in a standardised format comes

with a financial and time cost to organisations, so only the data which is required should be requested.

- Sufficient resources need to be allocated to verify the quality, to process and to analyse the data, as identified by the IA of the PREC.
- The value network and all actors required for data collection, processing and analysis need to be considered to avoid data gaps.

Alignment

Alignment at different governmental/ geographical levels was also identified as a success factor of a policy. From the experience of Tracimat, it was viewed that, as the neighbouring Brussels Capital region is not participating in the scheme, this will reduce the positive impact as some CDW waste will be processed across the regional border.

The Swedish Environmental Objectives also highlighted the danger of non-alignment at different governmental levels. The implementation of the system is left to individual ministries and their actions may not be sufficiently ambitious to reach the objectives.

Enforcement

The presence of an enforcement structure was also identified as a critical success factor of regulation. The Portuguese procurement policy was noted to have not had impact, as there was no enforcement. In part, this was due to a lack of ownership for the regulation.

Cost of compliance

A further conclusion was that the cost of compliance with a policy or regulation should not outweigh the cost of non-compliance. This was identified in the Tracimat IA which concluded that there needed to be a price differential between LERM and HERM to provide a clear incentive to comply.

Clear objectives

The benefit of clear objectives was highlighted through the IAs. Clarity of communication and better understanding of the policy are key benefits. It was noted in the Swedish Environmental Objectives IA that some of the objectives were more clearly stated than others; for example, the Good Built Environment covers such a broad area that the objective remains visionary rather than a clear goal.

6 CONCLUSIONS OF THE BEST PRACTICES

6.1 Methodology

Examples of best practices were sought from the BAMB consortium partners, from the BAMB Stakeholder Network, and from workshops in Brussels and at EcoBuild in London. Basic information on each identified best practice was collated, including the geographical area of coverage, the topic and type of measure.

With over 40 best practices identified, a scoring methodology was developed to provide an initial sift of the policies/regulations to focus attention on those with the most relevance to the BAMB project and in particular to the BAMB Systemic Changes (see Figure 5):

Change in design culture from mono-functional buildings to material banks
Change in value definition from financial cost & benefit to societal added value
Change in collaboration across all actors from a chain to a network.

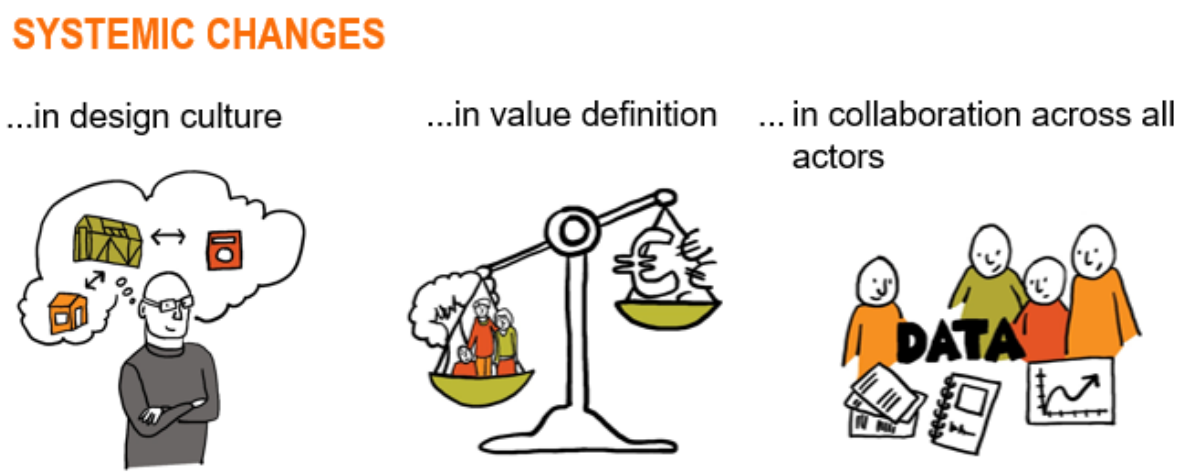

Figure 5: The BAMB Systemic Changes

The methodology considers alignment to the BAMB Systemic Changes, as well as the level of innovation and relevance to promoting a change towards Circular Economy:

Promotes a change in design culture
Promotes a change in value definition
Promotes collaboration across all sectors
Score 1-10 (1=not aligned to BAMB Systemic Change, 10=Completely aligned to BAMB Systemic Change)
Level of innovation, Score 1-10 (1= 'everyone is currently doing this', 10 = 'nobody else is currently doing this')
Promotes a change towards CE/impact Score 1-10 (1= likely to have no impact on uptake of CE principles; 10= likely to embed CE principles into Business as Usual)

The policies/ regulations were scored then discussed and verified in group sessions to ensure alignment. Based on the collated scores, the best practices with the highest overall scores were identified using the following equation:

> *Design culture + Value definition + Collaboration + Innovation + Circular Economy = TOTAL*

In order to ensure that policies/ regulations which only addressed **one** of the three systemic changes were not missed, scores were also collated for each systemic change individually to identify policies which might have the potential for promoting change in one or more areas:

> *Design culture + Innovation + Circular Economy = total for design culture systemic change*
> *Value definition + Innovation + Circular Economy = total for value definition systemic change*
> *Collaboration + Innovation + Circular Economy = total for collaboration systemic change*

Through this selection process, 16 best practices were prioritised as having the most relevance for the BAMB project and were selected for further analysis. The scoring matrix is contained in Appendix B. In addition, it was considered that Demolition and Deconstruction Permits in use in Seattle, USA, and the Green Demolition Bylaw in Vancouver, Canada, should also be examined, as no demolition/ deconstruction policies would otherwise be considered based on the top aggregate scores alone.

Taken overall, the selected best practices represent a wide range of measures, as shown in Table 1 below:

		Measure																			
Best practices	Country	Actor-based targets/ milestones	BIM format requirement	Building Passport	Financial/ tax incentives	Guidelines	Indicators	Inspirational demonstration	LCA methodology/ tool	Monitoring	Permit e-system	Permit requirements	Planning requirements	Principles	Public procurement requirements	Reuse incentive	Salvage guidance	Third party verification	Timing incentive	Visionary goals	Voluntary traceability
Act for the Promotion of Long-life Quality Housing	Japan				x	x															
Be.Circular/ PREC	Belgium	x			x		x	x		x										x	
Rijkwaterstaat Purchasing and Procurement	Netherlands														x						
Circular Buildings Green Deal	Netherlands			x		x														x	
Level(s)	EU					x	x			x										x	
BREEAM	International					x	x			x								x		x	
Design for Change	Belgium					x		x	x												
Circular Peterborough	UK	x																		x	
Procura +	EU					x															
Tracimat - VLAREMA	Belgium																				x
ISO 20887 (Draft)	International					x	x							x							
London Plan - Circular Economy	UK												x								
Leading the Cycle - Finnish roadmap to a Circular Economy	Finland																			x	
BIM Singapore	Singapore		x								x										
Demolition and Deconstruction Permits	USA				x							x	x						x		
Green Demolition Bylaw	Canada				x											x	x		x		

Table 1: Measures represented by the best practices included in this framework

6.2 Best practices

Three best practice examples had the highest overall scores, and which were therefore assessed as: being most innovative, promoting a change towards circular economy thinking and showing closest alignment to the three BAMB systemic changes:

- Longer Life Housing Law (Japan)
- Be.Circular (PREC) (Brussels, Belgium)
- Public Procurement Rules, Rijkswaterstaat (Netherlands)

These three are considered first, followed by those which show a close alignment to either one or two of the systemic changes.

6.2.1 Best practices showing alignment to all three BAMB Systemic Changes

Act for the Promotion of Long-life Quality Housing 2009[21]

The Japanese Act for the Promotion of Long-Life Quality Housing is designed to support the development of housing stock which has an extended useful life. According to the Japanese government, the average age of a house at demolition in Japan is just over 30 years, compared to nearly 67 in the USA and 80 in the UK. The Long-life Housing Law was therefore

[21] https://app.box.com/s/lixli1y11yl1x3tpc1pah27rg575qh9n

implemented to encourage the construction of high quality housing which can be easily maintained, “Long-Life Quality Housing”.

Long-Life Quality Housing is defined as superior housing with features to support long-term use in good condition. The legislation establishes an approval system for plans concerning construction and maintenance. Approved housing is eligible for exemptions from income taxes, registration taxes, and reductions in real estate acquisition taxes and fixed asset taxes. Other initiatives to promote the shift to long-life housing include the subsidized project for the development of long-life housing, the development of housing history records, and the improvement of housing finance.

This long-life-quality housing act is strongly related with the decades of experience in Japan regarding Open Building. Open Building is a design strategy taking into account the need to adapt the building during its life time, according to technological evolution and changes in user needs. One of the most important concepts within the Open Building is the disconnection of ‘support’ and ‘infill’ elements within the building. The support groups all elements within the building that represents communal responsibility, and the infill (or fit-out) as the aspect that stands for individual control. For housing the 'support and infill' concept means that dwellers have more control on design decisions regarding their own fit-out of the building. According to Seiichi Fukao (2008), the Open Building design strategy marries well the Japanese culture, because of the centuries old wooden building tradition in which Japanese carpenters build houses reflecting the requests of the residents. Some examples of Open Building in Japan are given by Fukao and BRIQS. One of the most famous is the NEXT21 pilot project, an experimental multi-family housing project constructed in 1994, in which each 7 years the building is completely refurbished according to the latest technological insights regarding energy performance (with experimental infill systems) and changing lifestyles of new groups of inhabitants.

Alignment with BAMB Systemic Changes

The Long-Life Housing Law provides a set of technical guidelines which promote a change in **design** culture. These include guidelines regarding ease of maintenance and renewal of services, particularly with respect to the disconnection of support and infill elements in a building with the requirement to be able to access service functions from outside the house. Adaptability is also considered important, with the fit-out giving great flexibility for individual residents and being configured to allow for refurbishment as required. Initiatives include:

- Minimum height between floor slabs to allow space for services to accommodate modification of the original room layouts
- Support for continuous customization in the life time of the building
- Free Plan Rental Housing with the fit-out owned by residents.

From a **value** perspective, the Long-Life Housing Law uses a mixture of legislative, taxation and budgetary measures to promote the transition from “*build and scrap”* attitudes to housing construction to the development of durable and high-quality housing stock.

In terms of a systemic change towards a change in **collaboration** across all actors, the law and the resulting adaptability has led to a high level of industrialisation of the building components. Japanese industrialised house and infill producers are taking advantage of information technology to make it possible for their customers to feel they are designing their house by themselves.

Circular Economy impact

The lengthening of the life of a house will reduce the consumption of natural resources and the economic burden of housing expenses for families and should contribute to the solution of global environmental issues and the impacts of waste in the future. The adaptability promoted by the Long-Life Housing Law should also encourage a move to a circular approach to residential property.

Recommendations

This regulation is considered to be unique in its scope and ambition. It considers design aspects to increase the lifespan of housing, as well as the adaptability, and quality of construction. It responds very well to the needs of Japanese housing in the 21st century. Since the 1990's Japan has been experimenting with Open Building design concepts, supported by the building industry. With the introduction of the Long-Life Quality Housing Act, it is expected that Open Building will only gain in importance. In Europe, some countries such as the Netherlands, Belgium and Finland also experimented with Open Building. However, this was never mainstream.

Exceptional elements of the policy include concern for spatial aspects, for example in specifying a minimum height between floor and ceiling, which allows sub-flooring for technical functions, piping, and electricity. Also notable is the requirement to access piping and utilities from outside the house. These kinds of requirements could be integrated in construction or permit regulation requirements.

Financial and tax incentives are coupled to the regulatory requirements, providing a positive cost rationale for compliance.

It is also noted that a side effect of the regulation is market facilitation. Companies are developing modular systems for the infill or fit-out of the houses in response to the laws.

Be.Circular / PREC[22]

This policy programme, the Regional Programme for Circular Economy (PREC), applies to the Brussels Capital Region of Belgium and runs from 2016 to 2020. It has 3 overall objectives:

- Turn environmental objectives into economic opportunities.
- Anchor the economy in Brussels – to produce locally when possible, reduce transport distances, optimize land use and create added value for Brussels.

[22] http://document.environnement.brussels/opac_css/elecfile/PROG_160308_PREC_DEF_FR

- Support job creation.

In order to reach these objectives 111 measures have been defined within 5 sectors: Construction, resources and waste, logistics, retail and food.

The policy programme is considered innovative. The actions undertaken with regards to the transition towards a circular and dynamic built environment are based on an analysis of the current situation within the Brussels Capital Region and the barriers and opportunities this offers in order to provide concrete measures and actions to be implemented. These are developed in close cooperation with the different stakeholders and based on experiments, stimulation of research and the monitoring of the suggested actors. Meanwhile, targets and actions targeting specific actors have been developed in collaboration with those actors.

Alignment with BAMB Systemic Changes

Different initiatives aim to support a change in **design**, integrating different principles of circular economy. For example:

- The vision document emphasises the importance of a change in design in order to meet circular economy objectives
- The "Appel à projet Be Circular - volet Chantiers Circulaires" (Be.Circular Call for circular building sites) initiative aims to support circular building construction and refurbishment, to support changes in design which will integrate principles of (in-situ) reuse, repair and remanufacturing. It provides a financial incentive as well as an inspiration/ stimulation for the market.

With respect to **collaboration**, there are a number of initiatives which align with the BAMB Systemic Changes, including the development of a platform for the stakeholders active in the reclaimed materials and products sector. Furthermore, the definition of objectives, indicators and the actions to be taken to achieve these objectives are based on a participative process integrating different types of stakeholders.

Circular Economy Impact

The policy and related initiatives directly support the move to a circular economy in the five target sectors by engaging citizens, industry and government through a range of measures.

Recommendations

From the construction industry perspective, the development of the PREC has included engagement with construction professionals, including designers and contractors. Together with the sector, the public authority is defining goals and indicators, which will make implementation easier.

Different working groups have been developed to develop actions, for example, on training. Overall, the implementation of the PREC is an example of *awareness raising* amongst professionals

For business and environmental aspects, the PREC takes into account the need for monitoring, and indicators[23] are currently being developed.

Rijkwaterstaat Purchasing and Procurement (Rijkwaterstaat – Inkoopbeleid en aanbestedingen)[24,25]

The Purchasing and Procurement Rules of the Rijkwaterstaat (the Ministry of Infrastructure and Water Management) is a national policy adopted by the ministry responsible for the design, construction, management and maintenance of all Dutch infrastructure, including roads, canals and water systems, such as dykes.

The Purchasing and Procurement rules reflect three pillars of sustainability: environmental, economic and social. The scoring is set so that higher positive scores for environmental and social aspects of a contract reduce the weighting factor for the cost.

Alignment with BAMB Systemic Changes

From a **design** perspective, contractors are given the opportunity to come up with innovative design approaches, as the Rijkswaterstaat makes use of solution-free requests (performance-based rather than prescriptive objectives), using functional specifications wherever possible.

Additionally, Rijkswaterstaat makes use of the MKI value (Milieu Kosten Indicator), or environmental costs indicator, which quantifies the environmental impact of a civil engineering project - the lower the value, the less environmental impact. Designs that differ considerably in terms of materials also differ in terms of environmental quality. The MKI is calculated using a system called DuboCalc, developed by the ministry to compare the sustainability **value** of design alternatives.

The MKI can be integrated into the calculation of the EMVI (Economisch Meest Voordelige Inschrijving), or Economically Most Advantageous Submission, so that the lower the environmental impact, the higher the economically most advantageous criteria. The Rijkswaterstaat aims to reserve a high percentage of the EMVI criteria for environmental quality.

CO_2 reduction is also encouraged, and is calculated through another Rijkswaterstaat tool, the CO_2-performance ladder. This is a certification system, through which contractors demonstrate the level to which they limit CO_2 emissions in their company and their projects.

The Rijkswaterstaat has introduced a new way of thinking about the division of roles between client and contractor which results in a more **collaborative** approach. BVP (best value

[23] http://document.environnement.brussels/opac_css/elecfile/PROG_160308_PREC_DEF_FR

[24] https://www.rijkswaterstaat.nl/zakelijk/zakendoen-met-rijkswaterstaat/inkoopbeleid/duurzaam-inkopen/

[25] https://www.rijkswaterstaat.nl/zakelijk/zakendoen-met-rijkswaterstaat/inkoopbeleid/aanbesteden/index.aspx

procurement) means a shift of 'control and manage' to 'let go and trust', of 'directed by the client' to 'guided by the contractor'. This means that the Rijkswaterstaat facilitates and lets the contractor take the lead. The expertise of the contractor is key as well as making the results achieved transparent for both client and contractor.

This leads to:

- A better use of the expertise of the contractor as well as better cooperation over the value chain.
- Transparency and monitoring in the performance and thus quicker learning for both the client and the contractor

Circular Economy Impact

The Purchasing and Procurement policy does not directly focus on the Circular Economy, although the use of DuboCalc promotes the reuse of materials and reductions in the use of raw materials. At this stage, multiple uses of materials are not included in the calculations. It is recommended that the Dutch Government (and others) consider implementing the CBA methodology to further support circularity instead.

It is noted that the Rijkwaterstaat is aiming to be climate-neutral and circular by 2030 and the policy has great potential for impact if Circular Economy assessment criteria are included in future.

Recommendations

Regarding value definition, the procurement policy works on three different pillars: price, environmental and social aspect. The public procurement process quantifies the environmental and social impacts and integrates external costs into the total price. Thus, if you decrease environmental and social costs, there is a higher tolerance for price. This has a clear impact on value definition.

That the Rijkwaterstaat can stipulate the performance of buildings, rather than pre-identifying solutions, encourages collaboration and innovative approaches. It can ask contractors to provide solutions and present a risk analysis which considers things which may not have been foreseen by the procuring entity.

Once a contract is ongoing, there are weekly reports to follow up and be sure that there is no deviation. If there is a problem, the procuring entity and contractor find a solution together, thus sharing the risk. This can be used to flag problems at a very early stage. There's a higher likelihood of risk as they are implementing innovation, so there may be unforeseen issues which haven't been anticipated by the procuring entity.

The experience of the Rijkwaterstaat demonstrates the principles of Green Public Procurement (GPP) in practice and its potential to become the default option (with the inclusion of circularity) at a wider scale.

The procurement system has four tools to support decision making. Given the likely future objectives in relation to circular economy, and the ability to reduce environmental impact

through circular building scenarios, there should be potential to add BAMB's Circular Building Assessment (CBA) into this process or adapt/build upon the BAMB learning and outcomes related to decision making support.

6.2.2 Best practices showing strong alignment to two or one systemic changes

The best practices in the following section show strong alignment to either two or one of the BAMB Systemic Changes

Circular Buildings Green Deal[26]

The Circular Buildings (CB) Green Deal in the Netherlands is one of a number of Green Deals in the construction sector. Initiated by the 'Rijksdienst voor Ondernemend Nederland', an executive department of the Dutch Ministry of Economic Affairs, this CB Green Deal lasted three years, from January 2015 to December 2017. It engaged 59 Dutch organizations (governments, knowledge institutes and businesses) to conceive circular buildings:

- using the smallest possible amount of new resources and products.
- retaining products and resources within the chain (for high-quality applications) for as long as possible. This also involves extending the life of buildings by making them as adaptable as possible.

Through the CB Green Deal a common framework was developed involving a 'building passport' in which details of essential circular building features are measured and recorded. The tool – applicable for new and existing buildings - and its manual are now freely available through the website of the CB Green Deal. Both instruments have been tested on 6 pilot projects. Insights and lessons-learned have been captured and disseminated through the website.

Although the Green Deal itself has now closed, new initiatives have started in the Netherlands. One of them is the CB23 platform, in which different Dutch protagonists of circular buildings joined forces to support the transition to circular economy in the built environment, by (1) knowledge gathering, (2) inventory and disseminating barriers, and (3) developing broad sectorial agreements. This platform has started in 2018 and will last 5 years, hence the name CB23 Platform. Three action teams have been set up, looking at:

1. a framework for circular building: towards a clear understanding of Circular Building and its principles
2. measuring circularity: towards a uniform and effective assessment method
3. passports for the building: towards harmonization of different building and materials passports initiatives.

The objectives of the CB23 platform are in line with the Green Deal Circular Building, and also the BAMB projects. The three action teams can be easily matched with the development of a Common Language, reversible building design tools, the Circular Building Assessment and Materials Passports in the BAMB project.

[26] http://www.greendeal-circulairegebouwen.nl/producten

Alignment with BAMB Systemic Changes

The CB Green Deal is particularly strongly aligned with the BAMB systemic change in **design**. Using the building passport assessment tool, designers are encouraged to approach design in a different way and critical questions are asked of the design proposal to encourage circular thinking. There is additional focus on how to make existing buildings circular during their lifespan.

With regards to **value**, the goal of the CB Green Deal is to make building components reusable and buildings adaptable, so that their value is better conserved through time, strengthening the business case for long-term investors. It is also noted that sustainability aspects go beyond the economic impacts. Themes for building elements include: adaptability, disassembly, origin of materials, end-of-life (EOL) of materials, extended lifetime / maintenance, energy consumption, financial continuity, health, and safety.

Considering issues of data and **collaboration**, 'Building circularity' indicators have been developed in the passport, regarding used products and materials, management and maintenance, refurbishment and adaptability of the building in the future. The passport can serve as a tool for both governments and market players who want to assess the circularity of a building during its operational phase and who want to contribute to the realisation of circular buildings.

Circular economy impact

The policy programme has great potential for circular economy impact. The building passport records essential features of circular buildings. Based on the shearing layers concept[27], introduced by Frank Duffy and further elaborated by Stewart Brand, important design criteria have been developed for the location of the building, its bearing structure, the building skin, technical services, space plan furniture and other utility items. The use of the building passport has been tested on 6 pilot buildings. Useful insights and lessons-learned were captured, providing insight into the different processes and steps that must be followed.

It was noted that the policy is broad and neutral. Whilst it provides some critical questions for the stakeholders (mainly in the operational phase) regarding a building's features (adaptability etc.), the framework is voluntary and contains no practical guidelines on how the designer can influence the circularity of the building, nor does it provide clear practical technical examples. The building passport developed within the framework of the Green Deal Circular Building must be seen as a first voluntary step in the Netherlands towards an open assessment method of circular building features. Already other initiatives have been started meanwhile, such as the CB23 platform and the BREEAM NL framework for Circular Building, providing more technical insights and validation of the work of the Dutch Green Deal Circular Buildings.

[27] The Shearing layers concept views buildings as a set of components that evolve in different timescales; Frank Duffy summarized this view in his phrase: "*Our basic argument is that there isn't any such thing as a building. A building properly conceived is several layers of longevity of built components*" (quoted in Brand, S. (1994). How Buildings Learn. New York: Viking)

Recommendations

The Green Deal focuses on building passports which can be used to assess the circularity of the building during the operational phase. However, these passports remain very broad and only used to assess qualitative characteristics of (circular) buildings. A simplified form of the Circular Building Assessment (CBA), incorporating quantitative indicators such as transformation capacity and reuse potential of the building, its spaces and components, could be brought into the building passports to embed circular economy thinking (e.g. a checklist). If the idea of building passports were to become more widespread, they could become a way of obtaining data on the value of the building stock.

Level(s)[28]

Level(s) is being developed to be a Europe-wide voluntary reporting framework and is currently being trialled. It is designed to improve the sustainability of buildings. Using existing standards, Level(s) provides a common EU approach to the assessment of environmental performance in the built environment.

Level(s) is an assessment framework (integrating different tools), supporting design and construction decisions. Indicators use Life Cycle Assessment and Life Cycle Costing principles to assess environmental performance. The indicators are directly linked to EU policy goals to allow users of the Level(s) framework, or schemes or tools that are aligned with the framework, to know that they are contributing to meeting these goals.

Macro objectives which are particularly aligned to BAMB are:

- Greenhouse gas emissions along a buildings life cycle
- Resource efficient and circular material life cycles
- Optimised life cycle cost and value.

There are three levels of performance assessment:

1. Checklist
2. Comparative assessment
3. Optimisation of performance assessment.

The Level(s) framework makes it possible to report on building performance by using building specific indicators at the following project stages along the life cycle of a building:

- Design stage (based on calculations, simulations and scenarios)
- Implementation stage (based on as-built drawings, specifications and tracking)
- Completion stage (based on commissioning and testing)
- Operation stage (based on measured performance and occupant satisfaction)

[28] http://ec.europa.eu/environment/eussd/buildings.htm

Level(s) is currently in the testing phase (scheduled to end in March 2020) and is being trialled on residential buildings and offices.

Alignment with BAMB Systemic Changes

Level(s) is broadly aligned to the BAMB system change on **design,** as it promotes adaptability, as well as making consideration of the impact across the whole building life cycle at the design stage. It takes a holistic approach to the building, including for example embodied carbon as well as energy performance. Amongst the tools which are available, Level(s) provides life cycle tools which promote changes in design through consideration of three scenarios:

- Building and elemental service life planning
- Design for adaptability and refurbishment
- Design for deconstruction, reuse and recyclability.

From a **value** perspective, Level(s) seeks to optimise the life cycle cost and value of buildings. It takes into consideration the potential *to recover, reuse and recycle major building elements*[29].

Recommendations

Through the Level(s) testing phase, data is being captured on buildings across Europe. This could be used to develop benchmarking tools at a later date.

The BAMB consortium should continue to engage with Level(s) for possible alignment with BAMB objective and potential for provision of additional tools to realise Level(s) objectives.

BREEAM

BREEAM stands for BRE Environmental Assessment Method. Established in 1990, it was the world's first commercial sustainability assessment method for master planning projects, infrastructure and buildings. It recognises and reflects the value in higher performing assets across the built environment lifecycle, from new construction to in-use and refurbishment. BREEAM does this through third party certification of the assessment of an asset's environmental, social and economic sustainability performance, using standards developed by BRE.

At the time of writing (Dec 18), over 566K certificates have been issued, 2.275 million buildings have been registered for assessment, in over 79 countries. Technical standards (against which developments are assessed) exist for Communities, Infrastructure, New Construction, In-Use, Refurbishment & Fitout.

In 2017, BRE published a report which mapped the resource efficiency related criteria in BREEAM Schemes[30].

29

http://susproc.jrc.ec.europa.eu/Efficient_Buildings/docs/170816_Levels_EU_framework_of_building_indicators_Parts.pdf

Key features related to material efficiency in the New Construction (2014) scheme include credits for responsible construction practices, design for durability and resilience, material efficiency (optimized during the design process) and construction waste management. Changes were made to this scheme (2018) that will further enhance Design for Disassembly and Adaptability (Wst 06).

In October 2018, the Dutch Green Building Council (the DGBC), who manage the BREEAM NL scheme, launched a publication called *A Framework for Circular Buildings: Indicators for possible inclusion in BREEAM*. The report identifies six crucial indicators to potentially include in BREEAM-NL. These are:

- Accountability and substantiation of building volume
- Design for reassembly
- Maximize amount of reused materials
- Maximize amount of renewable materials
- Availability of information (element, component, material)
- Building design embodies no or minimal toxicity

The work developed by DGBC and published in October 2018 will be reviewed and discussed with BRE in the near future.

Alignment with BAMB Systemic Changes

As a tool for designing and constructing sustainable buildings, BREEAM is well-aligned to the BAMB Systemic Changes, particularly regarding design and value.

Design – BREEAM has great focus on the planning and design process, this is where the most impactful decisions are made in terms materials selection and design strategies that could impact on ability to transform in-use, or deconstruct post-use.

Value – This is less impacted by BREEAM but does kick start a conversation through aspects like the pre-demolition and refurbishment audits. Further tightening of requirements for these audits to be undertaken earlier and through independent (of selected contractor) evaluation should improve outcomes here. Driving demand for reclaimed products and materials could also be a result (especially in Excellent and Outstanding categories).

Data – increasingly the use of data (via BIM) is used to determine various environmental and economic results, including options appraisals. BREEAM is a key driver to create a growing number of dedicated, BIM enabled, tools developed in the last few years – such as LCA related software. The requirement for evidence is also relevant, and environmental reporting tools, such as smartwaste.co.uk, have also been boosted by BREEAM requirements to measure and monitor performance.

Circular Economy Impact

BREEAM already has a good impact on aspects of circular economy, especially in those projects seeking Excellent or Outstanding ratings (where it is challenging to meet the

[30] https://www.brebookshop.com/samples/327792.pdf

requirements without addressing as many categories as possible), as various aspects can be mapped across and cover many of the best practices being promoted as Circular Economy.

As BREEAM is so widely used, it has the potential to support the transition to Circular Economy further, with the further integration of circularity indicators and reversible building design criteria.

Recommendation

Based on insights and developed work within the BAMB project (BRE being a partner in the consortium), with the DGBC, with other BRE projects and BREEAM stakeholders, BRE may provide a wider and deeper emphasis on Circular Economy in future updates of BREEAM standards. This may be scattered throughout the existing structure, or potentially aggregated into a dedicated section. The next update of BREEAM New Construction will start in 2019 and, as usual, will be open to several rounds of stakeholder consultation prior to finalisation.

Design for Change[31,32]

The Design for Change (DfC) assessment and transitional framework has been developed in the Flemish region of Belgium encouraging an alternative way of designing buildings, neighbourhoods and building elements, in order to create a built environment that supports change in a more efficient and effective way, e.g. by extending the life time of high-quality buildings and using building components multiple times. The assessment framework includes a qualitative and quantitative part, assisting decision-makers.

The qualitative part of the assessment framework consists of a set of 24 practical Design for Change guidelines (see Figure 6 below). Each design principle is discussed and illustrated on a separate sheet, available online, allowing designers, developers and policymakers to get acquainted with existing solutions and at the same time provide them with an understanding of the importance of applying the principle. Each principle also includes key questions in order to assess a design option and potential alternatives.

The synchronous treatment of three scales (building elements, buildings and neighbourhoods) ensures a holistic approach.

[31] http://www.ovam.be/veranderingsgerichtbouwen

[32] http://www.ovam.be/sites/default/files/atoms/files/TWOL-Design-for-change.pdf

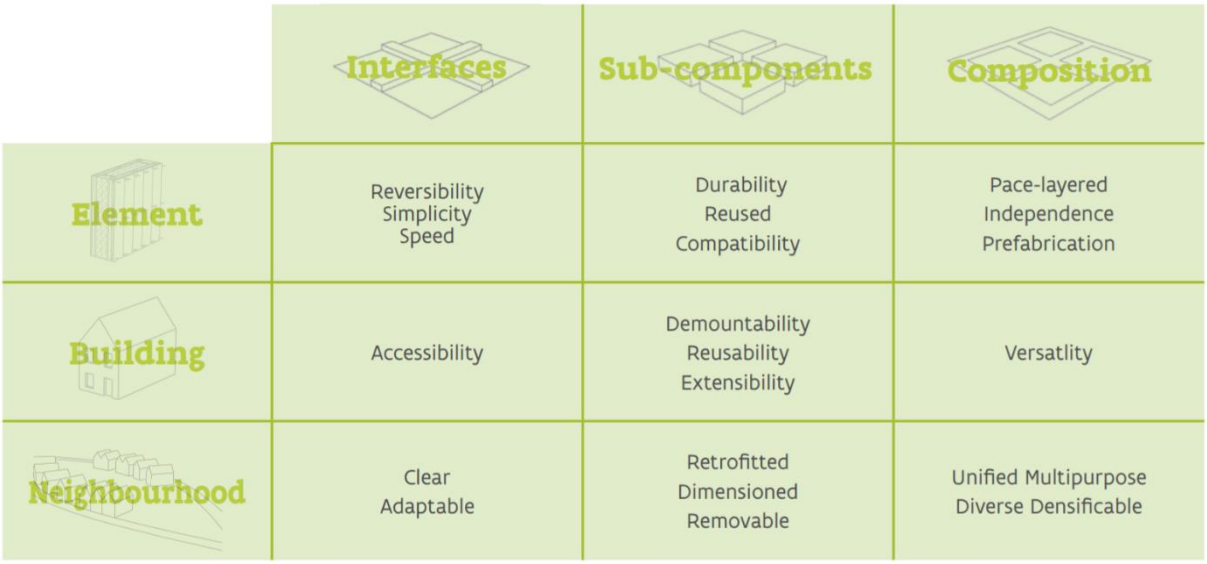

Figure 6: overview of 24 Design for Change guidelines (OVAM, 2015)

The quantitative section focuses on Lifecycle Analysis. Both initial and entire lifecycle impacts are calculated in financial and environmental terms. This quantitative assessment includes the analysis of different transformation and EOL scenarios. This is in line with the Circular Building Assessment (CBA) developed through the BAMB project.

DfC is considered to be very innovative. For the development of the framework, state of the art design for change principles were applied. The design guidelines were tested within a research project in two ongoing construction projects (and 3 more projects afterwards). To validate the new insights and improved assessment framework, two consultancy programmes were started and successfully completed for specific construction projects. For each trajectory, basic information was provided to the architects, a qualitative assessment of their design proposals was made, and quantitative lifecycle analyses were performed. In addition to disseminating the added value of Design for Change through real construction projects, this consultancy clarified potential long-term financial and environmental impact or gains.

Design for Change is one of the five transitional paths the OVAM (the Flemish Public Waste Agency) has put forward in its policy program "Material Conscious Building in Circuits". The transitional approach means learning by doing and doing by learning. Hence, short-term experiments that can propel a major social shift are also needed. For example, the OVAM is supporting the use of the 24 Design for Change guidelines in a number of blackfield[33] projects. The use of the Design for Change assessment framework is currently on a voluntary basis. The 24 DfC guidelines are straight forward and can be applied by the involved designers or other stakeholders. For the environmental and financial life cycle assessment,

[33] Blackfields - like brownfields - are underutilised sites where redevelopment is required, but where - unlike brownfields - the soil is so heavily polluted that project developers and investors no longer see the possibility of a profitable project. In these cases it is therefore up to the government to take initiatives, otherwise there will be no redevelopment of these lands.

currently some professional advice is still required. OVAM, is currently looking at ways how to integrate a circular LCA into TOTEM, a free and open LCA tool for architects.

Alignment to BAMB Systemic Changes

Design for Change is particularly closely aligned to the **Design** systemic change identified through the BAMB project. General design guidelines have been developed in the programme. Additionally, a breakdown by scale (element, building, neighbourhood) and by theme (interfaces, sub-components, composition) makes it possible to establish a comprehensive and clear qualitative assessment of the design and construction of a building.

Circular Economy Impact

Design for Change (or dynamic building) can play a key role in reducing the environmental impact of the construction industry. By anticipating future changes today it is possible to fulfil the ever-changing needs and demands of individual users and society with less polluting and less material-intensive construction works. Moreover, when the possibility exists to disassemble and recycle - or, even better, reuse - building elements, a lot of material loops can be closed.

At the building level, Design for Change supports adaptable and multi-use projects, including principles such as "support-and-infill" and "generality". At the building element level, Design for Change supports application of prefabricated and dismountable construction systems that enable the reuse of building elements or their components.

Recommendations

The BAMB Reversible Design Protocols could be adopted within the 24 Guidelines to develop DfC into a more quantitative assessment.

This assessment and transition framework could be scaled up to other European countries.

A number of transition projects have been defined and it is recommended that policymakers define and run experimental projects before developing policies.

Circular Peterborough[34]

The aim of the Circular Peterborough Commitment is to transform the city of Peterborough in the UK into a truly circular city by 2050. It is part of the Future Peterborough programme, delivered in joint partnership by Opportunity Peterborough and Peterborough City Council. The commitment was developed taking a collaborative approach and enables individuals, communities and businesses to pledge their support to the initiative. The Circular City Roadmap [35]details short term actions to 2021 and longer term ambitions to 2050 and has a 7 Rs approach, including rethink, redesign, repair and repurpose. Enabling change, implementing projects, and monitoring and learning, along with KPIs, key milestones and a Circular City Maturity Matrix are all crucial parts of the roadmap. Aspects of particular

[34] http://www.futurepeterborough.com/circular-city/circular-peterborough-commitment/
[35] http://www.futurepeterborough.com/circular-city/circular-city-roadmap/

interest to circular and dynamic buildings include the development of a systems thinking approach that evolves over time, the circular infrastructure & digital technology/connectivity objectives and their respective milestones. This is an ongoing programme of work with case studies and the network being developed continually. It is expected that progress by 2021 will be an important milestone in this long term city vision.

Alignment to the BAMB Systemic Changes

Circular Peterborough is most closely aligned to the **Value** and **Collaboration** systemic changes. However, one of its approaches is to encourage redesign to promote the move towards Circular Economy principles. The city is planning a Circular School Buildings project, to begin in 2019.

In terms of value, Circular Peterborough is working with stakeholders to changes processes, so that the life of infrastructure can be extended.

Collaboration is at the heart of the Circular Peterborough principles. It has engaged a group of Circular City Champions, which include Skanska and Viridor, who, as organisations, are working to embed circular principles into their businesses.

The systems thinking approach could also develop into an interesting case study on how the built environment and stages of its life cycle can be optimised at a city scale. This has scope to be closely aligned to all areas of identified systemic change – design, value, collaboration and data integration.

Circular Economy Impact

The city aims to be truly circular by 2050. It is taking a collaborative approach, engaging citizens, communities and businesses, and led by a partnership which includes the city council. If the ambitions set out within the roadmap are realised, this could have significant impact within the city, but also be replicated elsewhere, e.g. Peterborough are part of a small cities network through which further impact could be realised.

Recommendations

Collaboration with stakeholders is a key pillar of Circular Peterborough. Meaningful engagement with all sectors should make implementation easier and raise awareness at all levels. Progress in realising the objectives of the Roadmap should be monitored as well as lessons learnt from success and lack of success.

The Procura + Manual and Case Studies[36,37]

The Procura + manual provides guidelines to implement sustainable procurement. It provides suggestions for procurement in general, not exclusively public procurement. It builds on the EU 2014 Procurement directive.

16 Case studies presenting best practices in sustainable (public) procurement are presented on the Procura + website. Each best practice report contains a summary, background, development of the approach, implementation of the approach, results and lessons learned. The Case studies cover different sectors as well as different aspects of sustainability and provide exemplary innovative approaches for public procurement. Examples include:

- Promoting responsible purchasing (Nantes, France)
- Reuse and refurbishment of furniture through circular economy procurement (Public Health Wales)

Alignment with BAMB Systemic changes

The Procura + Manual aligns closely with the BAMB systemic change on **collaboration**. The Manual supports a different way of collaborating between contracting authorities and suppliers, but also between different contracting authorities.

Suggestions are made regarding the pre-procurement process, including how better dialogue, market investigation etc. can support better understanding, market engagement and resulting quality and sustainability.

Different procurement procedures offering more flexibility and enabling information exchange and discussion are suggested: *pre-commercial; procurement; innovation partnership; competitive dialogue; competitive procedure with negotiation*

The Procura + Manual also supports frameworks, central and joint purchasing. Larger volumes of demand can help incentivise suppliers to meet requirements, especially where there are up-front costs involved in attaining certification or auditing supply chains. These strategies also allow smaller authorities, or those with fewer resources, to access the sustainable procurement expertise offered by larger organisations.

Additionally, by integrating environmental and social aspects in the procurement, the **value** of the provided service or product encompasses more than financial aspects. The Manual supports Lifecycle Costing and Social Return on Investment. Examples of alternative ownership models are provided.

Circular economy impact

The Manual does not specifically focus on circular economy but could provide a significant impact when introducing the right circular economy assessment criteria.

[36] http://www.procuraplus.org/fileadmin/user_upload/Manual/Procuraplus_Manual_Third_Edition.pdf
[37] http://www.procuraplus.org/case-studies/

Recommendations

It is recommended that procuring bodies integrate environmental and social aspects in their procurement. There is also considerable value in the Procura+ approach of sharing best practice through a Manual and Case studies.

Tracimat – VLAREMA[38]

To stimulate the practice of selective demolition in Flanders, Tracimat (TRACIng MATerials), a voluntary demolition tracing system, was set up. Tracimat is a non-profit neutral construction and demolition waste (CDW) management organisation that certifies the selective demolition process by issuing a "certificate of selective demolition" for demolition waste that has been selectively collected and subsequently gone through a tracing system, thereby assuring the processing company of the quality of the recycled demolition waste.

If the CDW is accompanied by a "certificate of selective demolition" the processor can accept the demolition waste as "low environmental risk material" (LERM) and can therefore process it separately from waste streams with a high environmental risk (HERM).

Tracimat is legally incorporated into the Flemish environmental regulation VLAREMA for Sustainable Management of Material Cycles and Waste, which is the implementing order of the Flemish Materials Decree. Tracimat operates in feedback with the Common Regulation for Recycled Aggregates, allowing it to trace construction and demolition materials down to the crusher.

A new acceptance and processing policy (LERM vs HERM) for producers of recycled aggregates came into force in August 2018. From this point, all producers of recycled aggregates shall differentiate between materials with high and low environmental risk.

Alignment with BAMB Systemic Changes

The Tracimat system aims to enhance the quality of recycled aggregates for high **value** recycling. Purer waste streams with a low environmental risk have a greater upcycling potential. This in turn would open up opportunities for incorporation into more high-quality applications than are currently possible. The CDW management organisation also aims to enhance trust and collaboration and to stimulate professional selective demolition practices.

Tracimat aligns with the **collaboration** systemic change: The tracing process starts with the preparation of a demolition waste inventory and waste management plan prepared by an expert prior to the disassembly work and selective demolition. To guarantee the quality of the waste inventory and waste management plan, they must be prepared according to a specific procedure. Tracimat checks the quality of the waste inventory and waste management plan and issues a declaration on its conformity.

[38] http://www.tracimat.be

Circular economy impact

The lack of trust (e.g. the current lack of trust in the quality of recycled aggregates) between stakeholders within the building value network is found as one of the main obstacles of a circular economy within a built environment. The introduction of the new acceptance policy (LERM versus HERM) for producers of recycled aggregates should ensure a certain level of quality of LERM and by doing so is an important step to increase trust between demolition contractors, crushers, manufacturers and building clients.

Recommendations

The system could be scaled up to other countries, especially countries with high amounts of stony fraction, as well as including other fractions such as wood. In addition, it could be further developed to promote reuse and not just recycling.

The effectiveness of Tracimat might benefit from alignment of regulation in bordering areas

The collection and analysis of data captured through Tracimat provides an opportunity for the government to gain a greater understanding of the levels and quantities of waste products in demolition.

Comparison, or possible integration, with construction site waste/ environmental reporting systems, such as BRE's Smartsite[39], could provide a further data detail & standardization, refinement of End of Life scenarios, and provision of benchmarks to target and monitor performance.

ISO 20887 Design for Disassembly and Adaptability of buildings and civil engineering works – principles, requirements and guidance (DRAFT)

ISO 20887 is an international standard currently under development by the International Organization for Standardization (ISO), a federation of national standards bodies. Based on the Canada Code of Practice, ISO 20887 is intended to provide a framework for the Design for disassembly and adaptability (DfD/A) principles and the key issues that should be considered by those involved in a project. The ISO will provide guidance for decision making and illustrative examples.

Alignment with BAMB Systemic Changes

The key alignment of ISO 20887 to the BAMB systemic changes is in its potential to influence construction at the **design** phase. The ISO will standardise principles for overcoming barriers to disassembly and adaptability, such as difficulty of access to components and services, use of unnecessary finishes and interdependence of components. It will also encourage consideration of circular economy business models.

Recommendation

It is recommended that the ISO standard 20887 should be promoted through standards such as BREEAM and Level(s) as well as through public procurement and other channels, so that it

[39] https://www.bresmartsite.com/products/smartwaste/

becomes widely understood and accepted. The measurement side of Design for Disassembly and Adaptability is still poorly defined, so the Reversible Building Design protocols developed by BAMB could be potentially referenced in the final standard (depending on timings of both outputs).

London Plan - Circular Economy Statement[40]

The Circular Economy Statement applies to 'Referable' planning applications in London.

The London Plan is a strategic policy instrument which sets out the spatial development strategy for London. The draft new London Plan, currently under consultation, will require planning applications of a certain size to promote circular economy outcomes and aim to be net zero-waste. Applications will be required to include a Circular Economy Statement, demonstrating how they will meet the required criteria:

1. How all materials arising from demolition and remediation works will be reused and/or recycled
2. How the proposal's design and construction will enable building materials, components and products to be disassembled and reused at the end of their useful life
3. Opportunities for managing as much waste as possible on site
4. Adequate and easily accessible storage space to support recycling and reuse
5. How much waste the proposal is expected to generate, and how and where the waste will be handled.

Guidelines for development of the CE statement are currently being produced and should be available spring 2019.

Alignment with BAMB Systemic Changes

It is considered that the requirement for a Circular Economy Statement could have a large impact on **design**, if the focus and targets are set out to change design. It is currently unclear if this will be a requirement or a 'nice-to-have'.

The Circular Economy Statement could have an impact on **collaboration**, as it will necessarily stimulate discussions in the design process. However, it is unclear if these discussions will extend beyond this to include the client, contractors, demolition companies and other stakeholders.

Work is now underway to establish specific requirements and guidance to be referenced and followed when the final plan is published.

Circular Economy Impact

It is anticipated that the Circular Economy Statement could have a significant impact. With no other local authorities currently requiring Circular Economy assessments and provision

[40] https://www.london.gov.uk/what-we-do/planning/london-plan/new-london-plan/draft-new-london-plan/chapter-9-sustainable-infrastructure/policy-si7-reducing-waste-and-supporting

necessary in order to get planning permission, the introduction of this requirement could act as a driver and example for other Local Authorities in the UK and beyond to follow.

Recommendation

It is recommended that other local authorities consider the introduction of a Circular Economy Statement and review how it might be implemented under their particular planning framework.

Leading the cycle - Finnish road map to a circular economy 2016-2025[41,42]

The target of the Finnish government and the road map is to make Finland a global leader in the circular economy by 2025. The road map was drafted under the direction of Sitra, the Finnish innovation fund, in co-operation with the Ministry of the Environment, the Ministry of Agriculture and Forestry, the Ministry of Economic Affairs and Employment, the business sector and other key stakeholders in Finland.

The upper level targets:

- **Economy**: The circular economy will be a new cornerstone for the Finnish economy
- **Environment**: Finland as a model country for the challenge of resource scarcity
- **Society**: From adapter to pioneer

There are five initial focus areas, of which the three most relevant to BAMB are:

- ***Forest-based loops:*** *Global competition will increase with new commercial products, services, co-operation models and digital technology.*
- ***Technical loops:*** *Minimising the use of virgin raw materials and maximising the length of material and product lifecycles create a competitive edge.*
- ***Common action:*** *Legislators, companies, universities and research institute, consumers and citizens, and vibrant regions are all need to achieve systemic change.*[43]

Alignment with BAMB Systemic Changes

Although the construction sector is not a specific focus of the initial plans for Finland's circular economy, its consideration of technical loops supports the systemic change in **value** sought by the BAMB project. The plan considers that minimising the use of virgin raw materials creates a competitive edge. Additionally, Finland seeks to maximise the length of life cycles of materials and products, as well as increasing opportunities for reuse and changing business models to encourage use of services rather than goods.

[41] https://www.sitra.fi/en/publications/leading-cycle/

[42] https://media.sitra.fi/2017/02/24032659/Selvityksia121.pdf

[43] https://media.sitra.fi/2017/02/27052129/sitra_kiertotalous_infografiikka_some_en-1.jpg

In terms of **collaboration**, the road map emphasises the need for all levels of society to participate to achieve the required rate of change. It also identifies the importance of being able to identify and separate materials at the end of a product's lifecycle, encouraging high value reuse.

Circular Economy Impact

Although only five areas have been selected for initial focus (Sustainable Food Systems, Forest-based loops, Technical loops, Transport and logistics and Common action), the Finnish Circular Economy Roadmap has potential for great impact. Working at a national level demonstrates leadership and buy-in from the government, which aims for Finland to be a leader nation in the move to circular economy and to demonstrate the economic benefits of developing businesses based on the circular economy.

Recommendation

Finland has set a highly ambitious goal through the 'Leading the Cycle' policy. Governments should consider adopting ambitious visions, with the potential to create change through leadership.

BIM Singapore[44,45]

This relates to BIM e-submission for building permits. With effect from 19 October 2016 (for architectural plans) and 01 October 2017 (for C&S/MEP Engineering plans), BCA accepted voluntary BIM e-submissions in Native BIM format.

Alignment with BAMB systemic values

There is currently little alignment with BAMB systemic values other than data sharing and **collaboration**, which could be said for all BIM related activities, especially with data is open and transparently available. This is included as an example of all such activities and the potential that it offers.

Circular economy impact

Currently, there is no circular economy link to this policy/activity. BAMB has developed the possible approach and structure to enable BIM data to be combined with other data to provide semi-automated Circular Building Assessments (Reversible Building design, Environmental Assessment and Economic Assessment). However, this is generally BIM enabled, rather than focussed on the Singapore BIM e-permitting example.

Recommendation

[44] https://www.bca.gov.sg/bim/bimlinks.html

[45] https://www.corenet.gov.sg/general/building-information-modeling-(bim)-e-submission.aspx

BIM Singapore was selected for review as it represents a trend in the right direction.

The generic recommendation for BIM is to continue to standardise and promote the digitalisation of construction information from feasibility, design, construction and asset management, through to end of life and subsequent reuse or rehoming into future assets.

Best practices of interest but not strongly aligned to the BAMB Systemic Changes

Demolition and Deconstruction Permits[46,47]

In Seattle, USA, a permit system has been implemented which allows deconstruction of a domestic building to begin before a building permit has been issued. If a building is to be demolished, work can only start once the building permit has been issued. Minimum reuse and recycle rates for deconstruction are set by the city and all asphalt, brick, and concrete is required to be reused or recycled to be compliant.

A recent update has tightened the requirements for reuse to require a minimum (20%) reuse by weight, excluding certain materials. This is a positive step towards more circular economy thinking.

Green Demolition Bylaw[48,49]

In Vancouver, Canada, demolition permits for domestic buildings constructed before 1940 include recycling requirements. The system is enforced through the requirement for a $14,650 deposit, paid when applying for a demolition permit. There is a sliding scale for return of the deposit depending on the recycling rate achieved. For houses not designated by the city as 'Character houses', 75% of the waste (measured by weight) must be reused or recycled for full return of the deposit. Guidance on salvaging and reusing materials is provided by the city authorities.

From January 2019, this law will cover all homes pre-1950 – which account for around 70% of demolition. In addition, pre-1910 homes will have to reuse at least 3 tonnes of timber. Support for a deconstruction hub is also sought.

Alignment with BAMB Systemic Changes

[46] http://www.seattle.gov/dpd/permits/permittypes/residentialdeconstruction/default.htm

[47] http://www.seattle.gov/DPD/Publications/CAM/cam337.pdf

[48] http://vancouver.ca/home-property-development/demolition-permit-with-recycling-requirements.aspx

[49] http://vancouver.ca/files/cov/green-salvage-guide.pdf

These two measures are not considered to be particularly aligned to the BAMB Systemic Changes in their current form.

Circular economy impact

These two permit systems are considered to be unusual in the scope and nature of the incentivisation. Although currently they only affect existing buildings, they could have significant impact if they were linked into targets for reuse in subsequent developments.

Additionally, the type of incentivisation could prove an interesting model for supporting circular economy policies.

Both areas have recently updated (or plan to update) the regulatory requirements to expand and tighten the levels of deconstruction and reclamation occurring. This reflects, to a certain extent, a lack of reuse happening when left as a voluntary objective. It is clear from these examples that their markets are not yet sufficiently developed or incentivized to maximise reuse over recycling. It will be interesting to follow these newly defined regulatory baselines to see if this provides the stimulus needed to do things that are different to current business as usual.

Recommendation

The two measures identified here could be expanded to allow linkage for targets for reuse in future developments.

Innovative financial instruments, such as these, can be utilized to change attitudes towards waste materials in the construction sector.

6.3 Conclusions and recommendations

The best practices analysed above fall into four categories of mechanism (see Table 2 below):

- **Regulate** (through the implementation of hard legislation)
- **Realise** (by using mechanisms such as public procurement to drive change)
- **Stimulate** (e.g. through providing exceptions in regulations in order to encourage experimentation)
- **Inspire** (by disseminating good practice, or by providing leadership)

		Function					Systemic change		
Best practices		Regulate	Realise	Stimulate	Inspire		Design culture	Value definition	Collaboration
Act for the Promotion of Long-life Quality Housing		x	x	x			x	x	x
Be.Circular/ PREC				x	x		x	x	x
Rijkwaterstaat Purchasing and Procurement			x	x			x	x	x
Circular Buildings Green Deal			x		x		x	x	x
Level(s)			x		x		x	x	x
BREEAM			x		x		x	x	x
Design for Change			x		x		x		
Circular Peterborough			x	x	x			x	x
Procura +				x	x			x	x
Tracimat - VLAREMA		x		x				x	x
ISO 20887 (Draft)			x				x		
London Plan - Circular Economy		x		x	x		x	x	
Leading the Cycle - Finnish roadmap to a Circular Economy		x	x	x	x			x	x
BIM Singapore			x	x	x				
Demolition and Deconstruction Permits		x		x					x
Green Demolition Bylaw		x							

Table 2: mechanisms and systemic change of each best practice analysed

The best practices identified provide a very diverse selection of mechanisms which have the potential to drive a move to a dynamic and circular built environment.

By reviewing policies, regulations and standards from a broad geographical the research has uncovered a number of useful examples which could provide models for implementation elsewhere. One example, the Act for the Promotion of Long-life Quality Housing, demonstrates a strong focus on design elements which is closely aligned to BAMB. Its use of financial instruments to implement desired outputs is also particularly noted.

Procurement policy is another notable element which is introduced through the best practices. The Rijkwaterstaat Purchasing and Procurement Rules provide a good example of use of public procurement to drive a value change away from purely financial elements. The

collaborative nature of the rules, encouraging the contractor to become a trusted partner in delivery, is another noteworthy feature.

Analysis of the best practices has also identified that there are a number of gaps in policy, standards and regulation, which could be addressed:

Gap identified	Recommended solution
Framework programmes were found to tackle collaboration rather than design change.	Consider if the programmes might be re-framed to consider the design stages of construction in order to maximise the opportunities for the circular economy.
Procurement is also generally less focused on design change.	The adoption of Reversible Building Design tools in the procurement process might also provide an opportunity to establish circular principles at an early stage.
Assessment tools were not considered to contribute to the systemic change for collaboration.	As they target stakeholders at the beginning of the build process, they could provide an opportunity for capturing and sharing data and promoting collaborative processes.
Standards were found not to be driving the value definition	Focusing on environmental and social value of construction would enable a change in value definition
Demolition best practices were, as expected, focused on the end-of-life of a building.	BAMB is well-placed to support changes in these practices to enable circular design to be considered from the earliest stage of a construction project.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The policies, standards and regulations which have been examined in this report can be divided into the four categories of Regulate, Realise, Stimulate and Inspire.

Regulate

Across the research conducted for the Framework on Policies, Standards and Regulations, it is concluded that some of the instruments which regulate result in barriers to circular and dynamic building. For example, the emphasis on energy performance of buildings, through the *Energy Efficiency Directive* has the potential to promote solutions in building design and materials which do not allow for deconstruction and reuse of materials (see Section 3). The *EU Waste Framework Directive*, through lack of clarity over definitions provided, also presents a barrier to implementation of circular economy principles, in part through the different interpretations across Europe of key terminology such as 'recovery'. Indeed, fragmentation of regulation across different geographic areas and at different levels is concluded to currently be a barrier to circular and dynamic building.

Regulation does, however, provide opportunity. In Section 3, we identify that the current legislative frameworks for energy performance, waste management and construction product regulation are well placed to be extended to include Materials Passports and Reversible Buildings principles, which would therefore create a regulatory background more favourable to circular and dynamic building. However, it is also noted that an holistic approach to regulation is required to ensure that legislative drivers are not opposed to each other.

Realise

Policies, standards and regulations which realise, by using mechanisms such as public procurement to promote change, are identified as having great potential. The Rijkwaterstaat Purchasing and Procurement Rules provide an excellent example of this (see Section 6), using a change in value definition to stimulate solutions which have a social and environmental (rather than financial) impact, as well as promoting innovation.

However, it is also noted that policies, standards and regulations which realise need to be well framed and monitored to ensure that the desired outcomes are achieved. For example, regarding the public procurement rules for construction in Portugal (Section 5), there is a lack of awareness, technical information and monitoring across the industry for the policy. As a result, there is no definitive measure of its success.

Stimulate

A number of policies and regulations are identified as stimulating a move to dynamic and circular building design. These include the PREC in the Brussels Region of Belgium (Section 5 and Section 6). Engagement of stakeholders across the programme, for example in

involving actors in developing their own targets, results in a participative process with a high level of buy-in. Tracimat (Section 5 and Section 6) is also regarded as a policy which stimulates change, by requiring producers of recycled aggregates to differentiate between material with low and high environmental risk. This measure should lead to enhancement of high value recycling, as trust in the quality of the aggregates will be increased.

Inspire

Amongst all the policies, standards and regulations examined, the 'generational goal' of the Swedish Environmental Objectives is considered to be the most inspiring (see Section 5). It is closely linked to the Brundtland definition, combined with the understanding that what happens within one country influences others.

7.1.1 Success factors and gaps

Drawing on the work carried out in the State of the Art, interactions with other policy frameworks, best practice review and impact assessment of specific policies a number of common themes and areas which should be considered for future policy recommendations have been identified. These themes take into account success factors of existing policies, as well as gaps in policy making which illustrate why some policies and regulations have failed to make significant impact. The themes are explained in the table below:

Data	Data for monitoring; data consistency; provision of data repositories as knowledge centres; ability to update policy based on better information from monitoring and measuring
Benchmarking	Use of quantitative tools to allow meaningful evaluation
Enforcement	Requirements for meaningful monitoring; sanctions for non-compliance or incentives for compliance; consistency of enforcement approach and interpretation
Impact evaluation	Understanding the cost and the benefits and broader value of the policy; articulating the cost of compliance compared to the cost of non-compliance for stakeholders
Internalisation of external costs	Accounting for external costs to society and environment in calculating value of a project so that financial value creation is not the only consideration in decision making
Consistency	Overcoming issues of fragmentation at different levels of policy implementation (supra-national, national, regional, city); and reducing the likelihood of perverse effects caused by siloed thinking
Time	Noting that policy implementation takes time and that time can be utilized to maximise policy impact, e.g. through communication, stakeholder engagement; foresight for policy provided through tools and assessment, experimentation
Stakeholder input	Encouraging buy-in; engaging different perspectives to spot potential issues, including loopholes
Communication	Effective communication of policies, clarity in the policy and the use of experimentation as a means to communicate
Flexibility, adaptability and experimentation	Remaining open to different approaches which support the overall ambitions of the policy; ability to adapt the policy if required to optimise impact or respond to changing conditions; policy framework should encourage innovation, variation in approaches, experimentation and demonstration
Out of the box	Regulations and policies which take a unique approach and can provide inspiration and leadership

Figure 7 shows the themes as a dynamic system, with interactions and varied levels of significance in time:

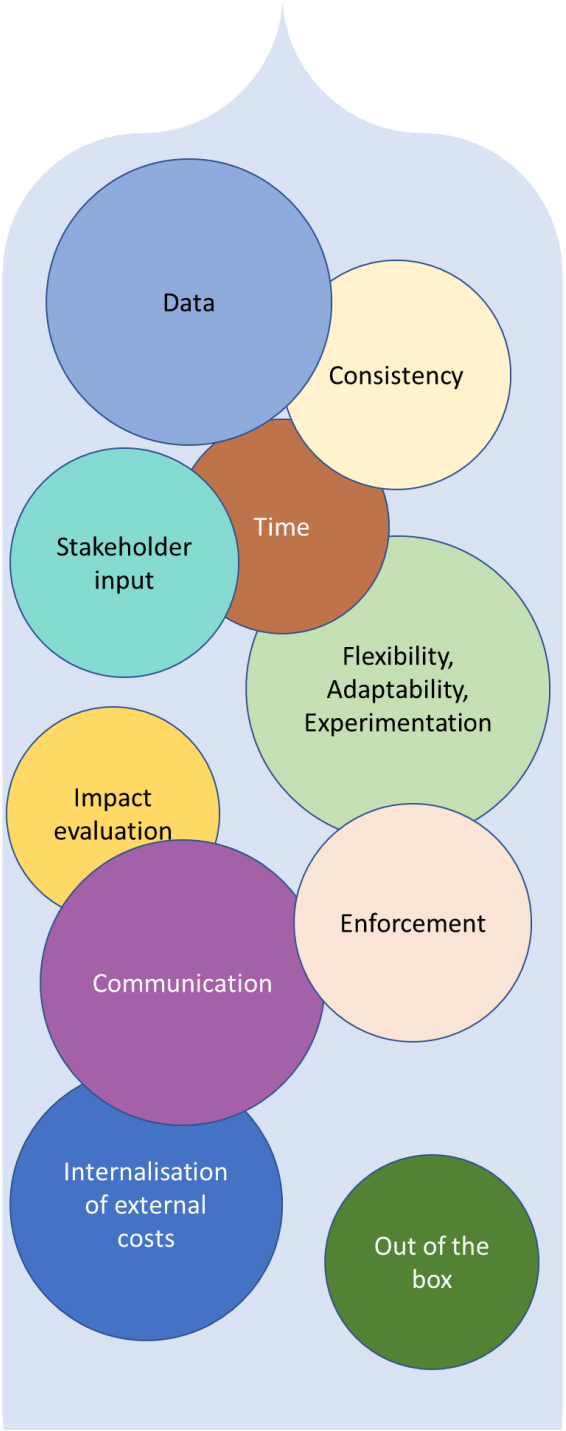

Figure 7: Themes for policy recommendations shown as a dynamic system

It is also considered that there are strong linkages between these themes, which taken together support moves to circularity. The linkages are identified in Table 3 below:

Cross-mapping of themes and their relevance in other contexts	Data	Benchmarking	Enforcement	Impact Evaluation	Internalisation of external costs	Consistency	Time	Stakeholder engagement	Communication	Flexibility, adaptability	Out of the box, experimentation
Data		■	■	■	■	■	■	■	■		
Benchmarking	■		■	■	■	■					
Enforcement	■	■				■			■		
Impact Evaluation	■	■			■		■	■		■	
Internalisation of external costs	■	■		■				■			
Consistency	■	■	■								
Time	■			■				■	■		■
Stakeholder engagement	■			■	■		■		■	■	■
Communication	■		■				■	■			
Flexibility, adaptability				■				■			■
Out of the box, experimentation							■	■		■	

Table 3: Cross-mapping of themes and their relevance in other contexts

Data

Throughout the research, high quality data has consistently been identified as a key element of a good policy, with lack of clear consistent data often contributing to lack of impact. The importance of data covers the whole policy cycle (see Figure 8): from the need for high quality data to support the development of policy, through collection of consistent data sets to monitor implementation and to enforce compliance, to data to understand the impact of a policy and inform future policies, or to support adaptation of policies where they are being less successful.

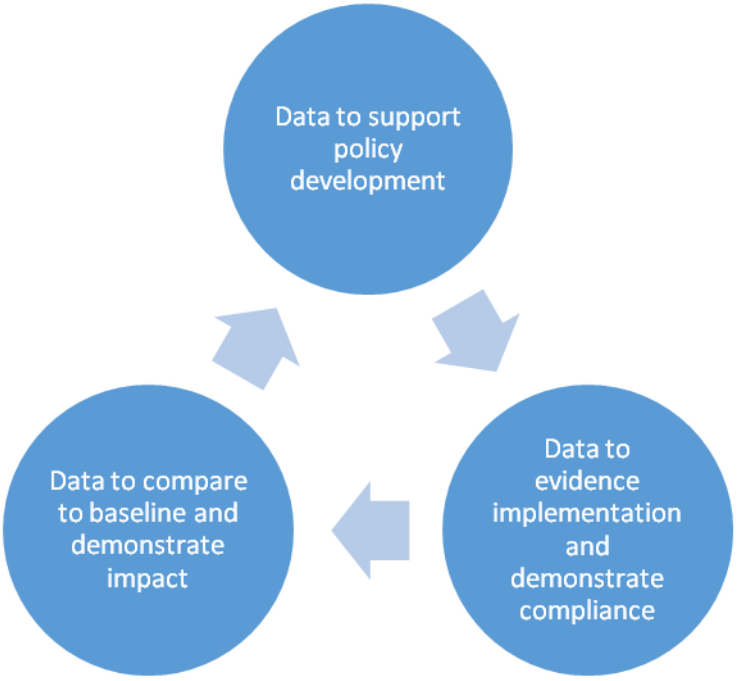

Figure 8: Data at the key stages of the policy cycle

In terms of monitoring, our research has uncovered several examples of policies where data is simply not collected at all. For example, the Portuguese government does not know the extent to which recycled materials are being used in public construction projects in line with its Incorporação de 5% de Materiais Reciclados policy, and therefore does not have information on the extent to which the policy is being complied with. Nor is there any evidence to support the assessment of the impact of the policy at any level. This is considered to have severely weakened the potential impact of the policy.

In the case of policy development, it was also identified that, in the Flanders region of Belgium, there is currently very little data on the production and quality of recycled aggregates. This will make it difficult to assess the impact of the new policy on the industry, as no data exists to use as a benchmark. However, once the new policy is in place, the requirement to conduct an inventory of waste from demolition is expected to lead to improved compliance with other legal requirements such as an asbestos inventory.

Lack of high quality data on construction and demolition waste is considered to be a barrier in the transition to the circular economy. This is evidenced in the Impact Assessment carried out for the PREC in the Brussels Region, which highlighted the lack of accuracy of data and resources required to process and analyse it, was hampering the ability to identify and fix targets for circularity.

The study has identified that a trusted repository of data presents a number of opportunities to support development and implementation of policies. By gathering data in a central location, as in the Tracimat example in our Impact Assessments, that data can be used to understand the

actual impact of a policy, can be fed into further policy adaptation, new policy development and helps to establish an authoritative database which can be used as an industry resource.

Benchmarking

Consistent and high quality data is also important for benchmarking. The use of a central repository of data, such as that in the Tracimat system, will assist with benchmarking. As identified in the Site Waste Management Plan IA, the required data needs to be well-defined and standardised to maximise its value and to allow for benchmarking and monitoring to be meaningful. These regulations supported widespread uptake of BRE's Smartsite system which enabled the production of construction waste generation benchmarks. These benchmarks contribute to the setting of thresholds for related waste minimisation credits in BREEAM.

Enforcement

This theme is closely related to that of data, as strong enforcement is usually linked to good data gathering (which in turn allows data to be collected to monitor, which can then be used to support policy development in a virtuous loop). Our research has identified that lack of enforcement for a policy can result in a lack of engagement and conformity. The example given above of the Portuguese Incorporação de 5% de Materiais Reciclados policy is a case in point. With no official data on levels of compliance, our own Impact Assessment found that over 50% of those aware of the policy were not complying. The Impact Assessment identified that no one organisation was responsible for enforcing or providing leadership for the policy and concluded that if an 'owner' for the measure were appointed, who was responsible for measuring, monitoring, enforcement and reporting there would be increased compliance.

It is also important to have consistency in the enforcement approach and interpretation and not to inadvertently create loopholes, which can result in negative outcomes in other dimensions.

In addition, rewards for compliance, or sanctions for non-compliance, can be considered. These can be monetary, as in the case of the Green Demolition Bylaw in Vancouver, Canada, or reputational, such as higher scoring in the BREEAM certification scheme. Across the European Union the 'polluter pays' principle has been a strong driver for reduction of landfill. However, no strong legal penalties were identified in the scope of the policies and regulations considered, although fines through the courts are implemented in other areas, for example, in Health and Safety and Environmental non-compliance.

Impact evaluation

Impact evaluation should be an essential part of the project cycle, as it allows authorities to understand the costs and benefits of a particular policy. It can also allow for value judgements to be made about the cost of compliance compared to the cost of non-compliance, or the economic/social value of pursuing a particular policy path. The clear quantification of value also supports take-up and buy-in from stakeholders at all levels. For example, the DG Environment project on the Resource Efficient Use of Mixed Wastes identifies that the

statistics on recycling do not take account reuse and therefore the waste that has been prevented is not given a value. Its recommendations include measures to promote better and more detailed data collection as well as promoting higher value recycling.

Internalisation of external costs

Internalisation of external costs is an important element of the Value systemic change identified by BAMB. The Rjkwaterstaat Purchasing and Procurement Rules provide a good example of how public procurement can be used to stimulate a change in the value system. The calculation of social and environmental costs provides a balance to economic cost when the overall pricing of a project is assessed.

Consistency

Fragmentation, or lack of consistency, was particularly evident in the state of the art as a barrier to the successful implementation of policies, both across different policy levels as well as between different policy domains. Examples include the way that Sweden's building regulations, which are defined on a national level, which tie local authorities to less ambitious policies for construction and buildings and prevent a move towards adopting more ambitious circular policies at a local level. Other examples across different areas of a country, for example in Belgium, where the implementation of the Tracimat system to identify and track construction and demolition waste in the Flanders Region may be circumvented by organisations who can access waste dealers across the regional border in Brussels. A third example is the implementation of the Level(s) framework for the sustainability of buildings, which is closely linked to the macro objectives of EU policy goals related to environmental performance in the built environment.

Consistency across the different policy areas is also important. As identified in the State of the Art, the energy efficiency policies implemented in the European Union are having perverse effects on the adoption of circular building principles. It is therefore important that the impact of a policy on other areas be considered. The likelihood of these perverse effects can be reduced by taking an holistic approach to the development of policy and by conducting a thorough impact assessment which includes related policy areas.

Consistency can also be promoted through certification schemes such as BREEAM. The externally verified approach allows for a consistency of building performance to be recognised, with aspects of dynamic and circular building design contained within the ratings. A further important element of consistency is that policies should remain stable over time to have impact. From the Swedish Environmental Objectives IA, it was noted that a strength of the system is its cross-party support, which should ensure its continuation regardless of the governing party in power.

Time

It was noted in the research that policy implementation takes time. Indeed, time should be taken to develop and plan policy to ensure the greatest impact. However, the time used to develop a policy can also be an opportunity to maximise its impact. This could be done through a range of strategies such as communication, stakeholder engagement, and experimentation to demonstrate proof of concept.

The development of a demonstrator project, either as a precursor to policy development, or independently, such as the BAMB project pilots is also considered worthwhile. An example where this is the case is the implementation of the Design for Change policy and framework in the Flanders region of Belgium. Design guidelines to be implemented through the framework were tested in two construction projects. Insights gained during the demonstration phase were validated and an improved assessment framework developed. The demonstrator also provided the opportunity to assess the long-term financial and environmental impact of designs developed using the guidelines.

Such demonstrators can be upscaled to a greater geographical area, and if linked to policy initiatives, also allow for the policy to be refined should initial problems be identified. A demonstrator or pilot can also provide strong counterfactual evidence which can be used in assessing the value of the project in the Impact Assessment phase.

Stakeholder engagement

Early engagement with stakeholders is considered to increase buy-in at all levels and helps ensure that the design of policy is workable for those required to implement it. An example is the Regional Programme for Circular Economy (PREC) in the Brussels Capital region of Belgium. Stakeholders have been engaged at all levels in development. For example, in areas related to the construction sector, industry professionals including designers and contractors have been engaged by the government to ensure that they contribute to the development of the policy, as well as contributing to the definition of goals and indicators. This is also the case for the Finnish Roadmap to a Circular Economy, where the Finnish Innovation Fund has engaged key stakeholders from business, as well as government, to develop a strategy to move towards a circular economy.

Circular Peterborough is also highlighted as a best practice which includes strong stakeholder engagement. A number of Circular City Champions have been appointed, including large businesses, to promote and provide leadership on the application of circular principles in the city.

Communication

Communication has been identified as a vital tool for the effective impact of policy and regulation. The example of the Portuguese Incorporação de 5% de Materiais Reciclados policy shows how important the communication of a policy is. Our own impact assessment identified that 30% of stakeholders are unaware of the policy's existence, which means that there is no likelihood of them conforming.

Collaboration and discussion with networks, trade associations and other bodies is also important in developing policy, standards and regulation. These can be used as champions for innovative approaches and can be used to identify case studies. Procura +, which builds on EU procurement law, hosts a number of case studies of sustainable public procurement which can be accessed by procuring entities. These include implementation, results and lessons learned, allowing others to identify success factors in similar circumstances.

Clarity in the way the policy is written is also considered important and can have result in a disconnect between the actual and perceived success of a policy. Analysis of the *EU Waste Framework* identified that key definitions are poorly defined. As a result, in the case of construction waste, high recovery rates recorded in many countries actually respond to down-cycling of stony fraction for use in road foundation, rather than recovery and retention of value at the highest possible level.

Experimentation can also be used as a means to communicate. Through demonstration projects, the art of the possible can be explored and boundaries tested. This can also be done in a virtual way, as in the Circular Flanders reburg.world website (see Section 6), which provides a space to illustrate the challenges and insights of implementing circular economy from the perspective of different stakeholders.

Flexibility and adaptability

It is considered that policy makers should remain open to different approaches which support the overall ambitions of the policy. In the case of the Swedish Environmental Objectives System, government departments and agencies have a great deal of autonomy in deciding how they should meet the objectives and milestones. This gives them a sense of ownership over the solution and how to reach the goals. However, it should be noted that this flexibility can also be a negative, as the solutions chosen are not necessarily sufficiently ambitious to meet the objectives.

The ability to change direction if the policy is not having the desired effect is also considered to be highly desirable. This could be linked to impacts reviewed in the policy Impact Assessment, and certainly requires the collection of high quality data which can be analysed to provide evidence for changes.

However, flexibility and adaptability should not be at the cost of a consistent approach, as stakeholders will be reluctant to commit time and effort if they are not sure that a measure will be kept in place for any duration.

Thinking outside the box

The BAMB policy work has identified two particularly strong examples of different approaches which support the application of dynamic and circular building design:

- The Act for the Promotion of Long-Life Quality Housing (Japan, 2009)
- Rijkwaterstaat Purchasing and Procurement Rules (Netherlands)

These two different policies/ regulations are not directly addressing circularity, but each takes a novel approach which could be harnessed for circularity in the built environment.

The Act for the Promotion of Long-Life Quality Housing takes into account design aspects to increase the lifespan of housing and includes requirements such as that piping and utilities be accessible from outside the house. These are elements could easily be incorporated into

construction regulations outside Japan. In addition, the Act is coupled with financial and tax incentives, providing clear monetary drivers for take-up (see Enforcement). A further positive of the Act is the way that it enables innovation and facilitates a market.

The Rijkwaterstaat Purchasing and Procurement Rules for the Ministry of Infrastructure and Water Management in the Netherlands demonstrate an innovative approach to procurement to ensure that cost is not the over-riding factor for selection. Scoring for procurements is set so that higher positive scores for environment and social aspects of a contract reduce the weighting factor for cost. The traditional value definition for public procurement is therefore disrupted, by allowing a higher tolerance for price if environment and social value are positively addressed. Additionally, procurement is solution agnostic where possible and is based on functional specifications to allow innovative approaches.

Both the Japanese Government and the Ministry of Infrastructure and Water Management in the Netherlands have adopted policies which provide inspiration for others and a model which can be adapted for dynamic and circular building design.

In addition, policy initiatives at smaller geographical scale can provide significant impact and demonstrate the art of the possible. Initiatives such as Circular Peterborough, identified in the Best Practices section of the report, provide valuable leadership and enable a proof of concept to be developed which may have potential to be scaled to a higher level.

A further area in which innovative approaches are useful is that of resourcing. Funds accrued from policies/ regulations with a tax element (such as the Landfill Tax) can be ring-fenced for use to offset the impact of actions. For example, the Aggregate Levy in the UK enables a community fund, which can be accessed by those communities impacted by the aggregate industry.

7.2 Summary of recommendations

Given the length of time taken to develop new policies, it is recommended that circular economy principles be embraced within existing policy wherever possible. There are a number of opportunities which were noted through the research. These include:

- At a Europe-wide level, the *Energy Efficiency Directive* sets a requirement for a strategy for renovation of residential and commercial buildings, as well as the renovation of 3% of public buildings owned and occupied by government, public procurement focusing on high energy performance of buildings and the reduction of embodied energy. These provide an opportunity to move towards circularity in the built environment.
- The current development of ISO20887 Design for Disassembly and Adaptability of buildings and civil engineering works. The ISO is closely aligned to the BAMB systemic changes in its potential to influence construction at the design phase. The ISO, once released could be adopted through BREEAM and other certification systems, as well as being integrated into public procurement requirements.

- BREEAM – as schemes are revised (there is an update of BREEAM New Construction scheduled to begin in 2019), there is an opportunity to feed circular economy principles into new versions.
- London Circular Economy – the Circular Economy statement could lead the way for cities to require elements of circularity in new construction projects.
- Changes should be made to CPR so that it does not present a barrier to trade.

To enable the BAMB systemic principles to be embedded in future thinking, there are some key examples which should be taken into consideration when planning policy and regulation for the circular economy. These are shown in the tables below:

Recommendations: **Change in design culture**[50]		Comment
Regulate	Existing EU level laws on energy performance, waste management and construction product regulations (by integrating Material Passports and Reversible Building Design Principles) should be extended to support the implementation of dynamic and reversible buildings.	See Section 3 for analysis of State of the Art in policy and regulation.
	The design link of the value chain needs to be targeted by regulation. This might include consideration of material loops from the perspective of design to transition from a value chain to a value network.	This has been identified as a barrier to circular economy principles in Sweden under the Environmental Objectives system (Section 5). It is also noted that a number of Circular Economy packages and strategies have recently been adopted (at EU and sub-national level) but that they do not currently address design. (section 3)
	Clear and measurable objectives should be set to ensure impact and to declare overall ambition	For example, the objectives of the circular economy plan of the Netherlands states that by 2030 the use of virgin resources needs to be reduced by 50% and that the Dutch economy needs to be fully circular by 2050. This has led to innovation in design and in development.
Realise	Provision of a set of technical guidelines by a government should be considered	The Act for the Promotion of Long-life Housing in Japan

[50] https://www.bamb2020.eu/topics/blueprint/vision/design/

	as a mechanism to promote a change in design culture	(Section 6) provides an example of government action to realise change
	Policy should be considered which enables experimentation and supports lighthouse projects in order to realise and stimulate change	The Chantiers Circulaires of the PREC in Brussels (Section 6) is an example of a framework which supports circular building construction in this way.
Stimulate	Public procurement should be used to promote change: for example using solution-free requests (performance-based) rather than prescriptive specifications stimulates innovation	Rijkwaterstaat Purchasing and Procurement policy (Section 6) provides the background for innovative solutions to be presented
Inspire	Innovative policy instruments should be given space for implementation. Implementing mechanisms which promote change in design can act as a driver and example for other authorities to follow.	The London Plan Circular Economy Statement (Section 6) is an example of leadership, using the planning framework to design in circular economy outcomes to construction projects.

Recommendations: **Change in value definition**[51]		Comment
Regulate	External environmental and societal costs should be integrated in the value calculation of any new policy	Although the Rijkwaterstaat Purchasing and Procurement system is not regulation, its weighting of external costs is noted (Section 6)
	Quantitative (rather than qualitative) milestones should be used as they are more effective in promoting change	For example, BREEAM has specific targets to meet to gain waste minimisation credits, based upon benchmarks produced by industry through online reporting software.
Realise	A framework which requires accurate data to support monitoring and definition of targets should be part of regulation to ensure value definition can be defined.	The experience of the PREC in Brussels (Section 5) also concludes that there must be a clear added value to stakeholders if they are to be required to provide data.
	The use of a mixture of legislative, taxation and budgetary measures should be considered in order to promote the transition to dynamic building	Japan's Act for the Promotion of Long-life Quality Housing is an example where a range of measures have been combined

[51] https://www.bamb2020.eu/topics/blueprint/vision/value/

		to positive effect (Section 6)
	Public procurement policies should be harnessed as a mechanism to internalise external costs	The Rijkwaterstaat best practice example (Section 6) demonstrates at the public sector can lead on creating a change in value definition
Stimulate	Authorities should ensure that room for experimentation is included in policy and regulation.	(as above)
Inspire	The setting of an overarching vision should be considered, as it provides strong leadership for action	The Finnish Roadmap to a Circular Economy (Section 6) provides an example of an inspirational vision, by identifying the value to the country which could be achieved through adopting the actions defined.

Recommendations: **Change in collaboration across all actors**[52]		Comments
Regulate	Enforcement of regulations is key to their take-up and there needs to be a clear line of responsibility for the regulation to ensure compliance	Impact Assessments on policies in the UK and Portugal concluded that enforcement is vital to the success of a hard policy, but that without a direct 'owner', enforcement is unlikely to be carried through (section 5)
	All actors should be actively engaged in the development of regulation in order to avoid a missing link which would result in reduced impact	The PREC IA (Section 5) identified that the inclusion and active involvement of stakeholders at an early stage is a key success factor in a policy. This is currently being implemented in the PREC within the Be.Circular call for circular building sites (Section 6)
Realise	Assessment tools target stakeholders at an early stage of the construction lifecycle. They could therefore be used to promote data collection and sharing and collaborative processes.	Section 6 identified this as a gap which is not currently addressed.
	Collection, assurance and analysis of high quality data should be sought, as it	The Tracimat system (Section 5) demonstrates how this can be

[52] https://www.bamb2020.eu/topics/blueprint/vision/collaboration/

	increases trust between different parts of the value network and promotes interaction between stakeholders.	achieved for CDW.
	Policy and regulation provides an effective way for agencies to work together and to cooperate, particularly where solutions are not articulated at a higher level	The Swedish Environmental Objectives (Section 6) were considered to have resulted in stakeholders engaging with each other.
	Public procurement should be used to effect a change in division of roles between client and contractor, for example by giving the (expert) contractor the freedom to provide innovative solutions to difficult problems; it should also support new types of business models and ownership which will lead to other types of collaboration	The example of the Rijkwaterstaat Purchasing and Procurement policy is considered to have promoted a change in collaboration by moving from prescriptive objectives and requiring an ongoing dialogue between contractor and commissioning body.
	Development of platforms and tools for industry stakeholders should be considered, as these bring actors together and allow for collaboration and knowledge-sharing.	Circular Flanders (Section 4) provides an example of a range of initiatives which stimulate experimentation and collaboration.
Stimulate	High profile frameworks and policies should be harnessed as an effective tool for communication and collaboration amongst stakeholders	The Swedish Environmental Objectives (Section 5) and the Finnish Road Map to a Circular Economy (Section 6) illustrate this at a national level.
	A collaborative approach in developing policy should be taken to ensure that policy changes take into account the reality of stakeholder groups and that targets set for actors are appropriate and likely to be adopted	Circular Peterborough (Section 6) provides an example of stakeholder engagement which includes close links with local industry; the PREC in Brussels Capital Region (Sections 5 and 6) includes the setting of actor specific targets developed by the actors themselves
Inspire	Public authorities have an important role in sharing information on best practices to demonstrate leadership and inspire.	The Procura + case studies highlighted in Section 6 provide an example of this.