25 YEARS ACR+ INSPIRING CIRCULAR CITIES SINCE 1994

SUSTAINABLE CONSTRUCTION GUIDELINES FOR PUBLIC AUTHORITIES

A Circular Economy perspective

December 2019

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The views expressed in this report are those of ACR+ only.

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Acronyms

BIM	Building Information Modelling
CDW	Construction and demolition waste
C&D	Construction and demolition
C2C	Cradle to cradle
CO2	Carbon dioxide
DSS	Decision support system
EI	Economic instrument
EoW	End of waste
ERDF	European regional development funds
ETV	Environmental technology verification
EU	European Union
GDP	Gross domestic product
GPP	Green public procurement
ICT	Information communication technology
LCA	Life cycle assessment
LRA	Local and regional authority
MOOC	Massive open online courses
MS	Member States
NACE	Statistical Classification of Economic Activities in the European Community
OECD	Organisation for Economic Co-operation and Development
PREC	Brussels regional plan for circular economy
R&D	Research and Development
SME	Small and medium enterprise

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Executive summary

The construction sector represents a wide range of processes, resources, infrastructures, buildings, products, services, culture, arts, communities, ... Its importance for our society is enormous and influences significantly the way we live.

It plays an important role in the European economy, generating almost 10 % of GDP, providing 18 million direct jobs, and it is one of the most resource-intensive sectors. It accounts for roughly half of all extracted materials, half of energy consumption, a third of water consumption, and 40% of all greenhouse gas emissions.

The goal to turn such a strategic sector into a sustainable system is an inspiring challenge. The circular economy principles can play much of a role in this transition. Current literature on sustainable construction covers energy efficiency extensively and often exclusively. In these guidelines, the focus is put on circularity and material resources efficiency. Social and cultural aspects are also crucial to design and implement effective solutions for citizens, achieving inclusiveness and economic cohesion. Circular economy can facilitate the process only if it is embedded in other dimensions (social, local development, health and safety, etc.). Otherwise, resources circularity as a stand-alone objective could generate negative consequences (e.g. low social acceptance, safety and quality of reused or recycled materials). Citizens and businesses develop trust about circular processes if they are provided with proper regulation, communication, transparency, and policy instruments to effectively implement new solutions. Local and regional authorities operate close to the citizens and can play a tremendous role to generate concrete and durable impacts.

This study is meant to describe some relevant instruments that LRAs can implement to trigger, make durable and replicate sustainable circular economy processes in the construction sector. The document is divided in two main parts. The first one refers to an overview of what sustainable construction sector stands for, starting from the current state of play and moving to the circular economy principles. The second part introduces approaches, principles, and examples. The journey starts from the analysis of the territory to identify priorities and objectives. Then communication and education are in the focus, representing key factors to involve citizens, frontrunners and practitioners. Research & innovation, business support, financial incentives, policy and regulation, public procurement are other tools to consider when striving for sustainability. However, this list is not exhaustive and the public debate should be kept open when elaborating such strategies. Boxes with good practices and experiences on specific topics turn the narrative in concrete examples.

These guidelines are complementary with previous ACR+ publications and contain several references to other studies and researches.

Part 1 – Clarifying sustainable construction

Figure 1 - Sustainable development concept

The 2005 World Summit on Social Development identified sustainable development goals (SDGs), such as economic development, social development and environmental protection.

Since the construction sector is also an expression of the local heritage, it is worth mentioning the fourth pillar of the sustainability, as introduced by the Agenda 21: culture.

Architects, designers, sociologist, urban planners cannot operate in the construction sector without taking into account cultural issues.

Culture, in this sense, could then be a driver to develop and implement new construction concepts, based on sustainability.

The construction sector includes a wide range of activities; this document mainly refers to urban planning, designing, construction (demolition/deconstruction) of buildings and civil infrastructure as well as waste management.

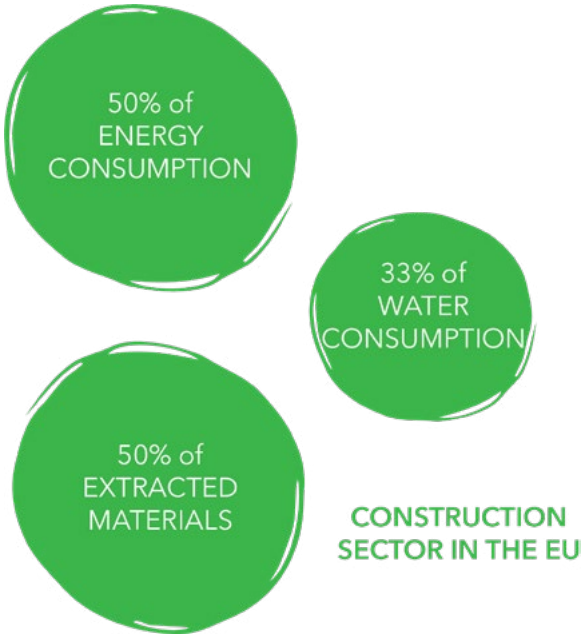
The construction sector has to face many challenges, such as energy efficiency, climate change mitigation and adaptation, resource efficiency, job employment, demographic issues.
The competitiveness of the construction companies is an important issue not only for growth and employment in general but also to ensure the sustainability of the sector.

The sector could significantly contribute to job creation by increasing its activity in some very promising areas, such as the renovation of buildings and infrastructures through appropriate policies to promote demand but also to encourage investment. Thus, the construction sector plays an important role in the delivery of the Europe 2020 Strategy on smart, sustainable and inclusive growth.

1. Context

1.1 Resource consumption in the construction sector

The construction sector is one of the most resource-intensive sectors in Europe[1]. It accounts for roughly half of all extracted materials, half of energy consumption, a third of water consumption[2], and 40% of all greenhouse gas emissions (European Commission, 2019).



The consumption of non-metallic minerals varies most across countries from around 2 tonnes per capita to more than 15 tonnes per capita. The differences between countries are influenced amongst others by levels of construction activities (investments), population densities, and size of infrastructures such as e.g. road networks (Eurostat, 2017).

The global figures are even more significant: according to OECD (OECD, 2018), the global materials use is projected to more than double from 79 Gt in 2011 to 167 Gt in 2060 and non-metallic minerals, such sand, gravel and limestone, represent more than half of total material use. Looking to the material intensity per USD produced per sector, the construction sector is the most intensive sector, as shown in Figure 2[3]. Circular economy is expected to significantly contribute to reduce the material intensity of the construction sector in 2060, thanks to proper strategies, action plans, and technology developments.

On the policy side, decoupling of materials use from GDP has become an effective proxy, both to set targets and monitor progress. The elaboration of local plans towards sustainable construction patterns and the implementation of the planned actions can definitely make the difference.

1 Ecorys calculated that the EU-27 consumed between 1,200 – 1,800 million tonnes of construction materials per year for new buildings and refurbishment between 2003 and 2011.

2 Environment/industrial policy: Live and work in better buildings, European Commission, 2 July 2014.

3 Source: Energy, transportand environmental indicators - Eurostat, 2017.

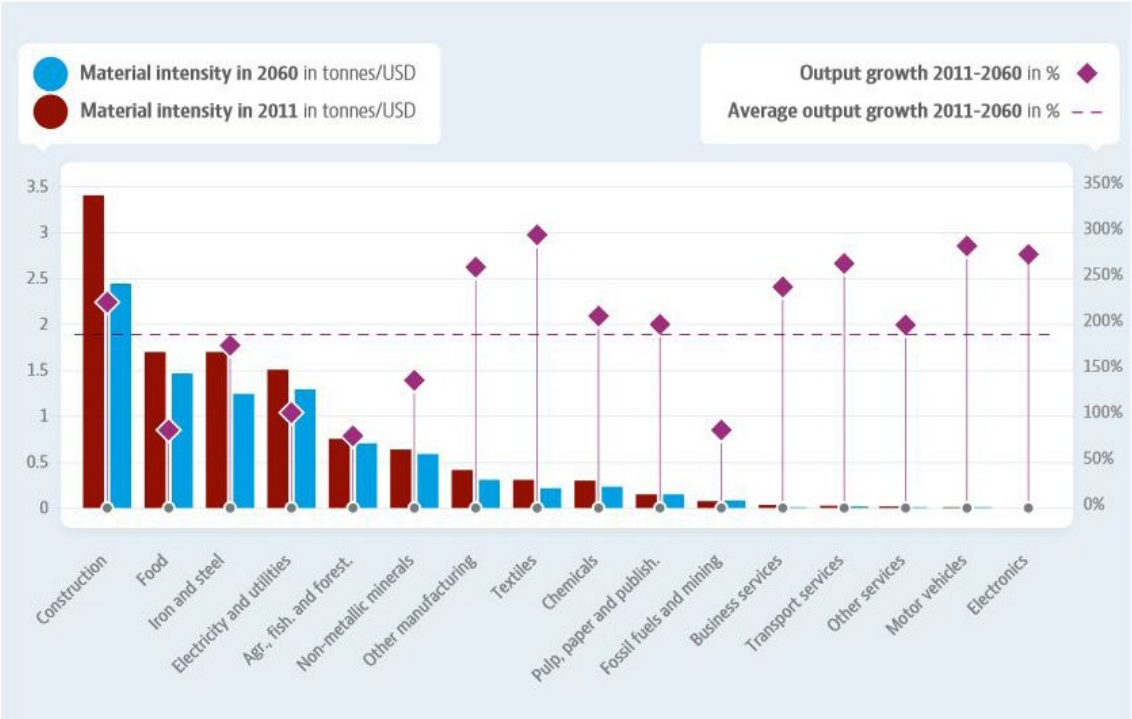
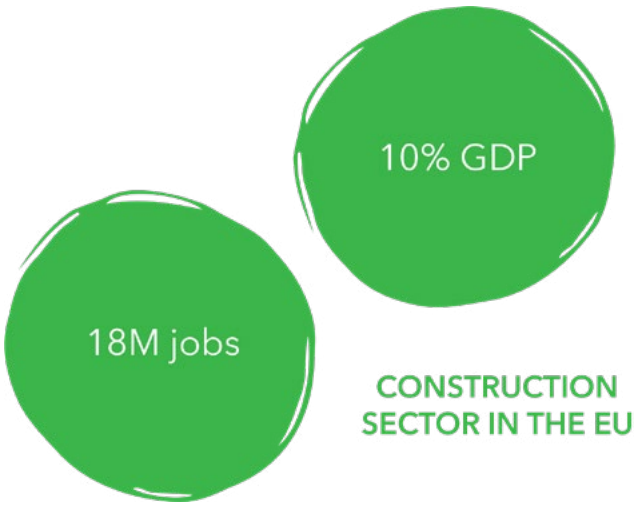


Figure 2 – Global material intensity per sector in 2011 and 2060. Outlook according to OECD, 2018

1.2 Construction sector competitiveness

The construction sector plays an important role in the European economy. It generates almost 10 % of GDP and provides 18 million direct jobs, mainly in micro and small enterprises (COM/2012/0433).



Since small and medium-sized enterprises (SMEs) use to operate in the construction sector mainly at local level, LRAs are the main reference public bodies having the responsibility to design strategies and the legal capacity of setting the rules. The establishment of clear legal frameworks, the implementation of technical tools and, the elaboration of local policy instruments are key elements to support SMEs towards sustainability. SMEs are the backbone of Europe's economy. They represent 99% of all businesses in the EU. In the past five years,

they have created around 85% of new jobs and provided two-thirds of the total private sector employment in the EU. The competitiveness of construction companies is therefore an important issue not only for growth and employment in general but also to ensure the sustainability of the sector.

1.3 Waste production in the construction sector

Total waste production in EU accounts for roughly 5 t/cap (Figure 3). Construction and demolition (C&D) activities generate a large amount of waste, contributing to 36.4% (by weight) of total waste generated in the EU in 2016 with 923 million tonnes, as shown in Figure 2 (Eurostat, 2017).

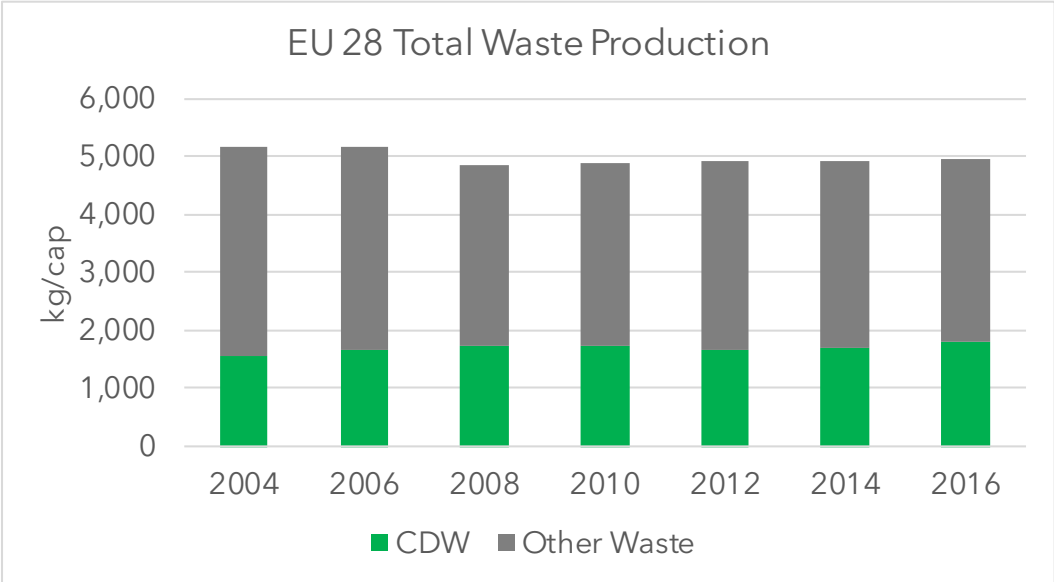


Figure 3 – Total waste production in EU 28 (per capita values). Source: Eurostat database, accessed August 2019. Elaboration: ACR+

The definition of CDW is key in order to determine the scope and to measure the impacts of action addressed to make the sector sustainable and resource efficient. According to the Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 (amending Directive 2008/98/EC), the definition of construction and demolition waste refers to waste that results from construction and demolition activities in a general way: private building works from the residential, school, hospital, commercial, industrial sectors, public works, including road planning and maintenance, to name a few. It also includes waste arising from minor do-it-yourself construction and demolition activities within private households. Construction and demolition waste should be understood as corresponding to the types of waste included in Chapter 17 of the list of waste established by Decision 2014/955/EU in the version in force on 4 July 2018.

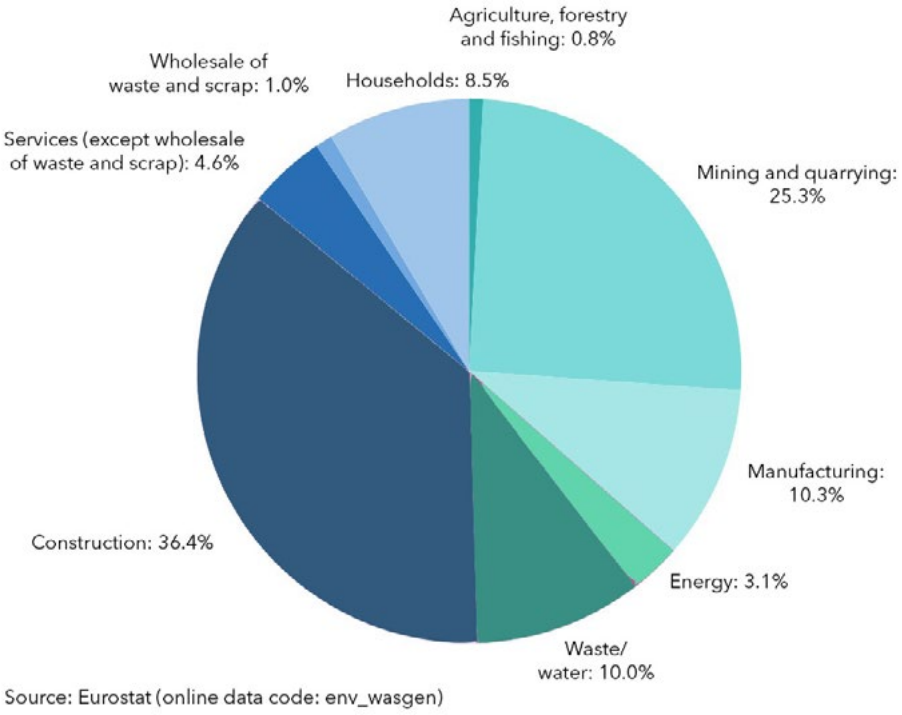


Figure 4 – Waste generation by economic activities and households (% by weight) (EU-28, 2016)

Public infrastructures have widely developed the use of recycled aggregates but the building sector is lagging behind. It faces major issues, mostly due to the diversity of sites and of materials involved (Deloitte, 2017).

Figure 3 shows the diversity of CDW per activity – this gives an overview of the materials involved and which should be addressed. However, it is important to remember that other resources are at play, namely fossil fuels, which are used for example for transport.

The various materials used are reflected in the waste too: excavated soil, concrete, bricks, glass, wood, metals, gypsum, plastic, solvents, and hazardous substances such as asbestos. Almost three-quarters of the total waste in the EU is mineral and solidified waste, mostly connected to mining and quarrying activities and to C&D activities.

Figure 5 – Diversity of CDW per activity (European Commission, 2017)

The percentage distribution of CDW in EU-28 is visualized in Figure 6[4]. The timeframe starts from 2010, to maximise the consistency of data (some reporting categories have changed as of 2010[5]). The sheer volume in question brings waste streams beyond municipal waste, such as CDW, into the limelight as key areas for policy action at local level. Furthermore, the CDW analysis highlights the potential for resource efficiency improvements in the construction sector as a whole.

4 ACR+ elaboration on Eurostat database accessed August 2019.
5 Source: Eurostat database (accessed August 2019). W12_X_127NH - Mineral waste (except non-hazardous dredging spoils, valid up to 2008), W12A - Mineral wastes (except combustion wastes, contaminated soils and polluted dredging spoils) (W121+122+W123+W125+W126, valid up to 2008), W126_127 - Soils and dredging spoils (W126+W127, valid up to 2008), W13 - Solidified, stabilised or vitrified wastes (valid up to 2008)

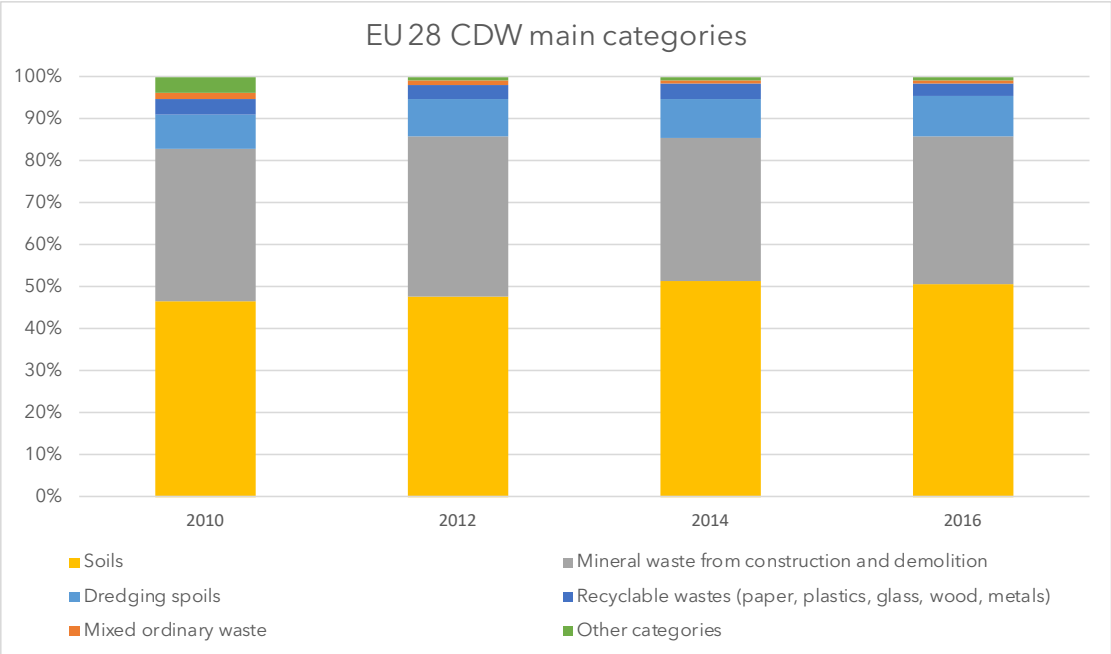


Figure 6 – Main categories of CDW from Eurostat database (EU 28)

The 2008 Waste Framework Directive (WFD) sets a binding target for Member States to prepare for reuse, recycle, and recover 70% of non-hazardous CDW by 2020. The share of hazardous waste in the total CDW stream showed a growth trend up to 2008, then followed by a quite stable drop below the 2% value (Figure 7).

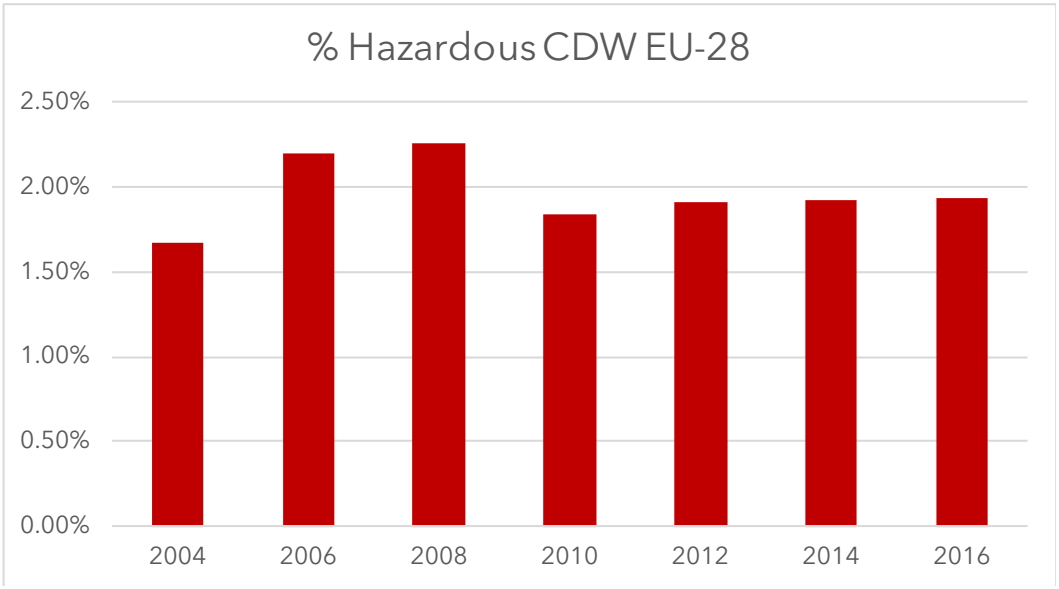


Figure 7 – Share of hazardous waste in the EU CDW: Source: Eurostat database, accessed August 2019

To move towards resource efficiency in the sector, the DIRECTIVE (EU) 2018/851 (amending the 2008 WFD), includes a new requirement, asking the Commission to consider the setting of prepar-

ing for re-use and recycling targets for construction and demolition waste and its material-specific fractions by 31 December 2024. Furthermore, a new definition of backfilling has been introduced, to clarify that it means any recovery operation of suitable non-hazardous waste for the purposes of reclamation in excavated areas or for engineering purposes in landscaping. The waste used for backfilling should be limited to the amount strictly necessary to achieve those purposes.

Many materials consumed by the construction industry can be reused or recycled. In particular, there is a large market for aggregates derived from CDW in roads, drainage, and other construction projects. Yet, in spite of the potential for recovery, rates vary widely across the EU. Although several Member States are set to achieve the target, the recycling potential is under-used. Figure 8 shows an overview of CDW treatment routes across the 28 Member States. The graph is based on Eurostat data from 2012, which must be used with caution due to statistical reporting discrepancies between countries. The status of backfilling is one of the main issues to be checked across the EU Member States to make the figures consistently comparable.

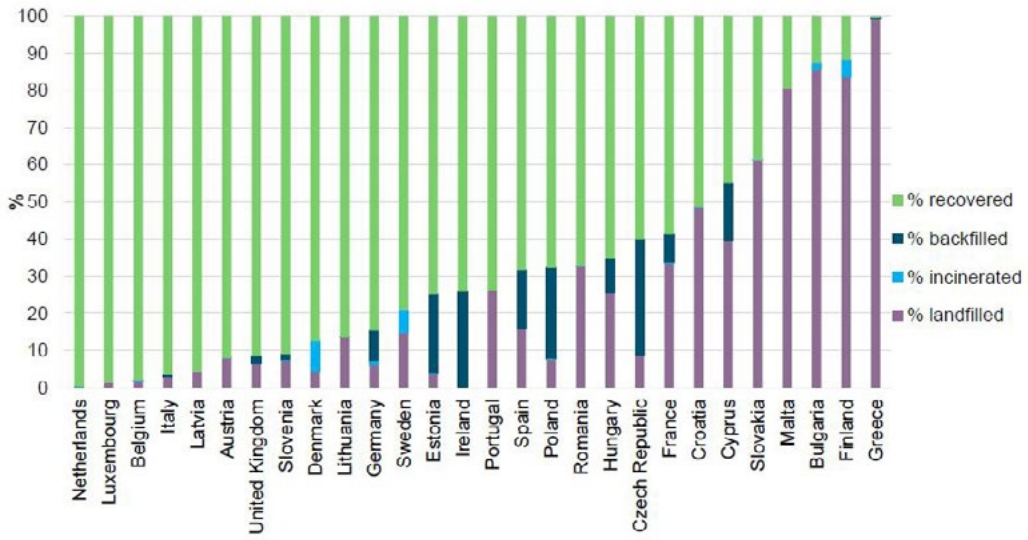


Figure 8 – CDW management summary for the EU-28 in 2012 (European Commission, 2017)

2. Sustainable construction: what does it mean?

There are several steps in a building's lifetime, design and the manufacture of products, followed by construction, occupancy, maintenance and renovation, repurposing, and finally deconstruction/disassembling/demolition. Every step has direct and indirect impacts on the environment, through the use of water, energy, and raw materials, the generation of waste, or potentially harmful atmospheric emissions.

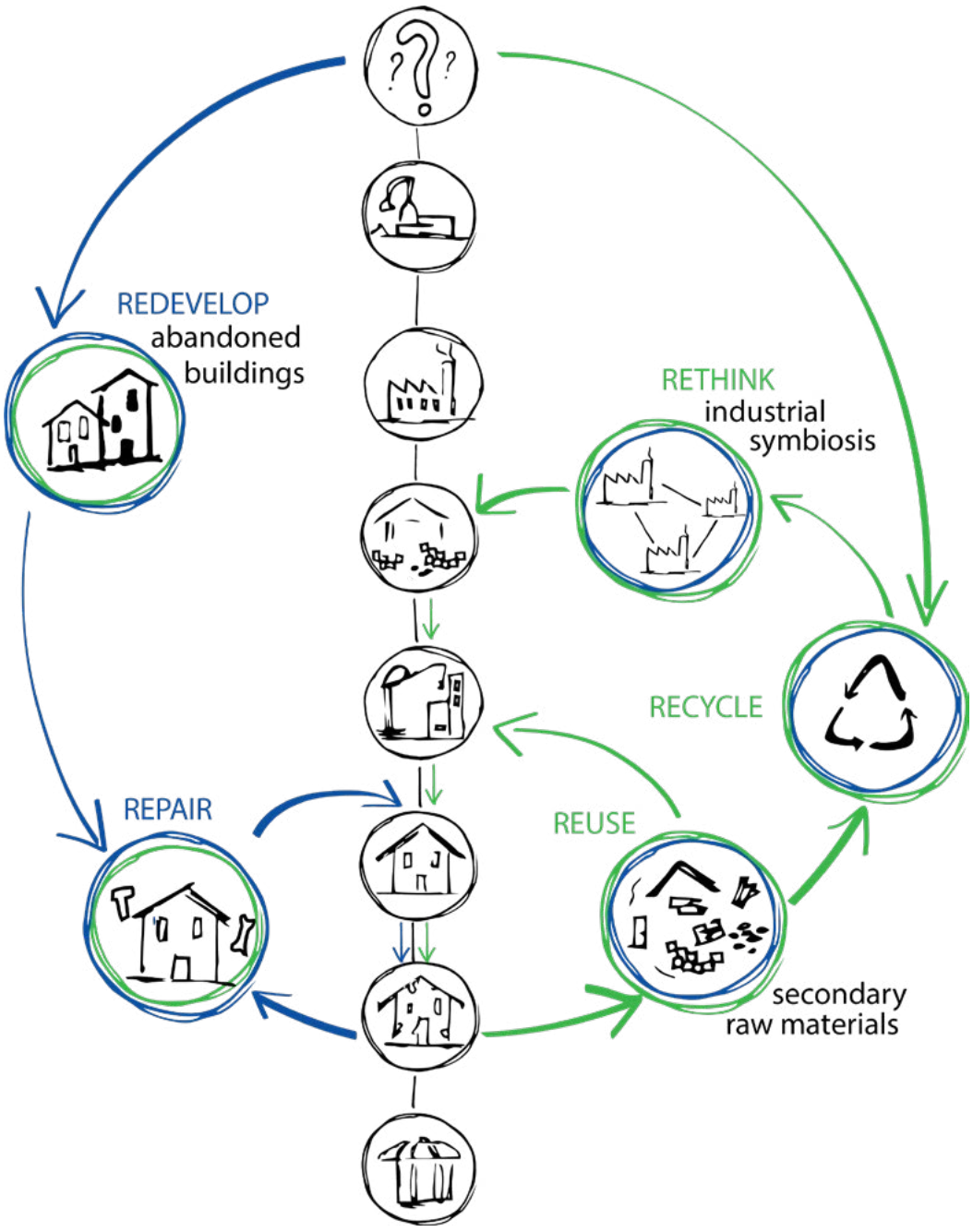


Figure 9 – Sustainable construction concept

There is no universally accepted definition for sustainable construction. On the contrary, interpretations abound – and so do the terms used: green construction, sustainable buildings – althought these words are often used rather interchangeably. Sustainability can include preservation of the environment, efficient use of resources, but also social progress, economic prosperity, and poverty eradication. At the core of sustainability lies the concept of **durability** and **minimising impacts**: only by ensuring the preservation of our environment can we leave the Earth in the same state or better for future generations. It therefore makes sense that the application of this concept to the building sector covers a broad spectrum. The cultural heritage preservation aspect is part of the issue: a distinction among different categories of buildings (new/old/preserved ones) could help finding effective targets towards sustainability as a whole.

Up until recently, when looking at buildings as a whole, the main policy focus was on energy efficiency. In terms of material resources, the focus was mostly on waste at the end-of-life. But circularity and resource efficiency have gained momentum, and the construction sector is no exception. It combines a multi-criteria, integrated approach and balances social well-being, environmental impact, building's economic performances and cultural heritage aspects.

Holistic approach in sustainable construction

In this context, **sustainable construction refers to the holistic approach** to design, construction, operation and occupancy, maintenance, renovation, and demolition processes of structures, all of which are environmentally responsible and resource efficient throughout a building's life-cycle, limiting the environmental impacts and ensuring optimal efficiency whilst creating a high level of quality of life for its occupants.

Different approaches may be followed according to the local socio-economic context: in some countries priority is given to resource use (energy, materials, water, and land use), while in others social inclusion and economic cohesion are the more determining factors (EC Task Force on Sustainable Construction, 2007:4).

As a result, sustainable buildings use less energy and materials, produce less harmful emissions. Their location is carefully considered right from the start. They offer healthier and more comfortable spaces for occupants. In addition to their reduced environmental impact, they offer long-term return on investments, as they are cheaper to run and last longer, making them more valuable properties. They can change purpose and can be deconstructed. At any stage in their lifetime, all information relative to the materials they contain is readily available. And at the end, when a

material is no longer needed, it is reused elsewhere whenever possible, or recycled by another industry.

Of course, there is a margin of difference between theory and practice, but these would be the ideals that sustainable construction strives towards. The local socio-cultural-economic context can address different solutions and actions, but the overall sustainability in the construction sector should be put as a strategical priority.

Word cloud

Sustainable construction includes a word cloud: materials performance, resource efficiency, energy efficiency, economic efficiency, environmental performance, social responsibility, architectural quality, technical innovation, transferability, flexibility of use, function and change, ethical standard, social inclusion, monitoring, dissemination, green construction, sustainable building, environmentally responsible, resource efficient, life-cycle thinking, eco-design, renovation, maintenance, operation, deconstruction, industrial symbiosis, BIM, …

2.1 EU sustainable construction state of play

At European level, the built environment is targeted by various policies and instruments. Sustainability in the construction sector is often spontaneously interpreted from an energy efficiency angle, which is well covered by the Energy Performance of Buildings Directive and the Energy Efficiency Directive. Under the Energy Performance of Buildings Directive (2010/31/EU), all EU Member States have established independent control systems for energy performance certificates and inspection reports for heating and cooling systems. These certificates must be included in all advertisements when a building is put up for sale or rent. Therefore, inhabitants generally have a good indication of their home's energy performance. But knowledge of how sustainable a home is often ends there. However, the broader vision at EU level now encompasses resource efficiency. The following graph shows the progression of the relevant EU resource efficiency policies and instruments in the construction sector.

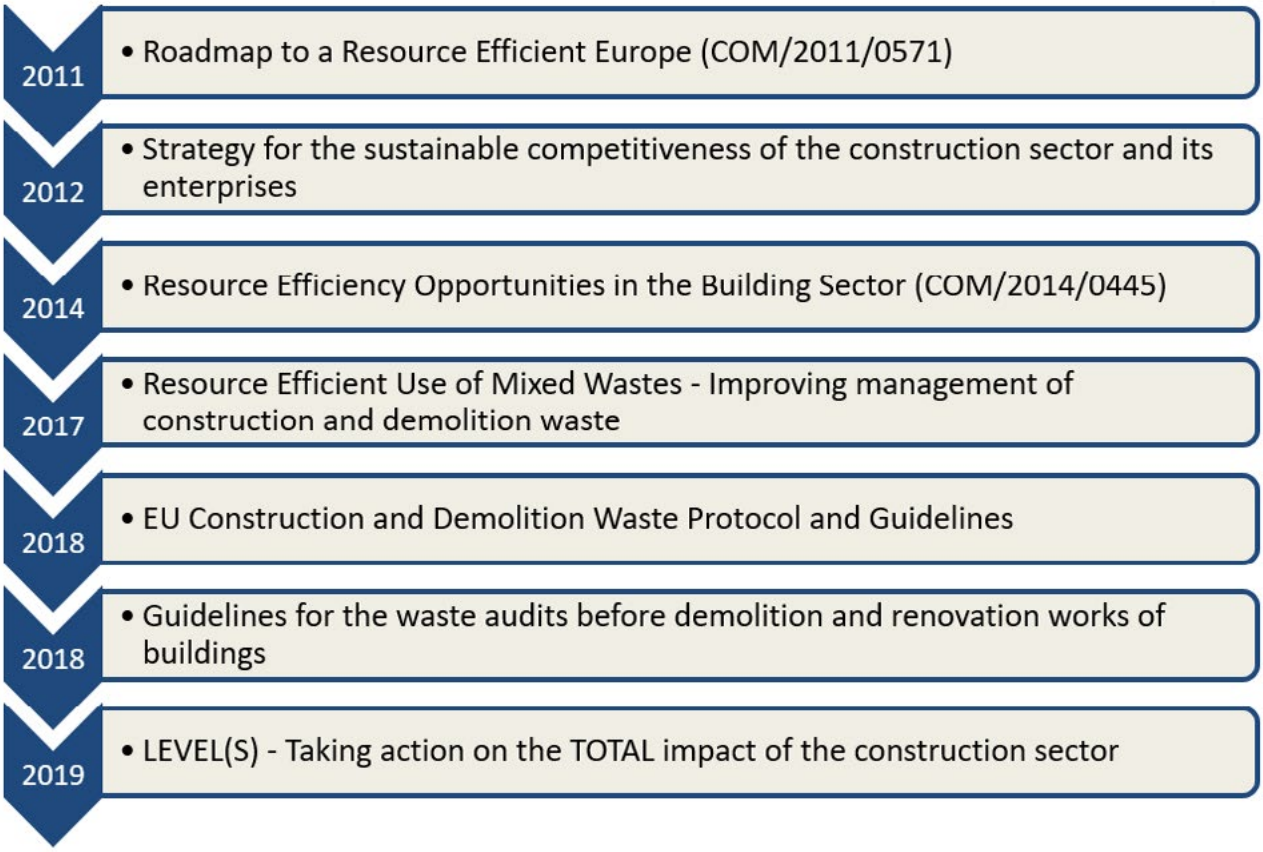


Figure 10 – List of relevant EU resource efficiency policies and instruments in the construction sector

Local and regional authorities can be inspired by the Construction 2020 Action Plan of the European Commission, which stems from the 2012 "Strategy for the sustainable competitiveness of the construction sector and its enterprises". Its aims at identifying and implementing measures to foster sustainable competitiveness in the construction sector in the short and medium to long term. In this strategy, the European Commission focuses on five key objectives, which reflect the priorities it has identified for sustainable construction (COM/2012/0433):

1. Stimulate favourable investment conditions;
2. Improve the human-capital basis of the construction sector;
3. Improve resource efficiency, environmental performance and business opportunities;
4. Strengthen the Internal Market for construction;
5. Foster the global competitive position of EU construction enterprises.

The 2014 Communication on Resource Efficiency Opportunities in the Building Sector (COM/2014/0445) published by the European Commission, takes things further to promote a more efficient use of resources. It aimed to improve design, construction, demolition, and recycling of construction products as well as simplify data in the use of resources to reduce waste. As part of the Construction 2020 strategy and the Circular Economy Package, the European Commis-

sion has developed a study in pre-demolition and renovation waste audits (VTT-TECNALIA-RPA, 2016), a study on the current status of CDW management and policies in Member States (European Commission, 2017), and the CDW Management Protocol, which includes a collection of Best Practices in CDW recycling, to name but a few of the most recent initiatives.

Various measures have also been taken at national, regional, and local scales in order to improve the sustainability of construction. The present guidelines aim to help local and regional authorities to navigate through sustainable construction, to understand what it means and to determine how to encourage it. The guidelines introduce the main concepts then list out practical steps which can be taken by public authorities to build their strategy, and present case studies for each type of action.

3. Sustainable construction principles in the perspective of a circular economy

There are few fundamental principles which can inspire and guide sustainable construction strategies developed by cities and/or regions. In a circular economy perspective, this report suggests a number of principles, approaches and examples. However, this list is not exhaustive and a participatory approach including different stakeholders as well as the public debate should be kept open when elaborating strategies.

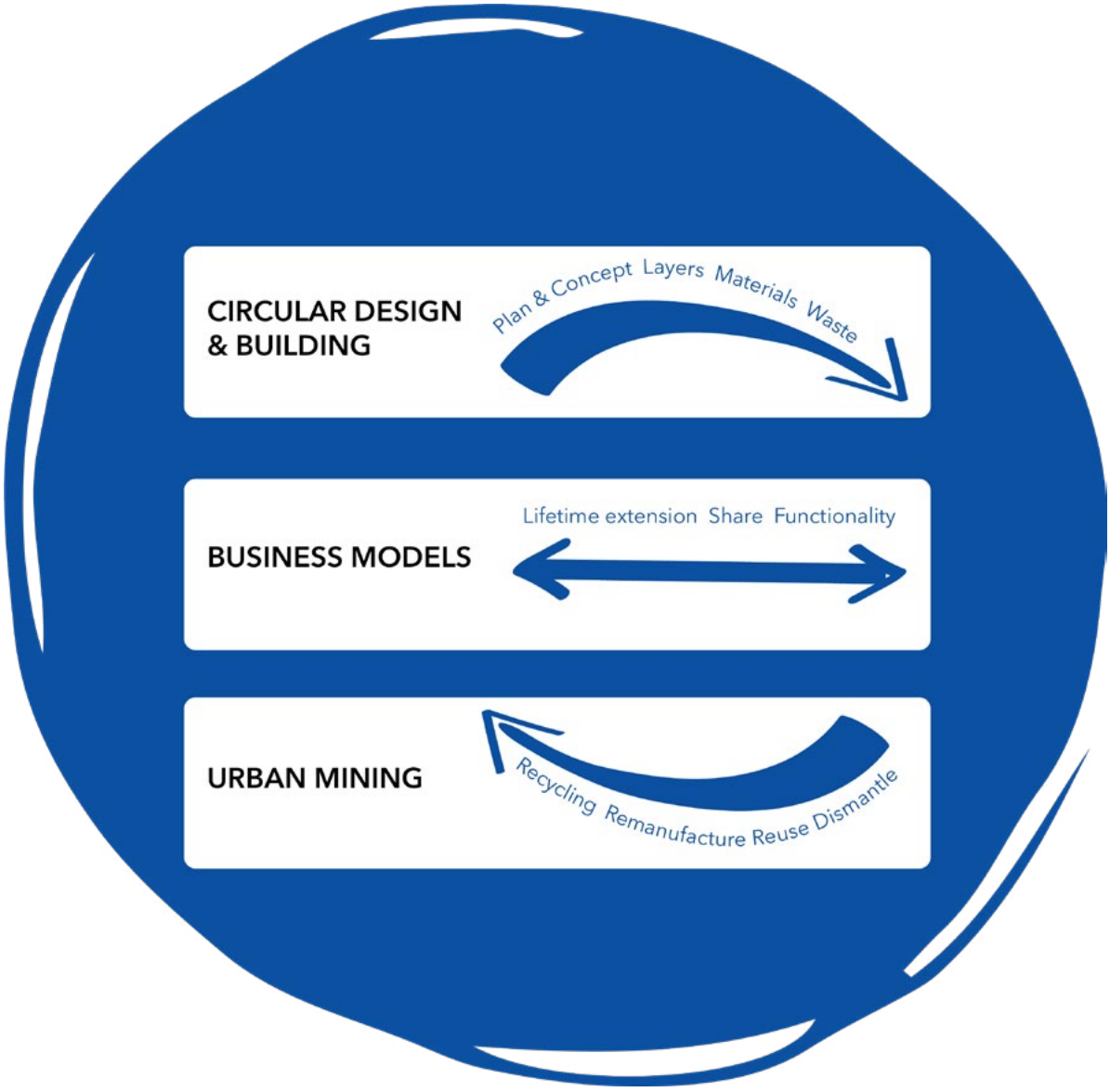


Figure 11 – Circular economy thinking in construction (WTCB - CCBH, 2017)

The application of the concept of circular economy thinking in construction is not limited to waste minimisation and recycling. It should be approached from an holistic perspective, starting with urban planning, circular design and construction and closing the loop with urban mining, as shown in Figure 11. Business models can enable materials to retain high values. Indeed, there are various aspects of material efficiency within construction. Design for deconstruction/disassembling is one of them, as is the modularity of buildings, since they can be reused many times. A Product-Service System Business model is another type of approach, favouring use over ownership, by selling services linked to goods and products rather than the products themselves (cf. second part, paragraph 1.8).

Some key aspects in applying circular economy across a building's life cycle, derived from the literature, are shown in Table 1:

Table 1 - Circular economy aspects across a building's life cycle stage are listed

Life cycle stage	Circular economy aspect
Design	Design for deconstruction (DfD)
	Design for adaptability and flexibility
	Design for standardisation
	Design out waste
	Design in modularity
	Specify reclaimed materials
	Specify recycled materials
Manufacture and supply	Eco-design principles
	Use less materials/optimise material use
	Use less hazardous materials
	Increase the lifespan
	Design for product disassembly
	Design for product standardisation
	Use secondary materials
	Take-back schemes
	Reverse logistics
Construction	Construction Minimise waste
	Procure reused materials
	Procure recycled materials
	Off-site construction
In use and refurbishment	Minimise waste
Minimal maintenance	Minimal maintenance
Easy repair and upgrade	Easy repair and upgrade
Adaptability	Adaptability (to new purpose)
Flexibility	Flexibility (rearranging the spaces)
End of life	Deconstruction
	Selective demolition
	Reuse of products and components
	Closed-loop recycling
	Open-loop recycling
All stages	Management of information including metrics and datasets

3.1 Resource preservation

As previously mentioned, the construction sector accounts for approximately half of all extracted materials, half of total energy consumption, one third of water consumption, and one third of waste generation in Europe. It comes as no surprise that resource preservation should therefore lie at the core of a sustainable construction strategy. These guidelines primarily focus on the material efficiency, as current literature on sustainable construction covers the energy efficiency aspect extensively and often exclusively. However, the circular economy approach can synergise with current energy efficiency policies at local level (e.g. Covenant of Mayors - Sustainable Energy and Climate Action Plan), implementing sustainable resource management processes. The consolidated metrics for energy efficiency (e.g. carbon dioxide - CO2) can also be deployed for the circular economy in the construction sector (cf. the ACR+ campaign "More circularity, less carbon").

The case of glass

Glass is an integral part of the built environment and makes up an ever-increasing proportion of modern construction projects. If removed and handled correctly, it can be reused or recycled indefinitely: this both minimizes waste, saves raw materials and reduces carbon emissions. The key to efficient glass recycling is to minimize non glass contaminants from becoming mixed with the glass. This can be achieved by careful segregation of glass during the deconstruction process. The glass can then be returned to an architectural glass manufacturer who can return the glass to their furnace and produce new glass products. Collection systems for architectural glass are starting to be developed and differ by country. Local glass organisations should be able to advise on the details in your location.

More information and case studies can be found by visiting the British Glass website www.britglass.org.uk

The hierarchy adopted by the Waste Framework Directive 2008/98/EC[6], is at the core of resource preservation. It is integrated in a five-level hierarchy, as illustrated in Figure 10. This hierarchy indicates the priority order to respect in both legislation and policy, unless life-cycle thinking can justify using another hierarchy.

6 The waste hierarchy is a concept that has appeared in environmental literature and in some EU Member States environmental legislation but before the waste framework directive of 2008 was not part of the European legislation.

1. **PREVENTION**
2. **PREPARING FOR REUSE**
3. **RECYCLING**
4. **OTHER RECOVERY**

(particularly energy recovery)

5. **SAFE DISPOSAL**

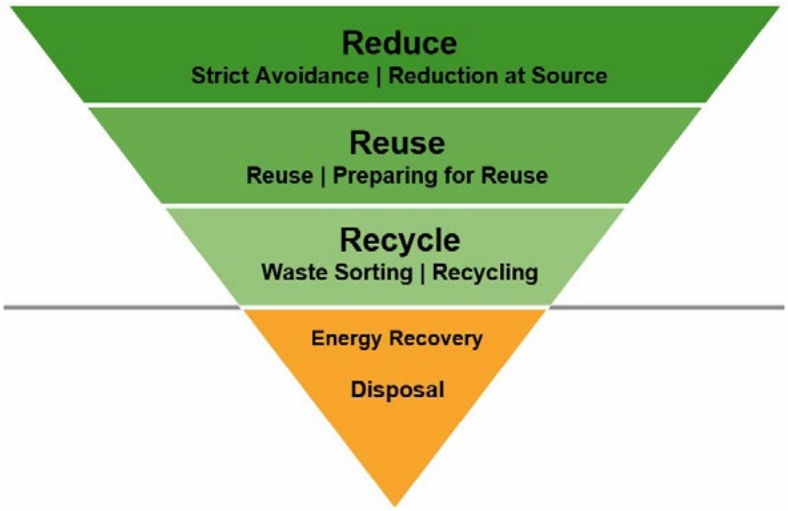


Figure 12 - Waste hierarchy pyramid

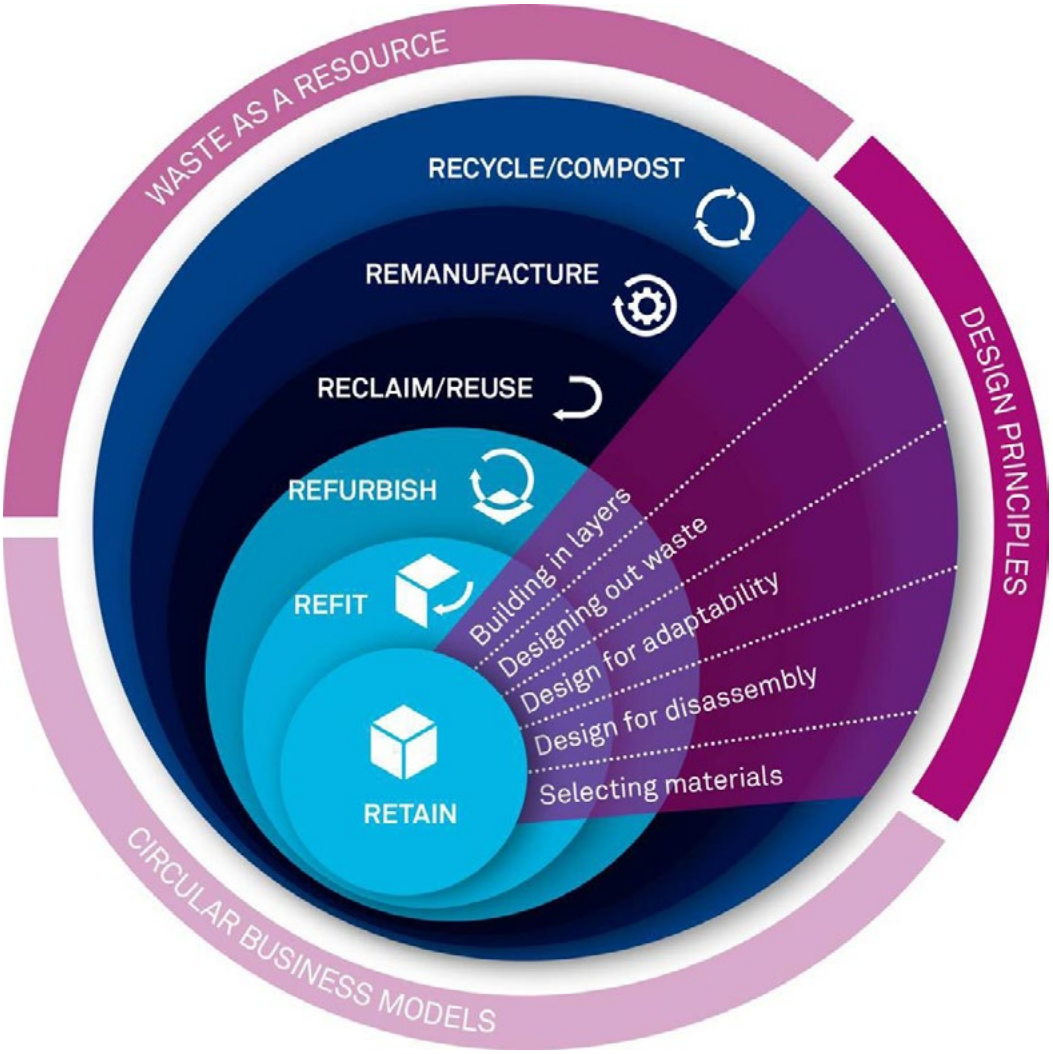


Figure 13 - David Cheshire, 2016. Building Revolutions: Applying the Circular Economy to the Built Environment, David Cheshire (AECOM), RIBA Publishing, 2016

The Waste hierarchy pyramid is effectively transposed into the construction sector through the image in Figure 13. The three inner circles show that retaining existing buildings is the most resource-efficient option, followed by refits and refurbishments. The outer three circles apply to building elements, where the priority is to design components that can be reclaimed or remanufactured and only recycled or returned to the biosphere as a last resort. The five segments on the diagram demonstrate the design principles associated with a circular economy. The trade-offs with energy efficiency are also in the focus: the life cycle approach helps to assess the whole sustainability of a building.

Prevention in the construction sector can be targeted by urban planning, analysing the opportunities to avoid/reduce demolishing and incentivising requalification/refurbishment. The land consumption is also an issue to consider: soils represent roughly the 50% of the total EU CDW yearly produced (Figure 6) and loss of biodiversity, landscape management are also in the focus. Local authorities can address solutions through proper strategic action plans, involving also private owners, by breaking down the causes of urban underuse, such as: abandoned and derelict structures, inefficient land use, segregated and/or polluted areas.

Good practices on reuse of building and empty spaces

Reusing buildings, changing their use, revitalizing empty spaces are the preferred options to avoid the consumption of resources and the production of CDW, offering local developments opportunities. LRAs can play an important role to support such initiatives, designing strategies with measure targeting sustainable objectives and facilitating actions' implementation.

Mapping the territory to detect **empty spaces** or unused buildings is key to set up the **baseline**. It requires a strong involvement of the private owners. The involvement of the civil society allows to co-design initiatives to liven up the spaces.

The (Re)making The City online tool is an effective source of inspiration, including a wide range of stories selected to showcase innovative and cost-effective solutions. This tool was created building upon the URBACT Action Planning networks knowledge, to promote and disseminate innovative planning approaches towards the rehabilitation of underused spaces.

About **one third of construction waste could arise from poor design decisions**, failing to implement prevention and waste reduction measures during the design stages (Osmani 2008, EPA Research 2015). There is a possibility to integrate this ideal from the very conception of the building. A building which is modular in design will allow to preserve resources during its lifetime. Indeed, by ensuring a certain level of flexibility, modularity can reduce the need for renovations. Similarly, when **designing for deconstruction**, the end-of-life is taken into account from the very beginning. This will help facilitate reuse and recycling of structures and materials, as they will be relatively easily disassembled for future use.

Circular Retrofit lab

This pilot project tested and implemented different scenarios for the reuse and refurbishment of the VUB (Vrije university in Brussels) Campus' prefabricated student housing, minimising waste generation. Strategies have been explored for internal transformations, external transformations, and the module's multiple functional reconfigurations.

The **circular refurbishment** tested dismountable, adaptable and reusable solutions for maximizing waste reduction. The pilot developed a co-creative process all along the (re) design, (re) build, (re)use, repurpose or dismantling phases. Strong collaboration with all the **value network stakeholders** and future users in the early development phase were key. The university organised several round tables with industry stakeholders where design solutions were debated and improved, as well as **hands-on workshops** with students where solutions were tested.

However, the onus is on all phases of a building's life-cycle, as we must take into account the large, existing building stock. During manufacture and supply the principle of **industrial symbiosis** can be applied. Industrial symbiosis is a form of brokering to bring companies together in innovative collaborations, finding ways for one to use the waste from another as raw material.

The facilitation of industrial symbiosis will help ensure that material which does end up as waste can still be used elsewhere as a resource. **LRAs have an important role** to play at this level, to **help building bridges** transparently among various industries and businesses.

3.2 Territorial hierarchy

Circular economy should be developed in short cycles as much as possible to increase its positive impact.

Transportation plays much of a role in terms of resources consumption and CO_2 emissions in many value chains, and construction sector makes no exception.

On site CDW treatment or construction sites reusing materials from a nearby deconstruction operation can be financially and environmentally convenient. Road renovations can also reuse some of the materials from the previous infrastructure, to avoid transporting waste away from the site and bringing in new materials.

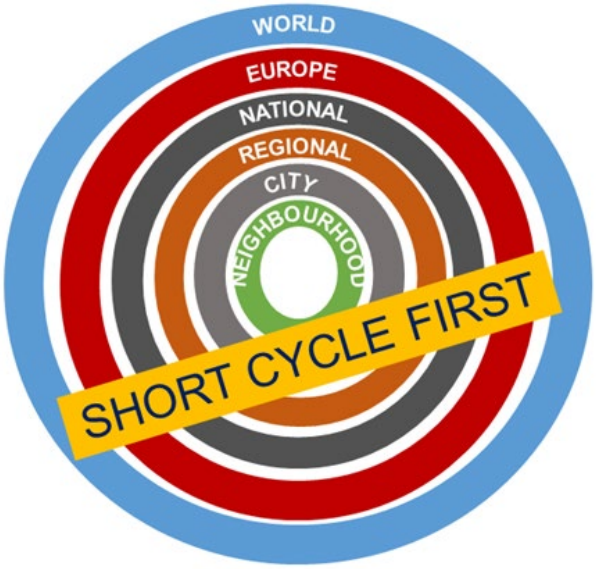


Figure 14 – Territorial hierarchy diagram

Renovation projects can involve local communities by donating reusable products/elements/materials of the buildings (office furniture, lighting, doors, radiators, etc.) to local organisations. Both parties win in such situation: there is no need to pay to have these elements disposed of as waste and the benefitting organisations can save money while purchasing new equipment. The establishment of local networks can also incentivise the selective deconstruction, creating cost effective reuse/recycling opportunities.

Made in Moerwijk

This initiative takes place in The Hague municipality (Netherlands). Local communities were involved to give a second life to the furnishing and other materials of an old school about to be demolished. The project created local economic value in a circular perspective.

The Hague municipality is active in the frame of the Urban Agenda Partnership on Circular Economy (UAPCE), implementing several initiatives about the urban circular collaborative economy concept.

3.3 Shared governance

LRAs should cooperate effectively to boost sustainability at different scale. Across Europe there are significant differences about the responsibilities of the national, regional and local authorities. However, a strong and effective cooperation among the authorities is necessary to put in place circular processes.

Regional authorities can develop strategies and plans adapting international and national targets to different territories. Local authorities can turn into actions the planned measures to achieve the goals. There is a wide diversity of stakeholders involved in sustainable construction and they display different levels of education and expertise. When developing policies and regulations to foster sustainable construction, it is essential to involve all of them in the process at some point, in particular:

- Sociologist and urbanists;
- Designers: architects, urban planners;
- Manufacturers and suppliers;
- Construction and demolition professionals: contractors, engineers, entrepreneurs, builders, electricians, plumbers, …;
- Public clients, consumers, and citizens;
- Researchers and educators: architecture & engineering schools;
- Government: local and regional authorities, as well as federal government bodies;
- Trade associations and unions;
- Non-profit sector: reuse platforms in particular.

Several fields of expertise are involved, and sustainable construction requires the cooperation of various services and departments within public authorities. The most obvious are: engineering, urban planning, public works, housing, and environmental or building permits. But health and safety, social and economic development, transport and parking, or even history and tourism could be involved.

Social engagement and acceptance are key to success and participative strategies should be developed accordingly. This is true for all LRAs actions, but more visible when it comes to construction. Road works can divert traffic and disturb neighbourhoods. Public works which are deemed unsustainable or short-lived will be accused of being a waste of taxpayer money and will consequentially meet strong resistance from the civil society. New, stricter building regulations to foster sustainability could meet resistance of the construction professionals if the additional burden comes across more than the overall benefits. Engaging into a multi-stakeholder dialogue is therefore essential, firstly to hear all points of view and improve the strategies, and secondly to ensure that the right message comes across.

Clear communication and dissemination strategies, as well as open access of information are also necessary. For example, the Brussels Capital Region set up a web portal which allows construction professionals to find all information related to sustainable construction. This single point of access communicates on the general framework, includes thematic, detailed guidelines, and measures that the users can take to improve their practices, as well as case studies. It also disseminates news, including regulation changes.

Industrial symbiosis platforms[7] also allow a form of networking between manufacturers, matching the waste produced by one with the raw material requirements of another. Local mapping helps to connect stakeholders, to identify their needs and potential synergies.

The construction sector is sometimes affected by negative habits such as black market, unfulfillment of regulations, price and competition distorsions[8], lack of transparency in the procurement processes. Stakeholders' involvement, networking and commitments towards circular economy targets can definitely help spreading transparency and social inclusion in the construction sector.

7 There are several initiatives focused on the industrial symbiosis, such as the following EU funded H2020 projects that are developing specific platforms aimed at facilitating and boosting the processes: SHAREBOX; EPOS; MAESTRI; SYMBIOPTIMA; SCALER; FISSAC; SPRING; URBANREC; PAPERCHAIN.
8 Read the report on Distorsion de la concurrence por le marché de la construction, 2015-2016.

Part 2 – Sustainable construction in practice

4. Strategies and cross-cutting themes

When developing a sustainable construction strategy or specific policy actions, instruments of all types should be considered: legal (building permits for example), economic (landfill tax on soil and other materials, rebates), training, etc. Furthermore, many aspects should be addressed: health and well-being, environment (landscape, energy and materials efficiency), economy, community developments, education and skills, urban planning, local culture and tourism, etc.

Including complementary instruments in the local strategy will definitely increase its chances of success:

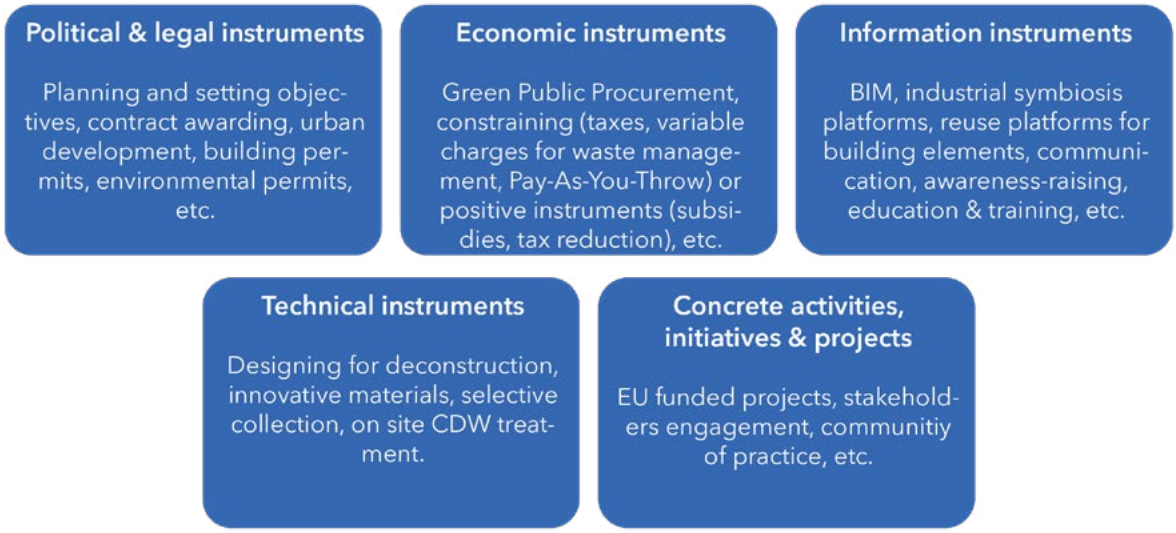


Figure 15 – Types of instruments

Approaching the topic from different angles is an excellent way of ensuring a sustainable construction strategy from a circular economy perspective as relevant as possible to the territory and its stakeholders. This section elaborates on **cross-cutting themes** which are essential to a sound strategy.

Figure 16 – Cross-cutting themes

4.1 Arguments to develop a sustainable construction strategy

An increasing number of territories are developing circular economy strategies, as public authorities realise the benefits they can draw from it – although a certain stress should be made on the environmental urgency of the matter. A key driver to develop such a strategy is the interest in **seeing businesses prosper and in generating employment for local communities**. Circular economy strategic action plans at regional or local level addressed to the construction sector have for example been developed by (list non-exhaustive): Paris (Bio by Deloitte, 2019), Ile-de-France region (IAU Ile-de-France, 2013), London (London Waste & Recycling Board, 2015), Amsterdam (Circular Amsterdam, 2016), Glasgow (Circular Glasgow, 2016), Noord-Holland Province (Circulair Noord-Holland, 2016), Brussels-Capital Region (Brussels-Capital Region, 2016), Flemish Region (Circular Flanders, 2017), Walloon Region (Walloon sustainable development strategy, 2016).

Circular Noord-Holland

The Dutch province of North-Holland set up a strategy for the circular economy with the construction sector in the focus.

The public authority started the process mapping the territory through a Circle Regional Scan, in order to provide insights about the most promising areas where the transition could happen. The scan identifies key economic clusters and shows what the benefits in terms of materials savings, CO2 emission reductions and job creation could be if circular strategies are applied. In the province of North-Holland, 58 practical circular opportunities have been identified and clustered in seven pivotal categories: tourism, logistics, road construction, hospitals, horticulture & seeds, and food processing & retail.

The construction industry is highly significant to sustainable resource management improvement and to the economy. As a key sector in most territories, it therefore should be identified as such in a circular economy strategy, or a separate strategy for the sector could be developed. The "Circular economy strategies and roadmaps in Europe" report (European Social and Economic Committee, 2019) points out construction as the most represented economic sector in the analysed strategies. Unfortunately, the construction sector is in the focus of all but one analysed strategy at local level.

Local and regional authorities have a pivotal role to play to drive forward the development and use of sustainable buildings. Mistrust in the quality of reused or recycled construction products, as well as the lack of market drivers, amongst other things, have slowed progress in the sector. Yet public authorities can change this with more than policies, regulation, and incentives. Indeed, the **public sector is a major client** of the construction industry. As means of illustration, the Chartered Institute of Building (COIB) calculated that public sector works account for about 40% of all turnover generated by the UK construction industry. According to a survey delivered by SOeS - Service de l'Observation et des Statistiques - in 2014 18% (42 Mt) of the total CDW generation in France (228 Mt) was originated from the building sector while 82% (186 Mt) was from the public works stream.

Paris circular economy plan

The plan is based on the "Cradle to Cradle" concept, with three areas of action (waste management, goods and services provided by economic actors, demand and behaviour of consumers) and seven pillars (recycling, extension of the product lifespan, sustainable resource management, eco-design, industrial and territorial ecology and functional economy).

The **strong political commitment** is a key factor for the success of the strategy. The task of steering the circular economy strategy has been assigned to the Deputy Mayor of Paris, who is also responsible for issues related to social economy and social innovation. As circular economy is by nature a highly cross-cutting area, several of Paris' other elected representatives are involved in the process.

Among the ambitious thematic strategies, the construction sector plays a significant role. One of the plan's actions is aimed at developing an internal reference system for Paris in order to define sustainable construction criteria that take into account circular economy principles, to establish target standards and integrate them in specifications to guide project design. Another interesting action addresses to the **road regulations**, requiring the materials from road works to be reused or recycled.

Furthermore, local authorities can effectively inspire their urban plans towards sustainable targets, involving citizens, civil society and private stakeholders. The construction sector can be also meant as refitting instead of demolishing something, valorizing the heritage and social opportunities.

Clear goals and political commitment will act as a strong motivator for local stakeholders. Indeed, intervention of the authorities would be most welcome as the architecture, engineering, and construction industry is sometimes considered inherently defensive about change (EAE, 2015). Its project-based nature is a challenge, as change will be implemented on the level of individual projects (Brian et al., 2015).

Nalawala Hall, Fairfield City Council (Australia)

Delivering on commitments to circular economy set in plans and strategies can be a strong driver for sustainable construction. For Fairfield City Council, the commitment to sustainability and the local Agenda 21 was the main catalyst behind the choices made to build the "Nalawala Hall", a community centre and sustainability hub. This is the largest straw bale community building in Australia and it used 95% recycled concrete for its foundation slab, recycled window frames and doors, waste straw, as well as 800 plastic milk bottles for the toilet partitions. Links to pdf (1 - 2) and photos (1 - 2).

Beyond sustainable buildings, circular economy has an enormous potential. From an economic perspective, it can **increase productivity** and **create jobs**. At the same time, it can **reduce carbon emissions** and **preserve valuable raw materials**. These environmental benefits, in turn, increase the economy's **resilience**, protecting it from potential resource supply risks and volatile commodity prices.

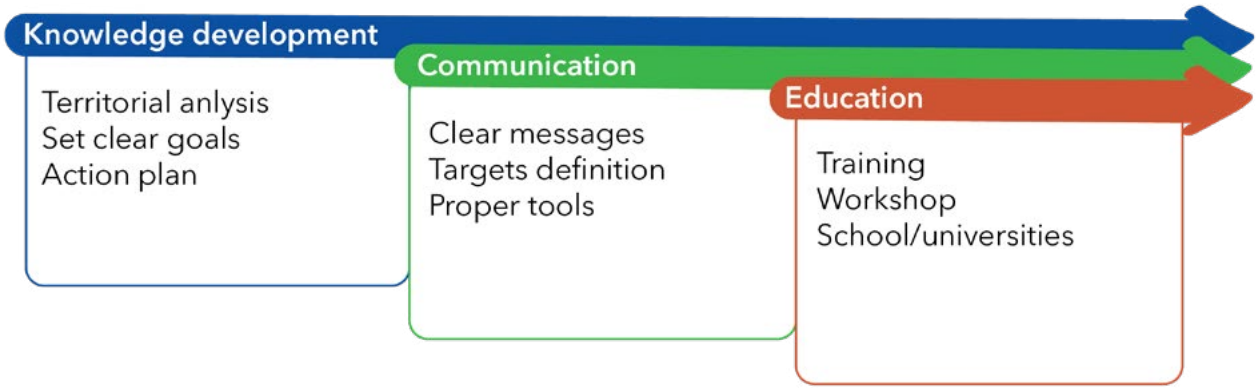
Queen Elizabeth Olympic Park (London)

The Olympic Delivery Authority (ODA) pledged to hold the greenest Games of modern times and sustainability was built into all the activities, from the procurement to the operation of the Games. The ODA set a number of CDW targets during the demolition, design and construction phases of the London 2012 Olympic Park, including: 90% re-used or recycled construction/demolition waste by weight; 20% of materials to be from a re-used or recycled source by weight; 25% recycled aggregate by weight.

In this way, the public sector can provide **leadership** and a catalyst for change, with a long-term, practical solution to the world's **emerging resource crisis**. Indeed, developed economies annually consume around three to four times the amount of resources that are sustainable in the long term. The Ellen MacArthur Foundation has estimated that £300 billion could be saved from resource benefits, including energy, if we apply circular economy thinking to the European built environment by 2030 (Ellen MacArthur Foundation, 2015).

4.2 Knowledge development, communication and education

A sustainable construction strategy cannot be developed without having first identified the **priorities** and **challenges** which are specific to the territory. Once that is done, the benefits of a circular economy need to be shared widely with clear and relevant communications to the sector, to ensure greater adoption. The next logical step is to go beyond simple communications and ensure lasting changes with continued education. Knowledge is power, as the saying goes, and by developing it in favour of circular economy, shared knowledge will multiply the positive effects in a territory.



4.2.1 Territorial analysis

By monitoring resource flow, usage, and performance efficiency, public authorities can use this information to set clear targets and define an evidence-based roadmap that accounts for local context.

Detailed flow analyses and qualitative diagnostics are key to creating a strategy as the first step is always to know one's territory to define where the biggest opportunities for intervention are. By commissioning a study before setting goals, local authorities can obtain a first "**screenshot**" of the current situation, monitor the evolution in following years, and analyse the impact of the actions taken to transition the sector towards circular economy.

Brussels territorial studies & ERDF-funded BBSM project (Belgium)

Theme: Knowledge development and communication

Type of instrument: Study/analysis and ERDF-funded project

Funded by: Brussels Capital Region and European regional development funds (2014-2020 ERDF)

Implemented by: Brussels Capital Region, BBSM consortium

In 2014, the Brussels Capital Region commissioned a urban metabolism study to review existing materials, weigh the region's metabolic balance, and examine the impact of twelve flows if made circular, with detailed analyses of five of them. This study was a major step in the making of the Regional Plan for Circular Economy. It was followed up in 2017 with a study which was foreseen by the PREC, called "Circular economy in the construction sector in Brussels: stat of play, challenges, and future model" (Brussels Environment, 2017). Academics carried out the study on behalf of the environmental administration, analysing construction material flows and estimating their economic potential. A regional circular economy model for sustainable construction was then developed based on the results. Furthermore, the region also boasts a highly interesting, construction-specific example, with the BBSM project, which is funded with European Regional Development Funds (ERDF). BBSM stands for "Bâti Bruxellois Source de Nouveaux Matériaux", literally the Brussels built environment as a source of new materials. It aims to study and analyse urban metabolism to identify and encourage creation positive value loops.

Data on employment and turnover of construction companies is often collected by statistical offices. However, from a circular economy perspective, other pieces of information can be interesting – much of which can be found in public data - albeit from various sources:

- **Audience identification:** who are the main stakeholders?
- **Current practices:** state of knowledge and practices to improve sustainability of buildings and to manage resources and waste in the sector;
- **Urban metabolism:** analysis of the current building stock and infrastructure (evolution in time, material composition, typology, main trends, general state) – and foreseeable changes in the near future, such as major works which will be required;

The URBANWINS project

Theme: Knowledge development and communication

Type of instrument: EU funded project

Funded by: H2020 programme

Implemented by: URBANWINS Consortium

UrbanWINS was a European project funded by the Research and Innovation Program Horizon 2020 that studied how cities consume resources and products, and how they eliminate the waste produced, in order to develop and test innovative plans and solutions aimed at improving waste prevention and management. Launched in June 2016, the project analysed current strategies for waste prevention and management in a total of 24 cities and assesses how they contribute towards resilience and resource efficiency. The project followed the **urban metabolism approach**, in which cities are considered living organisms that use natural resources and create a flow of materials and energies. The results were used to define objectives and indicators of the Strategic Plans for Waste Prevention and Management in the **eight pilot cities**. Active participation from citizens, governments, organisations, suppliers, research institutes and educational centres was an essential part of the project, through physical and **online urban agora** in the eight pilot cities, where participants shared opinions, discussed ideas and planned solutions.

- **Cross-sectorial policy analysis:** current and upcoming regulations on material resources, building permits, urban planning, heritage sites, and environmental issues, as well as any other policies which relate to (sustainable) architecture, construction, and engineering;
- **Opportunities and barriers for circular approaches:** the previous items might present barriers to sustainable construction, or to circular economy in general – these should be identified at an early stage, to suggest ways to overcome them. Based on the data, a territorial analysis can consider products, sub-sectors, and materials likely to offer the greatest opportunities, as well as the actors which might be needed to realise them.

Amsterdam City Circle Scan and circular construction impact study (The Netherlands)

Theme: Knowledge development and communication

Type of instrument: Action Agenda and Studies

Funded by: Municipality of Amsterdam

Implemented by: Municipality of Amsterdam

The City of Amsterdam wants to be a leader in the field of circular economy and is looking for ways to accelerate this development. In 2015 the municipal authoritiy published Circular Amsterdam[9] – a vision and action agenda for city and metropolitan area. Results from this study provided guidance regarding potential steps to increase circularity. It followed a City Circle Scan, with four phases. First it analysed material and energy flows and employment levels. Secondly, a comprehensive analysis of the value chains that connect multiple sectors within Amsterdam was conducted. Thirdly two priority chains were explored: construction and organic residual streams. Finally, an action agenda and roadmap were drawn, with potential barriers identified. As a result of the City Circle Scan, Amsterdam commissioned an investigation (an English description here) into the impact of circular construction for the City. It analysed both the financial costs and the social benefits of a circular apartment complex.

9 In Dutch: 2015 Amsterdam - Amsterdam circulair een visie en routekaart voor de stad en regio. In English: 2016 Amsterdam - Circular Amsterdam-EN-210316

4.2.2 Communications and education

There is much information available on how to improve the circularity of the construction sector, however it tends to be scattered, and local stakeholders might not know where to look for territory-specific information.

The COLLECTORS project

Theme: Knowledge development and communication

Type of instrument: EU funded project

Funded by: H2020 programme

Implemented by: COLLECTORS Consortium

COLLECTORS is a European-funded, Horizon 2020 project which aims to identify and highlight existing good practices of waste collection and sorting. It focuses on three waste streams: paper and packaging, waste electrical and electronic equipment (WEEE), and construction and demolition waste (CDW). More specifically, it has three objectives: harmonize and disclose available information on different waste collection systems, gain better insight into the overall performance of collection systems, trying to bridge the gap with the recycling sector and support decision-makers in shifting to better-performing systems. A web platform has been set up, allowing the users to browse across 242 collection systems.

A sector-specific **hub of online resources** can be a valuable tool in communicating on policy, funding schemes, call for projects, good practices, guidelines, or any other relevant material. When they are sector-specific, most stakeholders in construction industry will soon know about them, as this information can be shared via key contacts (business federations, specialised research centres, chambers of commerce, trade associations, professional organisations, …).

Regional approaches to bringing local sustainable construction online (Belgium & United Kingdom)

Theme: Knowledge development and communication

Type of instrument: Web platform

Funded by: Regional Authority

Implemented by: Regional Authority

Belgium boasts various examples of such online information hubs, with differences among the three regions (Brussels, Flanders and Wallonia). Each Flemish province operates its own, such as the Sustainable Living and Building Support Centre in the province of East Flanders, De wijk van morgen run by the autonomous provincial company Kamp C in the province of Antwerp. The Brussels-Capital and Wallonia Regions work together to gather information on the Portail Construction Durable (by Brussels Environment and the Service Public de Wallonie).

Other territories, such as Scotland, have opted for a general portal on circular economy, resource efficiency, or waste, with subsection per sector. The method chosen depends on the roles and responsibilities of the public authorities involved, and on the expectations of local stakeholders.

Of course, putting the information out there is not enough, awareness-raising activities, campaigns, and events are a few of the other communication activities which are required to reach the target audience.

Education is key to develop new behaviour patterns, changes in our lifestyles and a transformation in our ways of thinking and acting. **Capacity-building workshops and seminars** for building professionals are an excellent way of ensuring that a territory will progress towards sustainable construction on the long term. Efforts could be made to encourage the introduction of circular economy principles applied to sustainable buildings into the c**urricula of architecture, engineering, and other relevant educational courses**. Public incentives could encourage individual teachers and projects, such as the BRIC and MØDÜLL 2.0 projects, which received support from the Brussels Capital Region's plan for circular economy, which has dedicated funds for educational pilot projects in sustainable construction.

For more information on education strategies, the United Nations Environmental Programme (UNEP) has created comprehensive "Guidelines on Education Policy for Sustainable Built Environments" (UNEP, 2010). In those guidelines, the UNEP describes measures which can be taken by governments, communities, the private sector, etc. along with best practices.

In the **"Circular Economy and Lifelong Learning: Scenarios - Methodologies - In action"** (a publication by ACR+ and Zero Waste Scotland) there are inspiring **stories of vocational training and green jobs**, sustainable consumption education and system thinking, of **pedagogical models** capable of empowering learners and urging institutions to include the principles of sustainability in their management structures.

Another interesting case takes place in Utrecht region (Belgium): circular construction back into education - Utrecht Circle Alliance.

Circular construction back into education - Utrecht Circle Alliance (The Netherlands)

Theme: Knowledge development and communication

Type of instrument: public-private alliance

Implemented by: Utrecht Circle Alliance

The alliance (companies, knowledge institutions and the 26 municipalities in the Utrecht Region) stimulates innovation and cooperation among companies, knowledge-based institutions and governmental organisations with the main goal to create a green, healthy and smart region. On the sustainable building industry, the Utrecht Circle Alliance set up collaborations (organizing CoP – communities of practices) that lead to innovation, job creation and economic growth, accelerating initiatives by opening doors to knowledge, skills and funding.

At the Faculty of Architecture & the Built Environment - Delft University of Technology, a team of professors have developed an online learning program for MSc and professional level students.

4.3 Stakeholder involvement and co-construction

The involvement of various professionals along the value chain is essential to design a broad yet relevant, ambitious yet realistic, globally-minded yet locally-centred strategy. **Identifying key**

stakeholders and fostering collaboration from the onset of planning will set the foundation to ensure the success of the sustainable construction strategy. **Co-construction** is key, both with external stakeholders but also within the **internal layers and services of public administrations**. This can be done using the intermediary of public consultations, the creation of a stakeholder platform, or the setting up of an advisory committee, amongst other things.

Public authorities have a bridging role to play, as they can get in contact with all forms of businesses, academia, non-profit organisations, citizens, and so on.

Urban Regeneration in Prato (Italy)

Theme: Stakeholder Involvement and Co-construction

Type of instrument: Urban planning

Funded by: Municipality of Prato and EU

Implemented by: Municipality of Prato

The City of Prato's strategy targets the construction sector, aiming at reducing and reusing construction and demolition waste. Prato is famous worldwide for its textile district, which represents about 3% of European textile production. The Prato textile industry, despite the economic difficulties and the major market transformations, is still active and vital: the urban policy of productive re-organization based on the circular economy principles, is recognized at EU level as a model for urban economies improvement. The Municipality of Prato is an active member of the EU's Urban Agenda Partnership on Circular Economy (UAPCE) initiative and the case is included as best practice in the Circular Europe Network (CEN) . The City has developed measures to r**egenerate degraded and marginalised parts of the city**, engaging several **partnerships at both local and European level**. Circular economy in Prato has been integrated in the city's Strategic Operational Plan, aiming not only at urban regeneration but also at an **improvement of social cohesion and community life**. Circular Economy in Prato also means the reuse and the transformation of existing buildings ("Rethinking the City"), in particular those of the industrial areas, with the logic to improve the environmental performance of buildings and infrastructures in their entire life cycle.

The **social aspects have not to be overlooked**. Social engagement and acceptance are a key challenge for the development of a circular economy and of a market for secondary raw materials in the construction sector.

Social engagement refers to one's degree of participation in a community or society. Key elements of social engagement include activity, interaction, social exchange and lack of compulsion (Prohaska et al, 2012).

A general definition of **social acceptance** is "*a favourable or positive response (including attitude, intention, behaviour, and – where appropriate – use) relating to proposed or in situ technology or social technical system by members of a given social unit (country or region, community or town and household, organisation)*" (Upham, 2015). Social acceptance can be influenced by a very wide range of factors, including project and product characteristics, perception of the distribution of costs and benefits, and degree of public participation.

One of the **barriers** to achieving more sustainable construction is the **rather low acceptance of the use of recycled materials in construction projects**. This influences the market for secondary raw materials. Furthermore, the social dimension of circular economy is such that companies need to interact more extensively than it is required for normal business practice – in particular in the case of industrial symbiosis, where waste from one company will be used as a resource by another.

Living Labs in the FISSAC project

Theme: Stakeholder Involvement and Co-construction

Type of instrument: EU funded project

Funded by: H2020 programme

Implemented by: FISSAC Consortium

FISSAC (Fostering Industrial Symbiosis for a Sustainable Resource Intensive Industry across the extended Construction Value Chain) is a European project funded by the Research and Innovation Program Horizon 2020, that involves stakeholders at all levels of the construction and demolition value chain to develop a methodology and software platform to facilitate information exchange that can support industrial symbiosis networks and replicate pilot schemes at local and regional levels. Nine regional Living Labs have been established with their own defined purpose and scope. The Living Lab leaders engage actors from the construction industry value chain to identify appropriate challenges related to industrial symbiosis in their regions. Through purposely designed meetings their collaborative knowledge and experience will then be used to understand how these challenges can be addressed.

Collaboration and co-creation in an open innovation network are excellent ways of approaching social engagement and acceptance. Living Labs build on this idea. A Living Lab, in contrast to a traditional laboratory, operates in a real-life context with a user-centric approach. The physical and/or organisational boundaries of a living lab are defined by purpose, scope, and context.

The notion of living laboratory was first proposed by Prof. William Mitchell at MIT Media Lab as: "a research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real-life contexts." From a methodological perspective, today's living labs are networks composed of heterogeneous actors, resources, and activities that integrate user-centred research and open innovation (Leminen et al., 2012). From the infrastructure perspective, they can be seen as facilities that enable experimentation and co-creation with users in real-life environments (Sundramoorthy et al., 2011).

4.4 Research & innovation

Radical and systemic eco-innovations are needed to transform the linear patterns of production, construction, use, and disposal which have evolved in the past couple of centuries. Eco-innovations are innovations that reduce both the use of natural resources and the emission of harmful substances across the whole life-cycle (EIO[10] 2011). Two types of eco-innovations are involved in achieving a circular economy: the technologies and technical infrastructures required to reconvert waste into resources, and the expertise, skills, and business models to turn this transformation process into interesting business opportunities (EIO, 2016).

In order to foster circular economy innovations, public authorities can address some of the barriers that innovative buildings might face, for example by providing regulatory exemptions for pilot projects, or by introducing new policy measures (mainly addressed in Section 1.7 in the next pages).

In addition to regulatory and economic instruments, **research and development (R&D) support measures** can prove very beneficial. These can include grants for R&D and piloting activities, unlocking funding via territorial innovation agencies for example, innovation voucher schemes for SMEs, support to innovation incubators, and support programmes and incentives for R&D personnel.

Local authorities can also provide R&D infrastructures, with equipment, data, and so on, to test and accelerate scaling up of concepts, as done in Nantes Métropole with the City Lab (YHNOVA, social housing built by 3D-printing robot is an interesting case).

At European level, funding grants are well-known under the umbrella of the Horizon 2020 programme.

10 Eco-Innovation Observatory

The RE4 project

Theme: Research & Innovation

Type of instrument: EU funded project

Funded by: H2020 programme

Implemented by: RE4 Consortium

The RE4 (REuse and REcycling of CDW materials and structures in energy efficient pREfabricated elements for building REfurbishment and construction) project is funded under the European Union's Horizon 2020 research and innovation programme. The main objectives of the projects are:

- Development of innovative design concepts for smart installation and disassembly of the pre-fabricated elements into a prefabricated energy-efficient building unit;
- RE4 demonstration in industrial environment, testing and evaluation, replication;
- Enhancement of the sustainability and future applications of RE4 prefabricated products;
- Development of a BIM-compatible DSS and platform for CDW estimation and Management;
- Development of business models for industrial exploitation.

The project covers the main aspects of sustainable construction, from energy to material resource efficiency.

Local and regional authorities can also benefit from these grants, which they can then use to apply the results of the project and foster innovation on their territory. Specific calls related to industrial symbiosis or resource efficiency have resulted in many projects centred on the construction value chain: BAMB, FISSAC, Green Instruct, HISER, InnoWEE, REslag, VEEP, to name a few.

Material Passports in the BAMB project

Theme: Research & Innovation

Type of instrument: EU funded project

Funded by: H2020 programme

Implemented by: BAMB Consortium

The BAMB (Building as **material bank**) project brought together 16 partners from eight European countries, and from different places in the value chain, for one mission - to move the building industry towards a circular economy. BAMB developed and integrated tools to enable the shift to a circular building sector, supported by business models, policy propositions and a management and decision-making model. BAMB created ways to increase the value of building materials. Dynamically and flexibly designed buildings can be incorporated into a circular economy – where materials in buildings sustain their value, that will lead to waste reduction and the use of fewer virgin resources. The electronic **Materials Passports** developed in BAMB are sets of data describing defined characteristics of materials in products that give them value for recovery and reuse. BAMB Materials Passports aim to:

- Increase the value or keep the value of materials, products and components over time;
- Create incentives for suppliers to produce healthy, sustainable and circular materials/building products;
- Support materials choices in Reversible Building Design projects;
- Make it easier for developers, managers and renovators to choose healthy, sustainable and circular building materials;
- Facilitate reversed logistics and take back of products, materials and components.

Voluntary measures, such as performance labels and guarantees for products and services can also be developed to address barriers, such as the mistrust in recycled construction products. Voluntary agreements and commitments can also be used to boost eco-innovation. In the Netherlands, the Dutch government opted for the Green Deal approach to stimulate sustainable innovation. A Green Deal is an innovative model of a public-private partnership that unites a coalition of companies, civil society organisations, and the territorial government in a mutual agreement or covenant under private law.

Information and communication technology (ICT) and digitalisation are crucial in order to foster exchange of information to improve circularity within the complex construction sector in our quickly evolving society. In the long-run, using internet and big data will play an important role in harnessing material flows and optimising the supply and design of re-used materials. However, obtaining robust and accurate data at the input stage is a challenge for new buildings, and even more so for existing ones. The maintenance and assessment of these data along the lifespan of a building must also be addressed.

Building Information Modelling (BIM)

BIM is an intelligent model-based process that brings together data and visualisations within a 3D model – though it can include further dimensions such as time, cost, and as-built operations. It helps make design, engineering, project, and operational information accurate, accessible and actionable for buildings and infrastructure. It enables both the end-user and the whole project team to understand how a building will look and function, its construction process, what it will cost, and how it will operate – before it is even built. The output of the process is digital files that describe every aspect of the project and support decision-making throughout a project cycle, modelling both the building structure and the entire timeline form inception to demolition. This detailed, integrated information facilitates testing and analysis during the design phase, coordination between the project team, and structure maintenance.

Public authorities can start addressing this topic by developing and adopting ICT tools for their territory. In Belgium, the three regions of the country developed a tool to improve environmental performances of buildings: Totem, which stands for "Tool to Optimise the Total Environmental impact of Materials". The European Commission is also working on an approach of its own to sustainable building performance reporting, called Level(s).

LEVEL(s) – Building Sustainability Performance

Level(s) is a voluntary reporting framework 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. It is an initiative promoted by the European Commission.

Level(s) provides an easy starting point to introduce sustainability into your work. Within the Level(s) framework, each indicator is designed to link the individual building's impact with the priorities for sustainability at the European level. This focuses the Level(s) user on a manageable number of essential concepts and indicators at building level that contribute to achieving EU and Member States' environmental policy goals.

4.5 Business support

Local and regional authorities can create an **enabling environment for enterprises**, encouraging businesses to establish and develop sustainable construction activities in the community.

There are several ways to do this. With ICT alone, by using a dedicated section on the public authority's website or setting up a specific one for sustainable construction, authorities can **host a business directory, promote local good practices, and publish relevant job opportunities from local businesses**. However, a contact point is needed, which can be done by setting up a **facilitation team**, offering specialist advisory services within the authority's personnel. Governmental bodies have a facilitation role to play in accelerating the transition of the construction sector to a circular economy. This can be applied by **making it easier for businesses to obtain permits and licenses** when opting for a circular business model and by ensuring that a support network is available. The burden of responsibility does not rest with public authorities alone – as previously mentioned, a multi-stakeholder collaborative approach works best. Therefore, **partnerships with enterprise networks and the chamber of commerce** of the territory in question can have a wider and more relevant impact while also reducing the load carried by each partner.

Web Platform MaTerrio.construction (France)

Theme: Business support

Type of instrument: Web platfom

Funded by: Fédération Nationale des Travaux Publics (FNTP), Union nationale des industries des carrières et de matériaux de construction (UNICEM), Agence de l'environnement et de la maîtrise de l'énergie (ADEME)

Implemented by: MaTerrio Consortium

The MaTerrio.construction platform aims at providing the stakeholders with access to useful information, in order to develop the recovery and recycling of CDW, and more broadly to promote circular economy. The platform includes also a geographical information system, to visually identify the recovery opportunities. The website hosts publications and news about the sector, allowing the good practices to be spread out.

Circular Glasgow (United Kingdom)

Theme: Business support

Type of instrument: Network

Funded by: Glasgow Chamber of Commerce

Implemented by: Glasgow Chamber of Commerce

Circular Glasgow is a movement to inspire businesses of all sizes to innovate and become future-proof by adopting circular strategies. Connecting companies across the city, we help them to open up new revenue streams, increase competitive advantage and realise financial savings using a range of practical initiatives. The vision is to create a sustainable economy and a city with an enviable quality of life by inspiring businesses to assess and implement the circular economy in order to position Glasgow as a leading circular city. The initiative provides on line tools, such as:

- Circle Assessment, to help businesses understand the different operational and organisational aspects of the circular economy. By taking this assessment, it is possible to learn more about the circular economy opportunities for your business;
- Circle Workshop, to involve businesses in interactive and highly engaging workshops. The aim is to take the complexity out of the circular economy and guide SMEs through their transition to circularity.

4.6 Financial incentives

Making sustainable construction one of the **priorities** of the **territory's investment strategy** will ensure that it stays **high on the political agenda** and will stimulate **new initiatives**. National, regional, or municipal support and subsidies may be made available for investments in buildings, equipment, structures, and systems, but also for labour and services. However, in addition to the aforementioned grants to support R&D, there are various incentives which can help the transition to a circular economy without necessarily requiring large financial investments from the local or regional authority itself.

The **LIFE programme**, implemented by the European Commission, co-finances action grants with a priority area dedicated to Environment & Resource Efficiency. Some calls are set up specifically to implement plans or strategies, while others are to develop, test, and demonstrate policy or management approaches, best practices, and solutions. For example, Buzau County in Romania benefited from LIFE finding to significantly improve the situation of construction and demolition waste management in the County. One of the measures put in place thanks to the European fund was the development of a mechanical treatment plant to recycle inert CDW.

Regional authorities can benefit from the **European Regional Development Fund (ERDF)** to stimulate sustainable construction in their territory. The Brussels Capital Region, for example, identified five priority streams for their ERDF 2014-2020 operational programme: amongst those was "sustainable construction and renewable energy". The programme also identified priority axes, research & innovation, entrepreneurship, circular economy, improving the living environment and the environment. Naturally, this has encouraged project developers and led to the funding of the Brussels Retrofit Living Labs and BBSM projects. As well as Usquare, which aims to renovate and reconvert seven buildings of a former police school into a comprehensive site which will preserve historical heritage and include student housing, a sustainable food court and market, the Brussels Institute for Advanced Studies, welcoming public areas, and other public facilities.

Green building financing with the European Bank for Reconstruction and Development

The European Bank for Reconstruction and Development has dedicated green building financing products available for recipient countries (Central and Eastern Europe as well as Central Asia). Those available to public buildings are larger scale public-private partnership framework programmes, dedicated credit lines through local financing intermediaries, urban regeneration projects or green city action plans, labelled green property bonds, and structured financing.

Economic instruments are policy tools which apply economic incentives to influence people's behaviour. They can either change market prices directly (e.g. with subsidies or charges) or introduce new markets (e.g. with cap and trade schemes). As such, EI comprise all levies, permit trading schemes, and subsidies that create incentives and disincentives mobilizing the self-interest of producers, service providers, and consumers, to make environmental improvements or reduce adverse environmental consequences. Not only do such instruments leave citizens free to choose to benefit from them or not, but their administrative costs of implementation tend to be significantly lower than those associated with the monitoring of compliance with command-and-control regulation.

TRACIMAT (Belgium)

Theme: Financial Incentives

Type of instrument: Traceability tool

Funded by: The HISER project (H2020 programme)

Implemented by: TRACIMAT

TRACIMAT is a non-profit CDW management organisation, founded by the Flemish Construction Confederation (VCB), together with the Federation of Producers of Recycling Granulates (FPRG), the Belgian Demolition Association (CASO) and the organisation representing the engineering and consultancy companies (ORI), that aims at providing a traceability system to boost the selective collection of CDW. The construction and demolition waste management organisation is legally incorporated into the VLAREMA[11] regulation and operates in feedback with the Common Regulation for Recycled Granulates (ER). The ER establishes the requirements to be met by crushers and granulates in Flanders: a significant amendment has been introduced, requiring crushers to distinguish between materials with a low environmental risk (LMRP) and materials with a high environmental risk (HMRP) at the gate. The ER also establishes that LMRP streams can be processed more cheaply than HMRP streams. Tracimat issues a "certificate of selective demolition" for construction and demolition waste that has been s**electively collected and properly traced**. The demolition certificate lays down whether CDW can be accepted as "low environmental risk material" and therefore processed separately from waste streams with a high environmental risk. Purer waste streams with a low environmental risk clearly have a greater upcycling potential. This process is meant to **maximise the chance to reuse or recycle the materials**. The demolition waste comes with a certificate issued by a recognised and independent organisation, which will enhance trust not only in the quality of the material, but also in the quality of the demolishing company. It will also boost trust in the recycled product, resulting in improved and **more widespread marketing of recycled granulates**.

11 Decision of the Flemish Government establishing the Flemish regulation on the sustainable management of material cycles and waste (17.02.2012).

Because of the proper identification of all materials in a building by an extended waste inventory, the follow–up of the selective demolition process and the follow-up of all the demolition waste materials set free during the works, more guaranties about the quality of the demolition waste material can be given and purer waste streams will be set free. As the demolition waste comes with a certificate issued by a recognized and independent organization, this will enhance confidence not only in the quality of the demolition material, but also in the quality of the demolishing company. It will also boost trust in the recycled product, resulting in improved and more widespread marketing of those recycled products.

Online tools and a database support the quality system. The materials identified in the building are put into the online platform of Tracimat by the expert. The demolition company, as well as the building owner have access into this platform. The demolition company will give information in the platform about where the materials that were identified in the building (and listed in the inventory) were taken after demolition.

This database holds information about available quantities of various recyclable materials and is of great value for investors in their decision on in what technologies to invest and/or will help in dimensioning new recycling plants. Therefore, it is enhancing and stimulating the circular economy.

After one year in operation, Tracimat evaluated more than 2000 pre-demolition audits. These have shown that more than 95% of the buildings in Flanders that are being demolished contain hazardous waste and more than 90% contain asbestos in one or more applications.

Several producers of building materials are contacting Tracimat to set up a collaboration regarding data mining as well as quality assurance for those materials they want to recycle.

In this way Tracimat makes an important contribution to urban mining and the circular construction economy.

Various examples exist across Europe regarding economic instruments targeting construction resources and waste – although national examples are more frequent to come across . Landfill taxes and charges for unsorted CDW are well-known instruments used by countries to encourage sorting and recycling. The Autonomous Communities of Madrid, Murcia, and Catalonia have taxes on CDW. The deposit scheme is combined with an entry fee tax for waste entering landfills in the Madrid, Catalonia, Murcia, Rioja, Extremadura and Cantabria Regions. In Flanders there is a traceability system that allows to track CDW providing quality assurance for the recycling companies. The regional law classifies the CDW streams as LMRP – low environmental risk profile - or HMRP - high environmental risk profile - according to the risk of environmental contamination. The gate fee to treat the CDW streams at the sorting/crusher/recycling plant is higher for HMRP stream, giving incentive to produce LMRP CDW. CDW can be accepted as LMRP if selective demolition processes are in place, according to a preliminary inventory/audit and a tracking system (in particular focused on the removal of hazardous materials).

4.7 Policy and regulation

Sustainable construction strategies can help improve existing regulations or build new ones. Additionally, it is important to use all policy instruments available, as no single one will offer the solution to overcome all barriers alone. **Regulatory instruments**, such as regulations on recycling, producer responsibilities, eco-design, mandatory targets, codes, standards, and certification for products, can be highly effective. However, they should consider the waste hierarchy and requirements for circularity. For example, regulation to divert CDW from landfill, such as a ban on inert waste landfilling, should consider the alternative treatment options and ensure there is a more environmentally-beneficial option available and that other policy measures also support it. Otherwise, this could render the regulation ineffective or even counterproductive (e.g. use of alternative, unwanted pathways, or illegal dumping).

As previously mentioned, setting **commitments** and identifying **sustainable construction as a priority** in strategies can be a **strong driver for stakeholders and construction professionals**.

Denmark, the Netherlands, and Sweden have strong government support through front-running circular economy policy programmes[12], with policy initiatives targeting specifically the construction sector[13].

12 SOU 2017; MinIenM 2014; Naturvårdsverket 2012; Miljøministeriet 2014
13 Rijksoverheid 2016; StateOfGreen 2017

While the number of governments interested in the circular economy is growing, most still lack a sense of urgency. Cities should set up mechanisms to monitor resource usage and performance efficiencies, and use them to set targets and define an **evidence-based city roadmap** that accounts for local context. For example, **Amsterdam identified construction and organic waste** as having the **greatest potential for added value and job creation**. By identifying opportunities to reuse materials, it will reduce CO2 production by 500,000 tonnes per year (Circular Amsterdam – A vision and action agenda for the city and metropolitan area).

The development of targeted technical-environmental legislation that regulates new uses of products based on recycled material, such as the new Basque technical legislation on "construction and demolition waste", can help raising the circular economy regional profile.

Legislation on CDW management in the Basque Country (Spain)

Theme: Policy and Regulation

Type of instrument: Regional Order

The Basque Country has developed and applied an **EoW status** for (recycled) aggregates via the Regional Order 12/01/2015[14]. The Order lays down the definition of recycled aggregates from CDW and the criteria allowing the use in new products (e.g. bricks, concrete, etc.), ending the waste status. This has been helping to raise the circular economy profile in the Basque Country, giving a significant momentum to the construction sector.

14 "DISPOSICIONES GENERALES: ORDEN De 12 De Enero De 2015, De La Consejera De Medio Ambiente Y Política Territorial Por La Que Se Establecen Los Requisitos Para La Utilización De Los áridos Reciclados Procedentes De La Valorización De Residuos De Construcción Y Demolición." Departamento de medio ambiente y politica territorial, 12 Jan. 2015.

4.7.1 Demolition and renovation permits and licences

Local authorities are charged with **issuing demolition and renovation permits or licenses**. Such a permit allows local governments to promote and enforce the development of high-quality waste management plans based on **pre-demolition audits**. Likewise, a post-demolition follow-up and evaluation process is very important. Requiring demolition reports after the works have been carried out allows local government to monitor whether such plans are being implemented effectively. Local authorities are encouraged to provide the demolition operator with **incentives** to **climb higher in the waste hierarchy**. At the same time, when designing a regulatory framework for C&D waste, it is important that the **administrative burden is kept to a minimum**.

France: pre-audits compulsory on demolition sites

Law 2009-967 of 3 August 2009, known as "Grenelle I" law, and Law 2010-788 of 12 July 2010, known as "Grenelle II" law, make pre-audits compulsory on demolition sites for certain categories of buildings by Decree (n°2011-610 of 31 May 2011), which created specific articles in the French Construction and Housing Code. The pre-audits, named "diagnosis on waste arising from demolition works", aim to characterize the materials present on site and plan the CDW management.

This obligation is in place also in other European regions/countries (e.g. Brussels-Capital, Flanders, Wallonia, Catalonia).

The recycling facilities need to rely on the quality of the input material that has to be maximized through pre-audit inventory (before demolition, construction or renovation) and selective collection.

Several initiatives have been analysing the key role of the pre-demolition audit to ensure high quality secondary raw materials. The PARADE project is an outstanding example.

The PARADE project : best practices for Pre-demolition Audits ensuring high quality RAw materials

The project aims at developing lifelong learning materials on best practices for pre-demolition waste audits. The objective is to provide an harmonised approach for performing waste audits making references to legislation and best practices collected.

A **deposit system** could be an effective instrument to improve the recycling process: the release of a permit for starting a demolition/renovation/construction site can be subordinated to a binding deposit (paid in advance by the building owner or the contractor). This scheme could guarantee the **reduction of the illegal dumping** phenomena, even if it is important to develop a market for the recycled materials to allow the output material finding a proper way out. Once the scheme is consolidated, the market of the recycled materials could increase the economic sustainability of the recycling facilities.

PRECAT 20 - Catalonia government's program for prevention, waste and resource management (Spain)

Theme: Policy and Regulation

Type of instrument: Regional programme

Funded by: Generalitat de Catalunya

The programme is focused on the CDW recovery, putting a target of 75% recovery by 2020 (increasing the 70% target laid down at EU level). To develop the programme, the Catalan Waste Agency has implemented a procedure by law, based on a guarantee deposit scheme to obtain the work license. The amount of the deposit is proportional to the estimated quantity of CDW, calculated through a standardized methodology and cross checked by the local authority. The guarantee deposit is transferred from the future license owners to authorized CDW treatment plant managers. Then, these managers extend to owners an acceptation document confirming the economic transfer, and this will be proof for the local entity to extend to the owner the license to start the work. The deposit is returned as soon as the owner or the contractor shows the documentation certifying the complying stream of the CDW.

This private-private relation allows less administrative burden for local authorities and also has been contributing to the reduction of the illegal dumpsites.

In order to promote recycling processes instead of landfilling, the guarantee deposit scheme works in parallel with a tax on final waste treatments. This tax is also used to invest and promote circular CDW projects, studies or recycled materials researches.

4.7.2 Performance and assessment schemes

The "life cycle thinking" approach has been widely used to assess the sustainability of products in the construction sector for several years. The LCA results can be translated into Environmental Product Declarations (EPDs) for single products or Environmental System Declarations (ESDs) for kits. Existing and upcoming legislation in some Member States (for example France, the Netherlands, and Belgium) already refers to these LCA and EPD/ESD assessment methods. However, harmonisation among different approaches is needed to get consistency in the results, as well as to improve market and social acceptance.

The European Committee for Standardisation is working to guarantee harmonized assessment methods for several standards to assess the sustainability of the buildings. In parallel, many countries have developed building assessment schemes (e.g. BREEAM, DGNB, HQE, LEED, SBtool, VERDE) over the last two decades.

Adherence to standards helps to ensure that **products are safe, interoperable and good for the environment**. Harmonizing technical specifications of products and services can make industries more efficient, and can **break down barriers** to trade. However, the process to develop standards could be time consuming and complicated. In many cases, industry standards are embedded in regulatory frameworks, either directly or indirectly, and they are sometimes incorporated into national building codes. For this reason, the industry must strive to set optimal standards ahead of regulation, so that it can **shape the public agenda**.

4.8 Procurement and market development

Public procurement refers to the process by which public authorities, such as government departments or local authorities, purchase work, goods or services from companies. ACR+ wrote guidelines on public procurement related to circular economy, as part of the Circular Europe Network activities. Public authorities play an important role in setting the good example, to give extra weight to the urgent need to take sustainable measures. They can have a strong influence by taking the decision to invest in sustainable construction. Indeed, in the UK, the Chartered Institute of Building (COIB) calculated that public sector work accounts for approximately 40% of all turnover generated by the UK construction industry. Furthermore, in 2005 the National Audit Office identified £2.6 billion annual benefits to the public purse through the adoption of best practice procurement in the sector. The government recognised that this figure made a powerful business case to base procurement on whole life costs and to engage with the supply chain at an early stage.

Product-service systems (PSS) are business models that provide an integrated mix of products and services. Together, they will fulfil a particular customer demand based on innovative interactions between stakeholders of the value production system, where, in a sustainability context, the economic and competitive interest of the providers will lean towards continuously more environmentally-beneficial solutions.

In certain cases, the PSS will be more **product-oriented**. Customers own the product and services are provided to ensure product performance over a certain period of time – such as with warranties and maintenance contracts. However, in other cases, the service provider retains ownership rights related to the product. The customer can then purchase the use of this product over a specified period of time. This **use-oriented** form of PSS applies to renting, leasing, and sharing. But there is also a **result-oriented** approach, whereby customers purchase the outcome, the result of service provision, specified in terms of performance. A well-known example of this is the case of a company offering customers to pay for light instead of buying light bulbs and paying the energy bill. In this scenario, the service provider has a very strong incentive to maintain the energy bill as low as possible, by installing highly efficient light bulbs. This was, for example, implemented in the National Union of Student house in London and in the Shipol airport (Amsterdam). This form of PSS is exactly what circular procurement promotes: innovative performance or usage-based business models, focused on access to services and products, rather than ownership.

A low carbon, circular economy approach to concrete procurement in the City of Zurich (Switzerland)

Theme: Procurement & market development

Type of instrument: Local authority green public procurement

Funded by: City of Zurich

The local authority set out a **mandatory use of recycled concrete for public building** in 2005. The requirement refers to SN EN 206:2013 and SIA 2030 standards. This means that concrete products must contain at least 25% recycled aggregates in total mass. Furthermore, the local authority includes in the tender specifications that recycled concrete should reach the RC-C quality as a minimum, (concrete with 50% virgin and 50% recycled aggregates). However, RC-M concrete (concrete with 50% virgin and 50% recycled aggregates) is preferred, where technical feasible. These requirements have been allowing the development of a local market for CDW materials. This case is included as a best practice in the Circular Europe Network (CEN).

Zero Waste Scotland released the Construction Sustainable Procurement Guidance (Zero Waste Scotland, 2019). focusing on the purchasing power of public sector (highly influential throughout the supply chain) and how to guide it toward economic and environmental benefit.

Construction Sustainable Procurement Guidance (United Kingdom)

Theme: Procurement & market development

Type of instrument: Guide on public procurement

Funded by: Zero Waste Scotland and Scottish Government

The document provides an action plan to assist procurers during the pre-procurement and procurement stages. The 'Introduction to Sustainable Procurement' e-learning module aims to help procurers understand the context and importance of embedding sustainability into public procurement. As the e-learning modules emphasise, this guide complements Zero Waste Scotland's guidance 'Using the procurement process to drive resource efficient construction'.

The guidance follows the format of the e-Learning modules in providing suggestions in the following areas: pre-procurement–policy context, pre-procurement-strategy, specification development supplier selection and award, and contract management.

5. Intervention along the value chain and building life-time

While a strategy should integrate various cross-cutting elements, it should also adopt a holistic approach across the supply chain, combined with long-term thinking. Therefore, cross-cutting elements of a strategy should all take into account the whole value chain.

Many governmental bodies have published guides for construction professionals, illustrating how to strive for circularity at each step. This is a highly interesting measure to take – and one which can be easily replicated. Examples include:

- the EU CDW management protocol
- the "Sustainable Highways: A Short Guide" commissioned by the Department for Transport in the UK
- WRAP's construction client guidance

5.1 Idea phase: designing for circularity

Several concepts embrace the idea phase in a circular designing perspective: design for adaptability, flexibility, disassembly, standardisation; design in modularity; design out waste; specify reclaimed or recycled materials. **Landscape** and heritage/cultural aspects have to be considered to shape new buildings.

The EDECON project produced a practical introduction to eco-design for SMEs involved in the manufacture of products and the provision of services within the construction sector.

It is important to notice that also **social issues** are in the focus, as well as l**andscape and heritage**, pointing out their relevance within the sector. LRAs can significantly impact on SMEs and this document can offer source of inspiration to set up the best playground. The circular economy models offer many opportunities to create synergies among LRAs, businesses and local communities. A circular economy is not just about designing-out waste, it is fundamentally designing-out the concept of waste (David Cheshire, 2016). This means that designers have to think about the whole life of the building from the decision to build new or refurbish through to the eventual demolition or deconstruction of an obsolete building.

Designing for a circular economy

David Cheshire, Sustainability Director at AECOM and author of Building Revolutions, explains: "Designing for a circular economy isn't about building less, it is about **building differently** and with more thought to the future. This approach would make the construction industry less dependent on precious raw materials. Despite the barriers to a circular economy, there are pockets of innovative and practical methods coming to the fore. Wider adoption of these principles provides the built environment sector with an opportunity to drive the circular economy and leave a **truly lasting legacy for future generations**."

Therefore, the idea of designing-out waste means avoiding creating waste in the first place, and looking for opportunities to turn waste from other places into a resource.

For buildings, this includes:
- refitting and refurbishing existing buildings rather than building new;
- designing-out waste arising during construction;
- using reclaimed materials and components in design;
- applying lean design principles to reduce demand for resources and associated waste.

New hospital buildings

Alder Hey Children's Hospital **in the UK** is a large paediatric hospital in Liverpool which needed three new buildings. It opted for the use of recycled and refurbished prefabricated building modules to meet its immediate need while a new state-of-the-art health park was being constructed. Not only did the materials get a second life, but the modular approach allowed to expand the hospital while respecting the constraints of a busy site.

5.2 Manufacture phase: how the industry supplies products

The Construction Products Regulation (CPR) lays down harmonised rules for the marketing of construction products in the EU. The Regulation provides common methodologies to assess the performance of construction products. It ensures that reliable information is available to professionals, public authorities, and consumers.

The Environmental Technology Verification (ETV) seems to be a promising tool to help innovative environmental technologies reach the market. In the Guidelines developed within **the FISSAC project, ETV is tested in the construction value chain**.

Environmental Technology Verification

The Environmental Technology Verification (ETV) pilot programme, operating since 2013 as one of the key initiatives under the "**Eco-Innovation Action Plan**" of the European Commission, is a tool aimed to support and promote ecoinnovation at a European-level by helping innovative environmental technologies to reach the market. The programme is addressed to innovative technologies whose benefits in environmental and health terms cannot be proved through existing standards or certification schemes and whose performance claims could be stated from a credible verification procedure as a guarantee to investors.

LRAs can influence the way the industry supply products in the construction sector. In a circular perspective, the **industrial symbiosis concept** can support effectively the sustainability path and the GPP procedures can help developing such approaches, orienting the supply side towards specific targets.

Figure 17 - Construction value chain (source: FISSAC project infographic)

5.3 Construction phase: taking shape

LRAs have to put in place clear rules to make sustainable the construction operations. Construction operations in working sites must meet the **needs of local communities and environmental elements** (air, dust, soil, noise, traffic, etc.).

Working conditions, job quality, workers' health and job sustainability in the construction sector must also be in the focus. The outcomes of surveys on this topic are not that positive: for example "Construction sector: working conditions and job quality" report reveals some urgent challenges.

Construction sector: working conditions and job quality

The "Construction sector: working conditions and job quality" report gives an overview of working conditions, job quality, workers' health and job sustainability in the construction sector. It is based mostly on the fifth European Working Condition Survey (EWCS), which gathers data on working conditions and the quality of work across 34 European countries. Some of the main conclusions of the study are:

- the sector is highly male-dominated;
- there are very low levels of employer-paid training;
- workers report high levels of exposure to physical risks, but are well informed about health and safety in the workplace;
- job conditions are an issue for young male workers;
- the negative impact of work on employees' health needs attention.

Resource productivity is a key concept in the construction (and deconstruction) phase. Reclaimed materials (previously used in a building, then re-used in another) can effectively implement this concept.

The HS2 rail project

One such project that has the potential to generate approximately 130 million tonnes of excavated material is the proposed HS2 rail project. The project team states that **more than 86% of this material will be reused within the project** for the construction of engineering and environmental mitigation earthworks. HS2 has bold ambitions, many of which are justified: large-scale projects are already delivering this kind of performance, including the other major rail construction effort in the UK (e.g. case study on p118 of "From waste to resource productivity report"). Crossrail shows that there are huge opportunities for the management of excavation wastes, but that careful planning and advanced thinking are required to ensure that social, environmental and economic solutions are achieved.

5.4 Use and refurbishment: retaining value

Retain, refit, repair, refurbish, reuse are relevant concepts in a sustainable perspective. The setup of a proper plan for the **use phase** is key to enlarge the lifespan of a building, offering economic and social development opportunities. A relevant case of public authorities implementing these concepts is the Venlo municipality (in The Netherlands).

Cradle to Cradle principle

Venlo municipality (The Netherlands) is working with all local stakeholders to demonstrate that sustainable processes in the construction sector are possible. Venlo has embraced the **Cradle to Cradle (C2C)** principle as the first region in the world to do so. The Venlo C2C city hall was designed to be dismantable, with intended pathways defined for the materials selected. Deposit-return schemes have been applied on furniture. C2C also plays a role within education in Venlo. To inspire a next generation of innovators, the educational institutions in the Venlo region have defined common Cradle to Cradle ambitions.

5.5 This is the end: circular thinking for the afterlife

Pre-demolition audits, waste management plans, decontamination, source separation, selective demolition, reuse, remanufacture , recycling, industrial symbiosis are some of the concepts to put in place a circular thinking for the afterlife.

Collecting bricks for re-use

Odense Region (Denmark) is implementing an action to collect for re-use bricks in the civic amenity sites. Citizens can get rid of their bricks (from minor do-it-yourself construction and demolition activities within private households) through specific containers.

A set of communication activities (also including QR codes on the containers) are addressing effectively the scope of the initiative.

This action is included as good practice in the EU funded INTERREG project Regions for Recycling.

LRAs can effectively smooth the achievement of such objectives including in theirs plans specific requirement and incentives.

Circular procurement is an effective tool for LRAs to manage the end-of-life stage in a sustainable way. The "Public Procurement for a circular economy – Good practice and guidance" of the European Commission can inspire LRAs on the topic.

Conclusion

Exploring the construction sector is an inspiring journey and local and regional authorities (LRAs) have the responsibility to drive forward sustainable patterns.

This document pointed out several good practices of LRAs playing much of a role in achieving outstanding results.

A strong political commitment, with clear goals, is an effective starting point to set up a strategy. Making sustainable construction one of the priorities of the political agenda will boost concrete actions involving the whole stakeholders' ecosystem. Various cross-cutting elements should be then put in the focus, considering the local priorities. Circular economy models and principles have an enormous potential to design proper action plans striving for material resource efficiency. The pillars of sustainability help to face the challenge tackling the environmental, social and economic dimensions.

The cooperation between regional and local authorities, the involvement of the civil society and the engagement of the stakeholders along the construction value chain are the key processes to make sustainability happen.

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