# Handbook for trainers:

## The circular economy applied to the construction industry

Green Growth

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# CONTENT

## Objectives

- To understand what circular economy is and its basic principles.
- To identify the different dimensions, the phases and the life cycle of the built environment and the impacts generated in each phase.
- To know the tools to measure and facilitate the circular economy in the construction sector.
- To identify strategies to achieve circularity in the building sector in all its phases.
- To know the new business models that can be generated with the application of the circular economy in the construction sector.
- To know European circular economy policies applicable to the built environment.

## Introduction

Following this course will allow you to get an overview of the circular economy and how it can be applied to the construction sector.

Unit 1 deals with the concept of circular economy and its basic principles as an alternative to the current linear economy. It also explains the 9R law and the butterfly diagram, where the different technical and biological cycles of products are explained.

Unit 2 describes the environmental impacts of the building process at each stage of its life cycle, the different levels at which the circular economy should be addressed and the tools available to measure and monitor the circularity of the building process.

Unit 3 presents the strategies to achieve circular buildings in three scenarios: the design of new buildings, the rehabilitation of the already built building stock and the deconstruction techniques when the building reaches the end of its life. This unit also shows the new business models that are generated in the construction sector with the implementation of the circular economy.

Finally, unit 4 explains the current European policy on circular economy in the construction sector.

## Conceptual map

**Handbook for trainers**

- **Circular economy**
  - Concept
  - Basic Principles
  - 9R Law
  - Butterfly Diagram
    - Technical Cycles
    - Biological Cycles
- **Circular economy in the construction sector**
  - Environmental Impacts
  - Tools to measure and monitor circularity
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- **Strategies to achieve circularity**
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  - Circularity in the built environment
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- **European circular economy policy**
  - European Green Pact
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    - New wave of renovation

# Unit 1. Circular economy

## Introduction

Climate change, the loss of biodiversity and the depletion of natural resources have provoked an unprecedented global crisis, giving rise to what some scientists consider to be a new geological era: the Anthropocene.

This situation has been caused, in large part, by the current model of **production and consumption**, called "**linear economy**". This economic system, implemented since the first industrial revolution, is based on the pattern of "produce, use and throw away", under the assumption that natural[1] resources are inexhaustible. However, the linear model is reaching the limit of its capacity and has resulted in significant negative environmental impacts[2] that compromise the habitability of the earth for future generations.

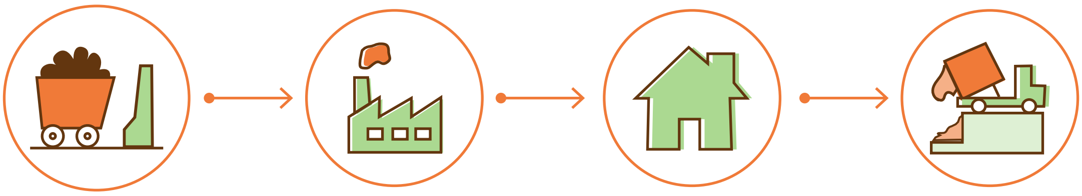
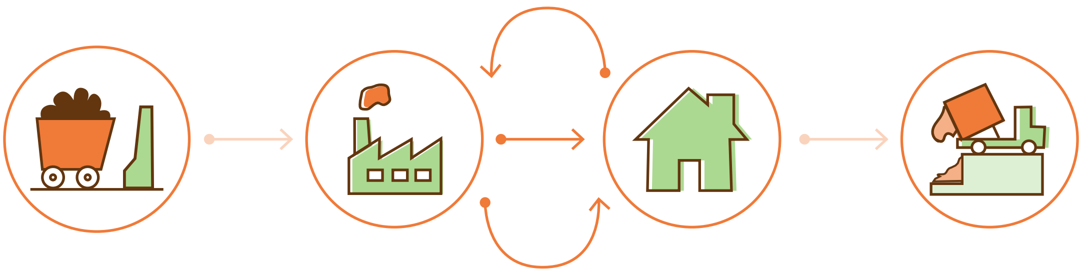


*Diagram of linear economy. Source: GBCE. Circular economy in building.2021*

As an alternative to the "linear model", a new model of production and consumption emerges, called "**circular economy**", whose objective is to achieve more efficient and resilient production and consumption systems, less polluting, that minimize the use of natural resources and preserve the ones they use within continuous cycles, maintaining or improving their value.

The circular economy must be applied to all productive sectors and requires a new approach in the following areas: the design of products and services; management and market models; how to convert waste into resources; national regulations; and the commitment of citizens to change their consumption habits. All of this implies a paradigm shift.

The decarbonization of European Economy by 2050 is at the core of the European Green Deal adopted at the end of 2019.The implementation of the circular economy will be key to achieving a decarbonised Europe.



*Circular economy scheme. Source: GBCE. Circular economy in building.2021*

1 ***Natural resources*** are elements of nature that man exploits and processes to obtain his development and well-being. Resources can be renewable or non-renewable.
***Non-renewable resources*** are limited and cannot be replaced, regenerated or brought back to their original state in a time less than or equal to the time it takes man to consume them, e.g. minerals, and fossil fuels.
***Renewable resources***, considered unlimited, are those that can be replaced, regenerated or brought back to their original state. For example, solar radiation, wind, tides, water, plant and animal species. The most widely used renewable material in construction is ***wood*** and its derivatives, as long as it comes from ***sustainably managed*** forests.

2 Environmental impacts are modifications of the environment due to human activities. Impacts can be negative, indifferent or positive. They are negative when they harm the environment


## Circular economy: basic principles

The concept of circular economy (CE), as well as its possible practical applications in the economy and industry, gained momentum starting from the seventies of the twentieth century. This concept integrates different schools of thought such as: the "*Limits to Growth*" theory of the Club of Rome, the "*Regenerative Design*" theory of John T. Lyle, the "*Performance Economics*" theory of Walter Stahel, the "*Cradle to Cradle*" concept of Braungart and McDonough, the "*Industrial Ecology and Biomimicry*" of Janine Benyus, the "*Blue Economy*" and "*Natural Capitalism*".

According to the Ellen MacArthur Foundation, an organization dedicated to promoting the transition to a circular economy, this can be summarized in three principles of action, applicable to the building sector:

- "**Avoiding the generation of waste and pollution by design**". To achieve this, it is necessary to reduce the amount of raw materials, water and energy needed to meet the needs required at any given time, and prioritize the use of renewable energy and secondary raw materials[4].

- "**Keep products and materials in use for as long as possible**". To achieve this, efficient management of the resources that are used is essential. The aim is to keep material resources in use for as long as possible and to recirculate them in the value chain as many times as possible through reuse[5] and recycling[6] ... Energy recovery[7] should always be the last option and landfill is not envisaged in the theoretical framework of CE.

### Learn more

Currently, the Earth's annual demand for resources due to anthropogenic (human) activities exceeds its regenerative capacity. In 2019, humanity consumed an amount of natural resources equivalent to 1.6 Planets.

In the following **web page** you can consult data of the ecological footprint[3] in your country per person.

3 "The ecological footprint is defined as the measure of the impact of human activities on nature, represented by the area needed to produce the resources and absorb the impacts of that activity" Source: WWF.

4 Secondary raw materials are those obtained by recycling materials.

5 ***Re-use*** is: "any operation by which products or components of products which are not waste are used again for the same purpose for which they were conceived" Source: Waste Framework Directive 2008/98/EC.

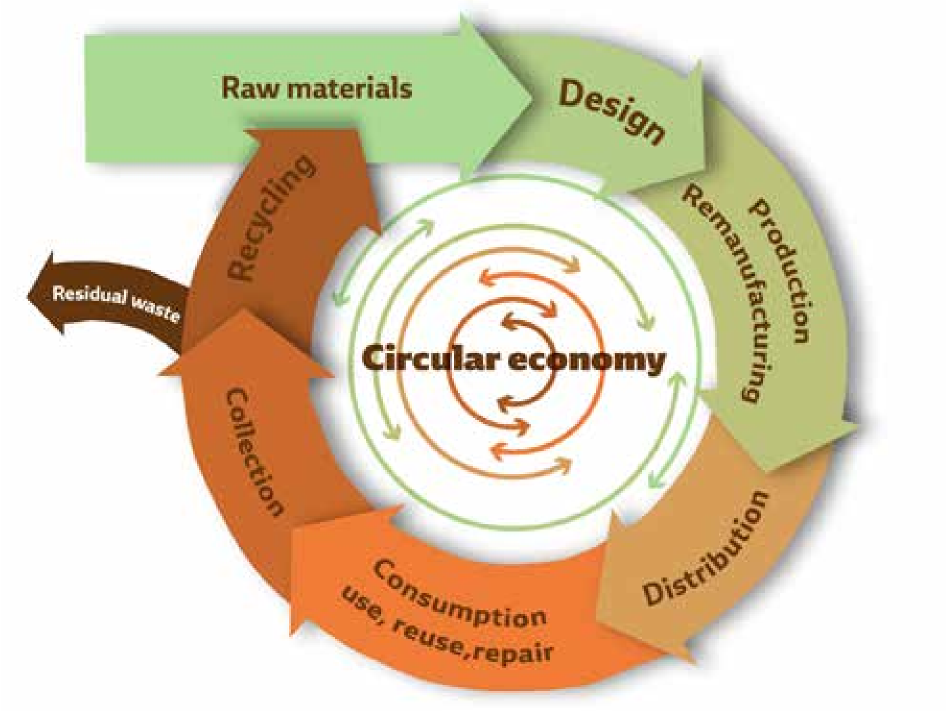
6 ***Recycling*** is defined as: "any operation by which waste materials are transformed back into products, materials or substances, whether for the original purpose or for any other purpose. It includes the transformation of organic material, but does not include energy recovery or transformation into materials to be used as fuels or for backfilling operations" Source: Waste Framework Directive 2008/98/EC.

7 ***Energy recovery is the*** transformation of waste that cannot be reused or recycled into energy, the conversion can be into electricity, steam or hot water for domestic or industrial use.

↗ "***Regenerate natural capital***"[8]. This principle is essential to guarantee the supply of natural goods and services on which human survival and well-being depends.

The circular economy is regenerative, and is inspired by natural cycles, where everything that is born and grows returns to its point of origin, the earth, and is born again, forming a constant dynamic balance. In nature there is no "waste", all elements have a function, and are reused and transformed to be used in different stages.

CE is directly related to sustainable development[9] as it redefines the growth model, seeking environmental, social and economic benefits. Not only does it provide environmental benefits, it also boosts competitiveness and employment generation, with the creation of new business opportunities and innovation in products and services. Implementing digitalization and new technologies is key to achieve circularity.




*Circular economy scheme. Source: Adapted from European Commission. COM (2014) 398 final*

8 Natural capital is the planet's natural resource reserves, including geology, soil, air, water, as well as all living things. From natural capital derive ecosystem services, which make human life possible. Ecosystem services include food, drinking water, climate regulation, insect pollination etc...Example: A forest produces new trees for timber, and also ecosystem services such as carbon sequestration, erosion control and provides habitat for wildlife.

9 According to the Brundtland Report, **sustainable development** means 'Meeting the needs of the present without compromising the ability of future generations to meet their own needs'. The aim is to ensure a balance between economic growth, care for the environment and social well-being.

**Sustainability refers** to the ability to live according to the productive capacity of the land while preserving its natural resources, i.e. to live without ecological deficit.

Sustainability is the goal of sustainable development.

Some principles of the circular economy have already been used by our societies at times in its history. In the pre-industrial era, reuse and recycling practices were common, more due to a lack of resources such as raw materials, labour, machinery, fuel, logistics and infrastructure, etc., than because of environmental awareness. For example, raw materials used in construction, such as stone ashlars, were reused from one civilization to another. Roman foundations served as the basis for Visigothic temples, then for mosques and later for Romanesque temples.

## Learn more

- You can find more information about the theories on which the circular economy is based on the following **website**:
- In this website you will find 8 **videos** that explain the circular economy.
- In this **link** you will find the film "closing the loop", with comments from world experts, as well as innovative cases of circular economy.

# Learn more

## 9R Law

The R-list includes three key strategies to increase circularity and innovation in product design. Each strategy has 3 actions associated with it. The strategies and actions in order of priority are:

### Circularity strategies within the production chain , in order of priority

**Circular Economy**

**Increasing circularity**

**Rule of thumb: Higher level of circularity = fewer natural resources and less environmental pressure**

**Linear economy**

**Strategies**

| | | |
|---|---|---|
| Smarter product use and manufacture | R0 Refuse | Make product redundant by abandoning its function with a radically different product |
| | R1 Rethink | Make producto use more intensive (e.g. through sharing products, or by putting multi-functional products on th emarket) |
| | R2 Reduce | Increase efficiency in producto manufacture or use by consuming fewer natural resources and materials |
| Make product redundant by abandoning its function with a radically different product | R3 Reuse | Re-use by another consumer of discarded product which is still in good condition and fulfils its original function |
| | R4 Repair | Repair and maintenance of defective product so it can be used with its original function |
| | R5 Refurbish | Restore an old product and bring it up to date |
| | R6 Remanufacture | Use parts of discarded product in a new product with the same function |
| | R7 Repurpose | Use discarded product or its parts in a new product with a different function |
| Useful application of materials | R8 Recycle | Process materials to obtain the same (high grade) or lower (low grade) quality |
| | R9 Recover | Incineration of materials with energy recovery |

Innovations in core technology

Innovations in product design

Innovations in revenue model

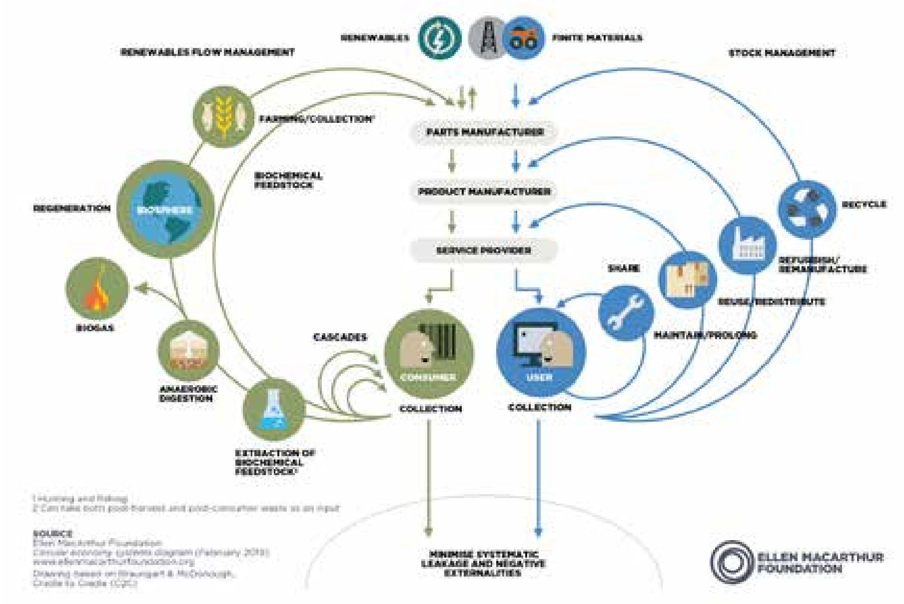
Socio-institutional change

*The 9R Framework Source: Plotting et al. 2017, et RLI (2015)*

## Butterfly diagram

The circular economy takes into account the entire life cycle of a material or product, from the extraction of natural resources to the treatment of waste at the end of its useful life.

The Ellen McArthur Foundation published the following "butterfly diagram". This conceptual scheme is based on the "cradle to cradle" theories formulated by McDonough and Braugart,




Material flows are organized in two sets of interacting cycles: technical and biological. The cycles are concentric and a bigger cycle implies greater consumption of material and energy resources than the previous one.

## Biological cycles

In **biological cycles**, biodegradable materials, such as wood and cotton, can be safely reintegrated into nature as nutrients after several cycles of use, thanks to natural processes such as composting or anaerobic digestion.

The reuse of products can be diversified or **cascading**. Wool, for example, is used to make clothing, in a next use it is reused as second-hand material, finally it can be used for the manufacture of thermal insulation. In a final step, the wool, which is a biodegradable material, is safely returned to the biosphere.

## Technical Cycles

In **technical cycles**, materials and components that are not biodegradable, such as metals, plastics and synthetic chemicals, are continuously kept in the value chain. They must be designed to be easily repaired and at the end of their useful life their components can be removed and reused or remanufactured or recycled into other products. These closed cycles avoid the generation of waste that goes to landfill.

**The first cycle** refers to **sharing, exchanging or renting goods or services**, rather than owning them, in order to intensify and optimize the use of a product. An example of this is the collaborative consumption of: machinery, a vehicle, a workspace, etc. It also includes **repairing and maintaining** a product by prolonging its useful life, such as an air conditioner, where most of its value is retained if it is repaired or upgraded. For products that require energy to operate, e.g. a boiler, consideration should be given to improving energy efficiency over time.

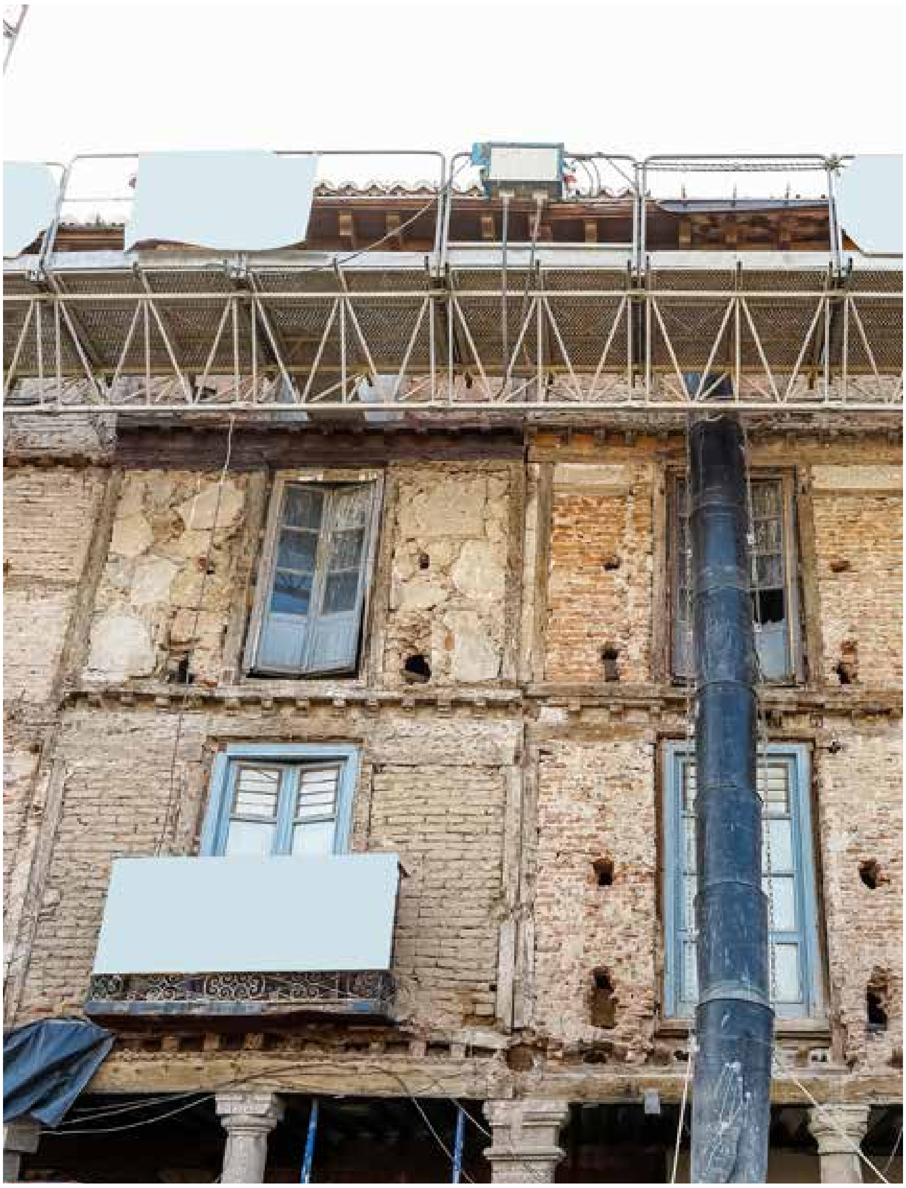
**Learn more**

Ellen Macarthur Foundation **website**

Arthur Huang Lecture

When maintenance of a product is not possible, **in the second cycle** the service or product provider carries out **the reuse and redistribution** of product components. For example, parts from a vehicle that has reached the end of its useful life can be used to repair another vehicle that is in use, or for another use.

In the **third cycle**, remanufacturing and reuse, the producer of the product makes a new product using parts of a damaged product that had the same function. In the case of buildings, this includes **refurbishment or renovation**.



The **fourth cycle is recycling**. In this cycle, the basic materials of a product that has reached the end of its useful life are separated and used to manufacture another product through industrial processing.

An important aspect that benefits circularity is that products and their parts are composed of pure, uncontaminated and easy to separate materials. This condition favours their collection and reintegration into the value chain, increasing their durability.

Very often recycled materials cannot be reused for the same type of product or for a product with higher quality requirements (**up-cycling**) but can be reused for another product with lower quality requirements (**down cycling**). Contaminants and the mixing of materials reduce the quality of the materials being recovered.

Inserting the materials that make up an end-of-life product into a new cycle can require large amounts of energy.

## Unit 2. Circular economy in the construction sector

### Introduction

The construction sector provides infrastructures, urban spaces and buildings on which all other sectors rely on, and is therefore a key sector for European economic and social development, generating 18 million direct jobs.

Sustainability applied to construction is based on: Innovating to achieve quality and efficiency at an affordable cost; using environmentally friendly products, using water and energy efficiently throughout the life cycle of the building; minimizing the consumption of non-renewable natural resources, and enhancing the use of renewable resources; reducing waste as much as possible and efficiently managing the waste that is generated.

A building is made up of a set of systems (structure, roof, façade, partitions, installations, staircase), in turn, the systems are made up of products (doors, windows) and components (beams, girders) and these are made up of materials (wood, ceramics, etc.).

In the construction sector, as in the rest of the sectors, moving from a linear model of open cycles to a circular model, of closed cycles, requires a **complete systemic change**. In the new model, all the agents involved must share strategies to achieve circularity, taking into account all the stages of the life cycle of buildings and infrastructures.

The circular model is a sustainable model which can provide important benefits for the environment, as well as new employment and business opportunities in the sector.

In the long term, all this has an impact on improving the environment, the health and well-being of users, increasing productivity, and saving costs.

Integrating the principles of the Circular Economy in the construction sector involves addressing different levels: material, component, product, system, building, city and territory.


The geological, biological and climatic peculiarities of the territory must be taken into account at the city and territory levels. The final objective is that the management of water, energy, waste and the rest of the resources necessary for life is sustainable. Some examples to achieve circularity at these levels are: reconnecting and enhancing natural ecosystems with urban[10] green infrastructures and re-naturalising the city by integrating "nature-based solutions[11]", which are solutions inspired by natural processes, such as "urban green corridors[12]" , rethinking the mobility model and the way of life of citizens, etc.

10 *Green Infrastructure* is a "strategically planned network of natural and semi-natural spaces and other environmental features designed and managed to deliver a wide range of ecosystem services. It includes green spaces (or blue spaces in the case of aquatic ecosystems) and other physical features in terrestrial (natural, rural and urban) and marine areas Source: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. In terrestrial areas, green infrastructure is present in rural and urban environments" Green Infrastructure: enhancing Europe's natural capital.

11 Nature-based *solutions* are "solutions inspired and supported by nature, which are cost-effective, provide simultaneous environmental, social and economic benefits, as well as help build resilience; such solutions bring more nature as well as natural features and processes, and with greater diversity, to cities and landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions." Source: European Commission

12 "greenways are portions of land containing linear elements that are planned, designed and managed for multiple purposes including ecological, recreational, cultural, aesthetic or other purposes compatible with the concept of sustainable land use" Source: Arhen (1995).

*Urban green corridor, Madrid Rio. Source: Ana Müller and Jeroen Musch, published in Burgos & Garrido Arquitectos.* [https://burgos-garrido.com/](https://burgos-garrido.com/)

This course will not deal with the city and territory levels.

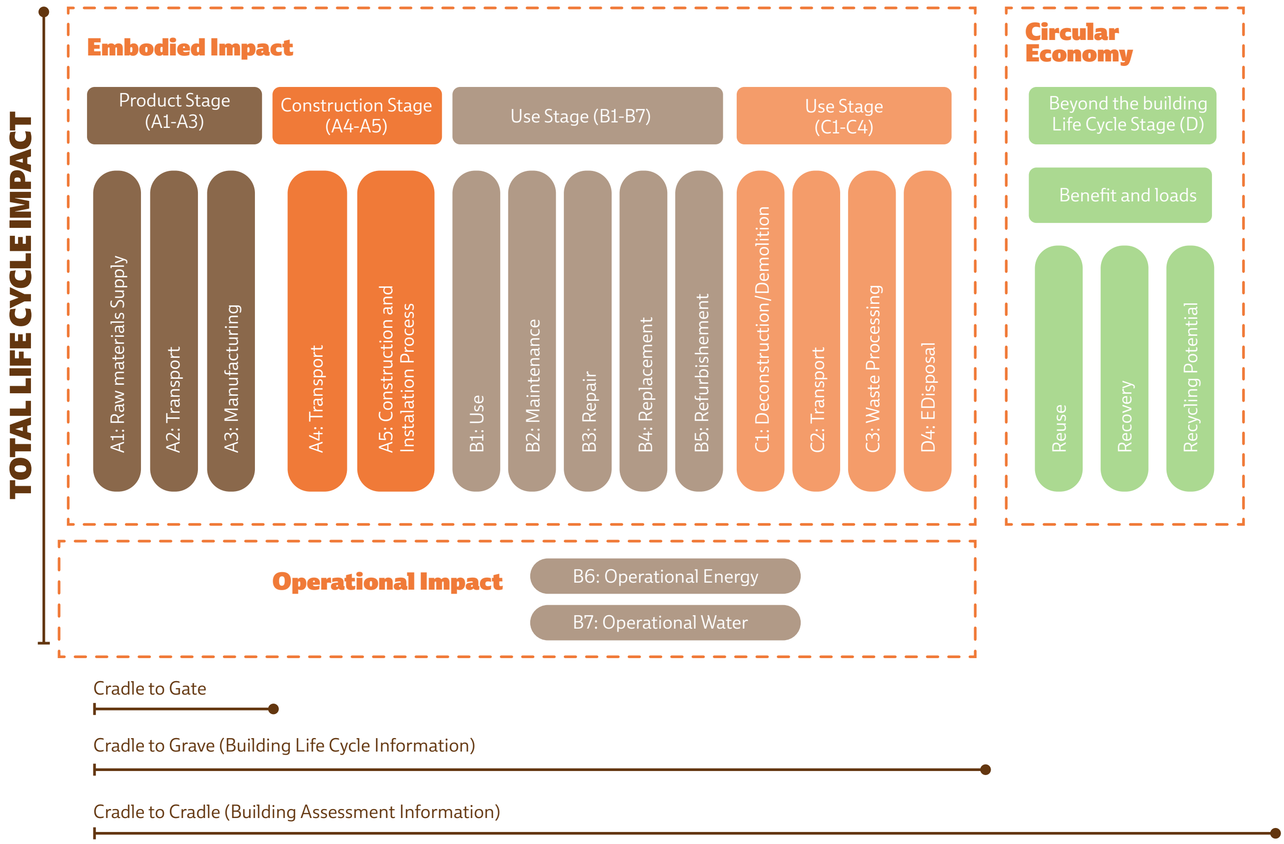
# Learn more

- ↗ EU **website** on The forms and functions of green infrastructure.
- ↗ **Video** showing the benefits of urban green infrastructure Landscape Institute, UK.
- ↗ EU **website** on Nature Based Solutions.

## Environmental impacts associated with the construction sector

During **their life cycle,** constructions modify territories, consume a large amount of non-renewable natural resources, emit harmful substances into the atmosphere and generate solid waste of all kinds.

The standard EN 15798:2011 (sustainability of construction works) establishes, in a generic way, the stages of the life cycle of a construction and adds a nomenclature to each of them. The stages are shown in the attached graphic:



*Extraction of minerals in a quarry*

*Cement factory*

For example, cement manufacturing generates approximately 8% of the world's $CO_2$ emissions. Sixty percent of these emissions are due to chemical reactions during the process.

Each stage has different effects on the environment, which depend on factors such as: the characteristics of the surroundings, the materials and construction techniques used, the energy and water consumed, the waste generated, etc.

In the production stage, raw materials are extracted, transported and processed into building materials. This stage generates significant negative environmental impacts. Many minerals and rocks are extracted in open-pit quarries and gravel pits, which implies, in the area of action, the elimination of vegetation, the loss of the organic matter layer of the soil and its exposure to erosion.

On the other hand, the physical-chemical processes to which the raw material is subjected in its processing generate polluting emissions into the atmosphere and soil, and a percentage of discarded material that becomes waste. In addition, during extraction, transport and processing, polluting gases are emitted into the atmosphere due to the energy used for these actions, which comes from fossil fuels. The building materials production industry is one of the most energy-intensive industries in the world.

In the **construction stage** the building takes shape and many agents are involved (city council, architects, builders, etc.). This stage includes the transport of materials to the site and the construction and installation process, and involves the environmental impact caused by the implantation of the building in the territory, the consumption of a large amount of materials, water and energy, as well as the production of waste from discarded materials, packaging, etc.

The **use and maintenance stage of** the building is the longest-lived stage. It includes maintenance, repair and renovation. It is associated with the consumption of water, operational[13] energy, and the emission of pollutant gases as a consequence of the consumption of energy from fossil fuels. The construction of energy efficient buildings[14] and the integration of local renewable energy systems, at building or neighbourhood level, significantly reduces the consumption of non-renewable energy. This is the case for NZEB near-zero energy[15] buildings.

At this stage, circular strategies such as repair and refurbishment extend the life of the building.

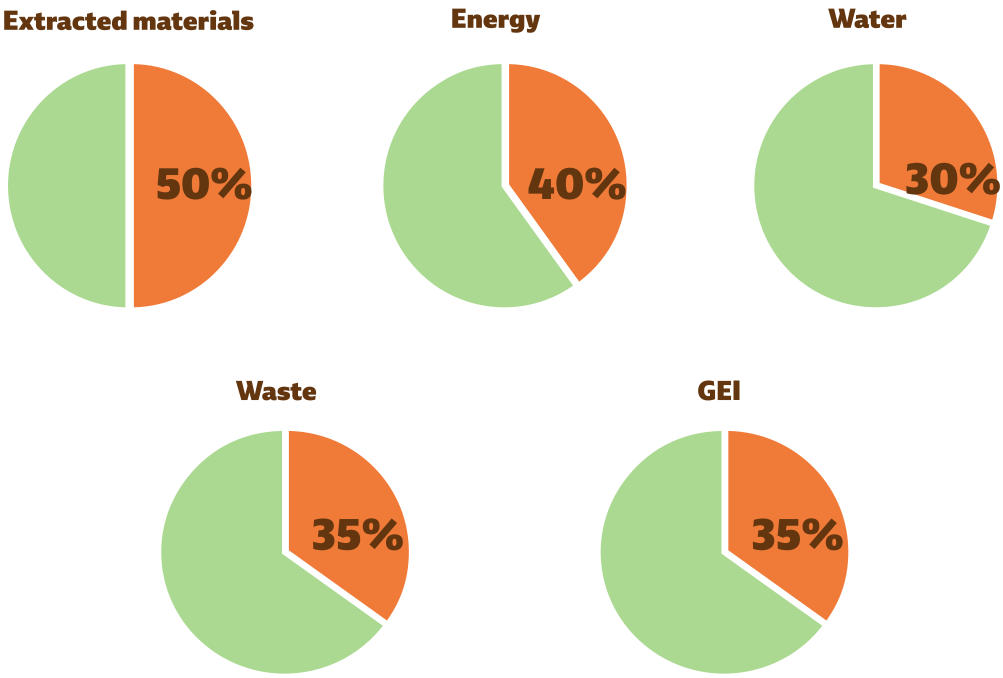
The end-of-life stage in a linear economy is the demolition process, where materials become waste. The possibility of reinsertion into the value chain of materials at the end of their useful life depends on: the type of materials and construction systems chosen in the design phase, and the way in which demolition and waste management are carried out. In this phase, the environmental impact is related to the burning of fossil fuels from machinery and transport, as well as emissions related to landfill disposal.

13 Operational energy, also known as operational energy or energy in use, is the energy consumed during the use stage of the building i.e. the energy used for heating, cooling, ventilation, lighting, appliances and office equipment (Harvey, 2006).

14 "energy performance of the building" means the calculated or measured amount of energy needed to meet the energy demand associated with normal building use, which shall include, inter alia, energy consumed for heating, cooling, ventilation, water heating and lighting; Source: DIRECTIVE 2010/31/EU

15 *Nearly Zero Energy Efficient Building, (nZEB*) "Building with a very high level of energy efficiency .... The near-zero or very low amount of energy required should be covered, to a very large extent, by energy from renewable sources, including energy from renewable sources produced on-site or in the environment; " Source: DIRECTIVE 2010/31/EU.

In Europe, in recent years, the data on the impact of the construction sector are as follows:




*Impacts of the construction sector in Europe. Data source: Eurostat 2016 data. Green Building Council Spain. 2021. Report on circular economy in building in Spain[TS2]*

## Tools to measure and monitor circularity in the construction sector

"What cannot be *measured cannot be improved*". Therefore, a series of tools have been designed to measure and compare in a quantitative and verifiable way the environmental performance of buildings and materials, and others to monitor the circular economy in the construction sector, these are:

### Life cycle assessment

**Life Cycle Assessment (LCA)** is a methodology that quantitatively analyses and evaluates the potential environmental impacts of any type of product, process or service throughout its entire life cycle, or parts of it.

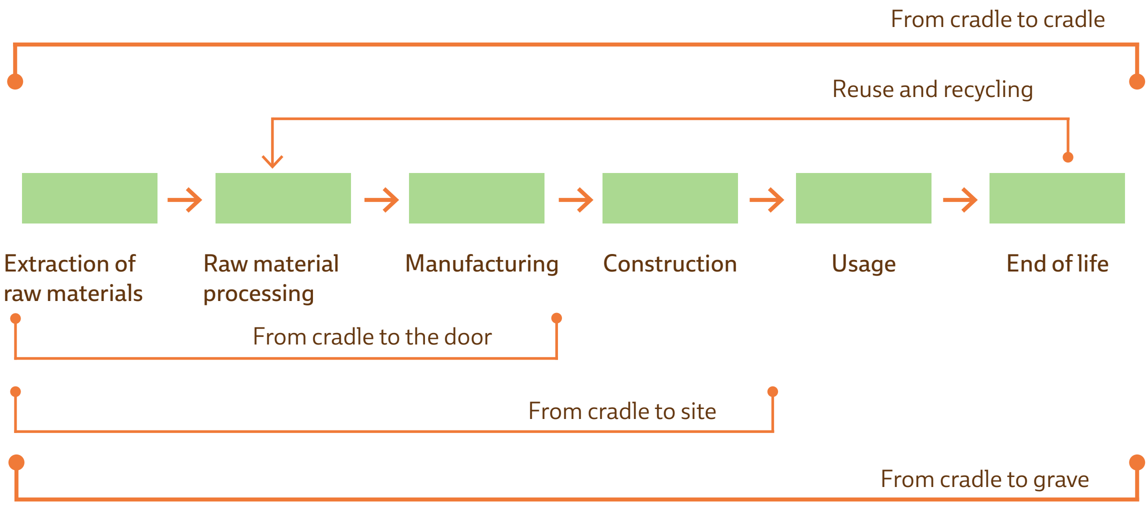
The environmental impacts of a building, system or construction product can be measured in certain sections of its life cycle, these sections are:

- "**From the cradle to the door**". This is the "product stage", comprising the extraction and processing of raw materials, transport to the factory and manufacturing.

- "**From cradle to site**": Comprises the "product stage" plus the "construction stage".

↗ "**From the cradle to the grave**". It covers the complete life cycle, including demolition and valuation as waste.

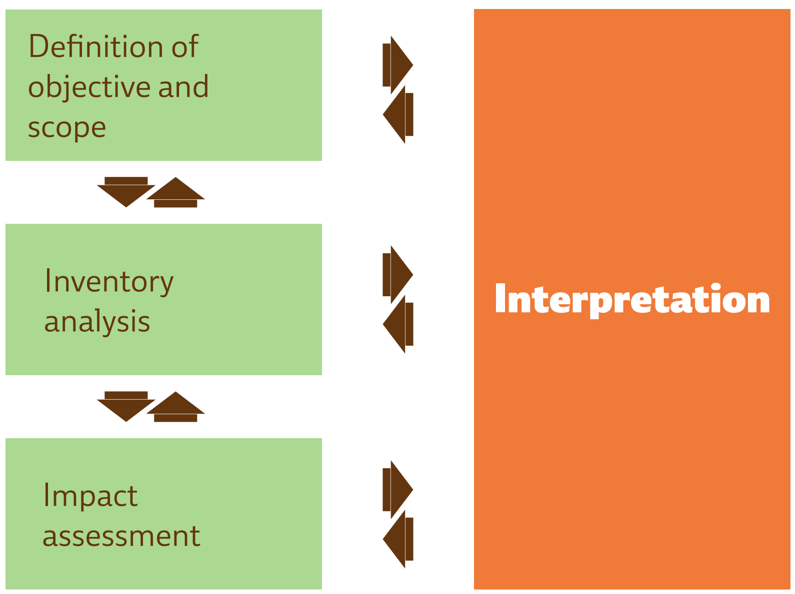
↗ "**From cradle to cradle**" is the life cycle of the complete product taking into account its reinsertion in the production chain if it is reused or recycled.



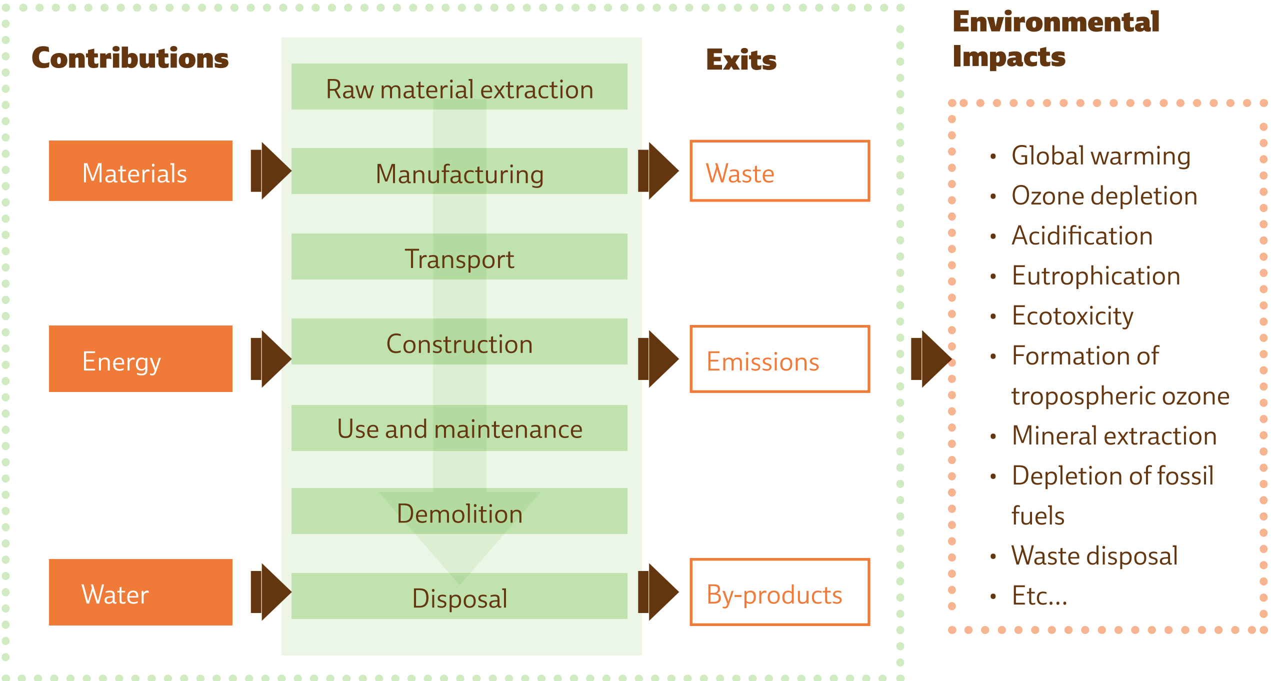

In the field of construction, the LCA is applicable to a material, a construction system, a building or an infrastructure.

The reference documents for the development of an LCA are the international standards ISO 14040:2016: 2006 (LCA: principles and framework for LCA) and ISO 14044 :2006 (LCA: requirements and guidelines).

The LCA is divided into four interconnected phases: Objectives, life cycle inventory analysis, life cycle impact assessment and interpretation.



In conducting an LCA, the first step is to define the objective or product to be studied, and the scope. Subsequently, the inventory of inputs and outputs of the system is carried out for each stage of the life cycle. The inventory identifies the quantities of material resources, energy and water that are contributed (inputs) and the waste and emissions to the atmosphere and water that are generated (outputs). Finally, the potential environmental impacts associated with the inputs and outputs at each stage are evaluated and the results are interpreted in relation to the objective of the study.




## Learn more

The indicators of the impacts associated with a construction LCA according to **EN 15978 are**:

| INDICATORS OF IMPACTS ASSOCIATED WITH LCA ACCORDING TO EN 15978: | UNITS |
|---|---|
| Global Warming Potential, GWP | kg CO2eq. |
| Stratospheric Ozone Depletion Potential, ODP | kg CFC 11 eq. |
| Soil and water acidification potential; AP; | kg SO2- eq. |
| Eutrophication potential, EP; | kg (PO 4) 3- eq. |
| Photochemical oxidant formation potential of tropospheric ozone, POCP; | kg ethylene eq. |
| Depletion of abiotic resources; ADP_e | kg Sb eq. |
| Potential depletion of fossil fuel resources; ADP_f | MJ |

| **WASTE CATEGORY INDICATORS ASSOCIATED WITH THE LCA** | **UNITS** |
|---|---|
| Dumping of hazardous waste | Kg |
| Non-hazardous waste landfilled | Kg |

| INDICATORS OF RESOURCE USE ASSOCIATED WITH LCA | UNITS |
|---|---|
| Non-renewable primary energy use, not including energy resources used as feedstocks | MJ, net cal. value |
| Use of renewable primary energy resources used as raw materials | MJ, net cal. value |
| Non-renewable primary energy use, not including energy resources used as feedstock. | MJ, net cal. value |
| Use of non-renewable primary energy resources used as raw materials | MJ, net cal. value |
| Use of secondary materials | MJ |
| Use of renewable secondary fuels | MJ |
| Use of non-renewable secondary fuels | MJ |
| Net tap water use | M3 |
| **INDICATORS OF FLOWS LEAVING THE SYSTEM** | **UNITS** |
| Components for reuse | Kg |
| Materials for recycling | Kg |
| Materials for energy recovery | Kg |
| Exported energy | MJ for supplier |

## Environmental Product Declarations (EPD)

**Environmental Product Declarations** (EPD) are standardized documents that contain quantitative and objective information on the environmental impact indicators of a product based on its LCA. EPDs are type III environmental labels that are regulated by ISO 14025 and can be verified by an independent third party.

The LCA for EPDs is performed following Product Category Rules (PCR) that ensure consistent criteria for product families with the same function.

The EPD information allows comparing the environmental performance of materials, products and services, such as maintenance. Its objective is to encourage demand for products and services that have a lower impact on the environment.

The demand for EPDs in the market is increasing. For example, EPDs are taken into account in the criteria that building materials and products must have in the main building certification schemes such as BREAM[16]. LEED[17] , GREEN[18] etc. and are starting to be cited in Green Public Procurement legislation in Europe.

16 **BREEAM** (Building Research Establishment Environmental Assessment Method). It is an internationally recognised certification system that assesses the degree of environmental sustainability of both new and existing buildings. It was created by BRE (Building Research Establishment) in the United Kingdom during the 80s, https://www.breeam.com/.

17 **LEED** (Leadership in Energy and Environmental Design) is an internationally recognized sustainable building certification system. It was created in the United States and developed by the US Green Building Council. LEED evaluates five aspects of the building: sustainable location, water savings, energy efficiency and renewable energy, conservation of materials and natural resources, and indoor environmental quality, with an additional category, innovation in design. Through the score achieved in these areas can be obtained different levels of certification which are: Certified, Silver, Gold and Platinum. https://www.usgbc.org/leed.

18 **VERDE** (Reference Efficiency Rating of Buildings) is a certification system recognized at European level created by the Green Building Council Spain (GBCE). Its objective is to quantify the environmental, social and economic impact of buildings. The evaluation system is based on the Technical Building Code and European Directives. There are several methodologies depending on the use of the building to be evaluated. Renovation is included. There are 6 levels of certification, ranging from 0 to 5. https://gbce.es/certificacion-verde/.

## Learn more

You can check what a EPD looks like in the EPD library on the following **website**.

The main European Programme Managers have created the ECO **Platform** Association for EPDs in the building sector with the aim of establishing an open international network of digital LCA data for buildings and infrastructure.

When a material or product, e.g. a window, has an EPD, it means that data on its environmental impacts can be compared with those of other similar products, i.e. other windows.

## Level(s)

Level(s) is a tool developed by the European Commission that provides a common framework of core indicators to measure the "sustainability performance" of a building throughout its life cycle. It aims to create a "common European terminology" for the building sector that facilitates the production of data, and helps to integrate buildings into the circular economy. It can be used in building projects or as a basis for other initiatives, policies etc.

Levels sets out six macro targets that address key sustainability issues at all stages of the building life cycle. These macro targets coincide with strategic EU policy objectives in areas such as: greenhouse gas emissions, durability and circularity of building materials, efficient use of water, healthiness of spaces and resilience to climate change, and optimised life cycle cost and value. Each macro-objective is associated with basic indicators that total 16.

The second macro-objective refers specifically to the circularity of materials.

| Thematic areas | Macro-objectives | Indicators | | | |
|---|---|---|---|---|---|
| Resource use and environmental performance | 1. Greenhouse gas emissions along a building's life cycle | 1.1. Use stage energy performance (kWh/m²/year) | 1.2 Life cycle Global warming potential (CO² eq./m²/ year) | | |
| | 2. Resource efficient and circular material life cycles | 2.1. Bill of quantities materials and lifespans | 2.2 Construction and demolition waste | 2.3 Design for adaptability and renovation | 2.4 Design for deconstruction, reuse and recycling |
| | 3. Efficient use of wáter resources | 3.1 Use stage wáter consumption (m³/ occupant/ year) | | | |
| Health and comfort | 4.Healthy and comfortable spaces | 4.1 Indoor air quality | 4.2 Time out of termal comfort range | 4.3 Lighting and visual comfort | 4.4 Acoustics and protection against noise |
| Cost, value and risk | 5. Adaption and resilience to climate change | 5.1 Protection of occupier health and thermal comfort | 5.2 Increased risk of extreme weather | 5.3 Sustainable drainage | |
| | 6. Optimised life cycle cost and value | 6.1 Life cycle costs (€/m²/year) | 6.2 Value creation and risk factors | | |

*Table with macro-objective thematic areas and Levels indicators Source: European Commission. Level(s): Putting circularity into practice. 2021.*

Level(s), for the moment, is an information tool, not a certification or classification system with specific benchmarks as is the case with BREAM, LEED, GREEN, etc. certifications.

**Learn more**

You can find more information in the following link

## Material Passport

The Material Passport (MP) is a computer database, developed by the European project "*Building as Material Banks*" (BAMB), which aims to enhance the design of circular constructions.

The MP is a digital dataset of building materials, which can be broken down into different levels: materials, components, products, systems and buildings.

The MP details the following information about the materials and components of a building: function, composition (including whether it is free of pollutants), quality, previous uses, maintenance guide, deconstruction guide, and reuse and recycling options. In addition, information from "*Product Data Sheets*", "*Material Safety Data Sheets*", DAP etc. can be included.

The MP, linked to the BIM model[19], locates the materials in the building. This information becomes a digital duplicate of the building where materials are identified, allows its traceability, and facilitates its future maintenance and reuse in the same building or in others enhancing the second hand market. **The building is conceived as a bank of materials and assembled components that can be incorporated into future buildings**.

*Liander building, one of the first with Passport Material. Source: RAU Architects http://www.rau.eu*

19 **BIM (Building Information Modeling)** is a collaborative work methodology that centralizes all the information of a building in a digital model and integrates all the parties involved in the building process. The use of BIM covers all phases of the building life cycle. Its objective is to facilitate the design, construction, operation, maintenance and deconstruction processes, and to provide a reliable basis for decision making. BIM integrates different functionalities that are usually worked specifically with other programs, such as geometry, spatial relationship, geographic information, properties of materials and construction elements, structural calculation, installations, lighting, hygrothermal comfort, etc. https://www.youtube.com/watch?v=SzhYGwKsnnA

## Learn more

- You can find a tutorial of the BAMB material passport platform in the following link
- You can have an overview of the idea of buildings as material banks in the following links
- The Madaster Foundation supports the development of concepts and solutions that enable the recording, documentation, storage and exchange of data on materials, components and products used in the built environment.
- A number of organizations are developing software and concepts similar to the Material Passport, including:

## Cradle to Cradle Certification

The Cradle to Cradle certification standard is a certification system that evaluates the circularity of materials and products.

Products are assessed by analysing their environmental and social performance in five categories: material health (toxicity rating), material reuse, renewable energy and carbon management (carbon footprint), efficient water management, and social equity. Each category is assigned a level of achievement, which can be: Basic, Bronze, Bronze, Silver, Gold or Platinum. The standard requires certification renewal every two years.

## Learn more

You can find more information on the **website**:

# Unit 3. Strategies to achieve circularity in the built environment

## Introduction

The first principle of CE proposes to "reduce waste and pollution by design". **Design for deconstruction and adaptability**" of buildings is key to achieving circular buildings. It means designing flexible and adaptable buildings and choosing appropriate materials and building systems, taking into account how they are produced, conditioned, assembled, modified and manipulated at the end of use cycles.

An essential aspect of reducing pollution is to achieve **energy-efficient** buildings. The objective is not only to achieve the decarbonization of the urbanized park with NZEB buildings, but also to make buildings "**prosumers**", that is, producers and exporters of renewable energy. To achieve this, it is essential to incorporate: passive cooling and heating systems; renewable energy generation systems; and intelligent digitalization of energy systems that provide real-time data on how, when and where energy is consumed.

**Digital management technologies** offer the potential to improve building performance when applied to building elements and systems. Using data obtained from sensors installed inside buildings, indoor comfort and energy efficiency can be improved. For example, customised energy demand profiles can be created, and actions can be taken to save energy according to the outside temperature, occupancy, etc. Likewise, artificial lighting can be modified to suit the needs of each moment depending on the outside light and the occupancy conditions of the building,

Another priority issue is to carry out efficient water management by integrating systems for the reuse of grey water and rainwater for garden irrigation, toilet flushing, etc.

Strategies to achieve circular buildings should be applied to both new buildings and existing buildings in their renovation processes.

## Choosing materials with low environmental impact throughout their life cycle

In the CE, construction materials should, as far as possible, comply with the following criteria:

- ↗ They do not emit toxic substances or gases at any stage of their life cycle. The materials must maintain healthy environments during their time of use.

- ↗ They do not generate excessive or hazardous waste during production or at the end of its useful life.

- ↗ They do not require costly maintenance work, nor are they potential sources of insects, pests and mould.

- ↗ They are of quality, durable, with long life cycles.

- ↗ They have potential for reuse and recycling so that they can be maintained in the many life cycles within the value chain.

- ↗ They integrate recycled material in its composition, whenever possible and when this does not require a large amount of energy in its processing.

- They are **natural**, preferably obtained from renewable resources. Organic materials such as wood, cork or bamboo should come from **certified sustainable[20] crops** with minimal transformation and adaptation processes.

- **They are locally sourced, extracted and produced close to the construction site**. This reduces energy consumption and emissions associated with transport and supports local economic development.

- They contribute to minimise the building's energy demand, i.e. materials with good thermal and acoustic insulation characteristics.

They improve outdoor environmental conditions, e.g. use green roofs and green walls.When choosing materials, the "Environmental Product Declaration (EPD)" is a useful tool as it reflects the environmental impact of a material throughout its life cycle and can be compared with EPDs of other products with the same function. "Cradle-to-cradle certification" and/or the "material passport" (MP) also provide information on the environmental performance and assess the circularity of building materials.

## Designing for Deconstruction and Adaptability

Design for Deconstruction (DfD) is a concept inspired by industrial design. It is based on designing durable, easily disassembled products, where individual components can be added and removed without damaging the rest, as in a Meccano. DfD is applicable to all types of products, regardless of their scale and complexity, from electronics, furniture or buildings and infrastructures, and takes into account their entire life cycle.


Design for adaptability" means that the building is versatile, convertible and expandable to be able to adapt to the present and future needs of the market, thus extending its useful life. It is about designs that allow alternative uses with minimal changes, transformations of distribution and uses and in which the rehabilitation and reform does not involve generating a lot of waste.

20 Certified sustainable crops are those with PEFC (Programme for the Endorsement of Forest Certification) or FSC (Forest Stewardship Council) certification. These certifications certify, throughout the chain of custody, that the materials come from sustainably managed forests.
*"The Chain of Custody (CoC) of forest products is defined as the monitoring of forest products (wood, paper, cork, bark, resins...) during the different stages of the production process and their subsequent marketing, in order to ensure the traceability of forest products from the final consumer to the forest, or in the case of recycled material, to the point where the material is recovered*. Source: AENOR.

Source: Casa Alamos / ESTUDIO GALERA. Image © Federico Cairoli

Designing to extend the life of a building and its components involves considering the following principles:

↗ **Understand the building as a set of systems with different functions organized in layers**. Each layer of a building has a specific lifetime, and the building should be designed and constructed so that the layers are independent. The more durable layers such as the structure and envelope should not be affected by the renovation and upgrading of the less durable layers such as the installations or partitions.

For example, interior cladding, partitions, fixtures and windows are replaced more frequently than elements such as the structure and exterior envelopes. The design can provide for the replacement of these elements without causing damage to the more permanent parts of the building. One example is to design the building's installations (electricity, plumbing, sanitation) to be accessible, as far as possible, facilitating their maintenance, upgrading, repair and replacement. Another example is to use cladding and partitioning materials panels screwed and / or tongue and groove that allows quick disassembly and replacement, without waste and without damaging other parts of the building.

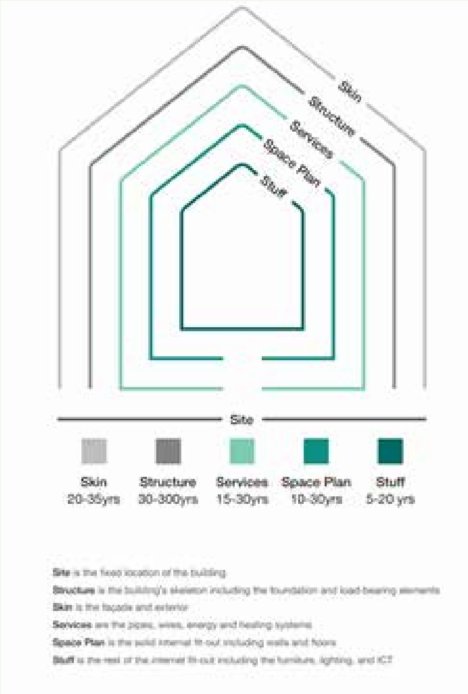
*Airbnb's European Operations Hub in Dublin / Heneghan Peng Architects. Source: © Ed Reeve.www.plataformaarquitectura.cl*

## Learn more

In 1994, Stewart Brand published the book "How Buildings Learn: What Happens After They're Built", in which he developed the "Shearing Layers" theory proposed by Frank Dufy in the 1970s.

Brand compares the built environment to a natural, dynamic and changing organism, in which its components are constantly replaced, like the cells of a living being.

It conceives buildings as a hierarchical system of layers and components (ground, structure, envelope, installations, partitions and furnishings), which in turn are part of other larger systems.




*Layers of a building according to Stewart Brand. Source:Arup. Principles to Practices: Realising the value of circular economy in real estate |Basado*

"An adaptable building has to allow slippage between the differently paced systems of site, structure, skin, services, space plan and things. Otherwise, the slow systems block the flow of the fast ones, and the fast ones destroy the slow ones with their constant changes"[21] .

↗ **Conceive the building as a material bank**, that is, as a temporary union of materials that must be preserved in good condition for their next use.

↗ **Choose durable materials and construction systems** and take the necessary protective measures to maintain their durability.

↗ **Design a building that is easy to dismantle**. Ease of disassembly simplifies the repair and recovery of different materials at the end of their useful life. In the field of construction it means designing with selective demolition[22] or deconstruction in mind to maximize the potential for reuse and recycling of its components.

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21 Stewart Brand. 1993. How Buildings Learn: What Happens After They're Built.

22 *Selective demolition involves the sequencing of demolition activities so that it is possible to separate and sort construction materials.* Source: Protocol for the management of construction and demolition waste in the EU. 2016

*Deconstructed materials from the People's Pavilion, Eindhoven. Source: © Jeroen van der Wielen. Arup. From Principles to Practices: Realising the value of circular economy in real estate*

Some construction techniques facilitate and make deconstruction more efficient, these are:

- Reducing the variety of materials and construction systems used, as well as the amount of material used. 3D printing of materials can reduce the amount of material used by printing customised construction elements.

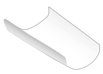
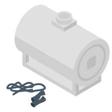
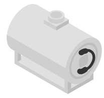
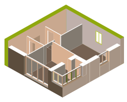
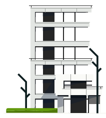
- Using modular and prefabricated systems where the elements can be easily assembled, disassembled and replaced. Nowadays, new digital technologies make possible a greater efficiency and quality in industrialization, without diminishing the uniqueness and adaptability of the finished work to its location.

- Using simple, standardized, reversible and accessible connections between materials and construction systems. Prioritize mechanical connections with screws, nuts, fittings, fasteners. When mechanical connections are not possible, use adhesives and sealants that allow disassembly.

The dismantling capacity of a construction system is related to the possibilities of reuse and recycling of its components.

The new ISO 20887:2020 standard, "Sustainability in buildings and civil engineering works, Design for Disassembly and Adaptability, Principles, requirements and guidance", provides an overview of the principles of design for disassembly and adaptability (DfD / A). aimed at all actors involved in the construction sector .

### Circular properties in the different scales and phases of buildings

| | Material | Product | Component | Space | Facilities | Structure | Skin | Building |
|---|---|---|---|---|---|---|---|---|
| |  |  |  |  |  |  |  |  |
| Design/ Rehabilitation Phase | Recycled Recyclable Recyclable Durable Renewable/ Bio-based Safe | Reusable Reusable Durable Compatible Handleable Accessible Replaceable Detachable | | Flexible | Accessible Maintainable Replaceable | Durable Accessible Modular Prefabricated Detachable | Modular - Prefabricated Freestanding - Demountable Manageable | Expandable Modular Versatile |
| Use phase | Report, Reuse, Recycle, Share | | | Adapt | Inspect, Maintain, Repair, Improve, Renew | | | |
| End of life | Separation, waste recovery and recycling | | | | | | | |

*Source: Adapted from Leticia Ortega. Instituto Valenciano de la edificación*

## Achieving the circularity of the already built environment

When the construction phase of a building or infrastructure is completed, its use phase begins and the owner becomes responsible for its state of conservation. This phase is associated with the servitization or contracting of services (cleaning, repairs, electricity, and gas supply). To facilitate subsequent repair and renovation work, it is important that the owner has in his possession all the technical documentation on the building, including the construction systems used, the installation plans with their actual layout and location, and the instructions for use and maintenance.

**Learn more**

**Video** about design for dissasembly.

**WikiHouse** is a digital building system. Its aim is to facilitate the self-build of energy efficient houses that adapt to different needs.

This phase comprises several cycles:

↗ **The maintenance or punctual repairs**. It includes cleaning, good use, small repairs, etc.

↗ **Rehabilitation**. It is a constructive action to improve the conditions of a building and adapt it to new demands. It can be:

- Partial refurbishment. Rehabilitation of specific areas, change of installations, materials, energetic rehabilitation[23] , etc.

- Total or integral rehabilitation may involve a change of use.

Therefore, from a CE point of view, it is much more cost-effective to adapt the built environment to the new requirements than to demolish and build anew.

According to ADEME, France's green transition agency, the amount of materials needed to renovate a residential building is 40 to 80 times less than to build a new one.

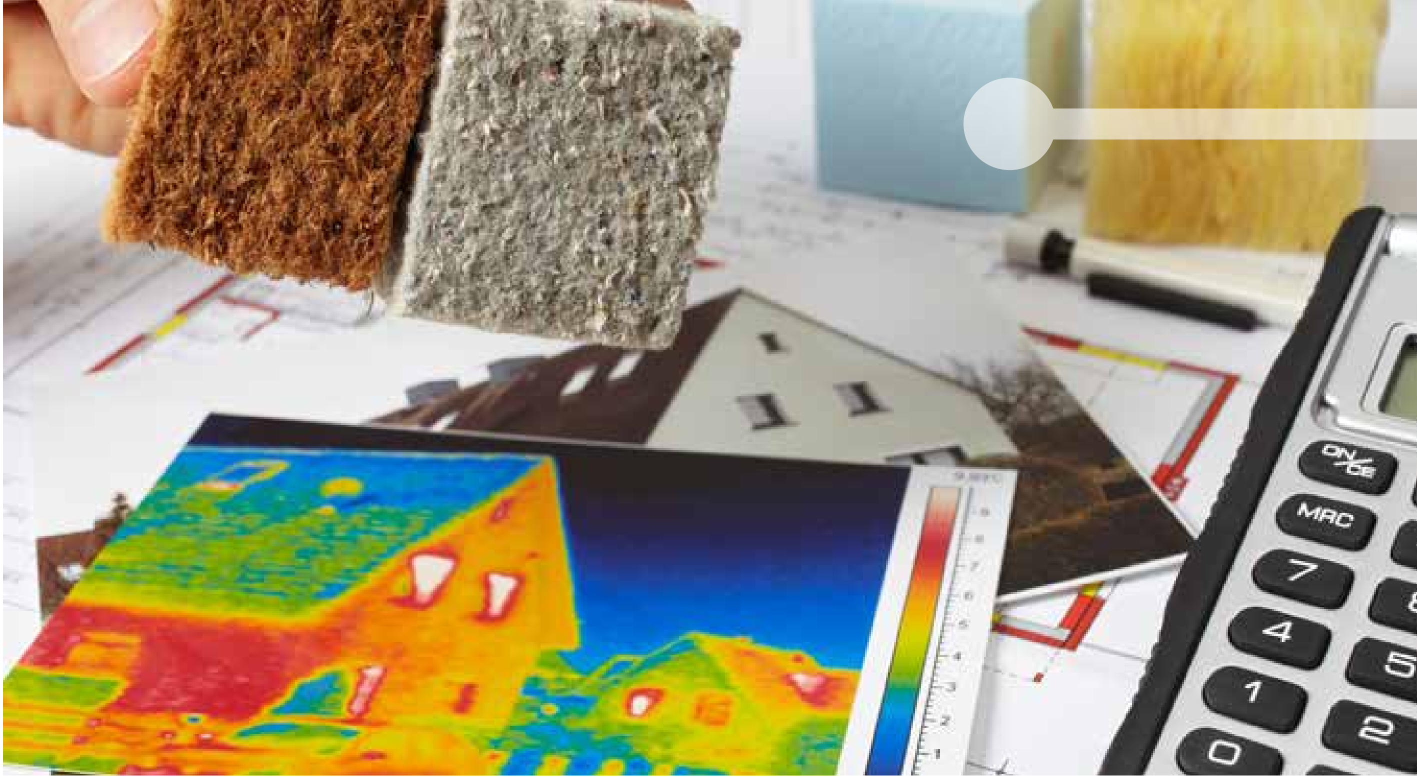
In Europe, 85-95% of the existing building stock will still be in use in 2050. Currently, 85% of the building stock was built before the 21st century, and most of it does not meet today's requirements in terms of habitability, health, sound insulation, accessibility and energy efficiency[24]. For example, 75% of buildings in the EU are energy inefficient, use outdated technologies and rely on fossil fuels.

Energy renovation of inefficient buildings could reduce the EU's total energy consumption by 5-6% and CO2 emissions by about 5%. However, only 0.2% of deep energy renovations, which are those resulting in a reduction of the building's energy consumption by at least 60%, are carried out annually.

The strategies to achieve deep energy renovations are: improving the insulation of the building envelope (facades, roofs, windows, contact with the ground), increasing the energy efficiency of cooling, heating and domestic hot water systems and the integration of renewable energies at building or neighbourhood level.

23 The energy renovation of a building is the modification of the building envelope (roof, façade, windows, surface in contact with the ground and non-habitable spaces) and/or the technical systems (heating, cooling and hot water systems), with the aim of improving its energy efficiency.

24 "In Europe, building codes with specific regulations on thermal insulation of the building envelope started to appear after the seventies of the last century. This means that a high percentage of the current building stock in the Union was built without any energy efficiency requirements: one third (35%) of the building stock in the Union is more than 50 years old and more than 40% was built before 1960. Almost 75% is energy inefficient according to current building standards". Source: Joint Research Centre (JRC) report, Achieving the cost-effective energy transformation of Europe's buildings].




The European Union faces the challenge of adapting the available built space to the new requirements, transforming buildings and urban spaces into more resilient, healthy and energy efficient ones. The refurbishment of the existing building stock is key to achieving circularity in the sector and should incorporate the principles of design for deconstruction and adaptability.
The energy rehabilitation of the building stock is one of the objectives to achieve a decarbonised Europe by 2050.

## Deconstruction

At the end-of-life stage of a construction or part of it, a large amount of raw materials are dismantled and demolished. In a circular economy these raw materials must be returned to earlier stages of the construction process.

**Selective demolition** or deconstruction[25] and separate collection of waste is essential for the return of materials to the value chain through reuse, recycling or energy recovery. To get the most out of the materials from a demolition, the extraction of these must be coordinated and careful. The classification and management of the materials once extracted is a complicated task and requires specific protocols and plans for each case. One of the most important aspects is to ensure that hazardous waste is not mixed with other waste. Therefore, in order to guide the sector in waste management, the European Union has published the following documents:

*Recovery of hydraulic tiles in a demolition.*
*Source: Rotordc www.rotordc.com*

25 Separate waste collection: is collection in which a waste stream is kept separate due to the type and nature of the waste, so that specific treatment is facilitated. Source: Directive 2008/98/EC on Waste (Waste Framework Directive), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098.

- "Guidelines for waste audits prior to demolition and renovation works of buildings"[26].
- "EU Construction and Demolition Waste Management Protocol"[27].

*Separation of waste on site. Source: Ihobe public company for environmental education. Ihobe manual for drafting and implementing a construction and demolition waste management plan and good trade practices. 2012*

Well managed waste becomes a valuable source of raw materials, while poorly managed waste loses its recovery potential and becomes a source of pollution.

For example, 80% of demolition waste is inert and is produced from raw materials from the extractive industry (cements, aggregates, ornamental rock, limes, silica sands, slates, clays, etc.). ). In order for these materials to become secondary raw materials after the demolition or deconstruction process, it must be ensured that they are separated so that they are not contaminated or mixed with other waste.

*Source: Circular economy in construction. Go green with Aarus. Sustainability Committee, City of Aarhus*

**The current EU Construction Products Regulation (CPR) requires construction products to be CE marked as a general rule. However, this is often not possible for reusable construction products. The European Commission is in the process of amending the CPR to facilitate the use of reused and recycled materials in the future.**

The following infographic published by the European Environment Agency shows examples of circular actions that improve the management of construction and demolition waste.

26 https://ec.europa.eu/growth/content/eu-construction-and-demolition-waste-protocol-0_en
27 https://ec.europa.eu/growth/content/eu-construction-and-demolition-waste-protocol-0_en

## High-grade products with high-recycled content

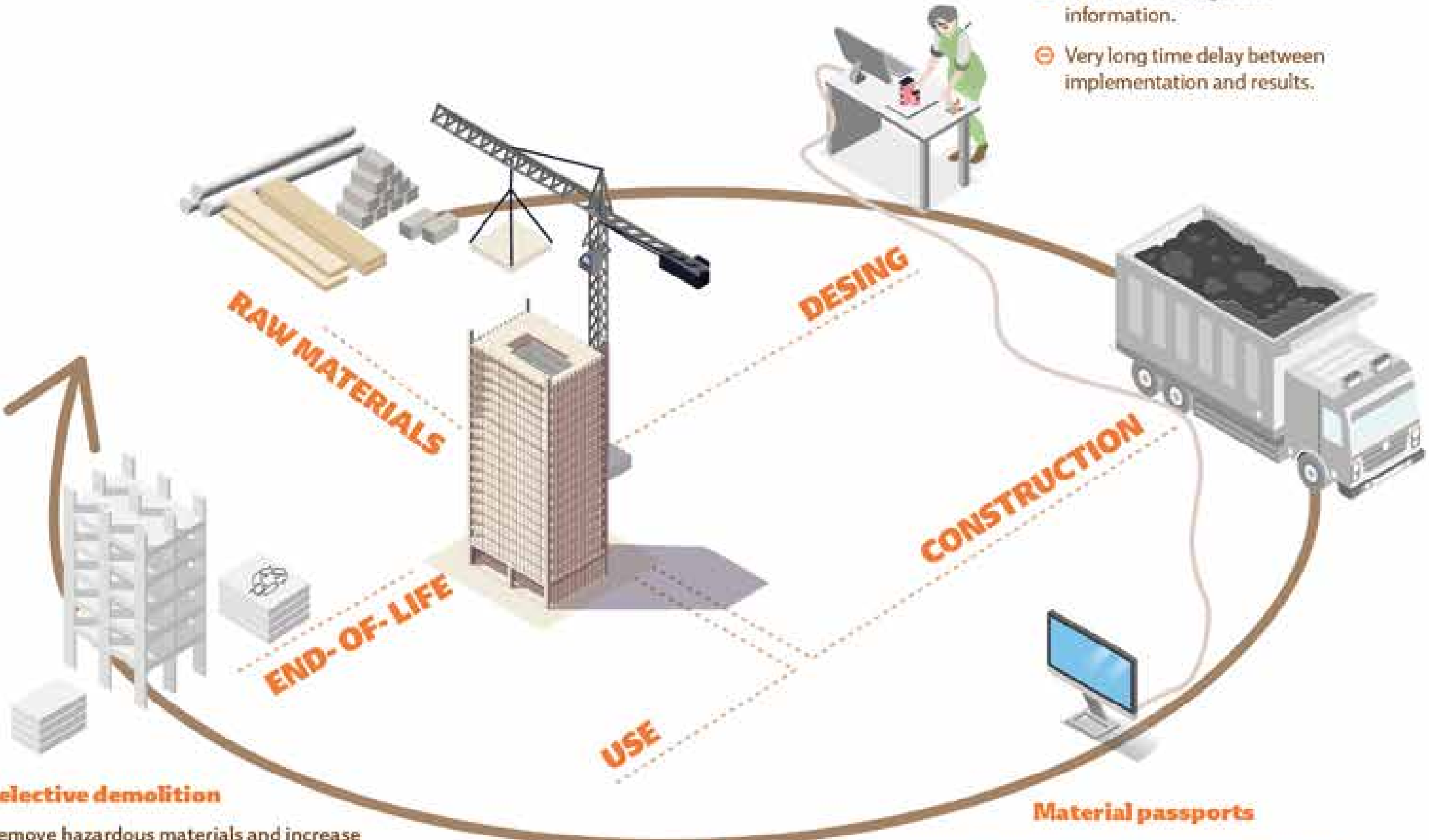
**Materials with high durability used in structural elements**

- ⊕ Prolong construction's life span, thus contribute to waste prevention.
- ⊕ Creates demand for recycled material
- ⊖ Low Price of virgin materials vs high cost of waste processing
- ⊖ Doubts on quality of recyclables, lack of standards

## Design for disassembly

**Design construction products so they are easy to separate into components that can be reused, reassembled, reconfigured, recycled**

- ⊕ Re-use is part of waste prevention, separation of components makes recycling easier.
- ⊖ Higher complexity of dissassembly.
- ⊖ Potential conflict with other legislation such as energy efficiency.
- ⊖ Lack of knwoledge and information.
- ⊖ Very long time delay between implementation and results.




## Selective demolition

**Remove hazardous materials and increase source separation into high value, pure material fractions.**

- ⊕ Increase quantity and quality of recycling.
- ⊖ More time consuming and potentially more costly demolition.
- ⊖ Lack of traceability (limited information on waste material origin.
- ⊖ Complexity of buildings and construction materials.

## Material passports

**Sets of data describing defined characteristics of materials and components in building products.**

- ⊕ Facilitate source separation of end-of-life materials, increases recycling quality and closed loops.
- ⊖ Facilitate source separation of end-of-life materials, increases recycling quality and closed loops.
- ⊖ Information and data management for long tiem periods.

## Expansion of construction service life

**Renovate, improve maintenance, upgrade, repair and adapt constructions.**

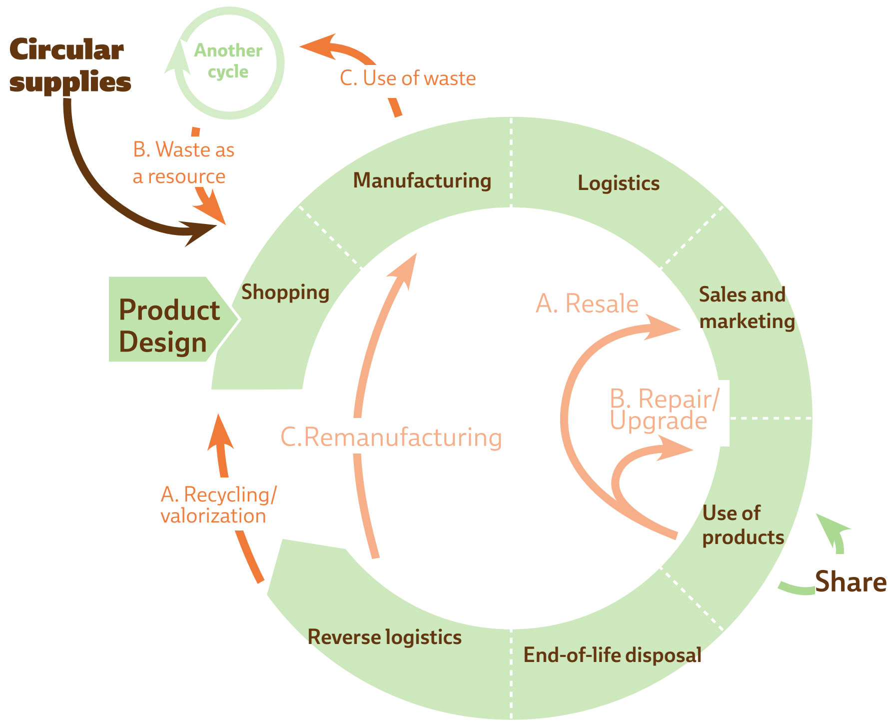
- ⊕ Implementation of waste prevention.
- ⊕ Avoidance of new construction and related envirnomental impacts.
- ⊖ Energy inefficient buildings also extend their life span.
- ⊖ Risk from the presence of inferior materials in buildings and degradation of structural building elements.
- ⊖ High labor costs.
- ⊖ Changes in architectural preferences.

*Source: European Environment Agency. INF 151. https://www.eea.europa.eu/media/infographics/examples-of-circular-actions-that/view*

## Business models

- Circular supplies: Use of renewable energy, biomass or recyclable materials instead of perishable resources.
- Resource recovery: Obtaining useful energy/resources from waste or waste products.
- Product Life Extension: Extending the life cycle of products and components through repair, upgrade and resale.
- Platform sharing: Increasing the level of product usage by sharing usage/access/ownership.
- Product as a service*: Access to products whose ownership is retained in order to internalize the benefits generated by the productivity of circular resources.

**Applicable to product flows at any point in the value chain*




*Source: adapted from Accenture*

Maersk (a logistics company) uses steel from its retired ships to build new ones. In order to do this, it produces a "material passport" for each part.

## Circular supply chain: recovery and recycling

This model is based on the use of recyclable materials, biomass or renewable energies. It has two business approaches:

- The company produces circular resources for itself. Products are produced wholly or partly from recyclable input materials.
- Companies develop and produce a circular product and/or resource to sell to others as input material for their production.

## Waste recovery

This model is based on obtaining resources from waste, through its recovery[28] .

A company can recover its own waste or that of other companies. The work ranges from preparation for reuse to processing.

**Gamle Mursten** (a construction company) buys bricks from demolition sites, sorts them, cleans them and reintroduces them to the market. The cleaning is carried out with a patented system using vibrations and without the use of chemicals and water. Once cleaned, the bricks undergo quality control. One of the main barriers to the use of reused building materials is that they are not CE marked. The company was the first in Europe to obtain a European Technical Assessment (ETA) in order to obtain CE marking for its bricks.

**Belgian company Rotor deconstruction** is a pioneer in the field of reclaimed building components. It dismantles, refurbishes and sells the materials, as well as helping building owners, contractors and architects to reuse them.

**Miniwiz** transforms waste into more than 1200 products that can be used for construction, interiors and consumer products.

In addition, to manufacture some of these products, they have designed a mobile recycling plant for plastic and fabric waste that can be moved with a trailer truck and is powered by solar energy.

More examples

## Product shelf life extension

This model is based on extending the useful life of products, components or even buildings by repairing, upgrading and reselling them, with the aim of maintaining or extending their economic value for as long as possible. In this case, design for disassembly and adaptability gives opportunities for a product to extend its useful life and to be able to adapt to functions other than its first use.

The extension of the Brummen Town Hall in the Netherlands is an example of a circular construction designed to be dismantled. Ninety per cent of its materials and components can be dismantled and reused or recycled. Contracts include agreements with organisations that recover glass and aluminium for recycling. In addition, after 20 years, structural timber and metals can be returned, under contract, to suppliers, unlocking a minimum of 20% of their residual value.

28 recovery" means any operation the primary result of which is that the waste serves a useful purpose by replacing other materials that would otherwise have been used to fulfil a particular function, or that the waste is prepared to fulfil that function, in the facility or in the economy at large. Source: Waste Framework Directive 2008/98/EC.

Building restoration and rehabilitation are included in this model.

### Shared platform

This model, closely related to the **collaborative economy**, consists of extending the use of products that a user does not use intensively, sharing them with other users. To do this, technological sharing platforms are used, for example, apps or social networks. The platforms connect buyers and sellers, to rent, share or lend construction products, tools, machinery or even buildings. The platform owner acts as an intermediary and revenue is generated by access to the platform or by the sale of management services linked to the activity carried out through the platform.

**Loop Rocks** is a platform that connects construction sites to each other, so that they can exchange materials such as earth or stone. The aim of this virtual marketplace is to match supply with demand, in order to achieve a more sustainable and efficient use of building materials.

In 2016, in Sweden and Denmark, 1.5 million tonnes of secondary building materials were connected through this platform.

**MatMap is** a Spanish digital platform for the purchase and sale of construction materials from demolition, construction site surplus, over industrial production and discontinued items. The company has a logistics management service that aims to redistribute products that are not used for reuse.

### Products as services

This model is a direct extension of the exchange platform model. In product-service or servitization systems, the user, instead of owning a product, pays for access to the service that a product provides. In this way the company that owns the product and provides the service, which may be the same manufacturer, has an interest in using higher level and quality products, which are easily repairable and upgradable, as this is included in the service they provide.

Like other companies, EGC is implementing the *"light as a service"* model, where it retains ownership of the luminaires and offers installation, maintenance and upgrade services for the duration of the contract. To this end, they are developing luminaires with replaceable parts that allow them to maintain 95% of the luminaire when it fails.

Kaer designs, installs and services air conditioning systems. The company uses data sensing and analysis combined with artificial intelligence technology to constantly adjust the system to optimize it automatically and in real time. This model ensures that the system runs more efficiently and reduces energy and operating costs.

# Unit 4. European circular economy policy

## European Green Deal

As a response to the current environmental crisis, in December 2019, the European Commission presented the "**Communication on the European Green Deal**"[29].

29 Communication from the Commission to the European parliament, the European Council, the Council, the European economic and social Committee and the Committee of the regions The European Green Deal COM/2019/640 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1588580774040&uri=CELEX:52019DC0640

The Green Deal is a roadmap for achieving a sustainable, carbon-neutral, competitive and resource-efficient economy. Its objectives are:

- reduce net greenhouse gas emissions to zero by 2050,
- decoupling economic growth from resource consumption by promoting the circular economy,
- improve the quality of life of Europeans,
- restore biodiversity and reduce pollution.

The Commission announced initiatives covering interconnected policy areas, including climate, environment, energy, transport, industry, agriculture and sustainable finance. It highlights the need for a **holistic approach** in actions and policies to achieve the agreed goals.

**New circular economy plan**

Among the initiatives of the "Green Deal" was included to promote a new "**New Action Plan for the Circular Economy", which was presented in March 2020 and aims to modernize the European economy, through a green and digital transformation**[30]. and whose objective is to modernize the European economy through a green and digital transformation. The Plan presents initiatives applicable throughout the life cycle of products, and proposes measures to achieve:

- **That the products marketed in the European Union are sustainable.** Legislation will be introduced to ensure that products are more durable, easily reusable, repairable, recyclable and incorporate secondary raw materials. Single-use products will be restricted.
- **That consumers receive information on the durability and repairability of the products they purchase**. They will be able to avail themselves of the right to repair.
- **Avoiding the production of waste**, and converting the waste produced into secondary raw materials.


*Virginijus Sinkevičius, EU Commissioner for the Environment, Oceans and Fisheries. [European Union, 2020 Source: EC - Audiovisual Service]*

30 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions a new Circular Economy Action Plan For a cleaner and more competitive Europe COM/2020/98 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN

The Plan focuses on the sectors that use the most resources and have the greatest potential for circularity, including packaging, electronics, plastics, construction and housing.

In the construction sector, the plan proposes a comprehensive strategy to achieve a sustainable built environment based on the principles of circularity. This strategy aims to achieve coherence between all areas of action: "*climate, energy and resource efficiency, construction and demolition waste management (CDW), accessibility, digitalisation and skills*"[31]. In addition, the plan promotes the application of the principles of circularity throughout the life cycle of the building and to this end proposes:

- Introduce in the Construction Products Regulation requirements on the content of secondary materials for certain products, considering their safety and functionality.

- To increase the durability, adaptability of buildings following principles of circularity in their design, and to elaborate digital building books.

- Integrate life cycle assessment into public procurement using the Level(s) tool. Consider setting carbon reduction targets, as well as investigating the potential for carbon storage in buildings.

- Review the targets set in EU legislation for CDW, for the recovery of materials and their specific material fractions.

- Reduce the area of soil sealing, rehabilitate abandoned or contaminated sites and promote the safe, sustainable and circular use of excavated soils.

## New renovation wave

In October 2020, the European Commission published its communication Renovation Wave.

Another initiative of the Green Deal, directly focused on buildings, is the so-called "Renovation Wave"[32], published in a communication from the European Commission in October 2020. This strategic document is an action plan which aims to **double the annual rate of energy renovation of the built environment by 2030, to promote** in-depth energy renovations, while making buildings healthier, greener, more accessible and resilient. The ultimate goals of this initiative are:

***(a)*** *'combating fuel poverty and improving the least efficient buildings';*

***(b)*** *'the renovation of public buildings, such as administrative, educational and health centres';*

***(c)*** *'decarbonisation of heating and cooling systems'.*

31 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. New Circular Economy Action Plan for a cleaner and more competitive Europe. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0098

32 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Renovation wave for Europe: greening our buildings, creating jobs, improving lives. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1603122220757&uri=CELEX%3A52020DC0662


*Source: EC. Audiovisual Service*

To this end, the EU has set a number of key actions, these are:

- Review and update regulations, standards and information on the energy performance of buildings to make them more stringent. Gradually introduce mandatory minimum energy efficiency standards for existing buildings.

- Provide enhanced, accessible, and targeted funding. Provide grants and loans to support projects.

- Help improve training to formulate and implement energy rehabilitation projects.

- Promote sustainable construction based on the circular economy. Encourage the development of industrialized solutions that limit the cost and duration of the works and that include sustainable materials of biological origin and materials that come from reuse and recycling. Review reuse and recycling targets and European legislation on the marketing of construction products from secondary materials.

- Supporting the digitization and modeling of building information.

- Develop a participatory approach at community and district level, enabling local communities to integrate digital and renewable solutions and become energy producers that can sell to the grid.

- To create a **new** European **Bauhaus**, an interdisciplinary and experimental project, where science, technology and art are mixed to promote innovation and sustainable design. That is to say, to unite sustainability with style, to obtain pioneering and innovative solutions that are attractive and affordable for citizens.

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