BUS GoCircular

Shaping a Circular Sustainable Future

Module 1

Circular Economy and its Implementation in the Design and Construction Sector

Circular Economy in the Construction Industry

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Circular Economy in the Construction Industry Summary

Through this module the learner will gain an understanding of what the Circular Economy is in a general sense and what the benefits and barriers are in order to implement this today. They will explore the current situation within Europe and internationally in relation to the Circular Economy and further explore how this relates to the construction industry. Finally the trainer will define Multi-functional Green Roofs Facades and Interiors Elements and explore what the opportunities are when pairing this with Circular Economy.

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Objectives/Learning Outcomes

The learning outcomes for BUS-goCircular can be found here on the https://busgocircular.eu/ website. These Units of Learning Outcomes (ULO's) relate to the circular economy and the implementation of circular skills in the construction industry.

In this module, trainees will gain an understanding of the Circular Economy and Multi-functional Green Roofs Facades and Interior Elements which will then be built upon in future modules.

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Module Content

- The Circular Economy and its Application in the Construction Sector
  - Introduction to the Circular Economy
  - Circular Economy in the Construction Sector
  - The Key Elements Framework
- Multi-functional Green Roofs Facades and Exterior Elements and the Circular Economy
  - Introduction to Multi-functional Green Roofs Facades and Exterior Elements
  - Types of Green Roofs
  - Benefits of Multi-functional Green Roofs Facades and Exterior Elements

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The Circular Economy and its Application in the Construction Sector

Presentation

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What is A Circular Economy? Overview

In our current economy, we take materials from the Earth, make products from them, and then they become waste. In a Circular Economy, we try to stop waste being produced.

The circular economy is based on three principles, driven by design:

- Eliminate waste and pollution
- Circulate products and materials (at their highest value)
- Regenerate nature

It is underpinned by a transition to renewable energy and materials. A circular economy decouples or brakes the link between economic activity and the consumption of finite resources. It is a resilient system that is good for business, people and the environment.

Source: https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

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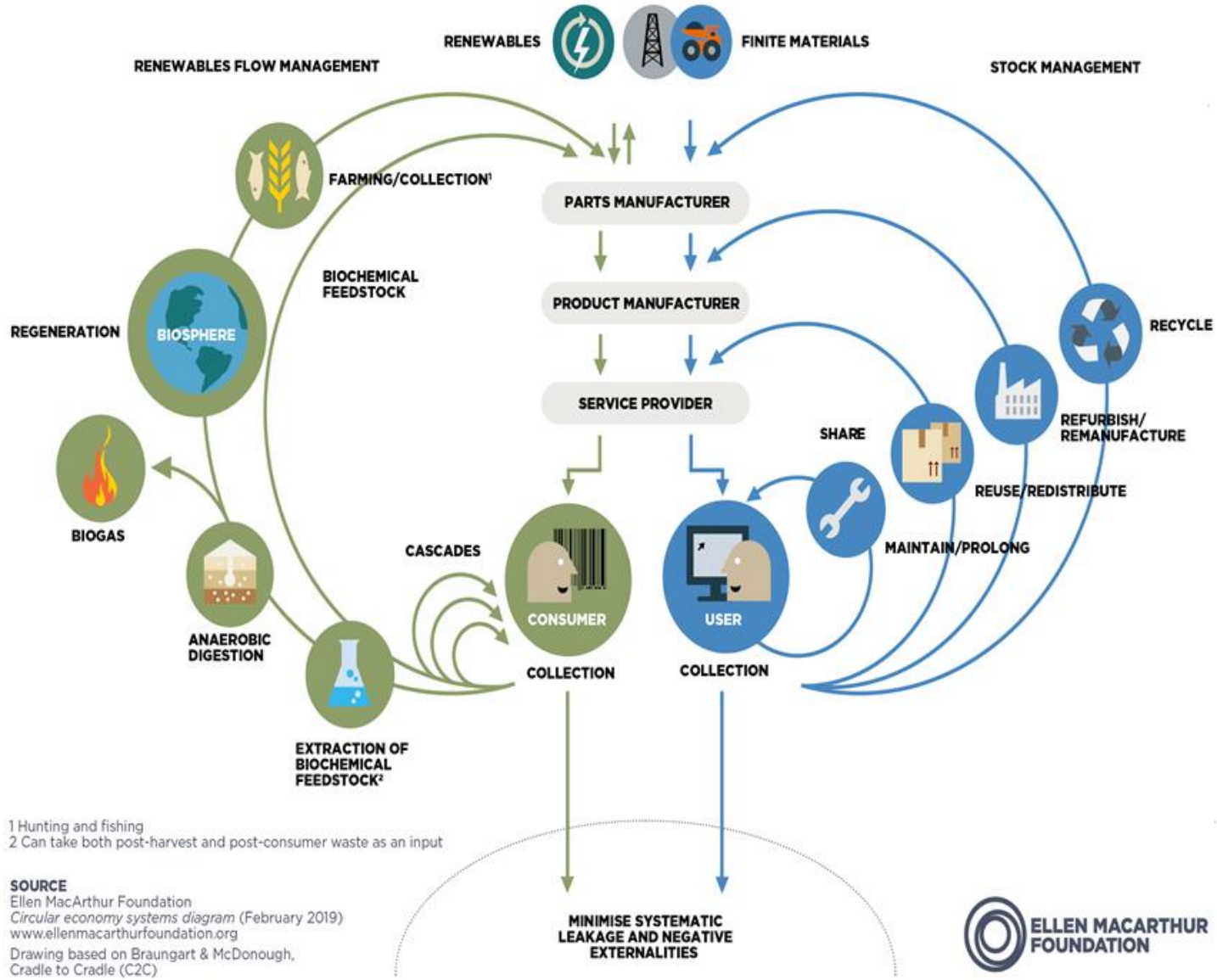

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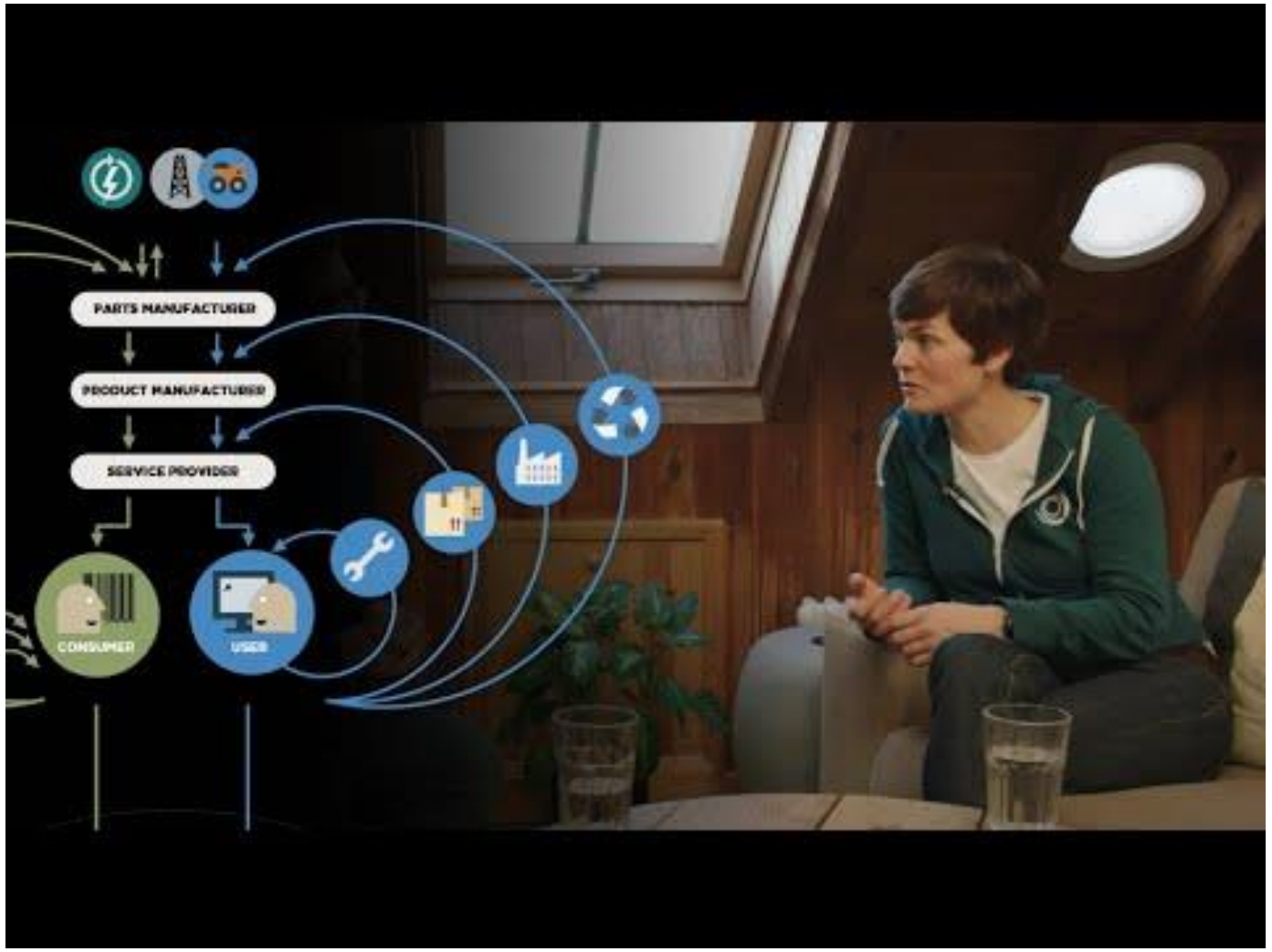
What is A Circular Economy?



Press play on video or go to - https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

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Why do we need a Circular Economy?

Climate change, the loss of biodiversity and the depletion of natural resources have provoked an unprecedented global crisis, leading to what some scientists consider to be a new geological era: the Anthropocene (The most recent period I human history).

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

Earth Overshoot Day marks the date when humanity has used all the biological resources that Earth regenerates during the entire year.

In 2022, Earth Overshoot Day fell on July 28. You can explore proposed solutions on their website.

Source: https://www.overshootday.org/

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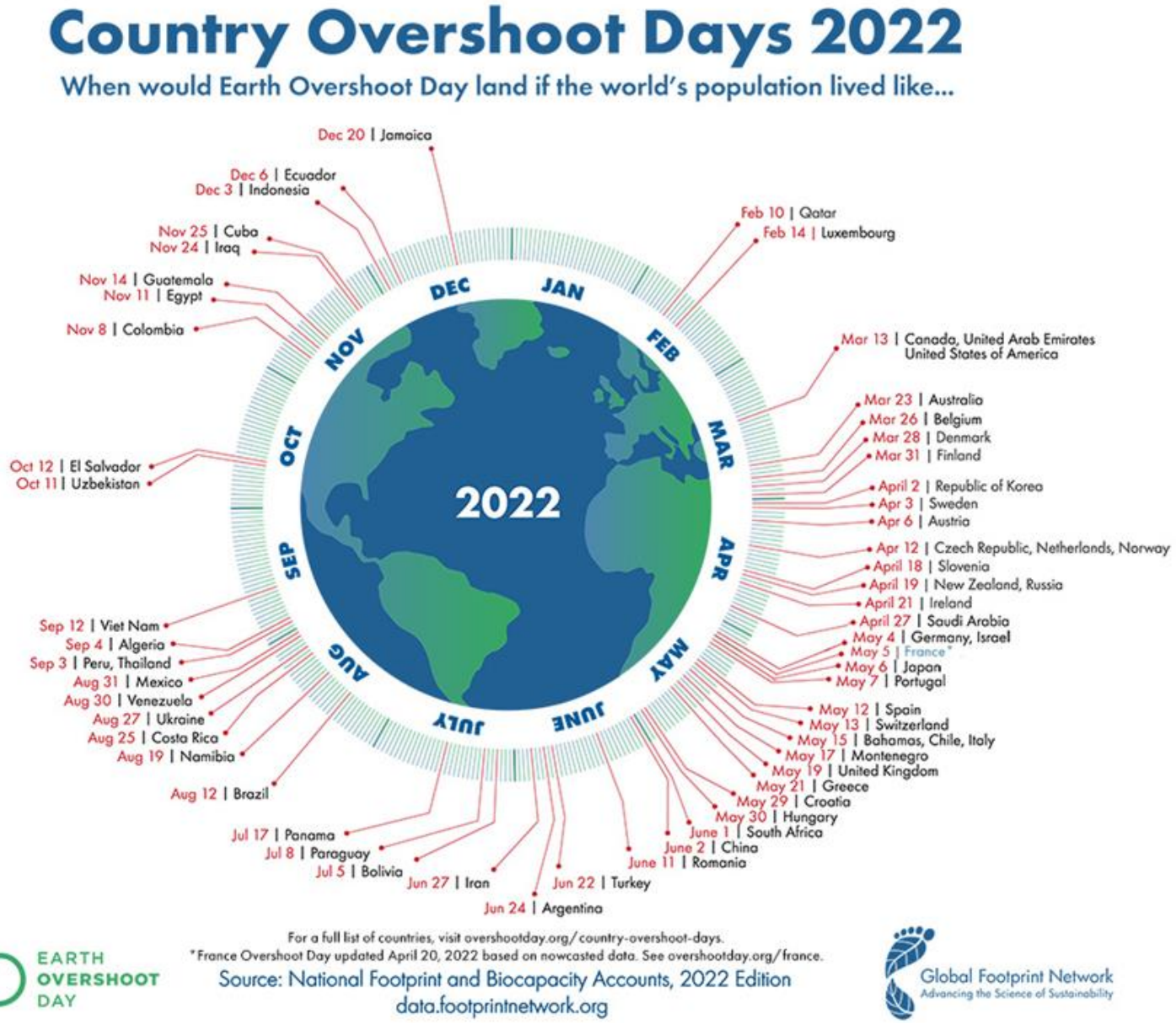

Source: https://www.overshootday.org/

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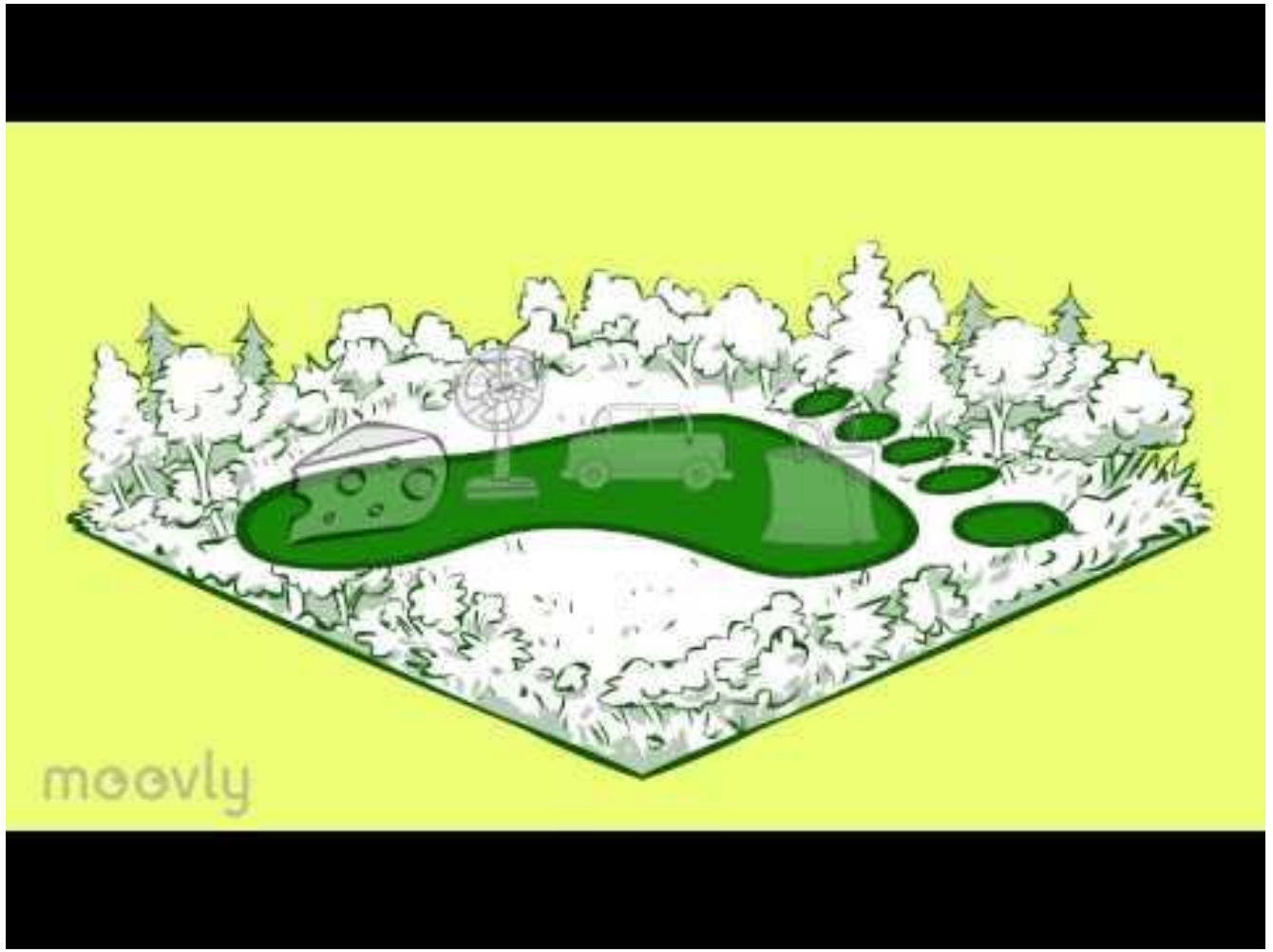
Our Ecological Footprint

Press play on video or go to - https://www.youtube.com/watch?v=fACkb2u1ULY



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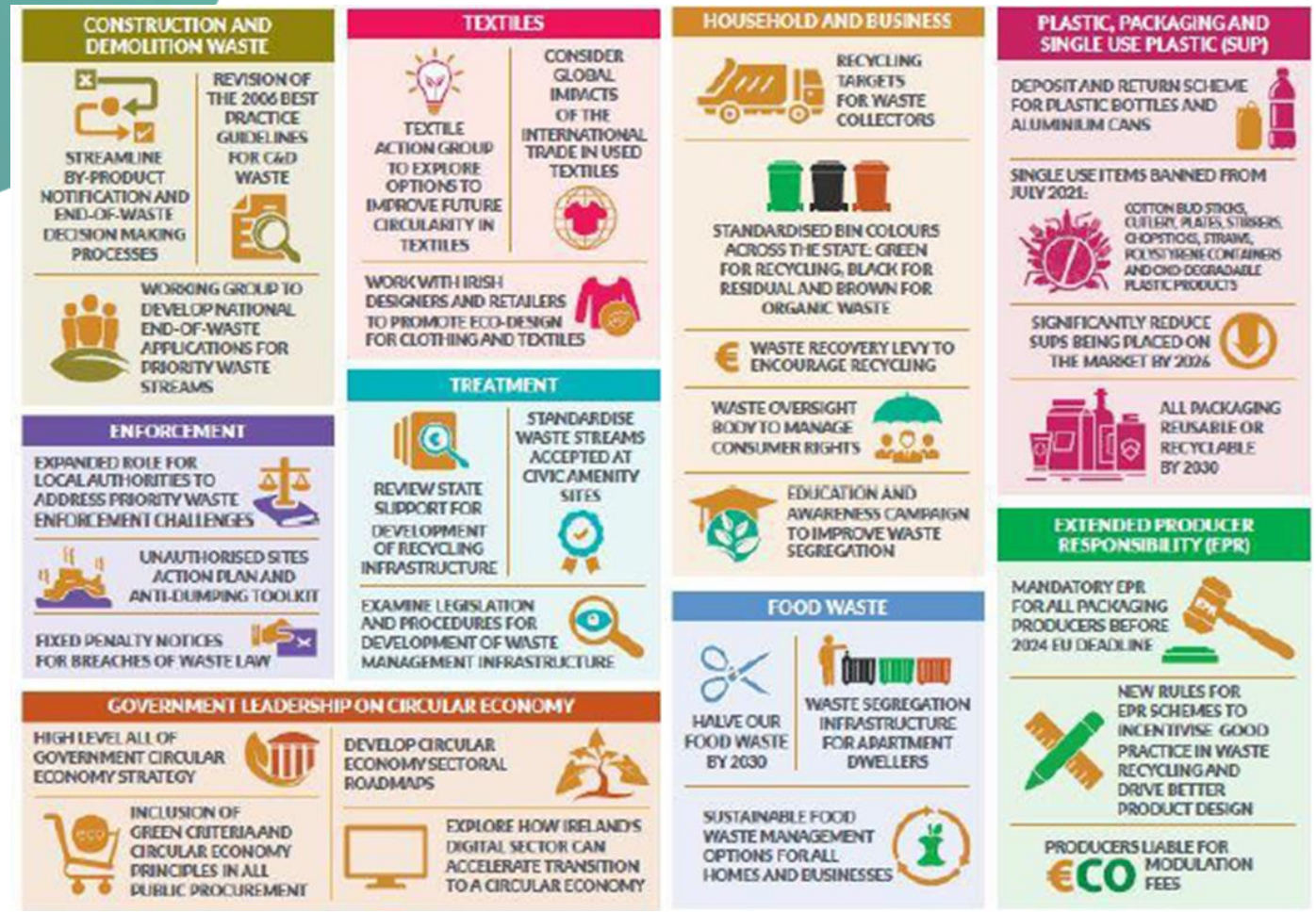
Waste and Recycling



Today, (2022) the global economy is only 8.6% circular

Source: https://gupp-class.eu/

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Linear Economy

Circular Economy application is still low which is caused, in 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 resources are inexhaustible.

This is the modern day consumer society!

So, what is Linear Economy?

Source: https://gupp-class.eu/

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Linear Economy

The linear model follows a source to grave approach where material is sourced, used to create products, distributed, consumed and then disposed of. This model means that the finite amount of materials we have on the planet are depleting, this poses a severe risk to our environment and

Source: https://uk.glasdon.com/images/news/linear-economy-graph.jpeg

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Linear Economy

The key learnings were that our current linear economy..

1. The ecological disadvantage of the linear economy is that the production of goods is at the expense of the productivity of our ecosystems. Excessive pressure on these ecosystems jeopardises the provision of essential ecosystem services, such as water, air and soil cleaning
2. Consumes 100 billion tonnes of material annually - a number which has tripled in the last 50 years
3. Emits almost 60 gigatonnes of greenhouse gas emissions - 70% of greenhouse gasses are directly linked to the extraction, handling, and consumption of materials. In other words, our out-of-control consumption patterns and systems are directly linked to the current climate crisis.
4. And of this 100 billion tonnes, only 7.2% is kept in the loop, 92.8% is wasted every year.

Source: Circle Economy and Michelini, Moraes et al., 2017

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The Current ‘Linear’ Economy . . .

Consumes

100 billion tonnes of materials annually

Tripled in the last 50 years

Emits over

59.1 Gt of GHGs

Expected to hit 80 Gt by 2032

Is only

7.2% circular

Wasting 92.8% of everything we use

Source: Circle Economy

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Circular Economy

The circular economy, as a model of production and consumption, is a more sustainable alternative to the linear economy.

The objective of the circular economy is to achieve more efficient and resilient production and consumption systems, that minimize the use of natural resources and preserve the ones they use within continuous cycles, maintaining or improving their value.

The Circular Economy requires a new approach in the following areas:

- the design of products and services
- management and market models
- how to convert and reuse waste into resources
- national regulations
- the commitment of citizens to change their consumption habits

Source: https://gupp-\class.eu/

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A Circular Economy Changes the Way we Produce and Consume Materials

Enabling us to...

1 prevent climate breakdown

2 future-proof businesses

3 create decent and more sustainable jobs

Source: Circle Economy

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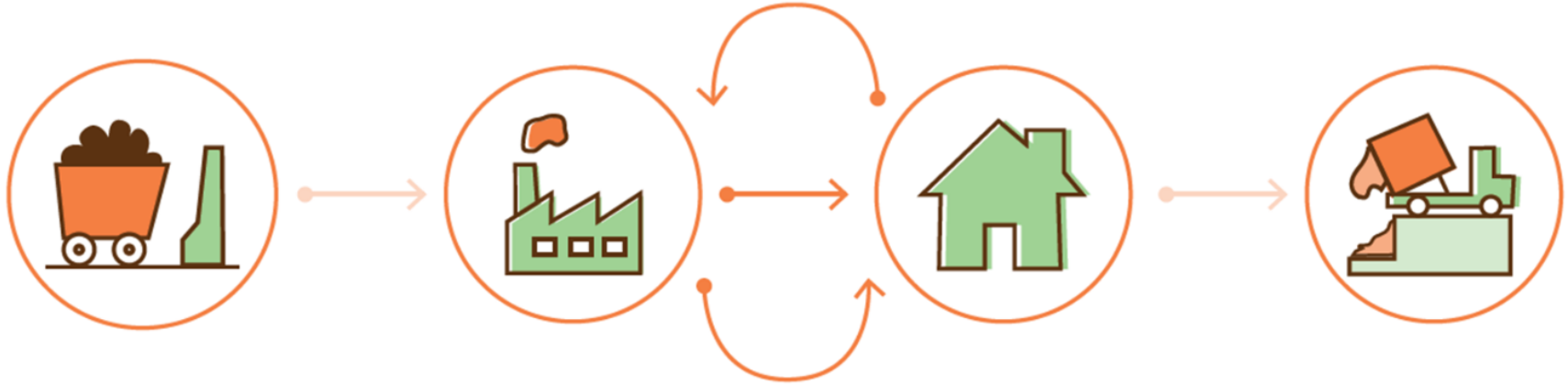
Decarbonizing Europe

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.



Source: GBCE. Circular economy in building.2021

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Type of resources

- Materials
  - including metals, minerals, concrete and wood (timber) used in construction;
- Energy (embodied) and related GHG emissions
  - this is energy used linked to the extraction of materials, manufacturing of construction products, the construction phase itself, construction and demolition, but not energy used directly during the use-phase (see below);
- Water
  - this relates to the full cycle but primarily to water use in buildings. However, quantifications of embodied water have been excluded after thorough investigation of existing literature due to a high level of uncertainty with the figures;
- Land
  - with land we understand direct use of land (land take);
- Biodiversity impacts.

Source: https://ec.europa.eu/environment/eussd/pdf/Resource%20efficiency%20in%20the%20building%20sector.pdf

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9 Rs of Circular Economy

Refuse, Rethink and Reduce (R0 – R2)

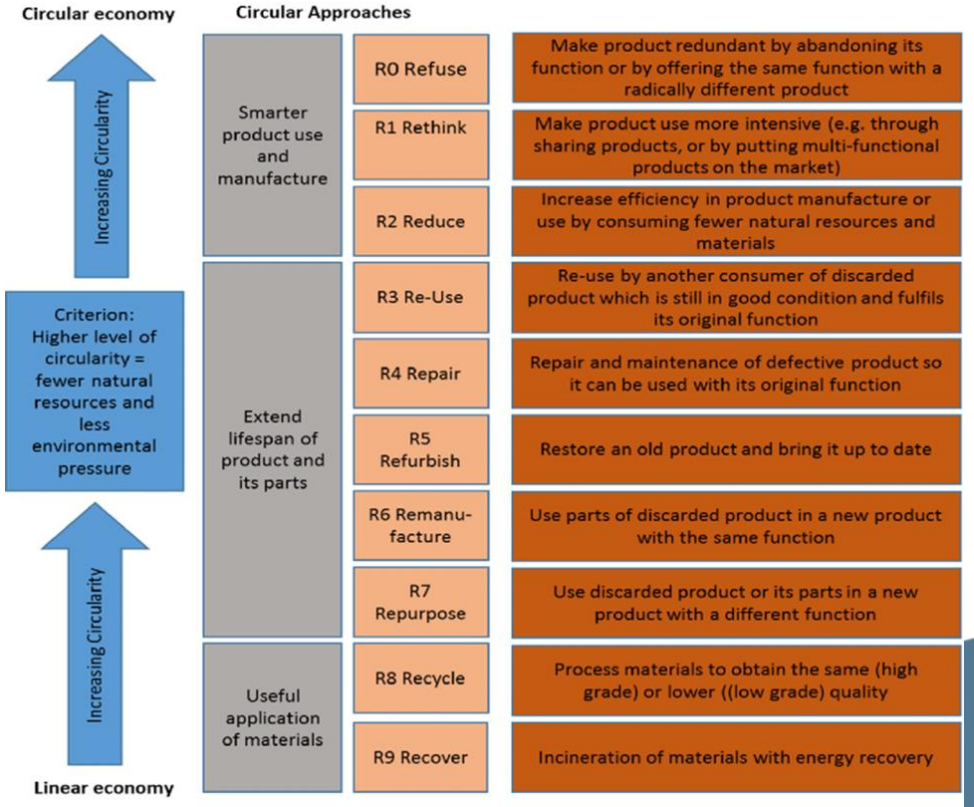
- Eliminating waste at the design stage. E.g. designing for disassembly.

Reuse, Repair, Refurbish, Remanufacture, and Repurpose (R3 – R7)

- Extending the lifespan of materials in a building. E.g. reuse of windows

Recycle and Recovery (R8 – R9)

- Applied to building products labelled ‘waste’ by the industry, requiring technical equipment and energy inputs to create a new value. E.g. recycling concrete by crushing it into rubble for road base



*Source:*https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.researchgate.net%2Ffigure%2FThe-9R-Framework-of-Circular-Approaches-with-the-production-chain-in-order-of-priority_fig5_328662037&psig=AOvVaw1lQiCR9uJDlwfx1lWLyUUG&ust=1670320537396000&source=images&cd=vfe&ved=0CBAQjRxqFwoTCPCF9Iab4vsCFQAAAAAdAAAAABAE

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For a circular economy there are 3 principles of action which apply to the building sector

1. **Avoiding the generation of waste and pollution by design**
2. **Keep products and materials in use for as long as possible**
3. **Regenerate natural capital**

Source:https://southernwasteregion.ie/sites/default/files/Circular%20Economy%20Checklist%20Construction%20Designers.pdf

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For a circular economy there are 3 principles of action which apply to the building sector

1. **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

Source:https://southernwasteregion.ie/sites/default/files/Circular%20Economy%20Checklist%20Construction%20Designers.pdf

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For a circular economy there are 3 principles of action which apply to the building sector

1. **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 and recycling... Energy recovery should always be the last option and landfill is not envisaged in the framework of Circular Economy.

Source:https://southernwasteregion.ie/sites/default/files/Circular%20Economy%20Checklist%20Construction%20Designers.pdf

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For a circular economy there are 3 principles of action which apply to the building sector

1. **Regenerate natural capital**

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.

Source:https://southernwasteregion.ie/sites/default/files/Circular%20Economy%20Checklist%20Construction%20Designers.pdf

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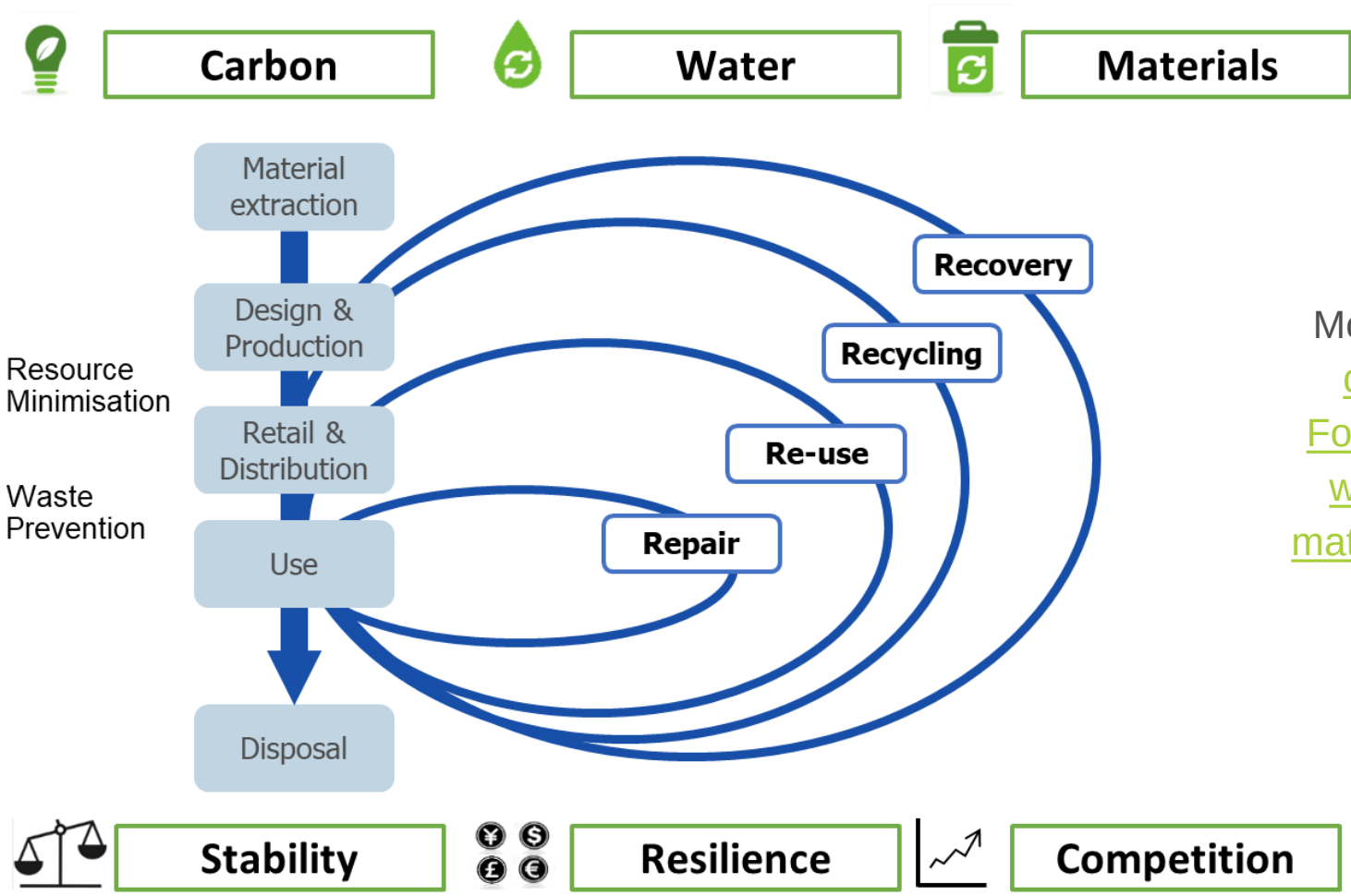

More Information: The more detailed Ellen MacArthur Foundation butterfly diagram with nutrient and technical material flows can be found by clicking this link

Source: https://gupp-\class.eu/

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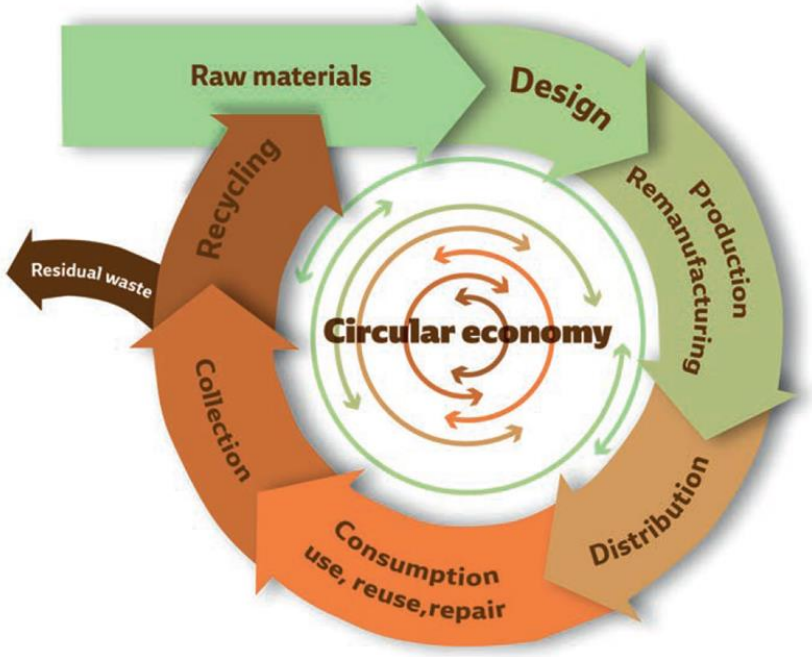
Circular Economy in the building industry

Not only does Circular Economy provide environmental benefits, it also boosts competitiveness and employment generation, with the creation of new business opportunities and innovation in products and services.

Key to achieving circularity is implementing digitalization and new technologies.



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

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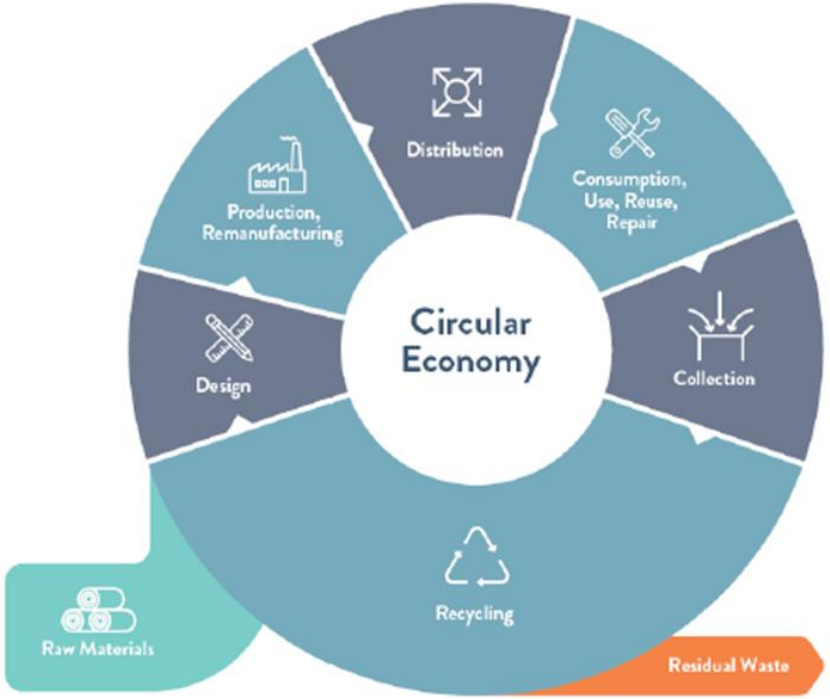
Impacts

Raw material extraction and material processing is responsible for 90% of biodiversity loss and water stress.

We need to make sustainable products, services and business models the norm and transform consumption patterns so that no waste is produced in the first place.



Source:https://www.un.org/en/actnow/facts-and-figures#:~:text=The%20extraction%20and%20processing%20of,keep%20up%20with%20our%20demands.

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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.

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The Challenge

The need for a Circular Built Environment

Construction materials are the biggest portion of the volume of materials consumed in most cities.

Despite high demands for concrete, steel, bricks and wood only 13% of these input materials originate from secondary and renewable sources.

Moreover, buildings generate nearly 40% of annual global CO2 emissions.

Source: Circle Economy

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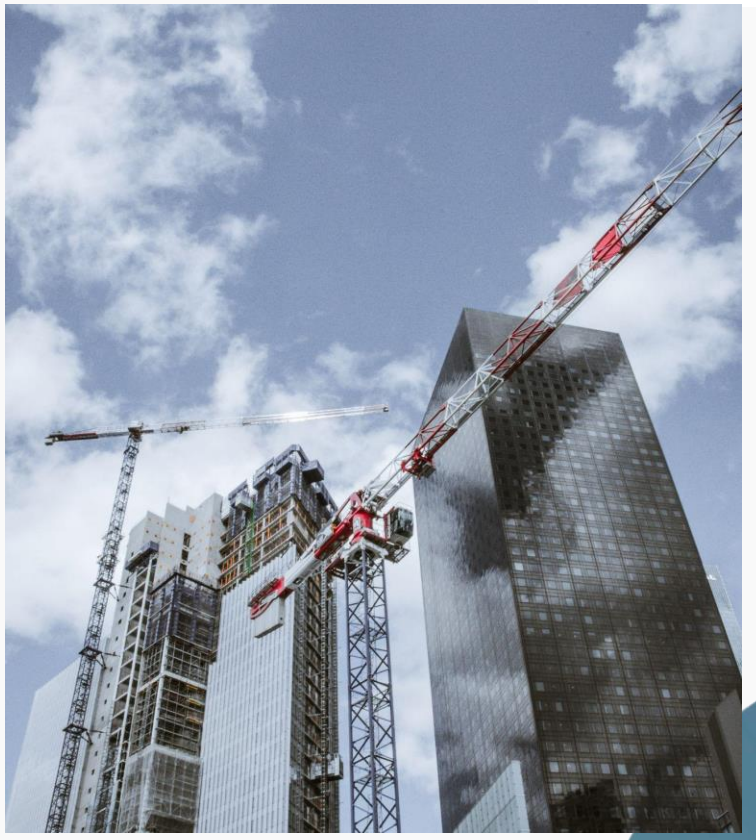
Why Care?

Why do we currently continue to mine, produce, and transport all materials from mines around the world, when there are abundant sources throughout the city to cover part of this demand?

However the most important barrier to tackle is the lack of information on what recoverable materials are present and what their value in reuse could be.



Source: Circle Economy

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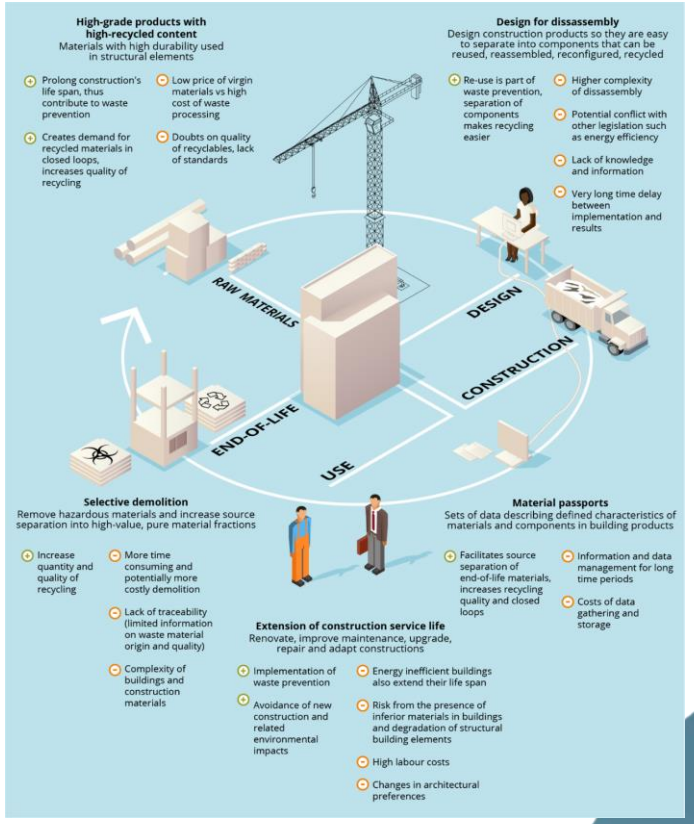
What Needs to Happen?
From current state to ideal state

Against a backdrop of bold ambitions and an increasing number of policies focused on the sector

- Real on-the-ground action is limited and scattered
- Collaboration is not happening at scale
- Investments are lacking and demand needs to increase

In short, we need a holistic strategy that aims at:

- Increasing awareness and scaling of the available opportunities
- Increasing knowledge exchange and collaboration
- Strengthening demand and investment in available solutions



Source: Circle Economy

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Circular Economy in the Construction Sector

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.

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.

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.

Source: https://gupp-\class.eu/

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

Source: https://gupp-\class.eu/

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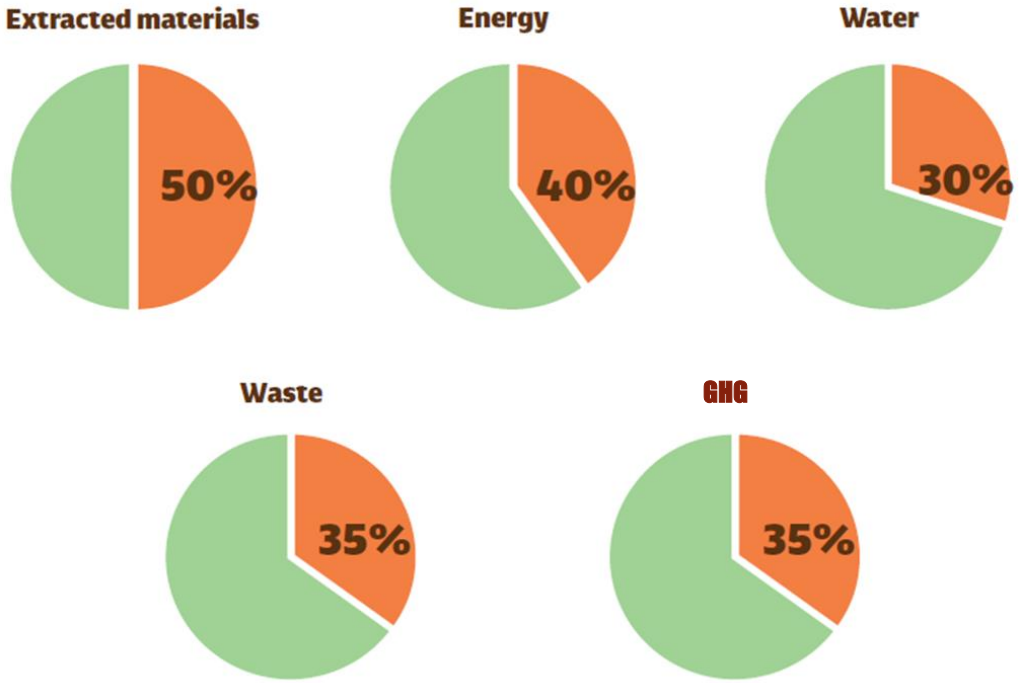
Impact

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]

Source: https://gupp-\class.eu/

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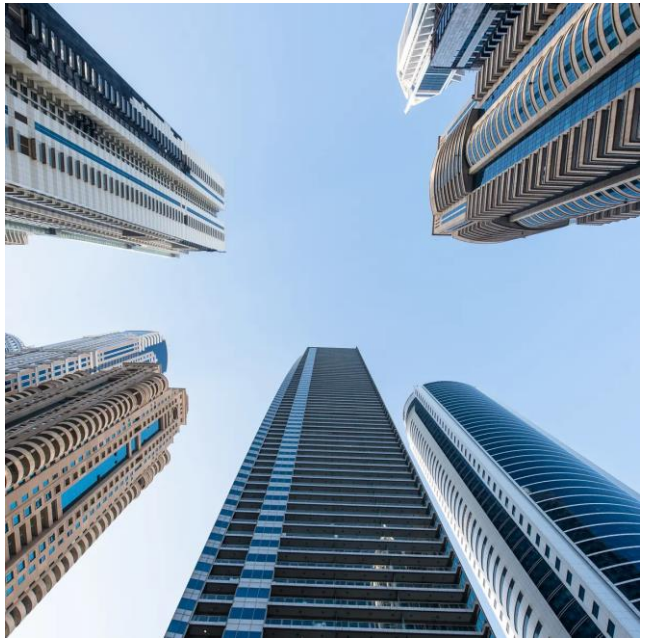
Climate Change and Building Stock

- In 2010, the world's buildings accounted for 32% of global final energy use amd 19% of all greenhouse gas (GHG) emissions.
- If we continue as usual the projections for use of energy in buildings globally could double or even triple by 2050.
- Even if emissions are immediately stopped, temperatures will remain elevated for centuries to come, due to the effect of greenhouse gases in the atmosphere from previous human impact.



Source: Google image search

Source: Fit-to-NZEB: Ecology & Sustainability

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Climate Change and Building Stock

- Limiting the rise in temperature will require substantial and sustained reductions of greenhouse gas emissions.
- Buildings face major risk of damage from the projected impacts of climate change, having already experienced a big increase in extreme weather damage in recent decades. There is likely to be significant regional variation in the intensity and nature of such impact.

Source: Fit-to-NZEB: Ecology & Sustainability

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Life Cycle

The standard EN 15798:2011 (sustainability of construction works) establishes, in a generic way, the stages of the life cycle of construction.

The four stages are:

1. Product Stage
2. Construction Stage
3. Use Stage
4. End-of-Life Stage

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.

Source: https://gupp-\class.eu/

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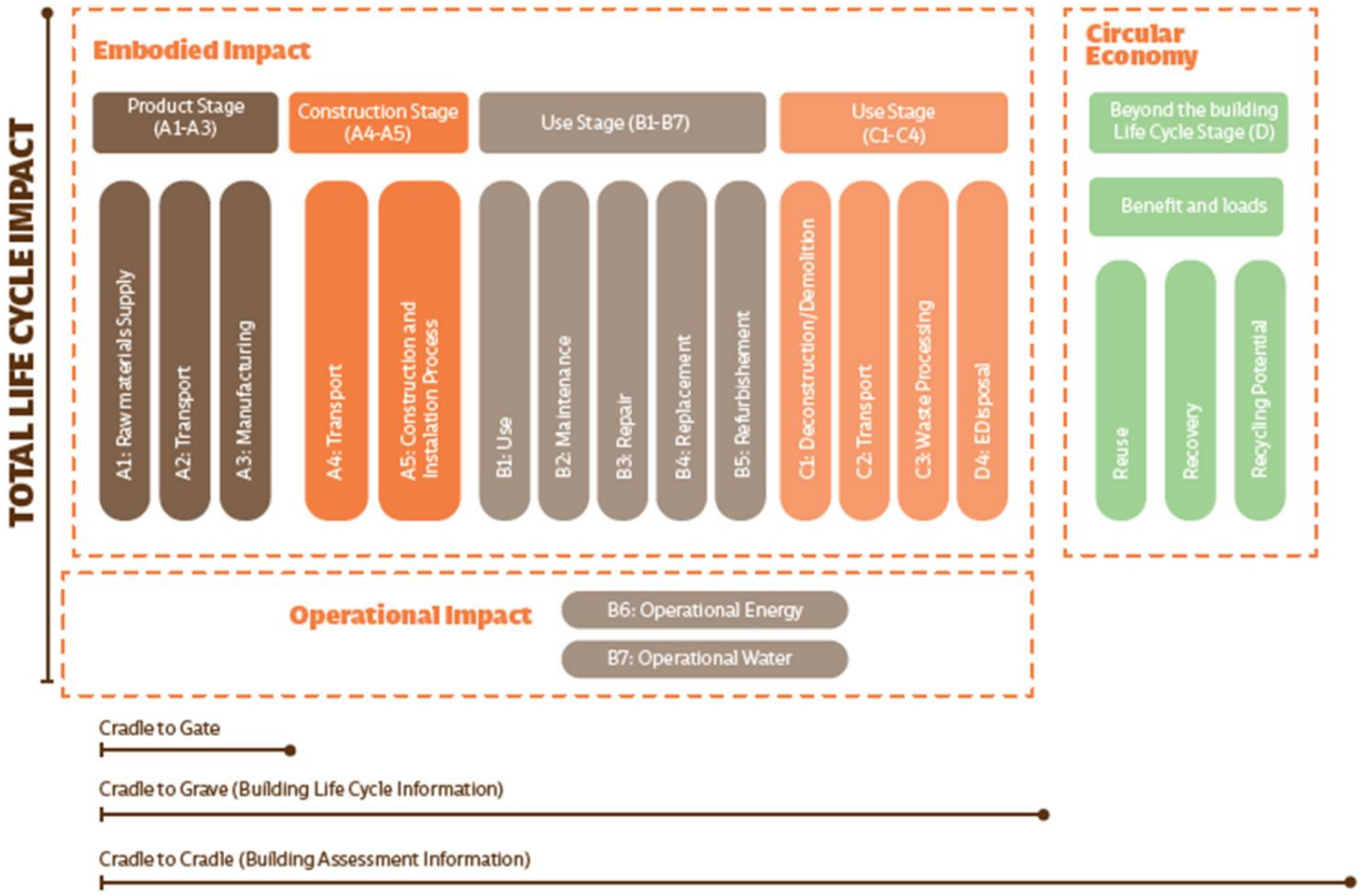

Source: https://gupp-\class.eu/

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Production Stage

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.
For example, cement manufacturing generates approximately 8% of the world's CO2 emissions. Sixty % of these emissions are due to chemical reactions during the process.

Cement factory
Source: Green Growth Project

Source: https://gupp-\class.eu/

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Construction Stage

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,.

Image source: Google images

Source: https://gupp-\class.eu/

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Use Stage

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 energy, and the emission of pollutant gases as a consequence of the consumption of energy from fossil fuels. The construction of energy efficient buildings 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 near-zero energy buildings (NZEB).
At this stage, circular strategies such as repair and refurbishment extend the life of the building.

Image source: Google images

Source: https://gupp-\class.eu/

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End-of-life (Deconstruction) Stage

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.

Image source: Google images

Source: https://gupp-\class.eu/

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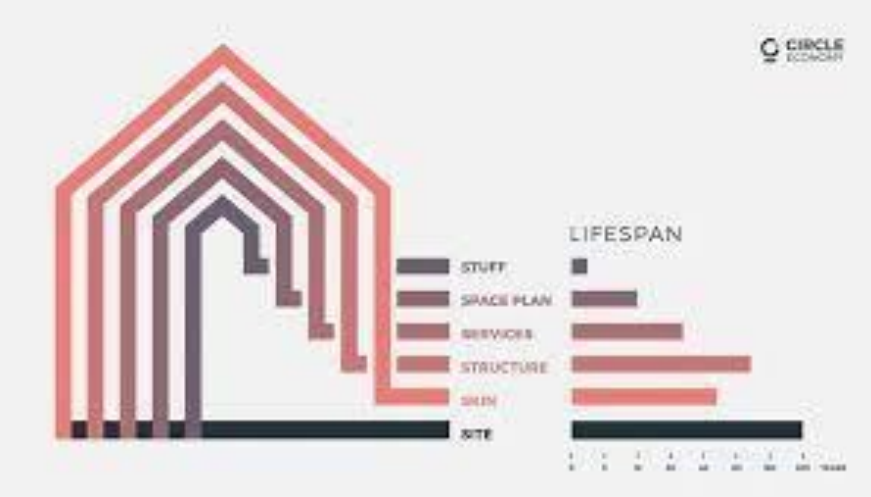
Building in layers

One technique to help envisage how to do this is to think of your project in layers and within each layer there are different opportunities:

- The site should be reused continuously.
- The structure should last as long as possible.
- The skin and services should be accessible and replaceable.
- The space plan should be flexible and adaptable.
- The stuff should be durable and reusable.



Source-https://www.circle-economy.com/resources/new-financing-needed-to-accelerate-circular-built-environment

Source: https://drive.google.com/file/d/1kO6DhVUIsmICevjrKGoDLfrQTWUIjuXd/view

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Tools to measure circularity in construction

"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 buildings and materials, and others to monitor the circular economy in the construction sector, these are:

1. Life Cycle Assessment (LCA)
2. Environmental Product Declarations (EPDs)
3. Level(s)
4. Material Passports
5. Cradle to Cradle Certification

Source: Green Growth Project

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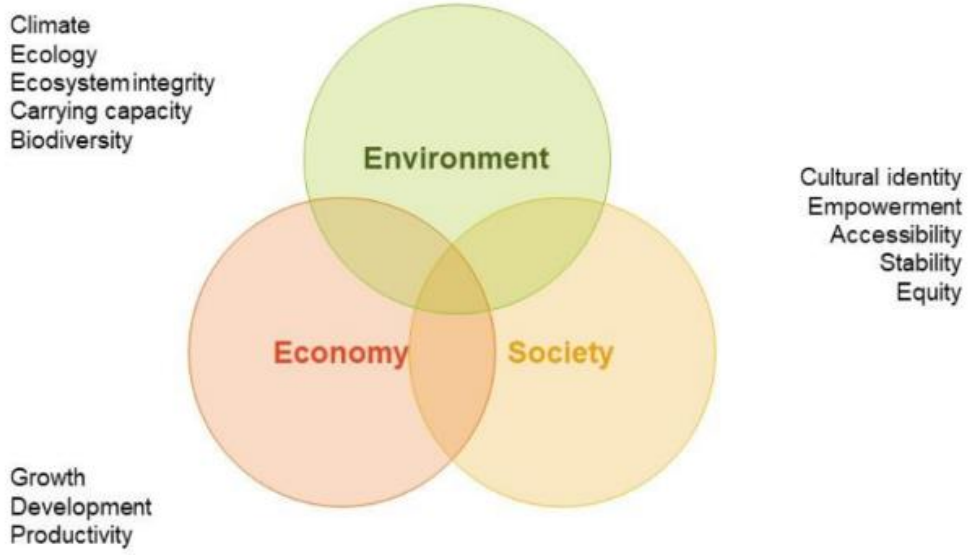
National & International Building Codes

1. “[A]green economy [is] one that results in improved human well-being and social equality, while significantly reducing environmental risks and ecological scarcities”, Green Jobs Report (UNEP,2008) and the Green Economics Report (UNEP, 2011a).
2. No country is the pan-European region has yet produced an assessment specifically focused on the green economy. Nonetheless, many countries are developing broad strategies for greening the economy, or have undertaken sectoral or topic-based assessments.
3. UN Environment Green Economy Initiates (GEI), a programme of global research and country-level assistance designed to motivate policymakers to support environmental investments.



Source: https://gupp-\class.eu/

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101033740

Targets and Reporting

Establishing targets and reporting structures to help achieve the client vision needs to be mandated through the procurement process in a relevant and proportionate manner. To do this, clients should embed the requirements into project-specific briefs/statements, and in the design team and contractor tendering process i.e. Pre-Qualification Questionnaire (PQQ) and Invitation to Tender (ITT) and the main construction contract (general conditions).

Source-https://www.metabolic.nl/wp-content/uploads/2019/02/roadmap_circular_land_tendering.pdf

Source: https://southernwasteregion.ie/content/circular-economy-checklists-construction

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Targets and Reporting

Planned actions, metrics and targeted outcomes should be communicated between the client and contractor and passed down through the supply chain (including design and consultancy teams, sub-contractors, waste management contractors and material suppliers) and across all project phases – from option identification and preliminary/outline design through to project completion and whole-life management.

Taking this approach gives a legal standing to the targets and will create binding key performance indicators that gives the client recourse should these targets not be met. A robust monitoring and reporting process will be needed to follow progress and achievements against the targets and reported at key stages within the project.

Source: https://southernwasteregion.ie/content/circular-economy-checklists-construction

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Further reading

Irish Green Building Council (IGBC) - Towards a circular economy in construction: Assessing low carbon, healthy, responsible products for the construction sector

https://www.igbc.ie/wp-content/uploads/2018/06/IGBC-Report-Web-Final-21.06.18.pdf

UK Green Building Council (UKGBC) - Circular economy guidance for construction clients: How to practically apply circular economy principles at the project brief stage

https://www.ukgbc.org/ukgbc-work/circular-economy-guidance-for-construction-clients-how-to-practically-apply-circular-economy-principles-at-the-project-brief-stage/

Circular Economy Implementation Packs for Products as a Service and Reuse

https://www.ukgbc.org/ukgbc-work/circular-economy-implementation-packs/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Further reading

Zero Waste Scotland - Construction Resources For a Circular Economy Procuring resource efficient construction projects

https://zerowastescotland.org.uk/content/procuring-resource-efficient-construction-projects

ARUP - Circular Economy in the Built Environment

https://www.arup.com/perspectives/publications/research/section/circular-economy-in-the-built-environment

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Key Elements

The Key Elements framework is a conceptual framework of eight elements of circularity that can be applied at different intervention levels (for example, national, regional, sector, business, product, process, or material) towards a circular economy.

The KE framework consists of three core elements and five enabling elements. Core elements deal with physical flows directly, whilst enabling elements deal with creating the conditions or removing barriers, for a circular transition.

Source:https://www.circle-economy.com/resources/the-key-elements-of-the-circular-economy-framework#:~:text=WHAT%20IS%20IT%3F,material)%20towards%20a%20circular%20economy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Core Elements

Prioritise Regenerative Resources

Stretch the Lifetime

Use Waste as a Resource

*Source:*https://www.circle-economy.com/resources/the-key-elements-of-the-circular-economy-framework#:~:text=WHAT%20IS%20IT%3F,material)%20towards%20a%20circular%20economy.

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PRIORITISE REGENERATIVE RESOURCES

Ensure renewable, reusable, non-toxic resources are utilised as materials and energy in an efficient way.

Keywords:

alternative bio-based materials ◦ reusable materials ◦ non-toxic materials ◦ non-critical materials ◦ material efficiency ◦ alternative water use ◦ water efficiency ◦ renewable energy ◦ energy efficiency electrification ◦ recyclable materials

Example on water efficiency:

Berlin (Germany) is becoming a sponge city, simply put, it promotes natural measures that allow the water system of the city to operate more naturally through green infrastructure projects. .

Find out more!

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STRETCH THE LIFETIME

Maintain, repair and upgrade resources in use to maximise their lifetime and give them a second life through take-back strategies, where applicable.

Keywords:

upgradeability ◦ maintenance & (self) repair ◦ take-back systems ◦ secondary materials ◦ adaptive reuse ◦ refurbishment ◦ remanufacturing ◦ part or component recovery ◦ preservation & conservation

Example on adaptive reuse:

Four immense disused gasometers in Vienna were successfully revamped into apartment blocks and commercial space as the structures were too beautiful to be demolished.

Find out more!

amme under grant agreement No 101033740

USE WASTE AS A RESOURCE

Utilise waste streams as a source of secondary resources and recover waste for reuse and recycling.

Keywords:

reuse ◦ repurposing into new products ◦ using already recycled materials ◦ recovery and reuse of waste energy ◦ mechanical recycling ◦ chemical recycling ◦ open loop ◦ closed loop

Example on reuse:

The Resource Rows is using upcycled bricks and waste wood, a recycled concrete beam used as a bridge and old windows and waste wood as rooftop community gardens huts with an atmosphere of allotment gardens.
Find out more!

mme under grant agreement No 101033740

Enabling Elements

Design for the Future

Rethink the Business Model

Incorporate Digital Technology

Team Up to Create Joint Value

Strengthen and Advance Knowledge

*Source:*https://www.circle-economy.com/resources/the-key-elements-of-the-circular-economy-framework#:~:text=WHAT%20IS%20IT%3F,material)%20towards%20a%20circular%20economy.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

DESIGN FOR THE FUTURE

CIRCLE ECONOMY

Adopt a systemic perspective during the design process, to employ the right materials for appropriate lifetime and extended future use and optimal recovery..

Keywords:

modularity ◦ dis- & reassembly ◦ reuse ◦ physical durability ◦ standardization & compatibility ◦ maintenance & repair ◦ adaptability & upgradability ◦ material recycling ◦ biodegradability ◦ mono-materials ◦ emotional durability ◦ design for reverse systems

Example on design for disassembly:

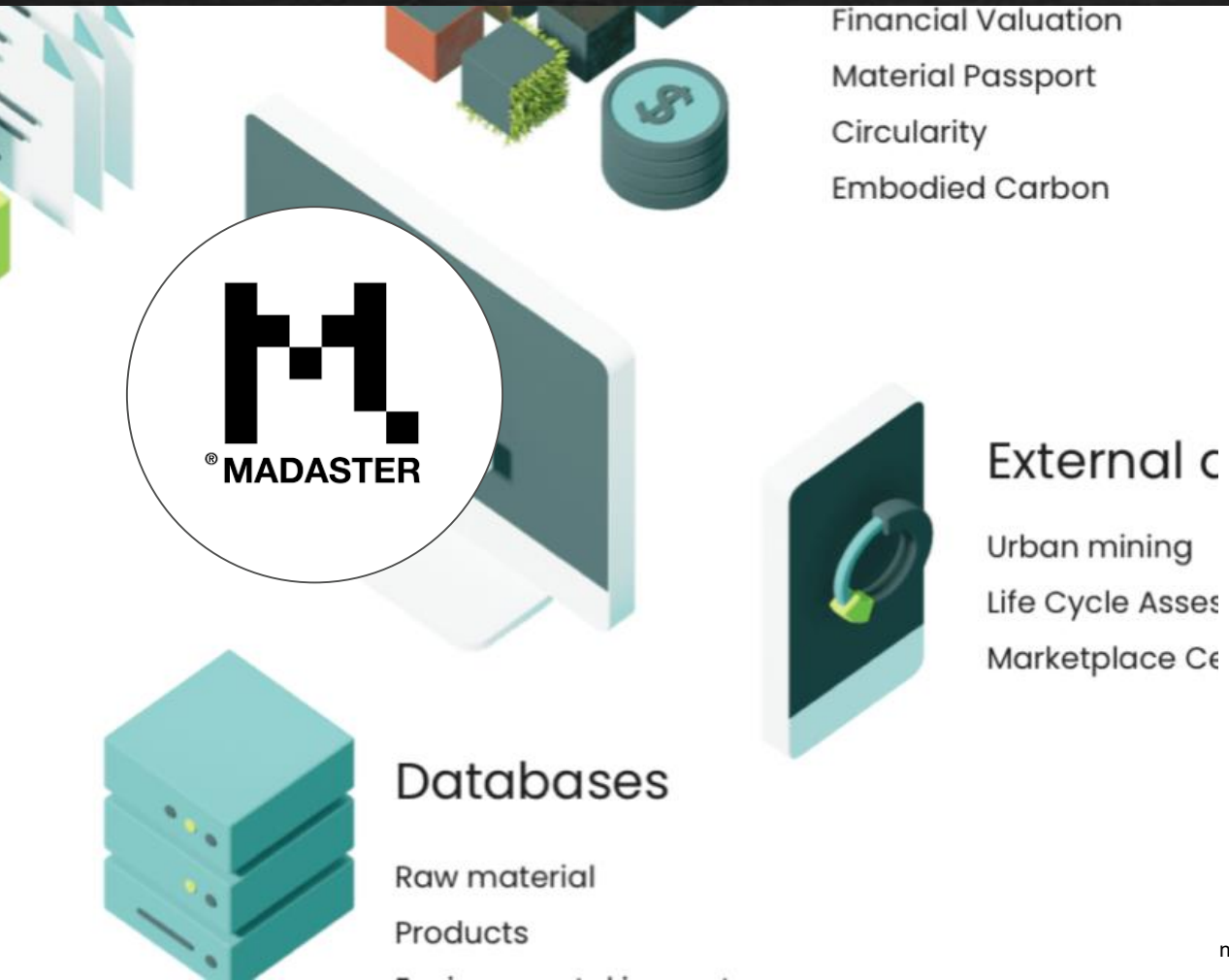
The temporary courthouse building has been designed with a well adaptable configuration of parts that can be easily assembled and disassembled , to render the structure as customizable and circular as possible.

Find out more!

amme under grant agreement No 101033740

INCORPORATE DIGITAL TECHNOLOGIES

Track and optimise resource use and strengthen connections between supply-chain actors through digital, online platforms and technologies.



Keywords:

data analytics ◦ data modelling ◦ internet enabled, connected operations ◦ sensors, monitoring systems ◦ additive manufacturing ◦ artificial intelligence ◦ online platforms ◦ peer-to-peer online marketplaces ◦ Material passports

Example on material passport:

Madaster is the online library of information on materials and products that provides insight into the materials and products used and their location, as well as their impact on circularity and the environment.

Find out more!

nnovation programme under grant agreement No 101033740

RETHINK THE BUSINESS MODEL

Consider opportunities to create greater value and align incentives through business models that build on the interaction between products and services.

Keywords:

sale of durable, long-lasting goods ◦ sale of exchangeable parts ◦ peer to peer sharing or resale ◦ leasing ◦ rental ◦ pay per use ◦ crowd-based services ◦ subscription based products and services

Example on product-as-a-service:

Chainable supplies modular and circular kitchen for residential projects through a circular business model: Kitchen-as-a-service to ensure a circular supply chain.

Find out more!

me under grant agreement No 101033740

TEAM UP TO CREATE JOINT VALUE

Work together throughout the supply chain, internally within organisations and with the public sector to increase transparency and create shared value.

Keywords:

Internal collaboration ◦ industry collaboration ◦ government collaboration ◦ community collaboration ◦ industrial symbiosis

Example on industrial symbiosis:

The 30 meters of plastic bike path contain recycled plastic equivalent to more than 218.000 plastic cups or 500.000 plastic bottle caps. An example of collaboration between bottle and construction supply chain.

Find out more!

ovation programme under grant agreement No 101033740

STRENGTHEN AND ADVANCE KNOWLEDGE

Develop research, encourage innovation networks, structure and disseminate information with integrity.

Keywords:

education ◦ curriculum ◦ knowledge management ◦ research and development ◦ communication and awareness ◦ co-creation ◦ living labs

Example on co-creation:

Digital solutions for smart urban mobility, energy efficiency, sustainable housing, digital public services, and civic-led governance. Through co-creation with citizens, the aim is to bring the economic and social benefits of this transformation to all local communities.

Find out more!

gramme under grant agreement No 101033740

MGRFIE - Multifunctional Green Roofs Facades and Interior Elements

Presentation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

What are MGRFIE

MGRFIE - Multifunctional Green Roofs Facades and Interior Elements

A green roof or living roof is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. MGRFIE encompasses green roofs, facades and interior elements that can involve several other uses such as, energy and water collection and storage and accessibility for public and private use.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

What are Green Roofs?

Green Roofs are made up of layers that create an environment suitable for vegetation to grow. They are becoming increasingly important as a mechanism in attenuating stormwater run-off from sites.

Examples of Extensive Green Roofs

Source: https://www.dlrcoco.ie/sites/default/files/atoms/files/appendix16.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Types of Green Roofs

There are two main types of Green Roof – Intensive and Extensive.

- Intensive Green Roofs or Roof gardens provide similar benefits as a small urban park. They have a deep layer of soil, which can support a range of plants, trees and shrubs. Native species (plants which would grow naturally in the local area) can provide a rich habitat for wildlife. Intensive Green Roofs are designed to include access for people. These Roofs may require regular maintenance.

Intensive Green Roof

Source: https://www.dlrcoco.ie/sites/default/files/atoms/files/appendix16.pdf

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Types of Green Roofs

- Extensive Green Roofs are more lightweight with a shallow soil layer and are not normally designed to provide access for people. They need little maintenance. There are three main types of Extensive Green Roof.
  - Extensive Green Roofs, which are made up of sedum or vegetated mats – fabric mats that are prepared before the Green Roof is built. The mats are sprinkled with sedum cuttings. These are then left in appropriate conditions to grow into the fabric mat. Once the mats are ready, they are rolled up and delivered to the construction site and laid down on to the roof.
  - Extensive Green Roofs where a soil layer is laid down and then planted directly with small plants. These plants (often sedum) will have been grown in small pots. They are often known as plug plants.
  - Extensive Green Roofs where the soil layer is laid down and then planted with seeds (which are suitable for the local environment), this type of roof is often known as a biodiverse or Brown Roof.

Source: https://www.dlrcoco.ie/sites/default/files/atoms/files/appendix16.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation progran

Green Roofs

Extensive Green Roof

Semi-Intensive Green Roof

Intensive Green Roof

Maintenance	Low	Periodically	High
Irrigation	No	Periodically	Regularly
Plant communities	Moss-Sedum-Herbs and Grasses	Grass-Herbs and Shrubs	Lawn or Perennials, Shrubs and Trees
System build-up height	60 - 200 mm	120 - 250 mm	150 - 400 mm on underground garages > 1000 mm
Weight	60 - 150 kg/m^2	120 - 200 kg/m^2	180 - 500 kg/m^2
Costs	Low	Middle	High
Use	Ecological protection layer	Designed Green Roof	Park like garden

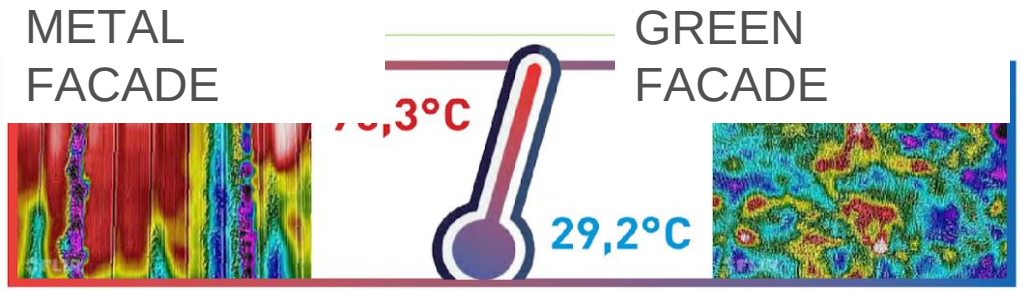
Green walls

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

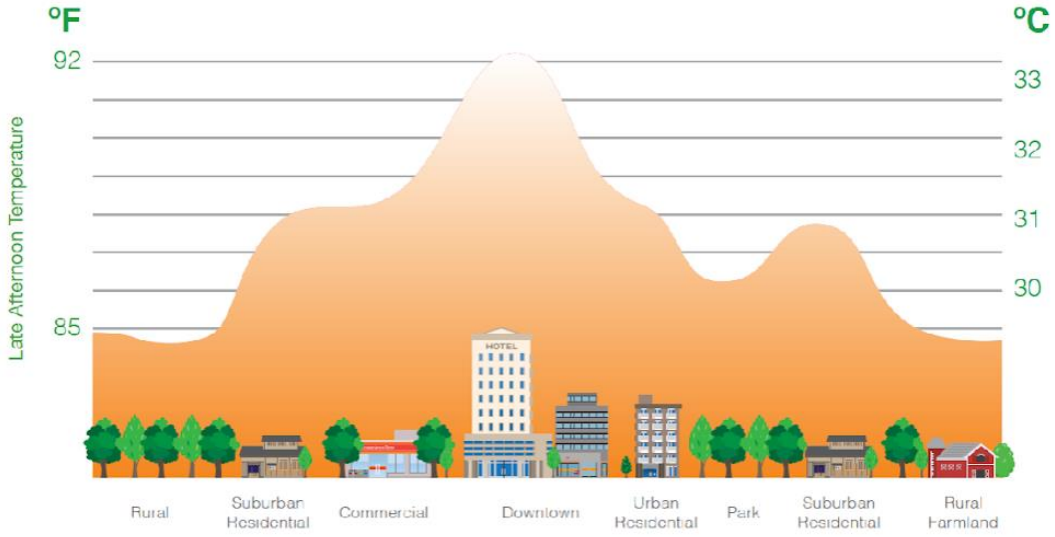
Green roof/facades benefits

- Reduction of Urban Heat Island and improvement of urban microclimate
- Water retention
- Thermal Performance
- Air Quality
- Sound Insulation
- Biodiversity
- Amenity Space
- Urban Agriculture
- Protection of Waterproofing
- Protection of Building Stock

EFB | European Federation of Green Roof Associations (efb-greenroof.eu)



Source: Bez názvu-1 (zivestavby.cz)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Types of Multifunctional green roofs, façades, and interior elements

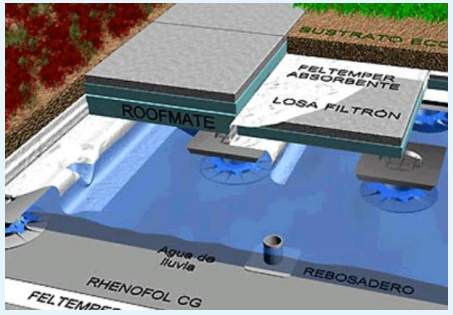
FUNCTION ⇨ **BY COLOUR - CODE**

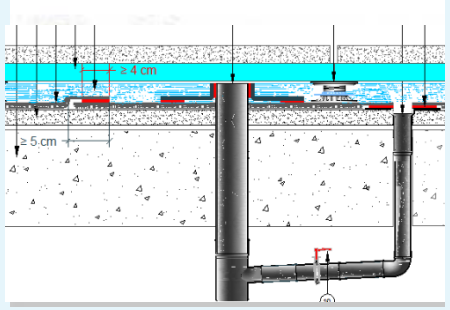
GREEN

Vegetation (from moss, grass to trees) and horticulture

BLUE

Water retention and harvesting



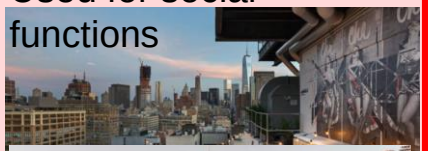


YELLOW

Generate sustainable energy (power or heat)

RED

Used for social functions



GREY

Host technical functions

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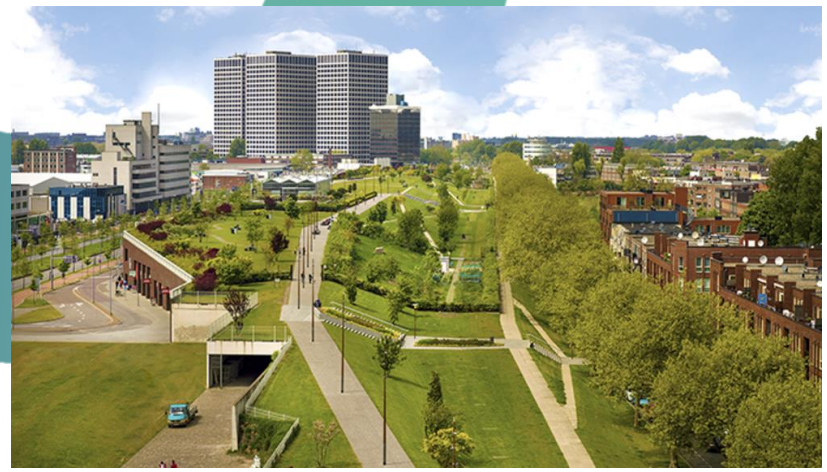
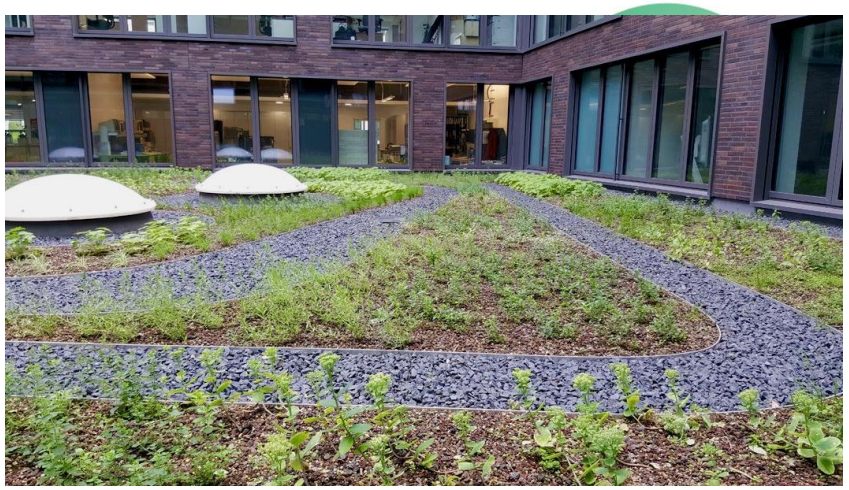
Green + Red



Rooftop garden - Green Conceptors

Green + Grey

Blue + Green



The blue green roof - helping cities cope with stormwater (livingroofs.org)

Green + Grey + Red

The best FREE water play spots in Singapore! | HoneyKids Asia

Green + Red

10 KEY BENEFITS OF ROOF GARDENS — Todd Haiman Landscape Design

Green roof gardens

Rooftop Farming Is Getting Off The Ground : The Salt : NPR

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Solar green roofs

EFB | European Federation of Green Roof Associations (efb-greenroof.eu)

Green + Yellow + Red

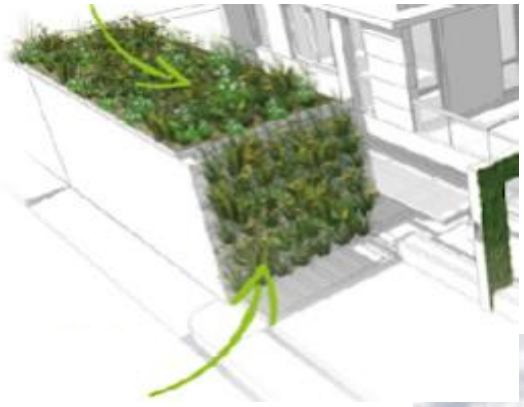
Solar green facades

Copenhagen's Four-Fold Path to Carbon Neutrality (renewableenergyworld.com)

The solar cells of tomorrow come in all colours and patterns (stateofgreen.com)

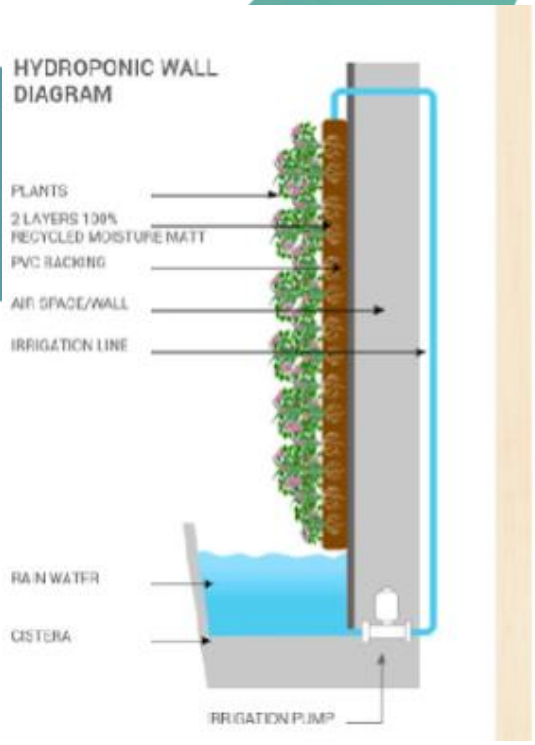
Rooftop and/or Facade root wastewater treatment plant

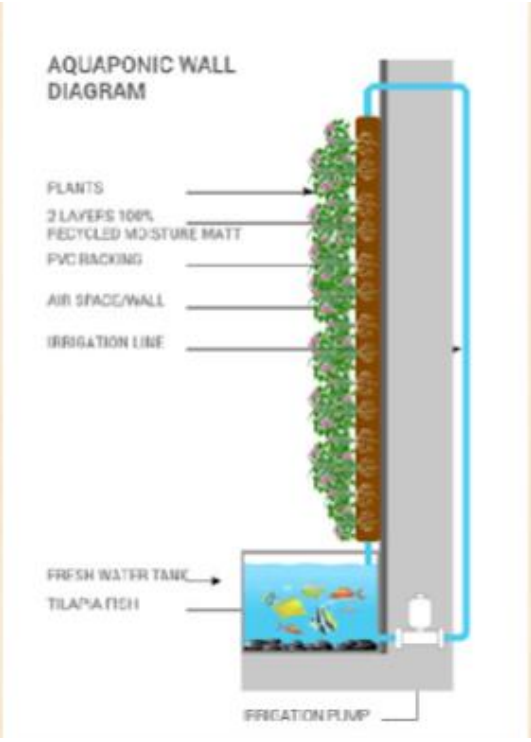
Zelená střecha, zelená fasáda, kořenová čistírna (zivestavby.cz)

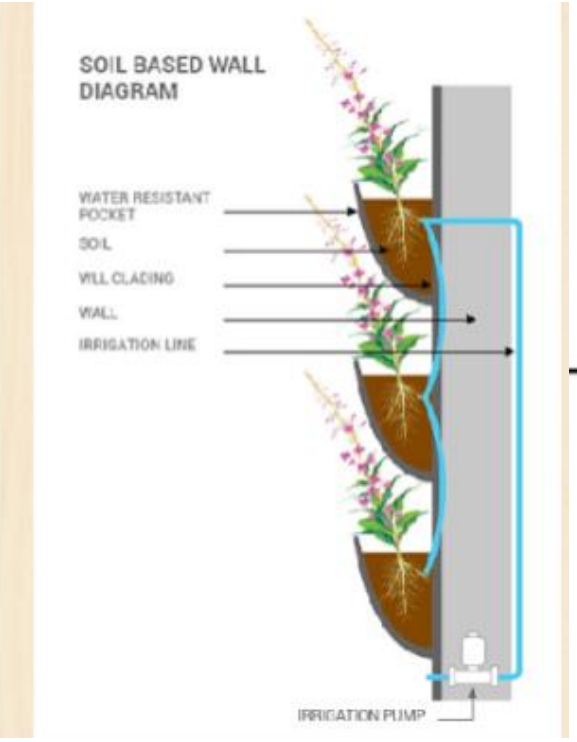


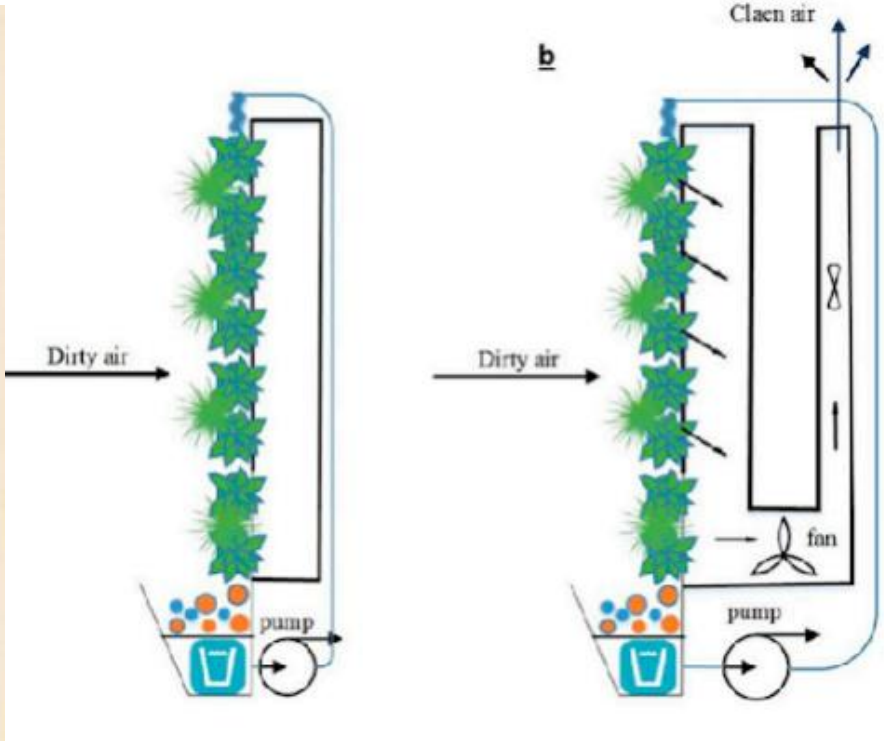
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Interior green walls (living walls)









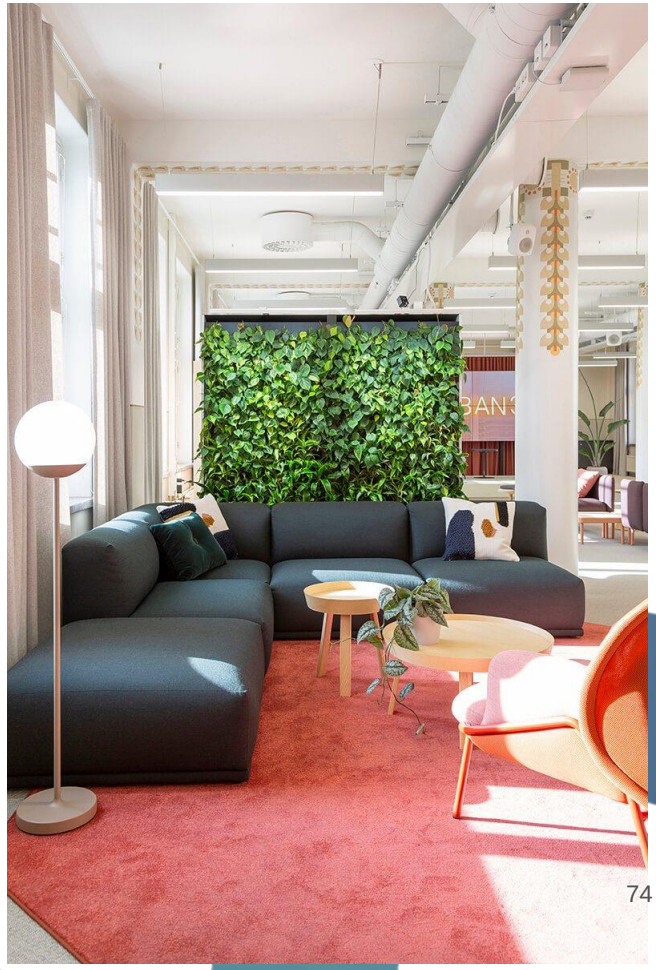
Source:Living Walls Planters Canada | Vertical Oxygen

https://livewall.com/

Benefits of interior green walls

- Better Air
- Better Acoustics
- Health & Wellbeing
- Productivity & Creativity
- Workplace Satisfaction

12 Spectacular Garden Walls and Atriums Worth Contemplating (forbes.com)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Design Considerations

- Planning Consent/Permission
- Access
- Manufacturers
- Biodiversity
- Fire Risk
- Maintenance
- Roof Pitch
- Capacity & Space

Source: https://architizer.com/blog/product-guides/product-guide/green-roofs/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Design Considerations

Planning Consent/Permission:

- Designing green roofs in a development may gain support which can help to secure planning consent.

Access:

- As with all roofs, maintenance is required and therefore access must be considered. It is important to design for ease of access to all types of green roofs, as all green roofs require some degree of maintenance. While extensive green roofs require less maintenance than intensive roofs, there are still routine cleaning and clearing that needs to be done.

Source: https://architizer.com/blog/product-guides/product-guide/green-roofs/

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Design Considerations

Manufacturers:

- It's best practice to include them in the design process as industry experts can advise you on the specifics of thermal performance, drainage, loading and other factors.

Biodiversity:

- Understanding the desired biodiversity and habitat is a major factor in selecting a green roof system. A general understanding of the bioregion, species requirements and planting can help inform clients which system makes the most sense. Biodiversity is also closely tied to everything from water management to insulation. When designing for this, consider a range of elements like deeper soils, un-vegetated areas, hard surfaces, as well as varying depths and composition of substrate.

Source: https://architizer.com/blog/product-guides/product-guide/green-roofs/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Design Considerations

Fire Risk:

- Dry vegetation on green roofs has the potential to catch fire. Consider a variety of factors when selecting your system: pebble or concrete paving, vegetation barriers around roof penetrations, routine maintenance to reduce the fire hazard, and try to make sure that green roof substrate does not contain a high volume of organic content.

Maintenance:

- The maintenance schedule should be considered during the design process.

Caixa Forum Museum

Source: https://architizer.com/blog/product-guides/product-guide/green-roofs/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Structure of a Green Roof - in general

Roof Pitch:

- Any pitch can be greened, over 45 degrees is considered a living walls. A pitched roof reduces the risk of water penetrating the roof structure.

Capacity & Space:

- The roof can often be the space where major building systems are specified. As a rule of thumb, extensive green roofs usually support 10-25 pounds of vegetation per square foot, while intensive roofs support 80-150 pounds of vegetation per square foot.

Source: https://architizer.com/blog/product-guides/product-guide/green-roofs/

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Structure of a Green Roof - in general

Usually, a Green Roof has a waterproof membrane at the bottom to protect the building from leaks. There is then an insulation layer and another protective layer, which will prevent damage from any penetrating roots, or other structural movement.

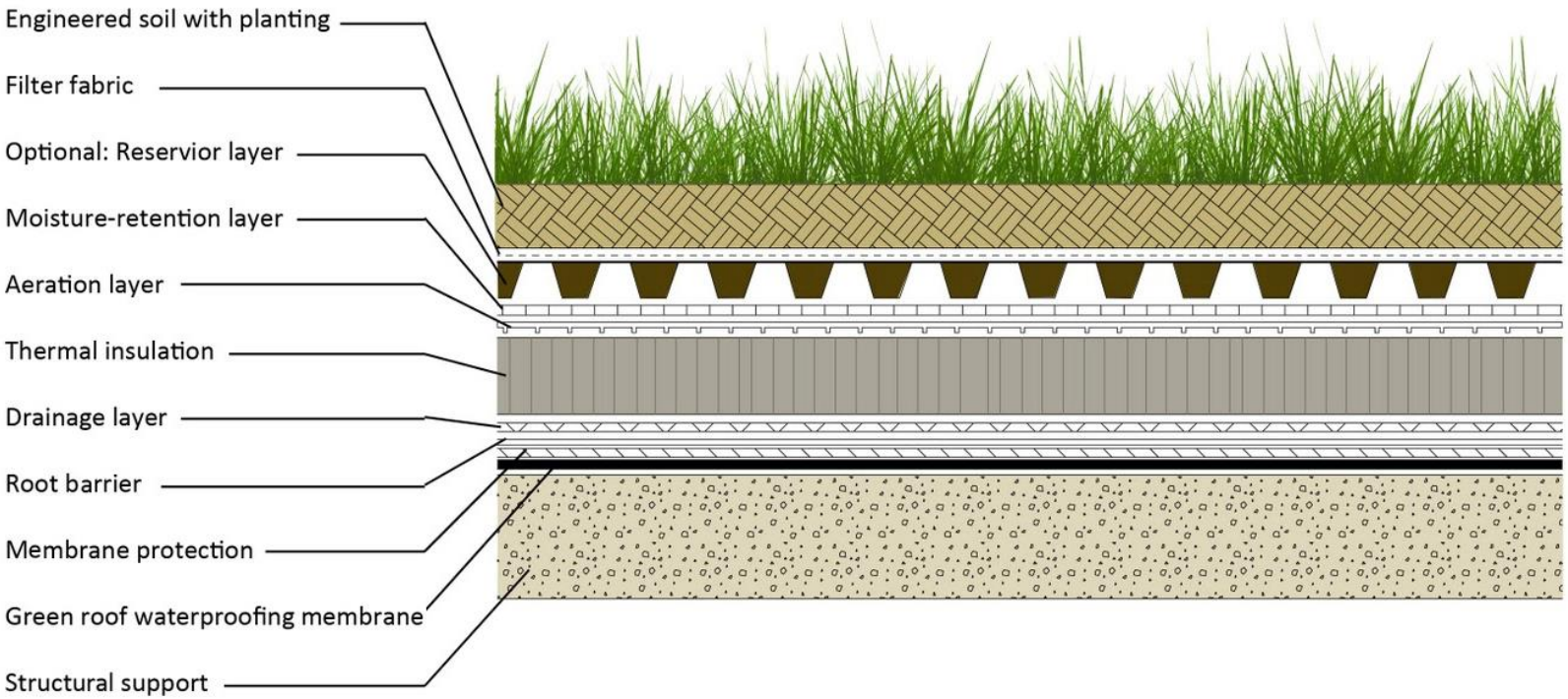
A drainage layer is then put down over the insulation layer and the protective layer. The drainage layer can be made of lightweight gravel or light granulated clay. It helps to keep air in the Green Roof and soaks up any extra water. The drainage layer can also help store water for the plants to use at a later time. For maintenance purposes, it is important that the drainage points can be accessed from above.

On top of the drainage layer, a filter mat may be installed to allow water to soak through. This will also prevent the fine soil from eroding. The top layers of a Green Roof system include the soil layer (or substrate), plants and a wind blanket. The soil layer is made up of a lightweight material (for example, crushed clay bricks, clay granules etc) and will help with drainage as well as providing nutrients to the plants. The wind blanket protects the soil layer until the roots of the plants take hold.

Source: https://www.dlrcoco.ie/sites/default/files/atoms/files/appendix16.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Structure of a Green Roof - in general



*Source:*https://architizer.com/blog/product-guides/product-guide/green-roofs/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

The Benefits of Installing Green Roofs, facades and interior elements

Green Roofs can be designed to give a wide range of benefits. These include:

- Reducing the amount of surface water running off the Roof and so reducing the risk of flooding. Completed projects show a reduced annual run-off of at least 40% and up to 60-70%. In some cases, for Intensive Green Roofs, the water retention can be up to 90%.
- Providing habitat, shelter and feeding opportunities for wildlife(especially in built up areas).
- Contribute to sustainable drainage systems and water quality improvement.
- Helping to meet the targets of our biodiversity action plan.
- Improving the character and appearance of the building and the wider area.
- Offering an opportunity to boost the environmental credentials of a business.

Source: https://www.dlrcoco.ie/sites/default/files/atoms/files/appendix16.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

The Benefits of Installing Green Roofs, facades and interior elements

- Providing extra heat and noise insulation.
- Keeping the building cool in the summer.
- Increasing the lifespan of the Roof membrane.
- Helping to reduce the amount of dust and pollutants in the air.
- Creating new open space for relaxation, providing potential for the creation of usable green spaces.

Source: https://www.dlrcoco.ie/sites/default/files/atoms/files/appendix16.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

Further Reading

Green & Blue Roof Guide 2021, DCC - Irish Green and Blue roof guidelines for Dublin city

https://www.dublincity.ie/sites/default/files/2021-12/dcc-green-blue-roof-guide-2021.pdf

A guide to GREEN roofs, walls and facades, Victoria, Australia - Growing Green Guide, guide to green roofs, walls and facades.

https://202020vision.com.au/media/41918/growing_green_guide_ebook_130214.pdf

Regularly updated Green Roofs Database

https://www.greenroofs.com/

European Federation of Green Roof & Wall Associations

https://efb-greenroof.eu/

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QUIZ/ASSIGNMENT/ACTIVITY

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EXTRA READING/STUDY

Activity

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EXTRA READING/STUDY

For Further Case Studies and Training Material Please Follow the Link Below

https://docs.google.com/spreadsheets/d/1DTte4Ph8pQ4lKzYGFt2_S-d1Z_Rmd9-i/edit?usp=sharing&ouid=112148808974461842163&rtpof=true&sd=true

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

EXTRA READING/STUDY

Discover and contribute practical examples of the circular economy

https://knowledge-hub.circle-lab.com/

Drive 0 - Circular Homes

https://www.circularhomes.eu/

King County Green Roof Case Study Report

https://kingcounty.gov/~/media/depts/dnrp/solid-waste/green-building/documents/KC_Green_Roof_case-study.ashx?la=en

An Architect's Guide To: Green Roofs

https://architizer.com/blog/product-guides/product-guide/green-roofs/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033740

https://busgocircular.eu/

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https://www.youtube.com/channel/UCXu4Rjs5WDXBE-yqda5kt5A

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Colophon

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Partners

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