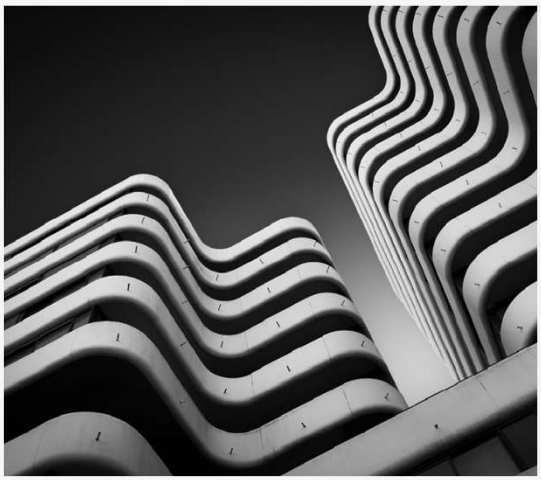
BF8011 Nearly Zero-Energy Buildings

Module 2 part 1
Circular economy



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Spring Semester 2026

Co-funded by the European Union

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Today's content

- Energy in European buildings
- The new EPBD
- The concept of circular economy
- Circular economy is market-oriented
- Examples within the building sector

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Resources and circularity
Four basic theses

- Matter and energy cannot disappeare or be made anew. They only transform to other matter / other forms of energy.
- Matter and energy tends to spread.
- Material values are characterized by concentration and struture. The value, quality, increases with increased concentration, purity and structure.

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Resources and circularity
Four basic theses

- Energy from outside is required for maintaining or increasing the order of matter's concentration and structure on earth. Energy mainly emanates from the sun, directly via radiation and the plants' photosynthesis, but also via geothermia and gravity.

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Energy in buildings

- In developed countries, most of the buildings in use in 2050 have already been built
- In Europe, this existing building stock is responsible for 40% of total energy use and app. 36% of CO_2 emissions
- During 50 years of a building's lifecycle the energy use, and the environmental impact, 85% are for running and only 15% for manufacturing
- Hence, the need for nearly zero-energy buildings

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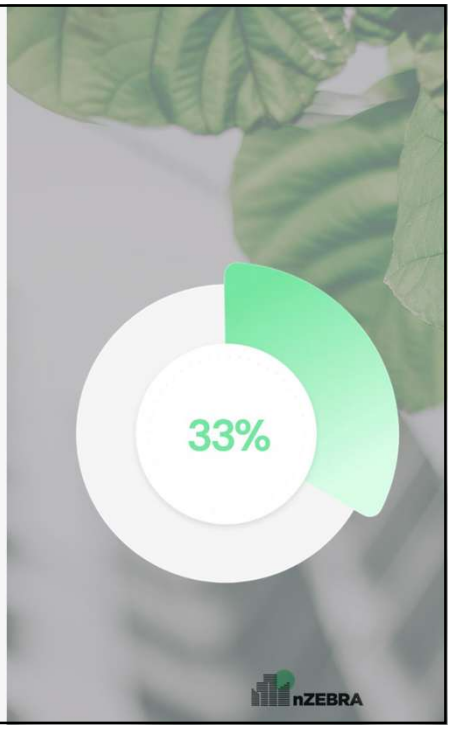
Energy in the building sector

According to the European Energy Performance of Buildings Directive, since 2021, all new buildings must be nearly zero-energy buildings (NZEB), as part of Europe's ambition for the decarbonisation of the built environment by 2050.



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The Energy Performance of Buildings Directive

The revised
Energy Performance of Buildings Directive
(EU/2024/1275, EPBD)
entered into force on 28 May 2024
and will need to be transposed
into national laws by 29 May 2026.

WHY?

- 85% of buildings in the EU were built before 2000
- App. 40% of energy consumed in the EU is used in buildings
- 75% of them have poor energy performance
- The annual energy renovation rate remains very low at 1%

https://energy.ec.europa.eu/topics/energy-efficiency/energy-performance-buildings/energy-performance-buildings-directive_en

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The Energy Performance of Buildings Directive

The EPBD recast introduces a coordinated strategy for renovating and decarbonizing existing buildings, aligning carbon disclosure with energy efficiency, modernization, and digitalization targets.

Member States must:
Renovate at least 16%
of the worst-performing
non-residential buildings by 2030,
rising to 26% by 2033.

https://energy.ec.europa.eu/topics/energy-efficiency/energy-performance-buildings/energy-performance-buildings-directive_en

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The timeline for EPBD

31 December 2026	EU countries submit their final national building renovation plans
29 May 2026	General transposition deadline
31 December 2025	EU countries submit their draft national building renovation plans
	Show 11 more items
December 2002	Energy Performance of Buildings Directive (2002/91/EC)

https://energy.ec.europa.eu/topics/energy-efficiency/energy-performance-buildings/energy-performance-buildings-directive_en

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The timeline

31 December 2026	EU countries submit their final national building renovation plans
29 May 2026	General transposition deadline
31 December 2025	EU countries submit their draft national building renovation plans
1 January 2025	Transposition deadline for Article 17(15) on phasing out financial incentives for the installation of boilers powered by fossil fuels
28 May 2024	The revised Energy Performance of Buildings Directive (EPBD) entered into force
8 May 2024	The revised Directive was published in the Official Journal of the EU
December 2023	Provisional agreement between the co-legislators on the EPBD revision
March 2023	European Parliament's position on the EPBD revision
October 2022	Council General Approach on the EPBD revision
May 2022	REPowerEU Plan, including the EU 'Save Energy' Communication
December 2021	Commission proposal for a revised directive
October 2020	EU Renovation Wave strategy
May 2018	Amending Directive 2018/844
May 2010	Energy Performance of Buildings Directive (2010/31/EU)
	Hide 11 items
December 2002	Energy Performance of Buildings Directive (2002/91/EC)

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What does this imply for us?

New take on energy declarations for larger or public buildings;

- information on greenhouse gas emissions and "whole-life carbon" (for new buildings) must be disclosed in addition to energy consumption and is named lifecycle-GWP
- The whole building stock shall be zero emission buildings in 2050

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Which of the UN sustainable development goals (SDG's) align with the transition to zero emission buildings ?

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Which of the UN sustainable development goals (SDG's) align with the transition to Circular Economy?

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The nine planetary boundaries

1. Climate change
2. Loss of biodiversity
3. Ozon layer's thinning in the stratosphere
4. Ocean acidification
5. Biogeochemical flows (phosphorus and nitrogen cycles)
6. Change of land use (e.g. deforestation)
7. Fresh water use
8. Aerosols in the atmosphere (microscopic particles impacting climate and living organisms)
9. New chemical substances ("Novel entities": e.g. organic contaminations, radioactive material, nano material and micro plastics)

- Source: Stockholm University

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”The area of the footprint is related to the area needed to create the resources that are consumed within the area where the consumption of the resources happens .”

Source WWF

- LCA ➡ life cycle analysis
- MIPS ➡ mass intensity per unit
- SPI ➡ sustainable process index
- EF ➡ ecologic footprint

Resources and circularity
Ecologic footprints

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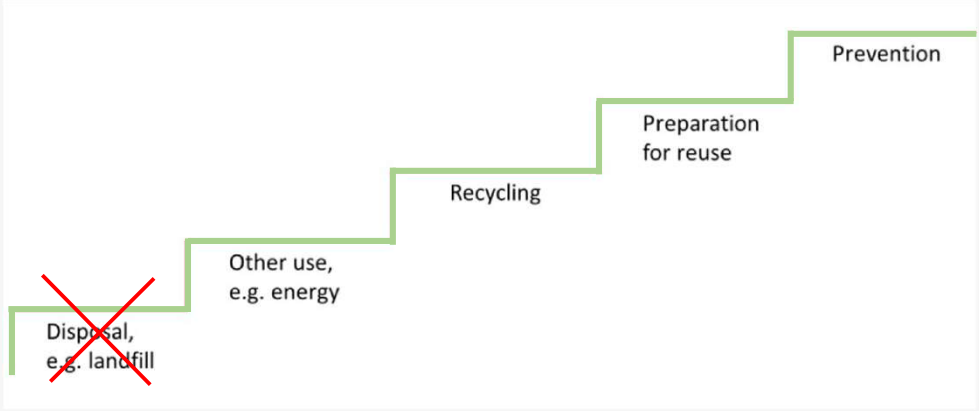
Our European waste plans



The five steps in the waste hierarchy as presented in ‘From waste management to resource efficiency’

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Resources and circularity

Waste or resource?

This applies to all sectors

- Minimize the use of materials
- Reuse of products and components
- Recycle all material fractions
- Recycle as energy

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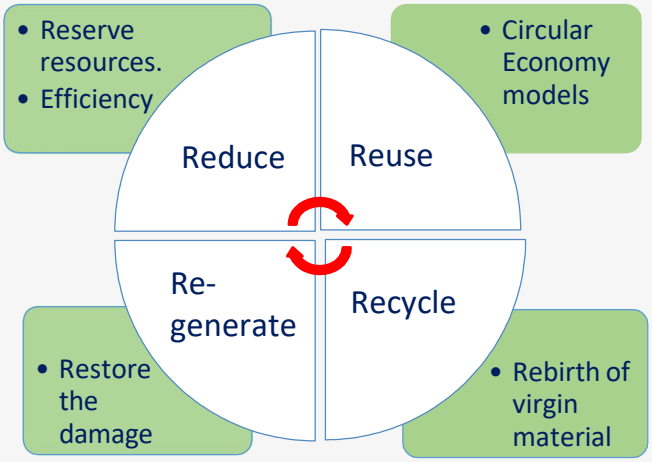
What is circular economy?

- CE depends on **your view.**
- Main goals:

resilience by **design.**

Some students' point of view on circular economy after a brainstorming week



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A Circular economy action plan

- **There is only one planet Earth, yet by 2050, the world will be consuming as if there were three**
- The plan speaks about biomass, fossil fuels, metals and minerals, biodiversity loss and water stress, and about the European Green Deal and a climate-neutral, resource-efficient and competitive economy
- **Scaling up the circular economy from front-runners to the mainstream economic players** will make a decisive contribution to achieving **climate neutrality by 2050** and **decoupling economic growth from resource use**, while ensuring the long-term competitiveness of the EU and leaving no one behind.
- The transition to the circular economy will be systemic, deep and transformative, in the EU and beyond. It will be disruptive at times, so it has to be fair. It will require an alignment and cooperation of all stakeholders at all levels - EU, national, regional and local, and international.

Brussels, 11.3.2020 COM(2020) 98
A new Circular Economy Action Plan For a cleaner and more competitive Europe

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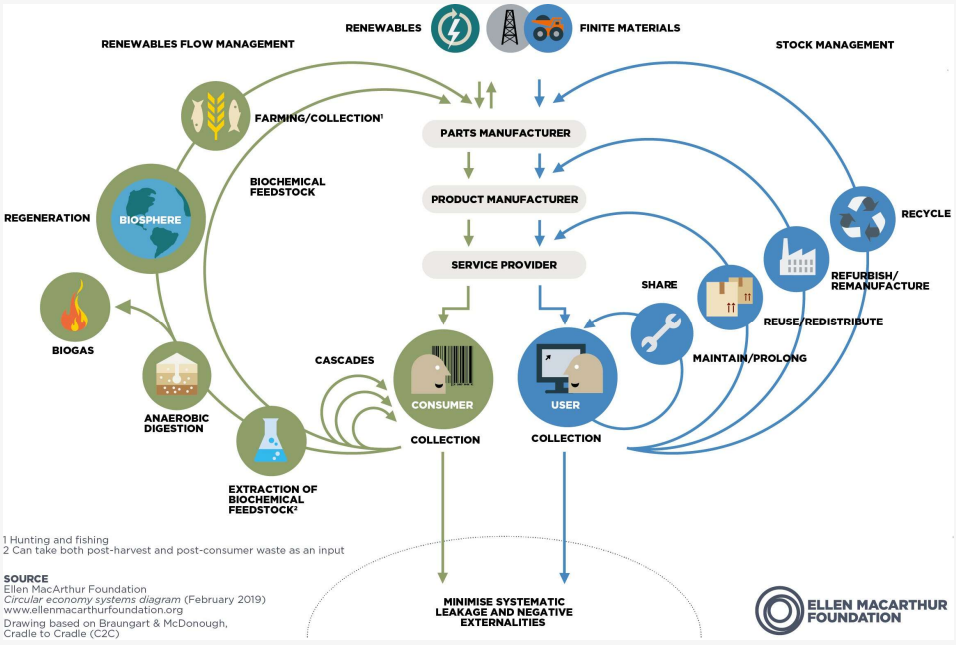

The concept of circular economy according to Ellen MacArthur Foundation

https://www.ellenmacarthurfoundation.org/circular-economy-diagram

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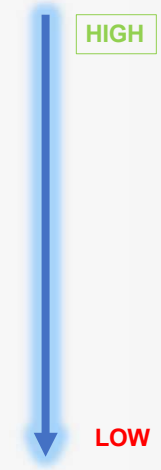
10 R, levels of circularity, the order of priority

1. Refuse – prevent raw materials' use
2. Reduce – decrease raw materials' use
3. Redesign – reshape product with a view to circularity principles
4. Reuse – use product again (as second hand)
5. Repair – maintain and repair products
6. Refurbish – Revive product
7. Remanufacture – make new from second hand product
8. Re-purpose – reuse product but with other function
9. Recycle – salvage material streams with highest possible value
10. Recover – incinerate waste with energy recovery



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Being sustainable by adapting to circular economy is to be market-oriented and competitive

The Freight Farm moves farm, not food and the aquaponic farming is possible everywhere

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Sweden's first Swan-certified renovation of a multifamily building

Ronnebyhus AB's multifamily buildings was to be demolished, but …

- preserved concrete construction and tile façade
- PV on the roof
- renovated windows with energy efficient glazing and preserved windowsills of stone
- the buildings' character were preserved
- other material resources were also preserved and 660 tonnes CO_{2eqv} avoided

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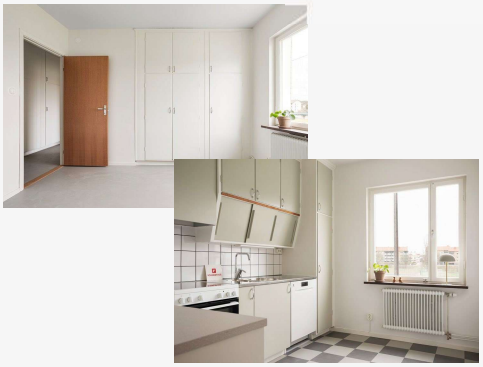
Sweden's first Swan-certified renovation of a multifamily building

- kitchen design and closetswith typical 1950s character were renovated and preserved
- mechanical ventilation heat recovery (MVHR) was installed for a healthy indoor environment
- costs were 30% less than for newbuild
- nominated to construction of the year in 2025
- Ronnebyhus AB are now applying this concept in other projects



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Car park garage in Lund with re-purposed wind turbine blades

- wind turbine blades are difficult to recycle
- the façade in a car park should be well ventilated so the blades filled a new purpose
- efficient energy use with PV panels with batteries and charging stations for electric vehicles
- 6 floors and 265 parking lots
- Green façades can contribute to biodiversity and take care of precipitation, and make use of the CO_2

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One of the worlds smartest houses

An ordinary old skyscraper was converted in 2004, achieving the highest environmental standard

- LEED Platinum
- windows reflect 50% of heat from sunlight minimizing the cooling need
- aerodynamically designed lifts are saving energy
- digital control system, and more …

Tai Pei 101, Taiwan

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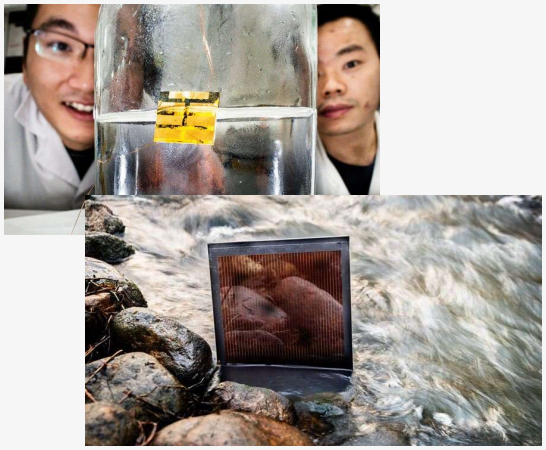
Recyclable PV cells can become the energy solution for the future



- researchers at Linköping Unversity have developed a recycling method *without* using dimetylformamid - an environmentally hazardous solvents
- the dismantling of the PV panels made of the new material perovskite only need water
- all parts of the perovskite PV can then be reused
- the PV cell also remarkably maintains its original efficiency

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Concrete has been use for thousands of years …

The concrete ceiling in Panteon, Rome

- cement act as the glue for stone, gravel, sand and water that concrete is made of
- there is only 10% cement in concrete, but it accounts for 90% of concrete's negative climatic impact
- the climatic impact can be reduced by using alternatives to cement like slag from steel industry and fly ash from the energy sector
- the climatic impact can be reduced by 10 to 50% by also using slim constructions and other measures

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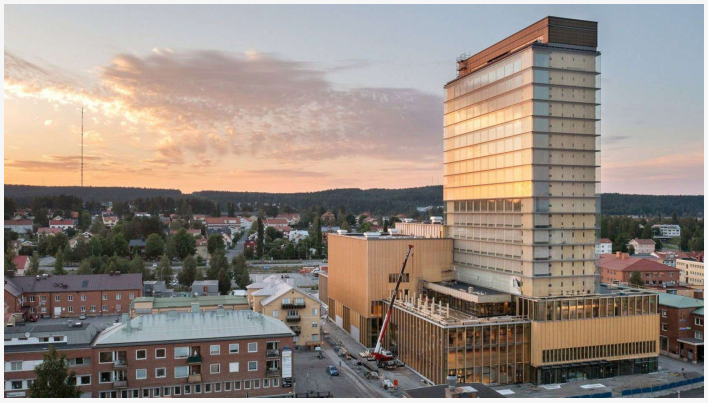
Wood is a traditional material used in all times and in all countries where forests are growing

- wood is a renewable material that use CO_2 for growth and captures it in the wood fibers
- wood is a traditional material for the future
- wooden glulam beams allows for very large spans and highrise buildings are also built with CLT, cross laminated timber



- Sara Kulturhus in Skellefteå, Sweden, is constructed entirely of CL timber, also the two cores for lifts

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Carbon footprints

The examples show that circular economy and low carbon footprint are possible to achieve in new as well as in old existing buildings. Tools that can be used are e.g.

- LCA ➡ life cycle analysis
- CF ➡ carbon footprint

Test your own carbon footprint! ➡ https://www.carbonfootprint.com/calculator.aspx

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Questions to discuss

- How do your ideas on sustainability look like?
- Do you have any ideas on energy issues, on circular economy, on waste or what issues do you have in your countries?
- What is the most common building material in your countries? Could it be replaced or recycled?
- Is circular economy part of your programme syllabus, and/or is it discussed in your courses?

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Literature on circular economy

In this module 2 you will find some files on articles that you should read, but here are some titles and web sites that are useful as references

- McDonough W. & Braungart M. (2002) Cradle to cradle: Remaking the way we make things. New York: North Point Press.
- Jonansson G., Sundin E., Wiktorsson M. (2019) Sustainable Manufacturing. Lund: Studentlitteratur AB.
- www.ellenmacarthurfoundation.org
- https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en

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About

nZEBRA is an **EU co-funded project** under the Erasmus+ programme, which gathers 5 European partners.

It aims to **empower professionals and Master's students** in architecture, civil and energy engineering to design innovative solutions for **climate-neutral buildings.**

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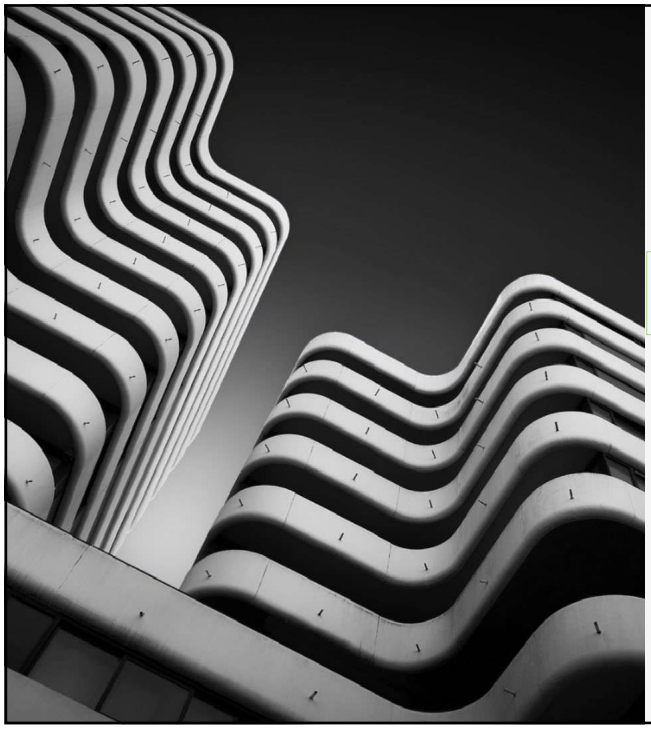

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