

BF8011 Nearly Zero-Energy Buildings

Module 2 part 2

Circularity Assessment and Industrial Symbiosis

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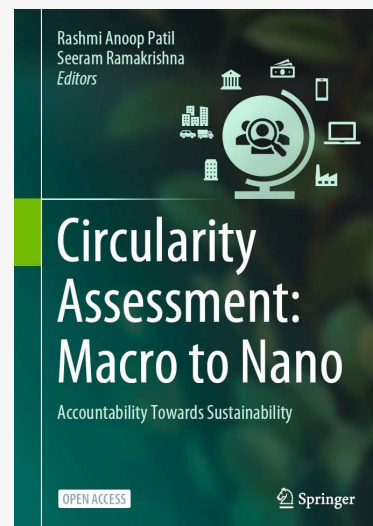
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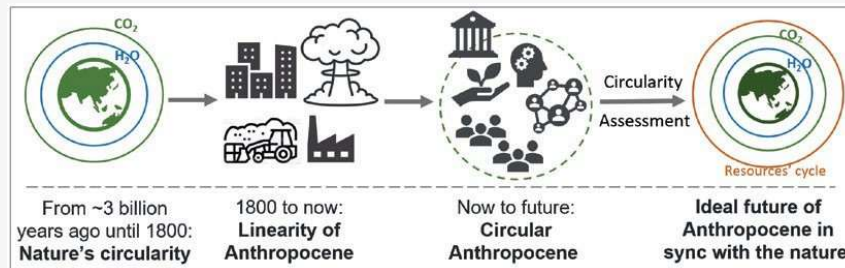
Today's content

- Circular assessment – from Macro to Nano, but also Industrial symbiosis and Examples



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Phases of circularity



- Circularity started with nature's circularity by evolution Phase 1, and Phase 2 represents human activities adversely impacting the environment resulting in a linear economy. Phase 3 is attempting to charter towards a circular economy, and in Phase 4, we do it through innovations, responsible behavior, and value contributions by the stakeholders, to be in synergy with nature.



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Circularity assessment

- For a transition to a low-carbon circular economy we need an integrated approach to circularity assessment including participation and cooperation of governments, businesses, and communities.
- All need to consequently engage in lowering carbon footprints to fulfill the SDGs.



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Circularity assessment

To facilitate the transition we need ...

- ... systemic changes in business practices, consumer behaviour, and government policies.
- ... significant investment in infrastructure, technology, and innovation.
- ... creation of new business opportunities based on products and services that use waste as a resource.



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Turning challenges into opportunities

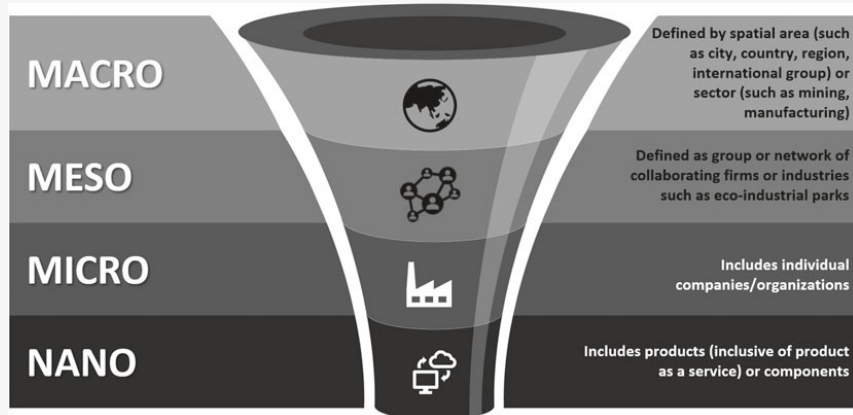
The Transfer to a circular industrial economy will create ...

- a **low waste** society with incentives to change individual behaviour— from consumer to user; through loss and waste prevention by intelligent resource management.
- a **low carbon** society preserving water, electricity, and CO₂ emissions embodied in physical assets;; through innovation into green electricity and circular energy
- a **low anthropogenic mass** society preserving the existing stocks of infrastructure, buildings, equipment, vehicles, and objects, developing circular material sciences



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Four levels of systemic hierarchy



Schematic representation of the four levels of systemic hierarchy considered for circularity assessment and the ISO 59000 series of standards is used to implement, monitor and measure circularity.



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The macro level

The Macro is defined by spatial area such as

- Circular cities
- Circular regions (or nations)
- Circular international group
- Circular sector



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Circular cities

The macro level

CE promotes changes in the whole society and its subsystems such as

- economic
- political
- cultural
- technical-technological

Assessment tools and indicators for monitoring the CE implementations at the macro level are e.g.

- Material Flow Accounting (MFA)
- Input Output Analysis
- LCA



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Circular cities

The macro level

- More than 50% of the global population live in cities
- Currently, cities and urban areas contribute to generating more than 60% of global gross domestic product (GDP).
- This cause an enormous concentration and need for food, materials, energy, water, and economic transactions.



Schematic representation of a circular city with various loops representing the circularity of water, energy, nutrients, and reusable materials.



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Circular cities

The macro level

“A circular city is a city that practices CE principles to close resource loops, in partnership with the city’s stakeholders (citizens, community, business, and knowledge stakeholders), to realize its vision of a future-proof city”

Prendeville S, Cherim E, Bocken N (2018)
Circular cities: mapping six cities in transition.



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Circular regions

The meso level

CE on this level can be represented by Eco-Industrial Parks (EIP) where they share resources such as

- water
- energy
- material
- by-products
- services



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Circular regions The meso level

The design of circular production and consumption models aims at ...

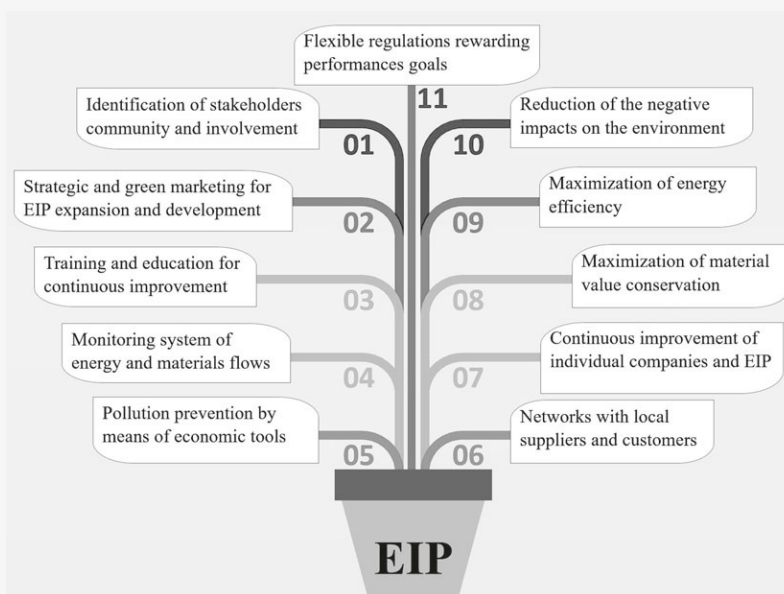
- reducing by improving the efficiency in the use of resources needed for products, processes, or systems
- slowing reduces the speed in the use of resources by designing long-life products e.g., applying the concept of design for durability or reliability and thus extending their service life
- closing the loops recycles materials, or other kinds of resources e.g., by-products, in both post-production and post-consumption avoiding landfilling



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Circular regions The meso level

Schematic illustration
of the key elements
characterizing an EIP



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Circular regions

The meso level

One of the definitions of Eco-Industrial Park is ...

- *... an industrial system which conserves natural and economic resources; reduces production, material, energy, insurance and treatments costs and liabilities; improves operating efficiency, quality, worker health and public image; and provides opportunities for income generation from use and sale of wasted materials.*

Côté R, Hall J (1995) Industrial parks as eco-systems.



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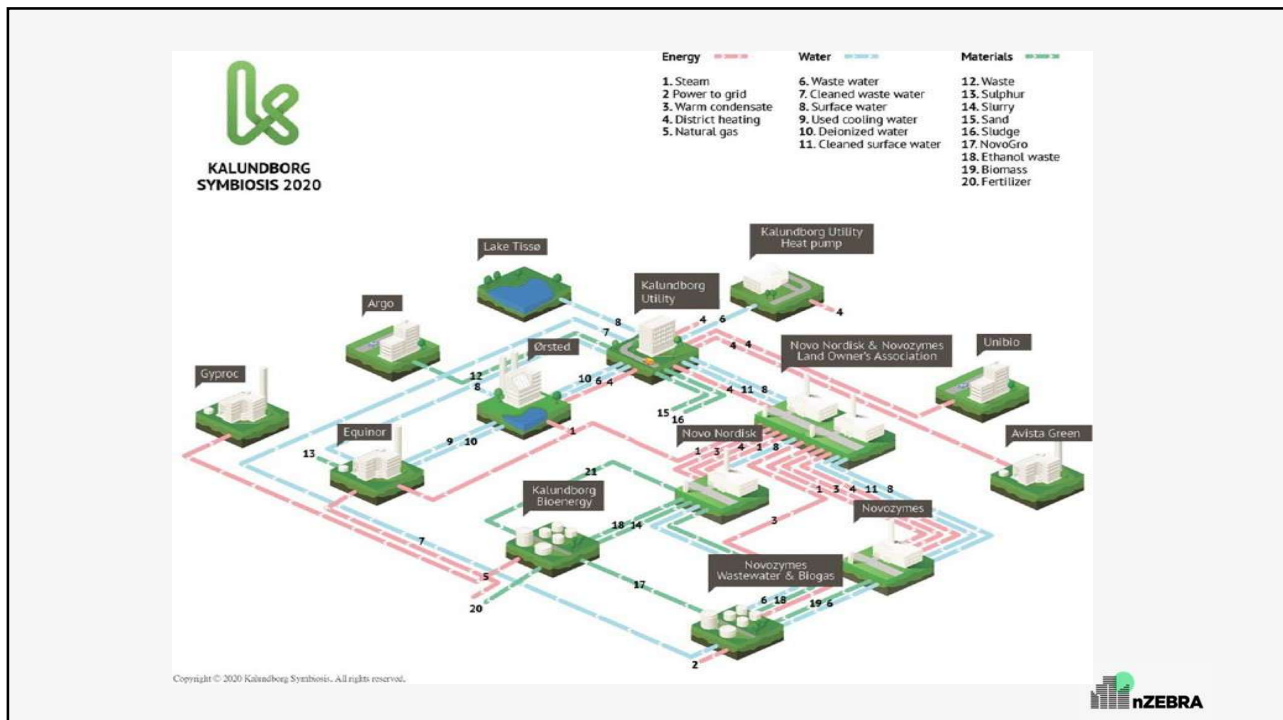
Symbiosis in an EIP - Kalundborg

The meso level

- Kalundborg is a local public-private partnership where companies provide, share, and reuse energy, water, and materials for mutual economic benefits which have been a key driver
- Combined annual benefits amounted to 24 million euros when assessed through LCA



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Symbiosis in an EIP - Kalundborg

The meso level

The Industrial symbiosis started small in 1961 and the EIP was formalized in 2021, and combined annual environmental benefits for the partners of the Kalundborg Symbiosis are ...

- Reduction of 635,000 tons of CO₂
- Reduction of 3, 6 million m³ of water
- Reduction of 100 GWh of energy
- Reduction of 87,000 tons of materials

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Circular businesses

The micro level

CE for businesses at the micro level are an integral part of the economy. SMEs contribute directly to the growth of local economies, but alongside the benefits they also generate waste and consume resources. Businesses play a vital role in realizing the systemic transition from linear economy to circular economy.



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Circular businesses

The micro level

Strategies for businesses:

- Improving supply chain and resource management
- Eliminating/minimizing waste through more resource efficient design
- Keeping the products, components, and material in use for as long as possible



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Circular businesses

The micro level

Indicators on circularity in micro-level are often based on:

- Material flows
- Environmental impact
- Economic factors

Standards often used by businesses:

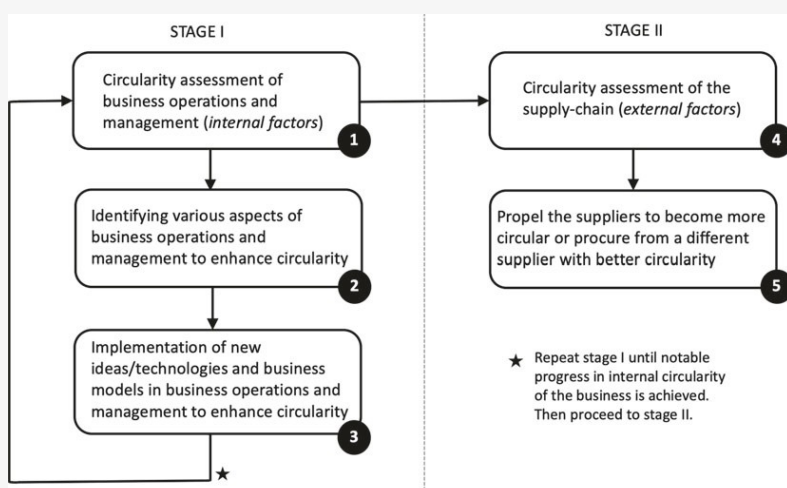
- ISO 59020
- Global Reporting Standard - Environmental
- IIRC's guidelines for natural capital reporting



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Circular businesses

The micro level



What is required for circularity in businesses?

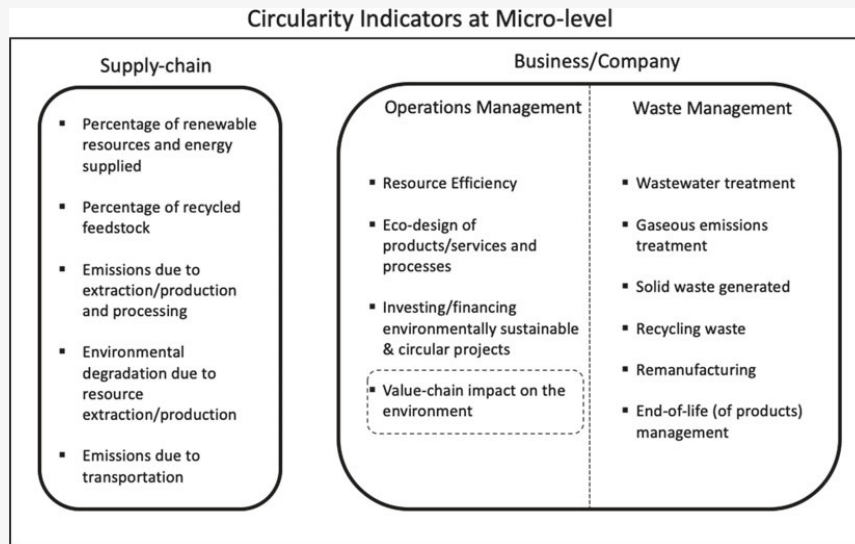
Stage 1 involves the circularity assessment of internal operations and management.

Stage 2 involves assessing and enhancing supply-chain circularity



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Circular businesses The micro level



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Circular businesses The micro level



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Circularity — products and services

The nano level

The systemic economic hierarchy considers products and services as being on a nano-level, to distinguish them from the micro-level and companies/businesses.

- So, what is required for circularity in products and services?

- ✓ A comprehensive metric for assessment which is the Life cycle assessment (LCA)

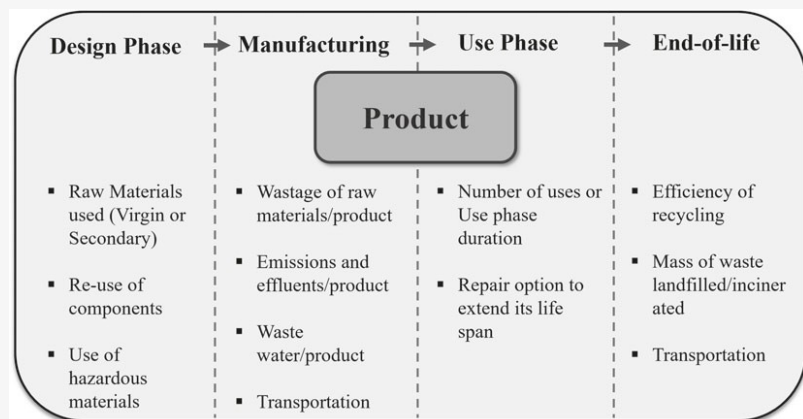


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Circularity — products and services

The nano level

The schematic representation of the factors influencing the circularity of a product at all stages of its life-cycle. Each of the influencers can be quantified using multiple indicators to measure the total circularity of a product considered



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Circularity — products and services

The nano level

Choice of materials should be such that it ...

- ... allow usage of secondary materials and less material by weight for an efficient product design,
- ... is non-hazardous to the environment and the biota,
- ... has a low carbon footprint (emissions from producing and processing of materials),
- ... can be efficiently and economically recycled,
- ... promotes the reusability of materials in the form of durable components.



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Examples — products and services

The nano level

- For an example of LCA you must go through Module 3 as whole
- There will be both lecturing and LCA calculations, so you will, actually, be testing to use LCA for a building
- Because the principles applies for all products from pencils to jeans to a whole building



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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**.



TUHH



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Thank you

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