SH2E

SH2E Spring School (20-24 May 2024)

Introduction to life cycle thinking

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Clean Hydrogen Partnership

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 101007163. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation program, Hydrogen Europe and Hydrogen Europe Research.

Introduction to life cycle thinking

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Implementation of environmental aspects

- Integrate environmental aspects into the global business strategy (Volvo).
- Pay attention to how consumers value the environmental qualities of products (Sony, Nokia, Aritona).
- Assess environmental investment proposals like any other investment (Ciba).
- Increase unit energy efficiency (Novo Nordisk).
- Reduce negative impacts on ecosystems.
- Recycle or use residual materials.
- Reducing the cost of credits (Kvaerner)
- Increase unit efficiency of raw materials (DuPont)

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Eco-efficiency

"Provide goods and services at a competitive price [illegible]man needs and quality of life, while progressively reducing the environmen[illegible]nsity of resource use throughout the life cycle, to a level compatible w[illegible]arrying capacity of the planet".

World Business Council for Sus[illegible]nt

More for less

Relationshi[illegible] of the product or service produced by a company an[illegible]environmental impacts throughout its life cycle

$$Efficiency = \frac{value\ of\ the\ product\ or\ service}{environmental\ impact}$$

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Eco-efficiency

- Reduce wastage of resources through continuous improvement.
- Reduce the volume and toxicity of waste generated.
- Reduce energy consumption and polluting emissions.
- The risks of non-compliance with laws are reduced and relations with the competent administration are favored.

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Eco-efficiency

- Subsidies.
- Orientation of the national and international market towards products with minimal environmental impact.
- Protection against competition from countries with societies that are less strict in environmental requirements.
- Reduction of costs in the consumption of resources and energy.
- Prevent new situations of demand or environmental issues.
- Establishment of an environmental safety guarantee that increases the value of facilities, reduces insurance fees, increases the confidence of investors and shareholders, etc.
- Improvement of relations with the administration and with the social environment.

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Industrial ecology

"An industrial ecosystem is needed in which energy use is optimized, waste and pollution are minimized, and there is an economically viable role for each product in a production process"

R. Frosch y N. Gallopoulos, 1989.

INDUSTRIAL ECOLOGY is the study of physical, chemical and biological interactions and relationships between and within industrial and ecological systems.

It also includes the identification and implementation of strategies for industrial systems to assimilate into ecological, sustainable and harmonious ecosystems.

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Industrial ecology

- Vision of the interactions between industrial and ecological systems.
- Study of the flows of matter and energy and transformations.
- Multidisciplinary approach
- Change from linear to cyclic processes.
- Reduction of the environmental impacts of industrial systems in ecological ones.
- Emphasis on the integration of industrial activity into ecological systems.
- Make industrial systems imitate the most effective and sustainable natural systems.

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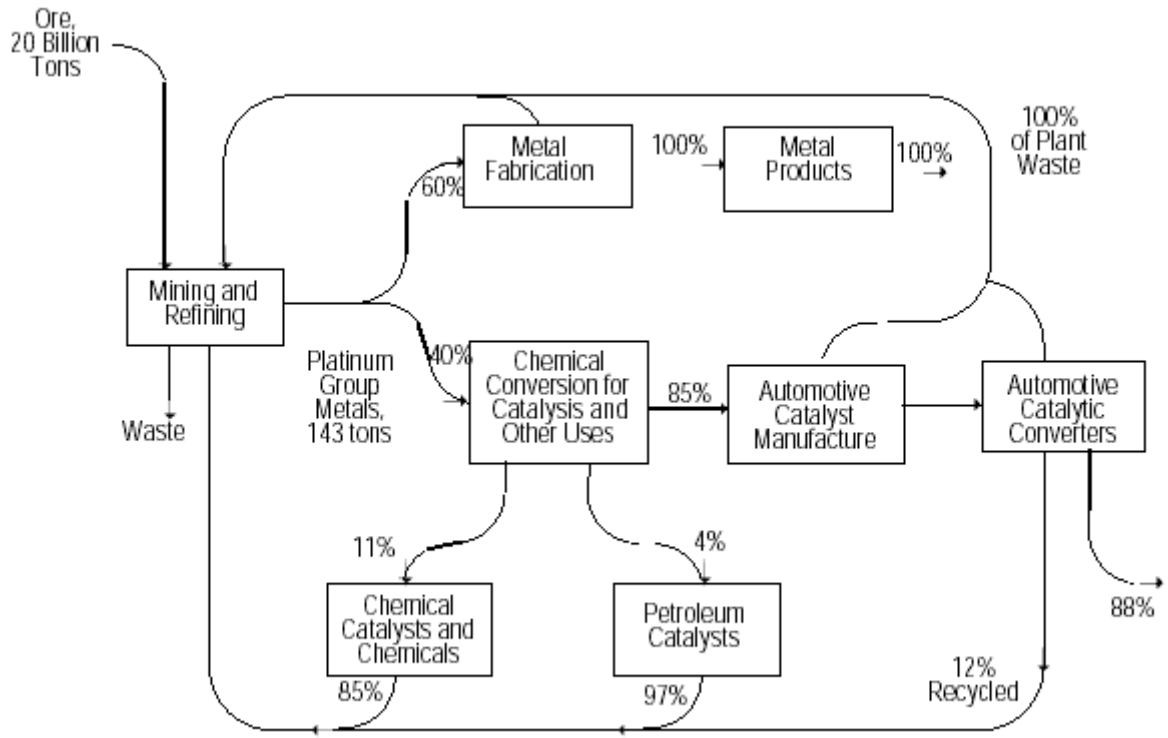
Industrial ecology



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Industrial ecology

Analogies to natural systems

Natural systems have evolved from linear to cyclical systems in which there is a balance between organisms, plants and different physical and chemical processes. Nothing leaves the system, because the waste is used as substrates by other organisms.

The objective of industrial ecology is to stimulate the evolution of industrial systems to achieve dynamic balance and high integration like natural ones.

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Industrial ecology

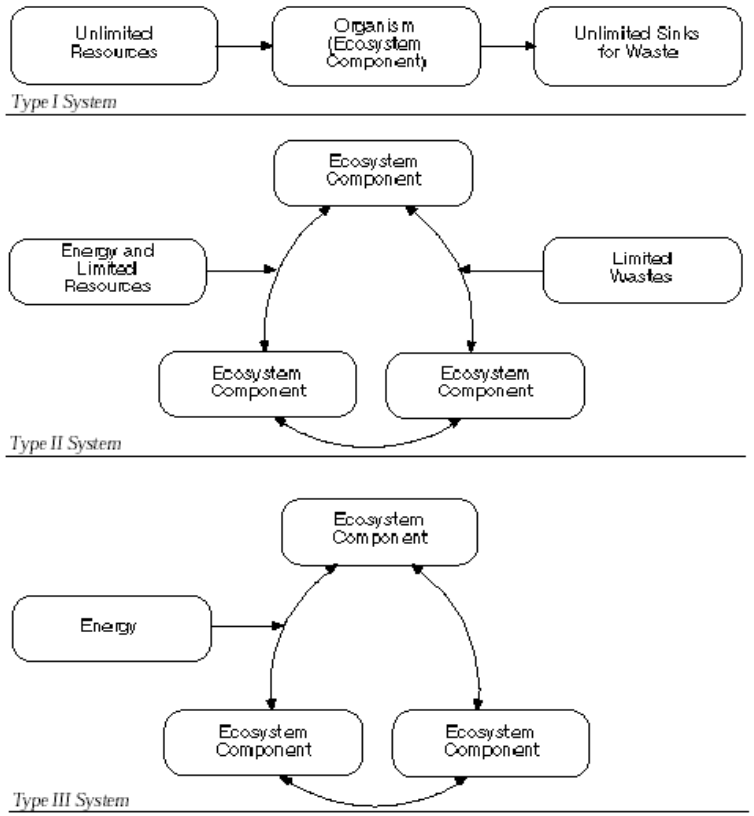

FIGURE 5: SYSTEM TYPES

Source: Braden R. Allenby, "Industrial Ecology: The Materials Scientist in an Environmentally Constrained World," *MRS Bulletin* 17, no. 3 (March 1992): 46–51.

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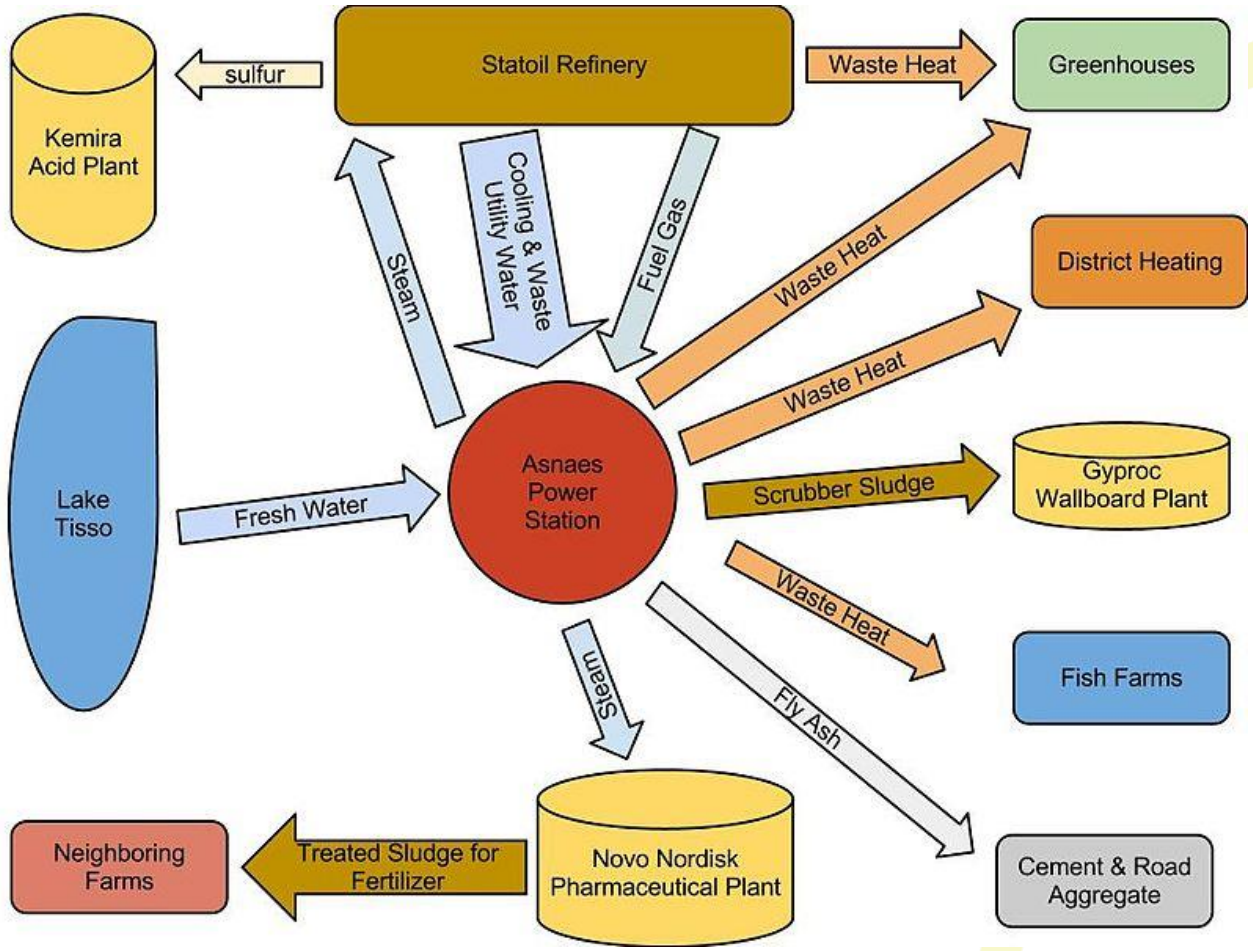

Kalundborg Park (Denmark)

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	Novo Nordisk	Novo Enzymes	Asnaes Power	Statoil Refinery	Gyproc	Soilrem	Municipality	Farmers	Fish Farm	Cement companies	Component recyclers
Novo Nordisk		1	1	1	0	0	1	1	0	0	0
Novo Enzymes	1		0	0	0	0	1	1	0	0	0
Asnaes Power	1	1		1	1	0	1	0	1	1	1
Statoil Refinery	1	1	1		1	0	0	0	0	0	1
Gyproc	0	0	0	0		0	0	0	0	0	0
Soilrem	0	0	0	0	0		0	0	0	0	0
Municipality	0	0	0	0	0	1		0	0	0	0
Farmers	0	0	0	0	0	0	0		0	0	0
Fish Farm	0	0	0	0	0	0	0	0		0	0
Cement companies	0	0	0	0	0	0	0	0	0		0
Component Recyclers	0	0	0	0	0	0	0	0	0	0	

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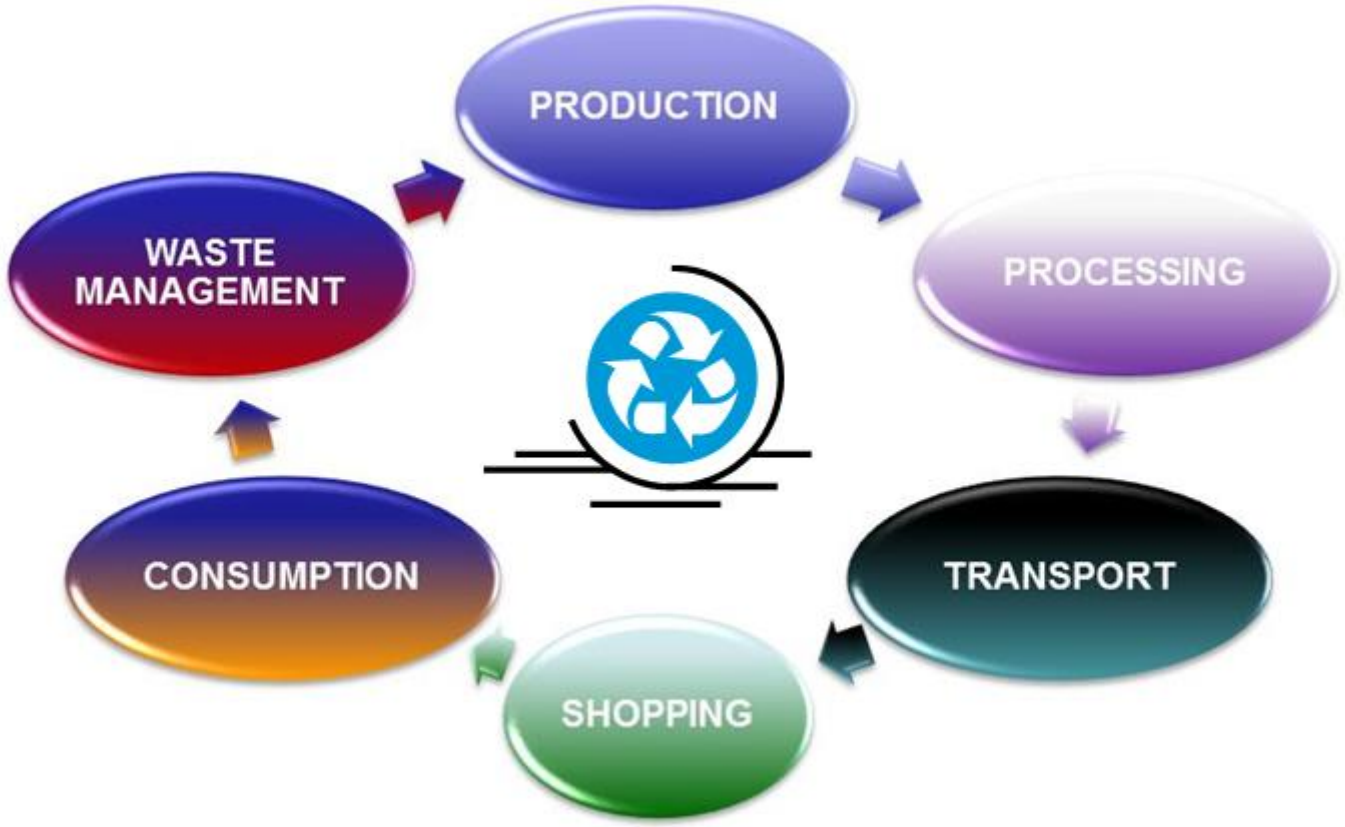
Life cycle



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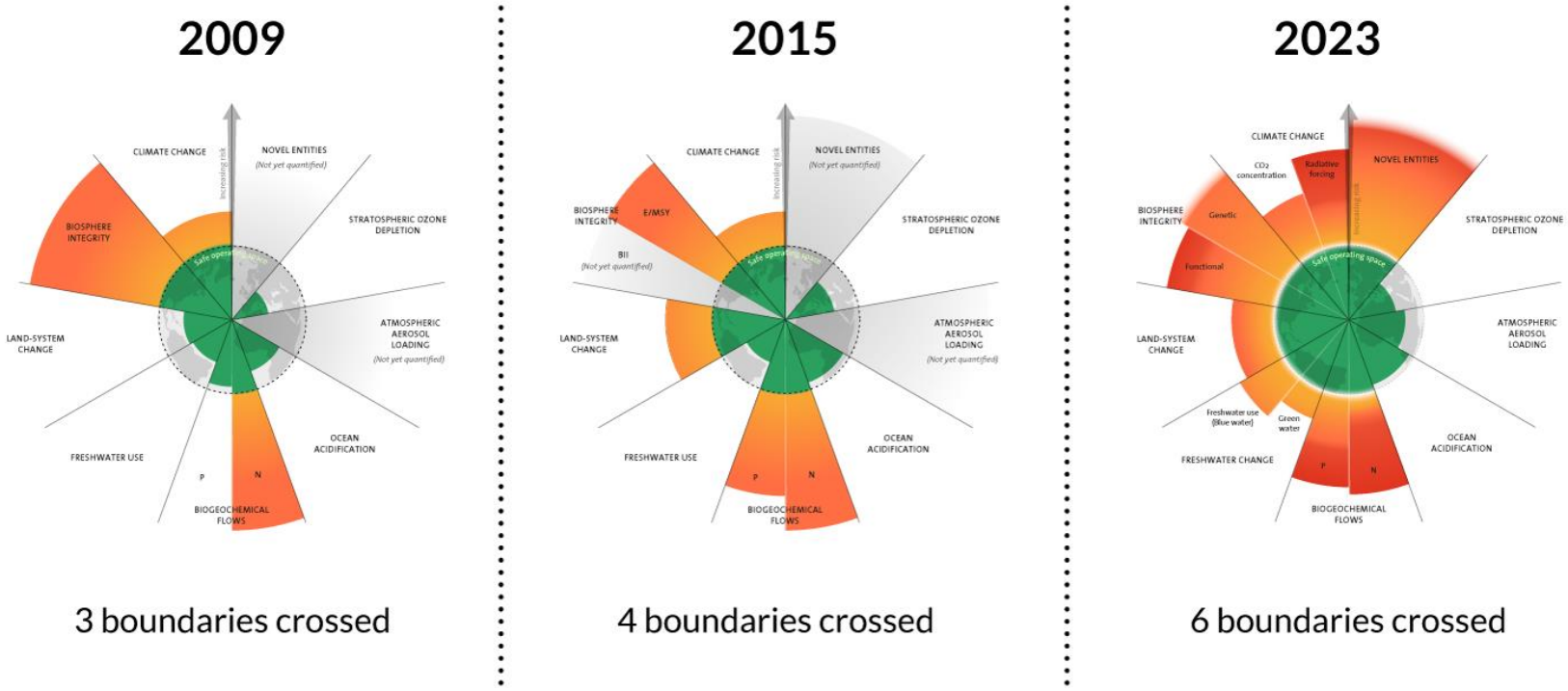
Life cycle



Azote for Stockholm Resilience Centre, Stockholm University. Based on Richardson et al. 2023, Steffen et al. 2015, and Rockström et al. 2009

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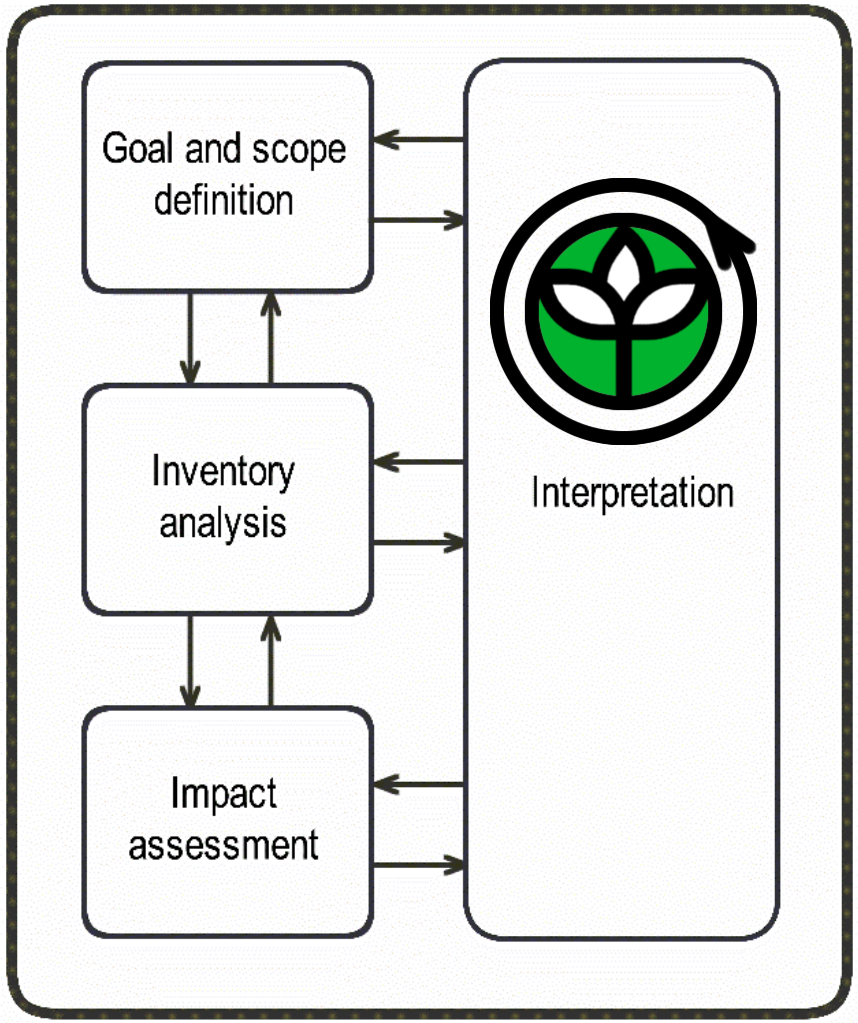
Life cycle assessment



ISO 14040:2006

ISO 14044:2006

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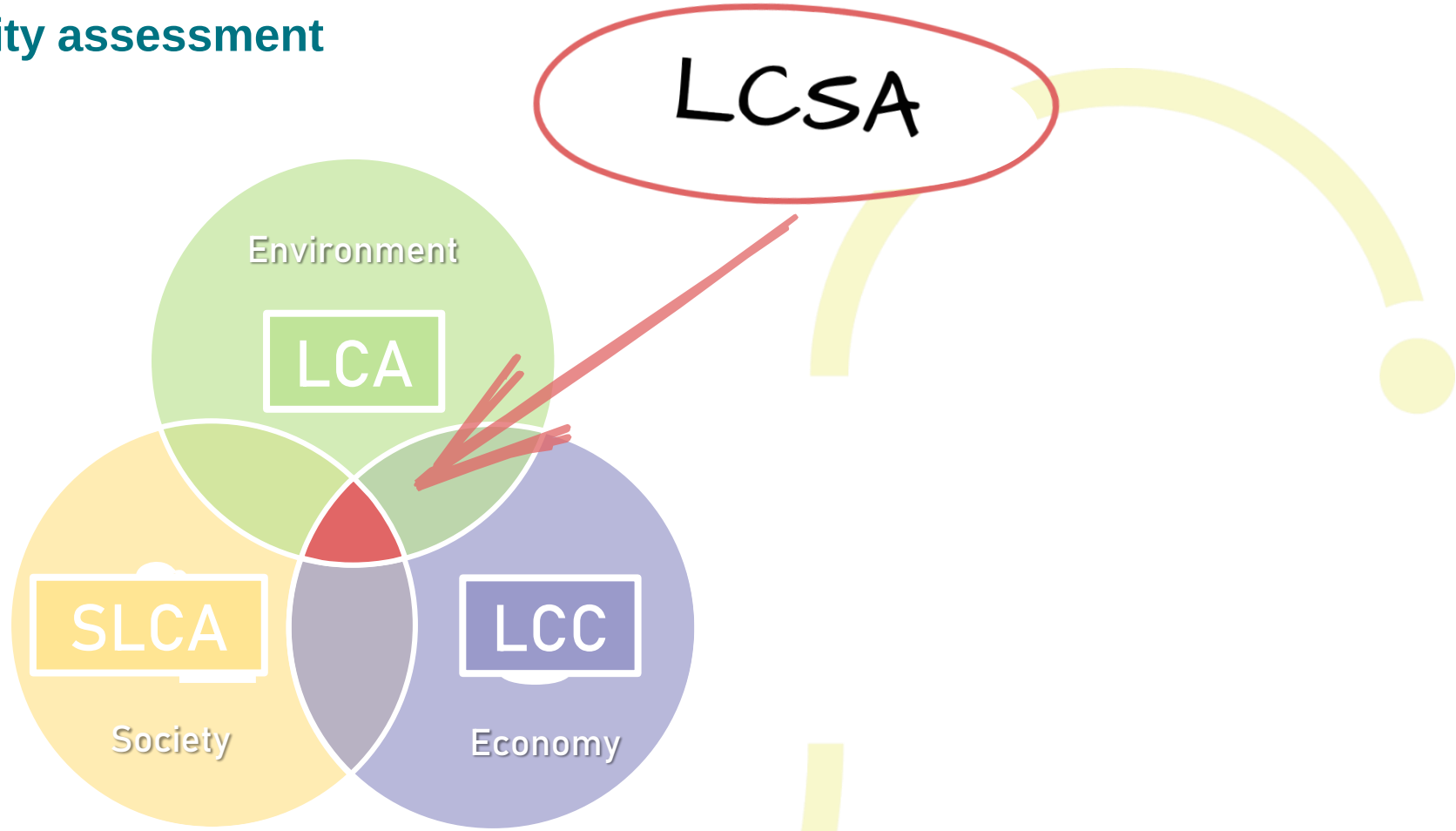
Life cycle sustainability assessment



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Eco-design

- The incorporation of environmental aspects in the stage of defining the design of a product, process or service.
- The reduction of the environmental load associated with the product or service cycle.
- Integrate actions to prevent and minimize the environmental impacts associated with the product in the design or redesign stage.
- Actions aimed at environmental improvement of the product in the initial design stage through its function, selection of less impactful materials, application of alternative processes, improvement in transportation and use, and minimization of impacts in the final stage of treatment.

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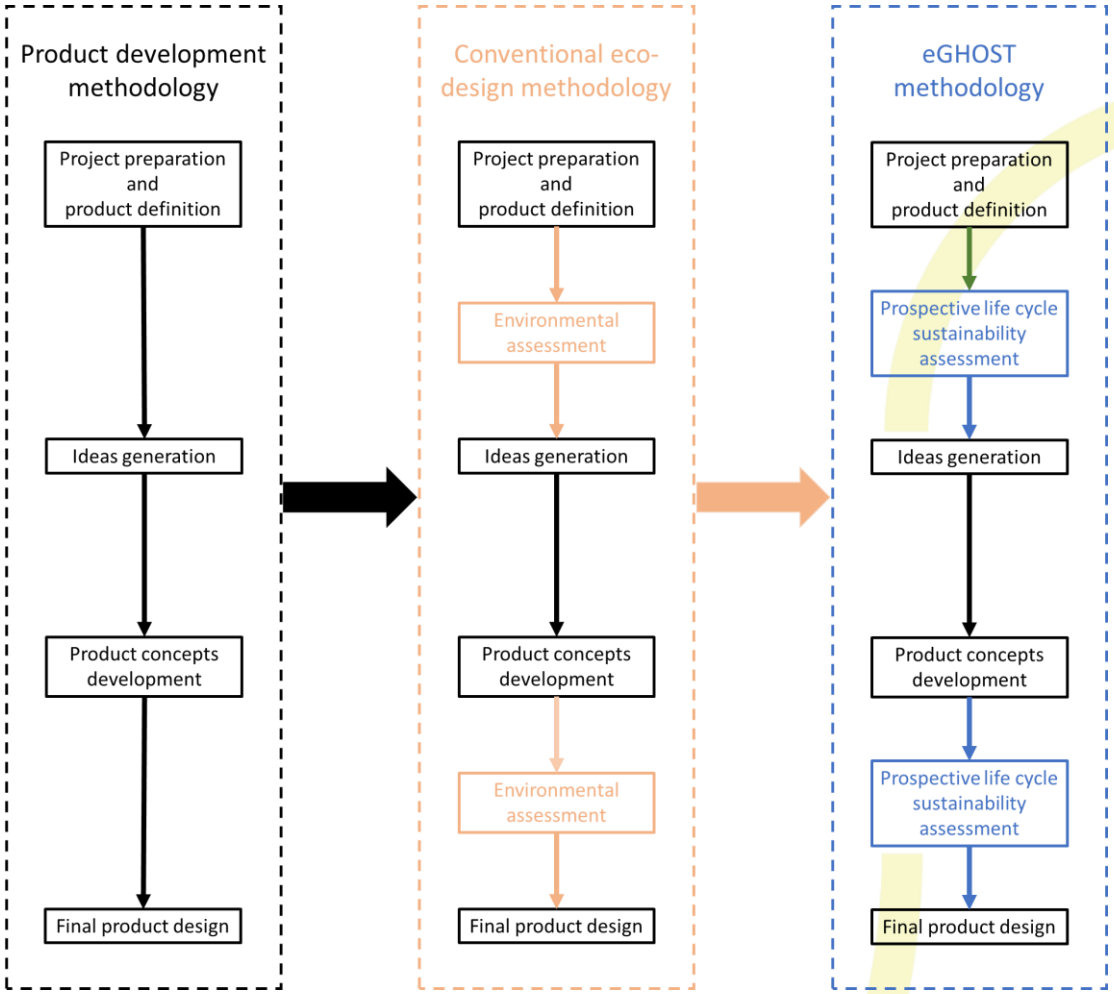
Eco-design



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SUSTAINABILITY ASSESSMENT OF HARMONISED HYDROGEN ENERGY SYSTEMS

For further information, please visit:

http://sh2e.eu

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