Aalto University
School of Arts, Design
and Architecture

Sustainable design S7

Tatu Marttila
Monday 13.5.2024

Agenda

13.15–13.45

Sustainability assessment in design – discussion & recap

Readings for the session

13.45–14.30

Circular economy (CE) & systemic sustainability; PSS design for CE

14.30–14.45

Break

14.45–16.00

Assessment and redesign exercise, part 1 – going through topics

Assessment and redesign exercise, part 2 – preps for session 8

Sustainability assessment in design – a recap

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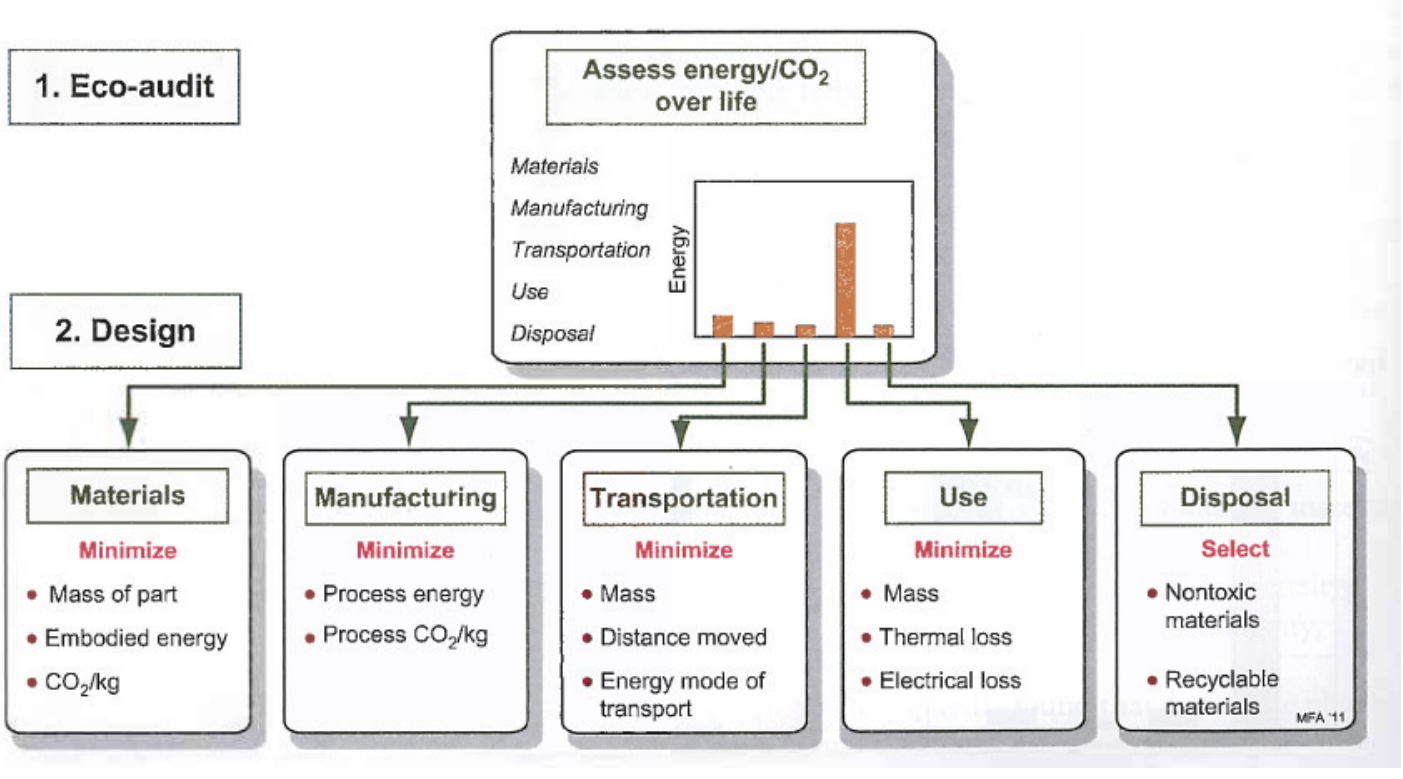
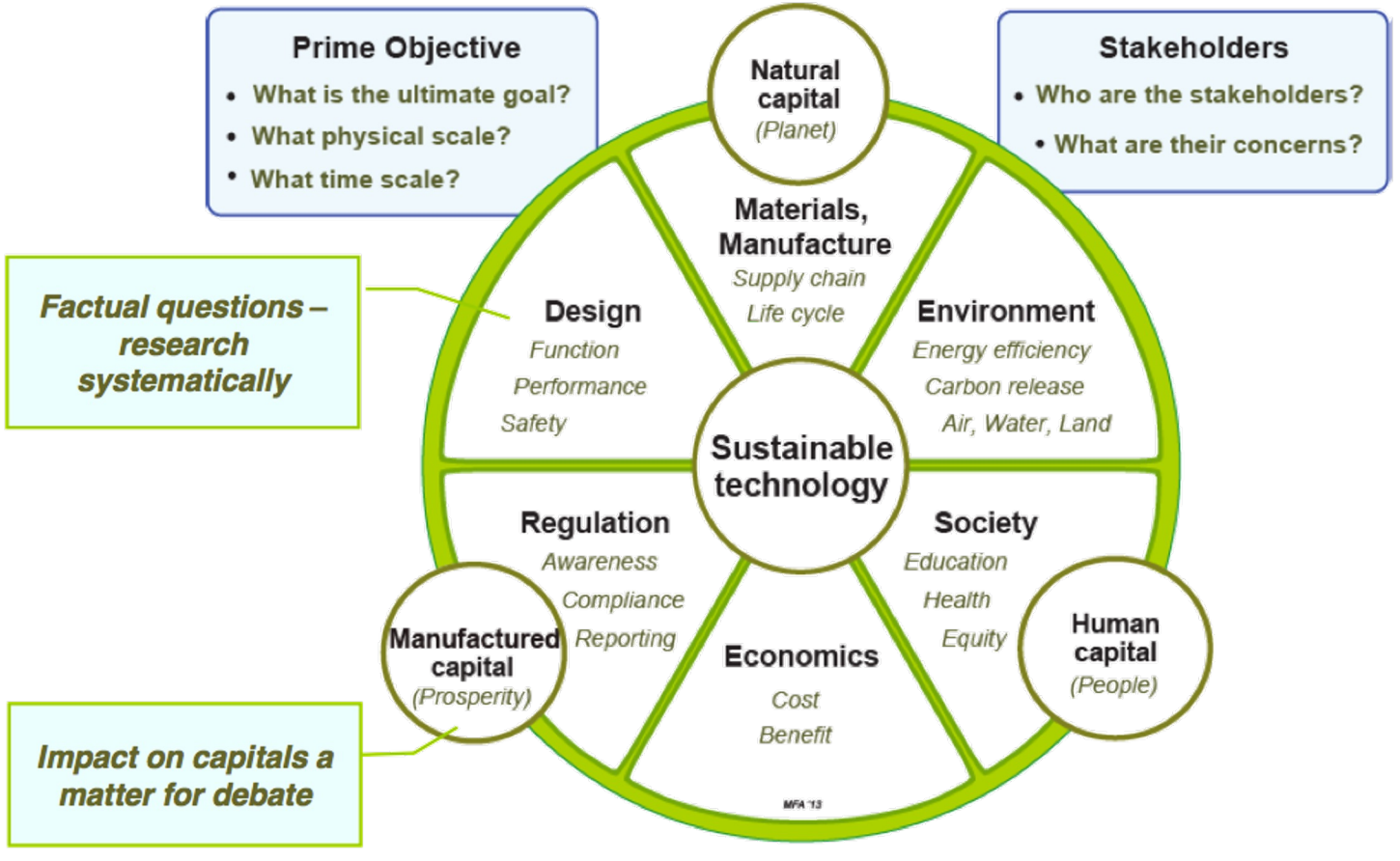
Product level life-cycle assessment:



Source: Ashby, M. (2012) Materials and the Environment: Eco-Informed Material Choice

Systemic sustainability assessment:



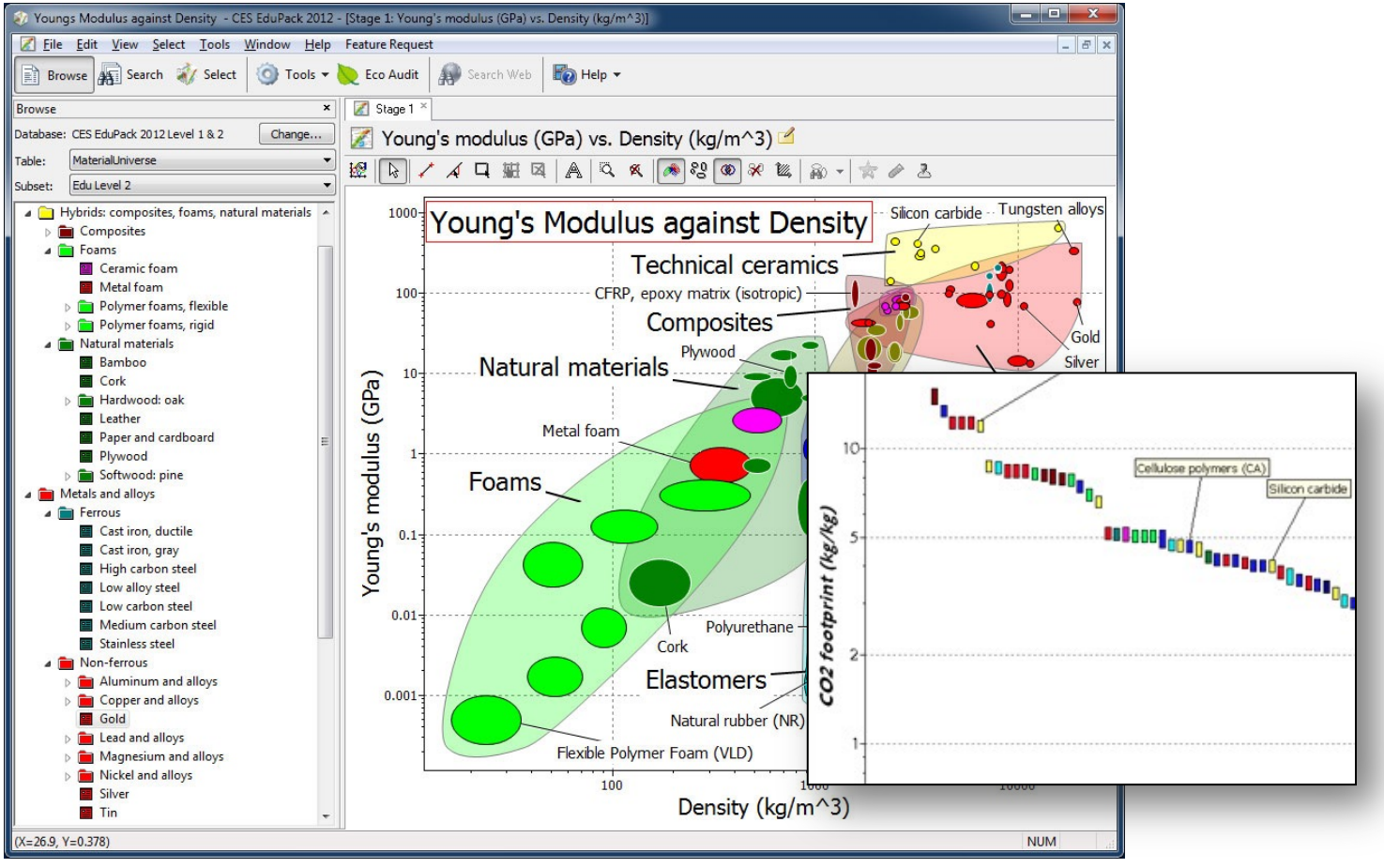
Source: Ashby et al. (2013) Materials & SD

Qualitative SLCA approach – MET matrix:

MET (materials, energy, toxicity) matrix/table is an SLCA tool/method to manage research in eco-auditing and LCA processes:

Life phase	Materials	Energy	Toxicity
Raw materials	List of components and materials	Embodied energy	Issues in materials production; eg. CO2
Production processes	List of production processes	Energy consumption in production	Eg. CO2 in manufacturing
Transport/ logistics	Infrastructure in transport & logistics	Energy consumption in logistics	Means of transport? CO2 per kg?
Use phase	Materials needed during use (eg. Coffee filters)	Energy consumption during use	Waste of consumables
End-of-Life (EoL)	EoL choices for components/materials	Impacts of EoL choices	Impacts of EoL choices

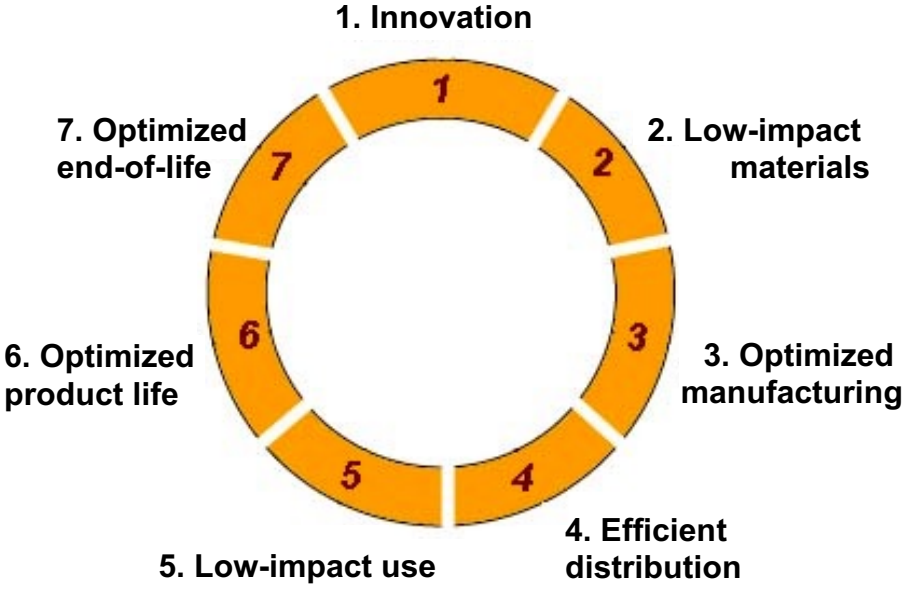
Quantitative data-driven approach:



See session 5 slides for Granta Edupack intro…

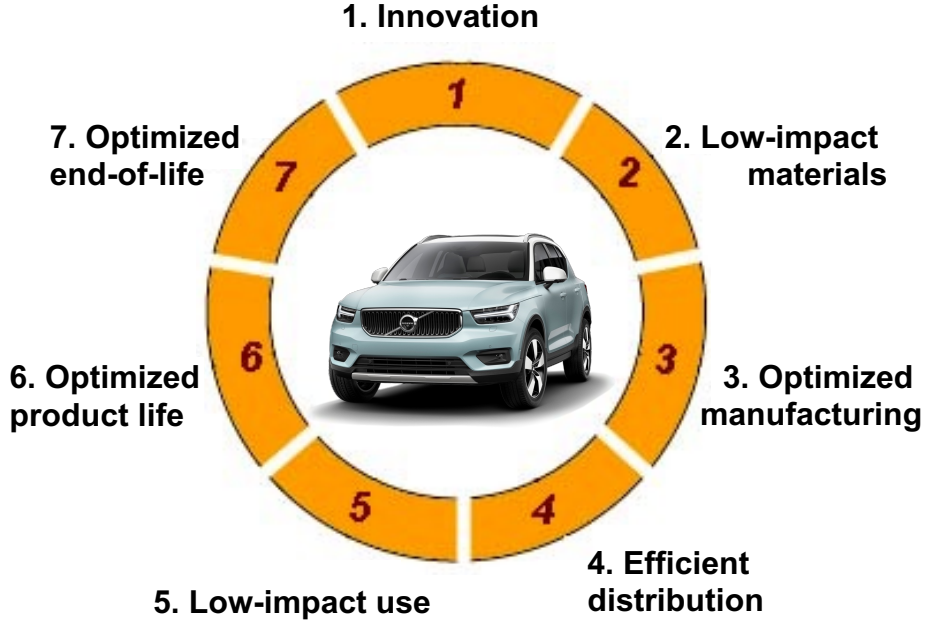
EcoDesign checklist: Strategy wheel

1. **Define the product idea, product concept or existing product that will be analyzed. Evaluate existing system or your concept.**
2. **Systematically score the product on each dimension of the strategy wheel, linked to life phases of the product.**
3. **Consider the optimization options for each of the dimensions, paying special attention to those where the current design scores badly.**



EcoDesign strategy wheel by TU Delft

Strategies to improve product sustainability



Readings for the session

Readings for this session

Allwood, J., & Cullen, J. (2010). Sustainable Materials – with Both Eyes Open

Chapter 16: Longer life products

Chapter 17: Reducing final demand

Longer life products

Potential to extend lifespan of products:

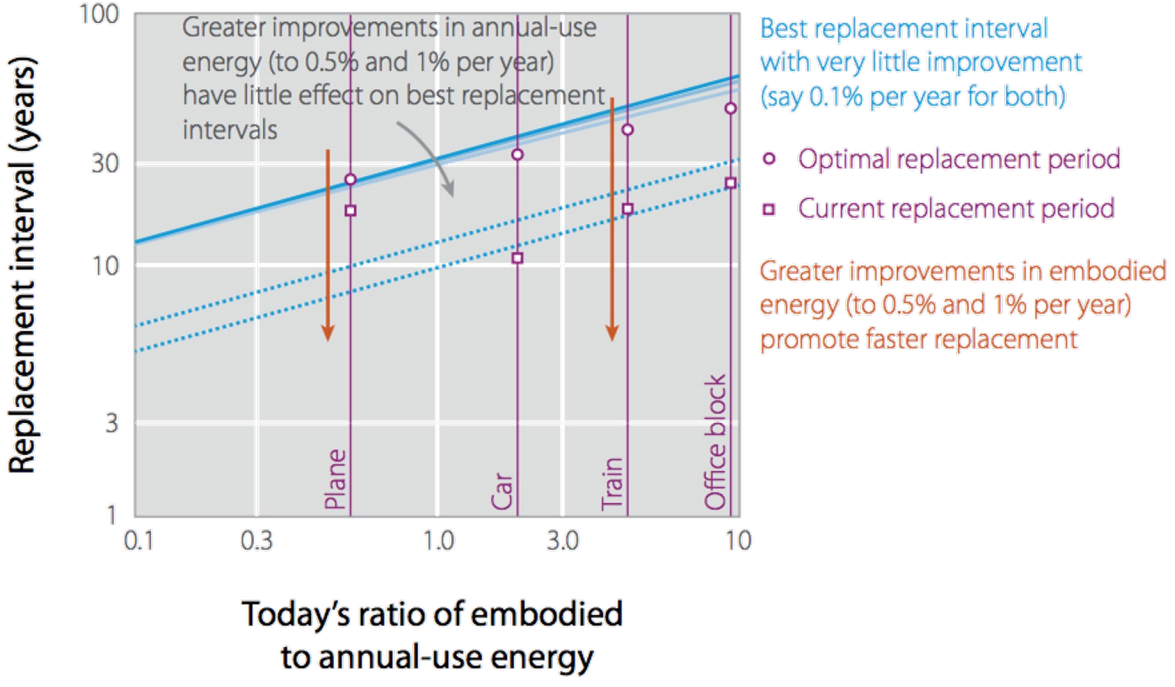


Figure 16.2—**Predicted product replacement intervals to minimise use and embodied energy**

Longer life products

Why do we replace goods? Why products are discarded – types of failure:

	... relative to when it was purchased	... relative to what's now available
The product's performance has declined ...	Degraded e.g. rail track	Inferior e.g. washing machines
The product's value has declined ...	Unsuitable e.g. sports car	Unwanted e.g. single hulled oil tankers

Table 16.1—**Types of failure**

-> Strategies to avoid product failures?

-> Consider also: Increased efficiency in use vs. longer life spans

Longer life products

Strategies to improve product life:

	... relative to when it was purchased?	... relative to what's now available?
Has the product's performance declined ...	Durability when degraded	Upgrade when inferior
Has the product's value delcined ...	Cascade when unsuitable	Design for recycling when unwanted

Table 16.3—**Strategies for 'peeling the onion'**

-> 'Onion skin model': Material considerations in design

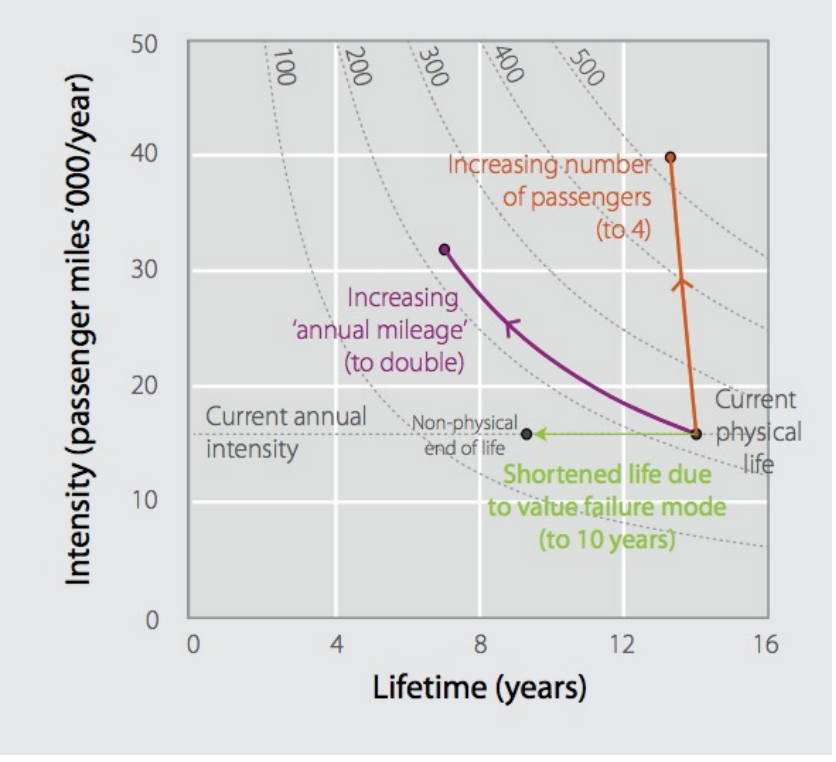
-> Consider: Modularity, repairability, recycling

Reducing demand

Providing more services with less materials

More intense use and reduced impacts per ‘service unit’ (eg. person / km travelled)

Example: Vehicles

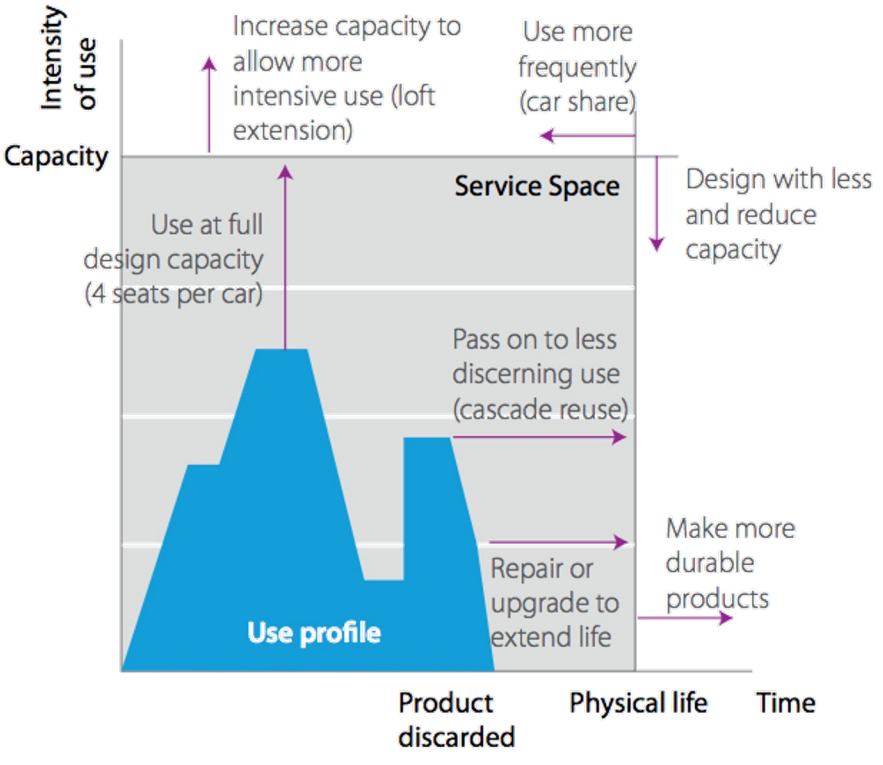


Reducing demand

Design strategies to improve material efficiency: Extending lifelifetime vs. more intense use

Services connecting with capacity increase and lifetime management

Reality? Problems?



Reducing demand: GDP & happiness

Connections with prosperity and emissions

Disconnecting happiness and material demand?

Design for Sufficiency?

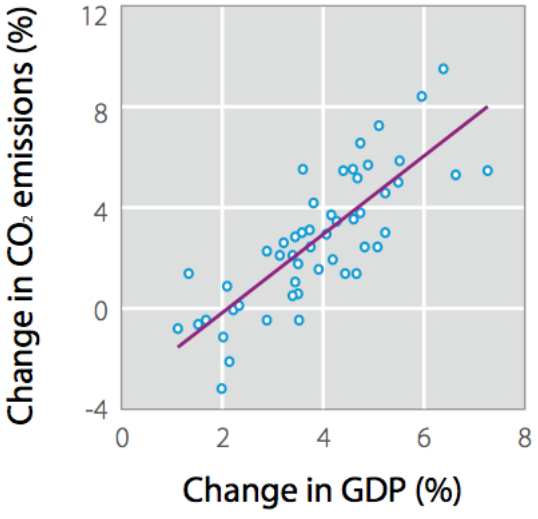


Figure 17.3—**The relationship between emissions and GDP**

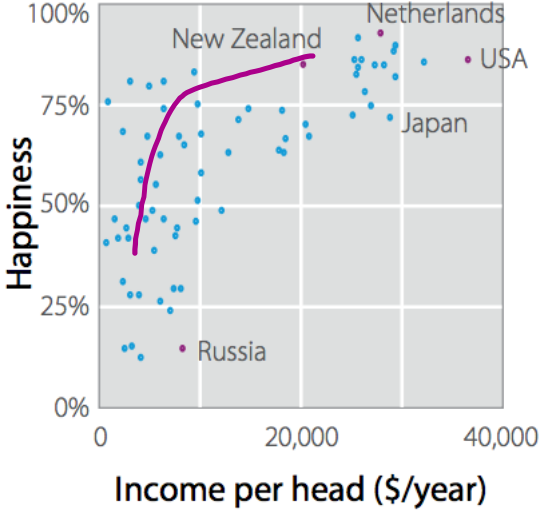


Figure 17.4—**The relationship between GDP and happiness**

Summary

Ecodesign and sustainability in design is based on:

- Increasing material/energy efficiency / decreasing negative impacts in production and end-of-life
- Increasing efficiency during use phase (per ’service unit’)
- Decreasing consumption (behavior change; sufficiency)

-> In policy development level (in EU):

- Sustainable Consumption and Production (SCP) scheme including various dimensions, e.g., eco-labels, eco-design directive (on electicity use)
- Extended Producer Responsibility (EPR) at various sectors (e.g. electronics, vehicles): Producers are responsible of the recycling of their products
- EU’s Circular Economy action plan

Circular economy and systemic sustainability

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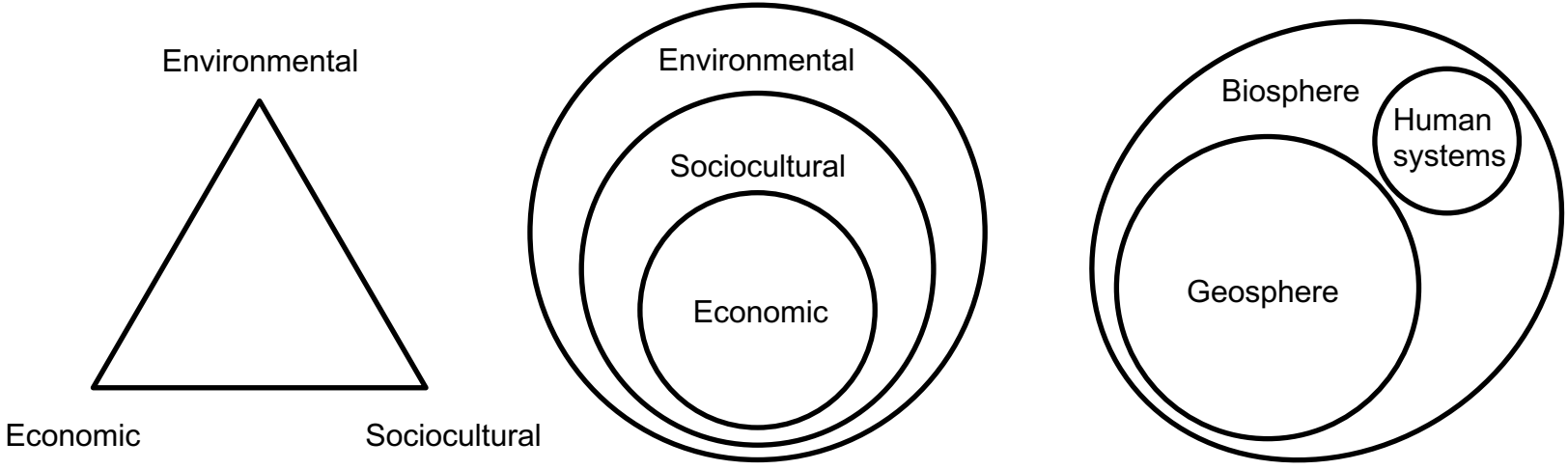
Different models to discuss sustainability

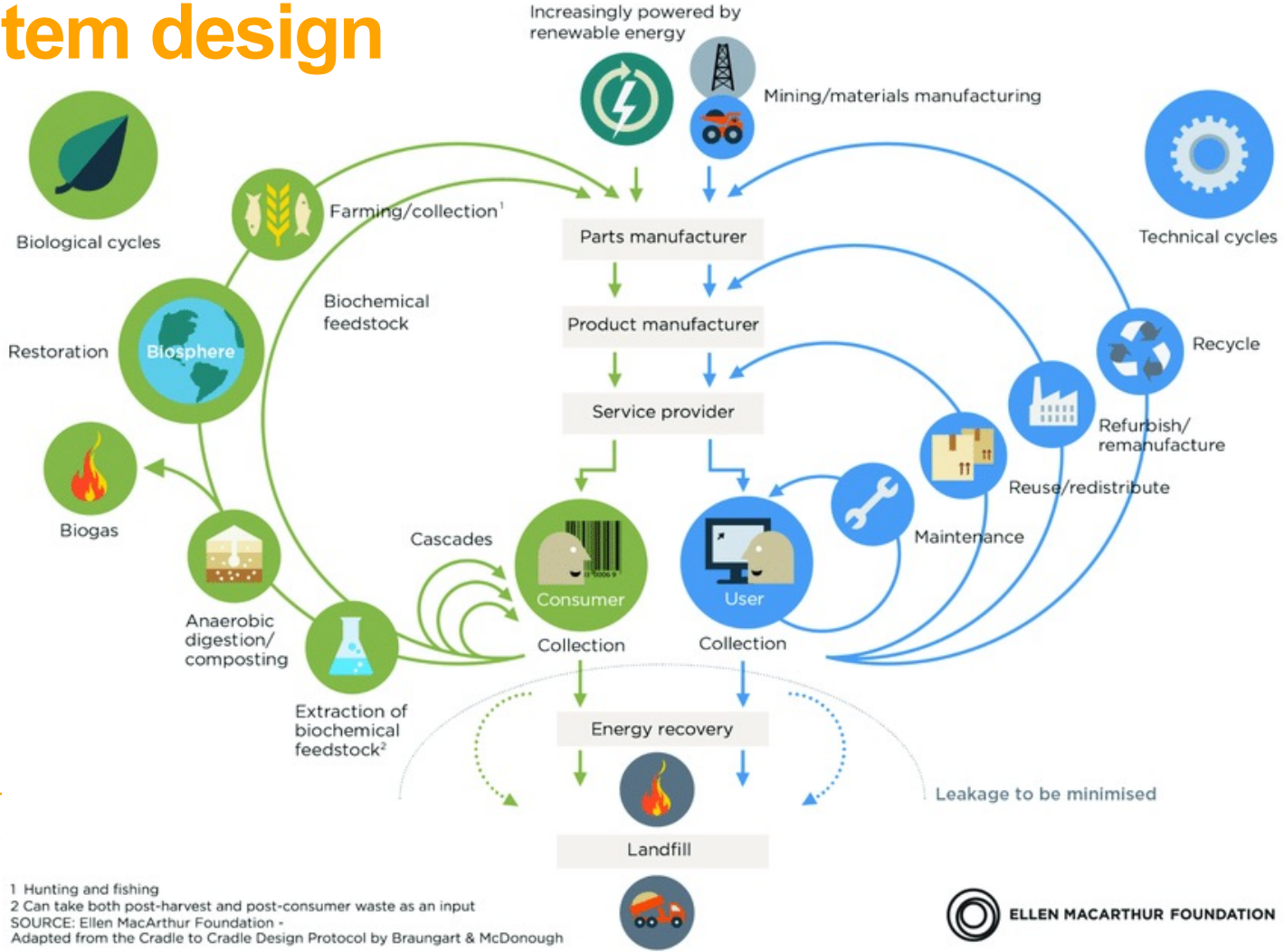


Different conceptual/systemic approaches to sustainability: *Triple-bottom line perspective (Elkington, 1994), nested model (IUCN), and a model that is not anthropocentric.*

Sustainable Development Goals

The SDG ‘wedding cake’. Source: Stockholm Resilience Institute.

Circular economy & system design



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input
SOURCE: Ellen MacArthur Foundation -
Adapted from the Cradle to Cradle Design Protocol by Braungart & McDonough

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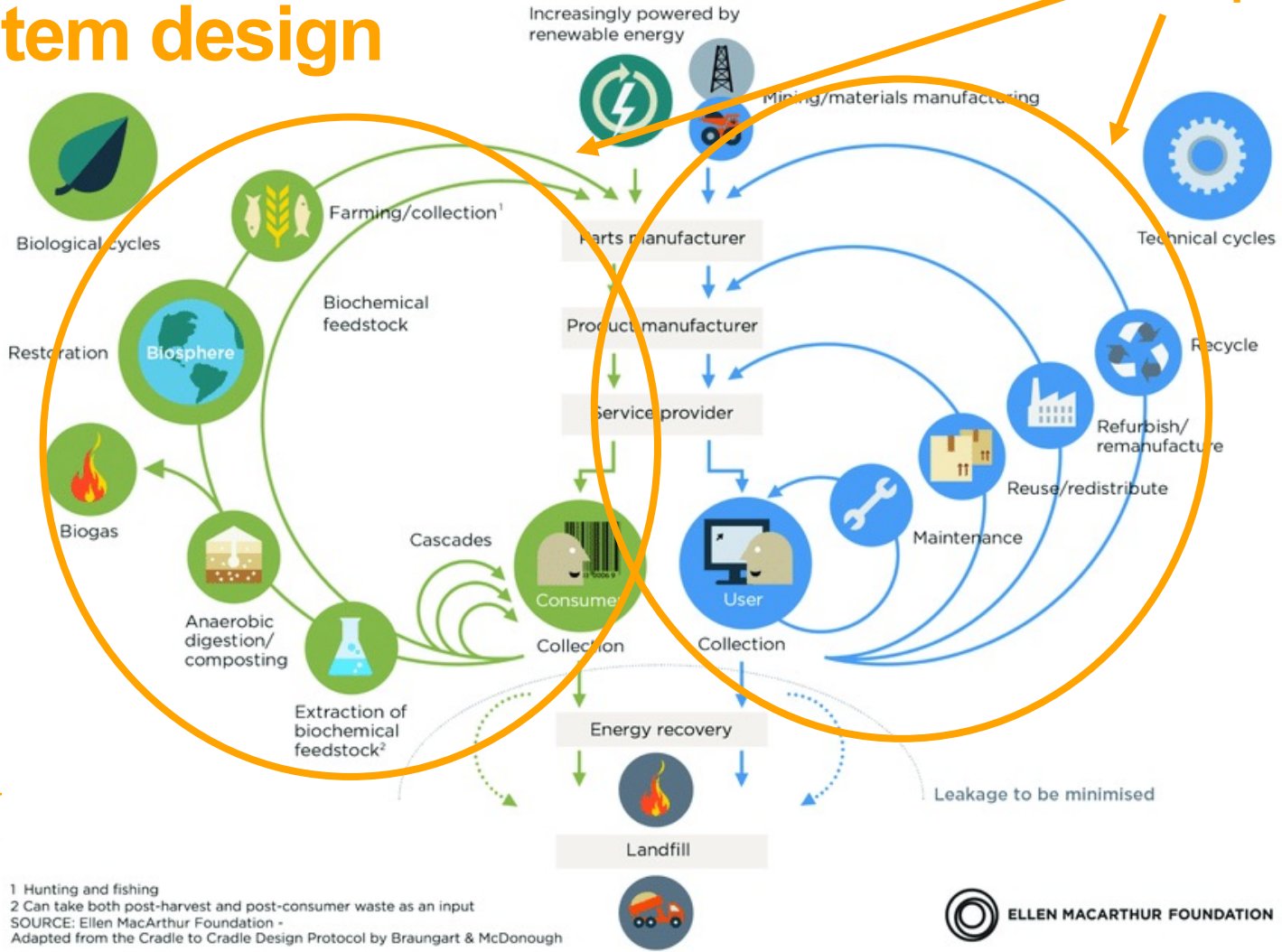
Circular economy & system design

Services rather than products!



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Product-service-system (PSS) design

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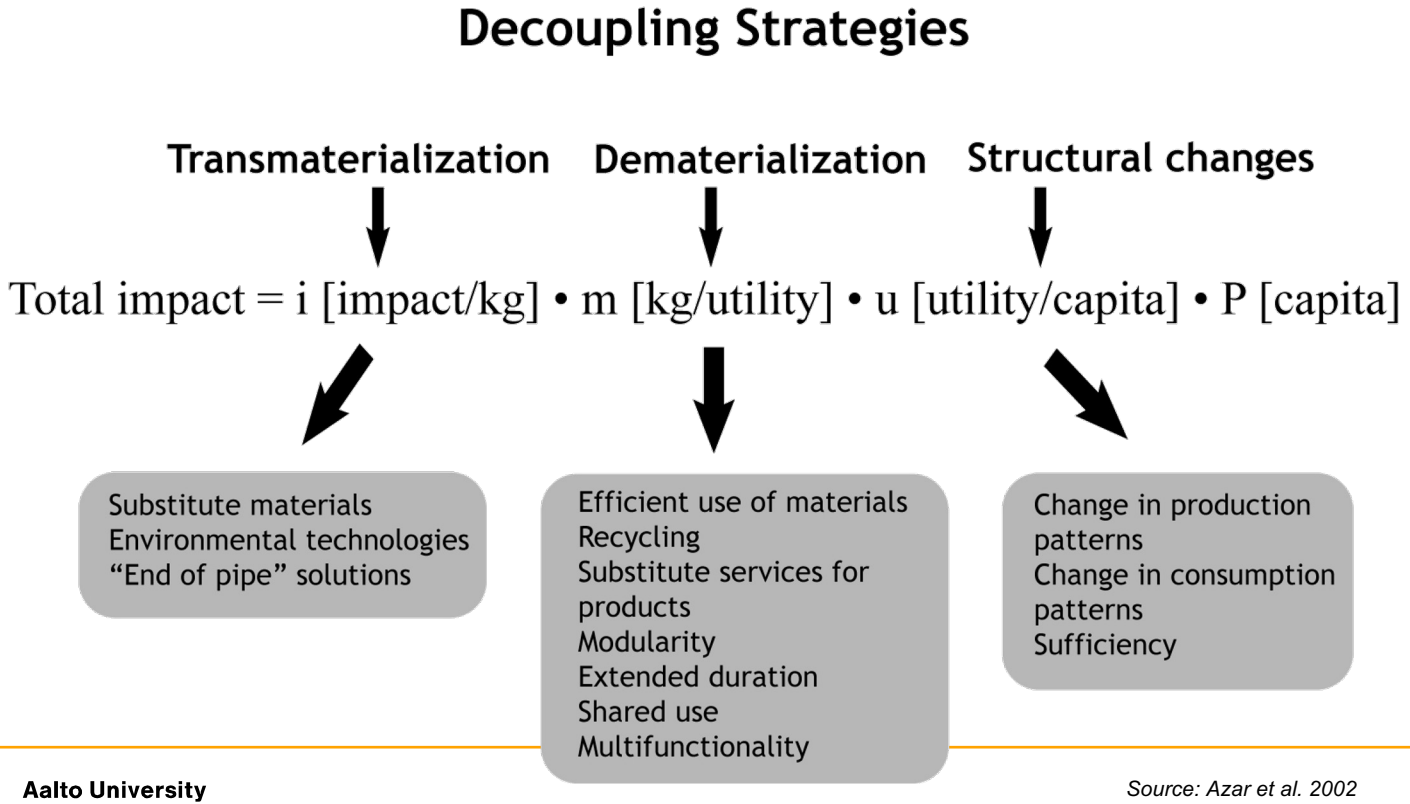
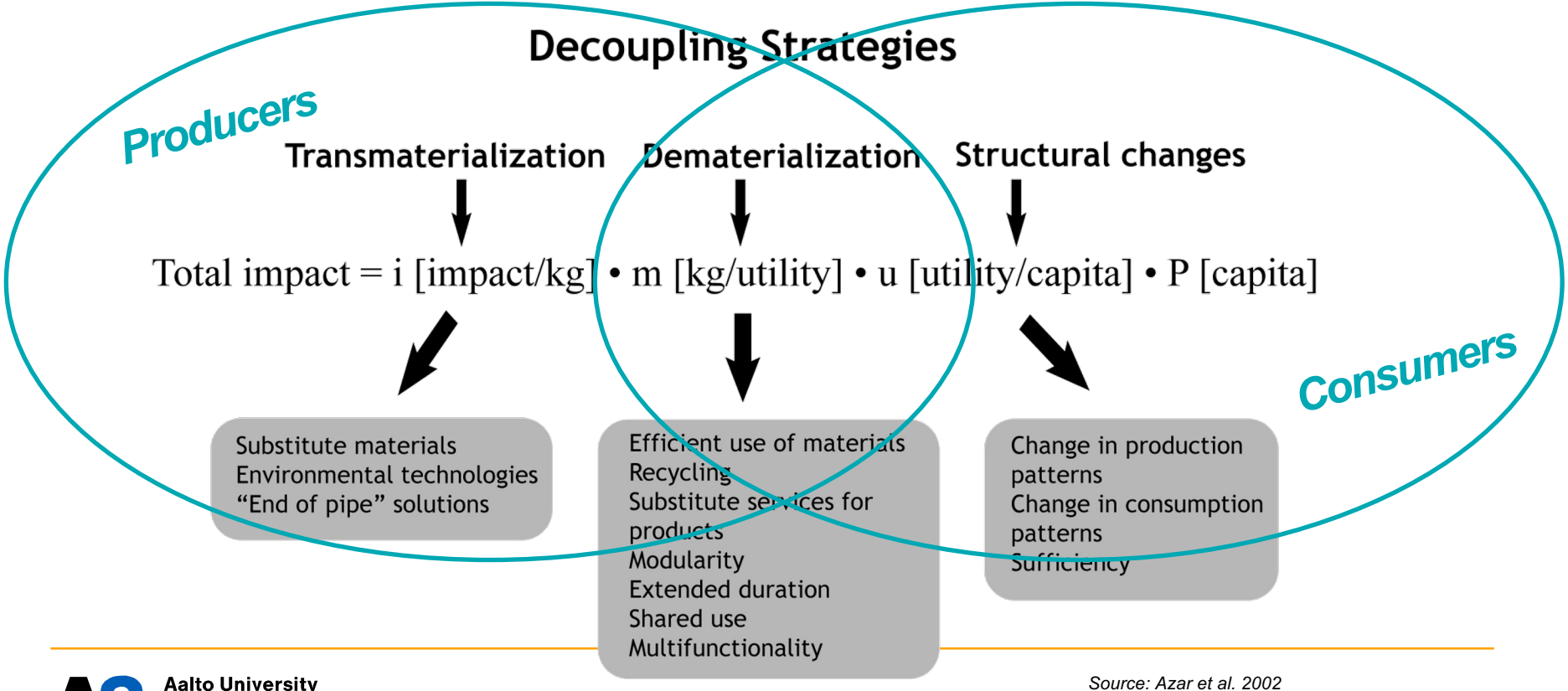
Strategies for Sustainable Consumption and Production



Source: Azar et al. 2002

Strategies for Sustainable Consumption and Production



Source: Azar et al. 2002

Product-Service systems (PSS) design

Products as artifacts offer interfaces to functions and services they provide. Product-Service System (PSS) design moves the focus of design action towards the whole system of service provision, and systemic efficiency and/or value addition within it.

- Assessing impacts per service-unit rather than product (e.g., km driven/CO2)
- Assessing ‘system’ efficiency and sustainability

PSS design considers alternative business and service models that could provide improved sustainability by adjusting ownership and revenue models, and adding more stakeholders into the process.

- Changing product ownership: services instead of products
- Co-governance in design and management

Sustainable Product-Service systems

However: There are several types of PSS – not all PSS are by default sustainable!
(Tukker, A. 2004; Mont, O. 2001)

Three key elements in creating new, innovative, and sustainable PSS concepts:
1) Innovative stakeholders network;
2) A shift from selling products to selling results;
3) A change in product and resources ownership.
(Vezzoli, C. and Ceschin, F. 2008)

Switching from product sales to selling a functional result has most sustainability potential. Here, the provider agrees with the client the delivery of a result.
(Tukker, A. 2004)

Example: Selling office lighting in lux per meter (Philips) or clean air per cubic meter

Different types of PSS

There are different types of PSS depending on how and where the value is created (Tukker, 2004).

- **Product oriented PSS** focuses mainly to extend the existing product-offering
- **Use oriented PSS** covers various models of leasing/sharing/pooling of products
- **Result oriented PSS** focuses to deliver a (novel) service with a 'functional result' (i.e., satisfy user need without product/material ownership)

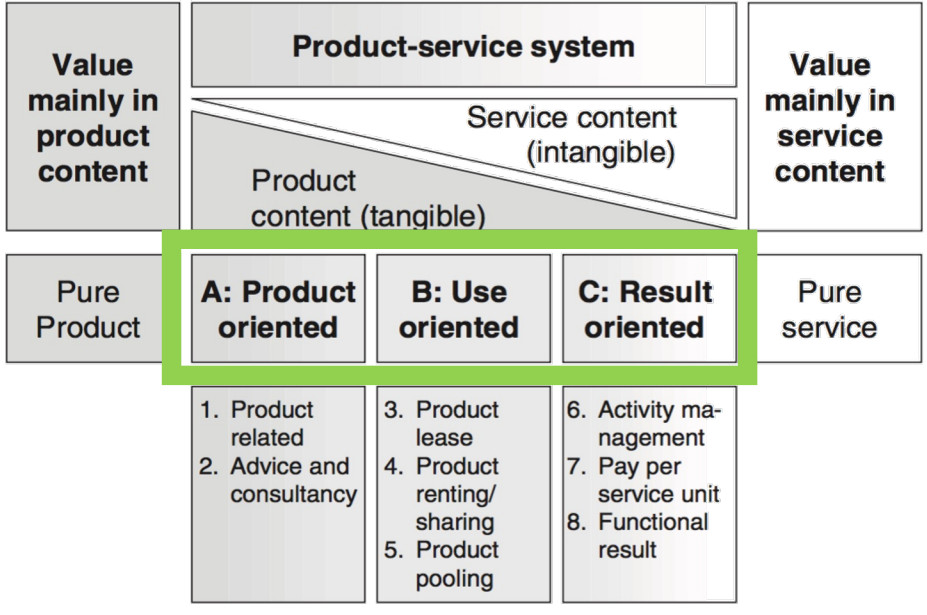


Figure 1. Main and subcategories of PSS

See: Tukker, A. 2004

Sustainable PSS: Examples

Product oriented:

Use oriented:

Result oriented:

Sustainable PSS: Examples

Product oriented:

Use oriented:

Result oriented:

Sustainable PSS: Examples

Product oriented:

Use oriented:

CITYCARCLUB

couchsurfing

Result oriented:

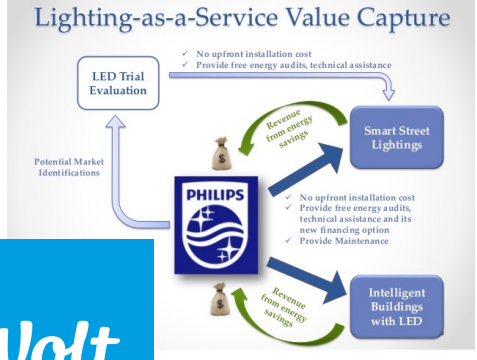
Ruoka-Osuuskunta
KAUPUNKILAISTEN OMA PELTO

Sustainable PSS: Examples

Product oriented:

Use oriented:

Result oriented:

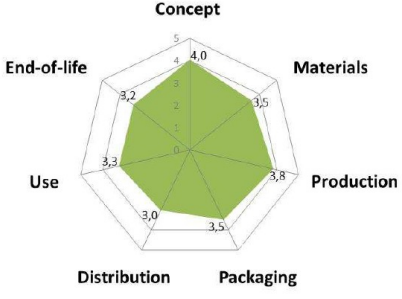


Sustainable PSS: Examples

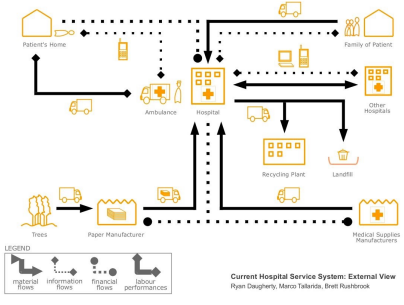
The PSS design process conforms to the conventional design process, starting from strategic analysis and opportunity exploration to ideation and system design, and to the further iteration and prototyping of the (PSS) design concept.

Methods and tools for PSS design cover various ecodesign and service design tools, and also the facilitation of strategic co-design and prototyping:

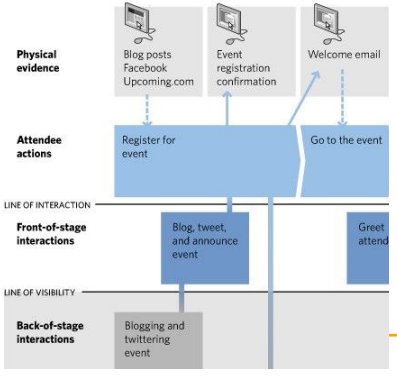
(Systemic) impact assessment



Stakeholder and system mapping

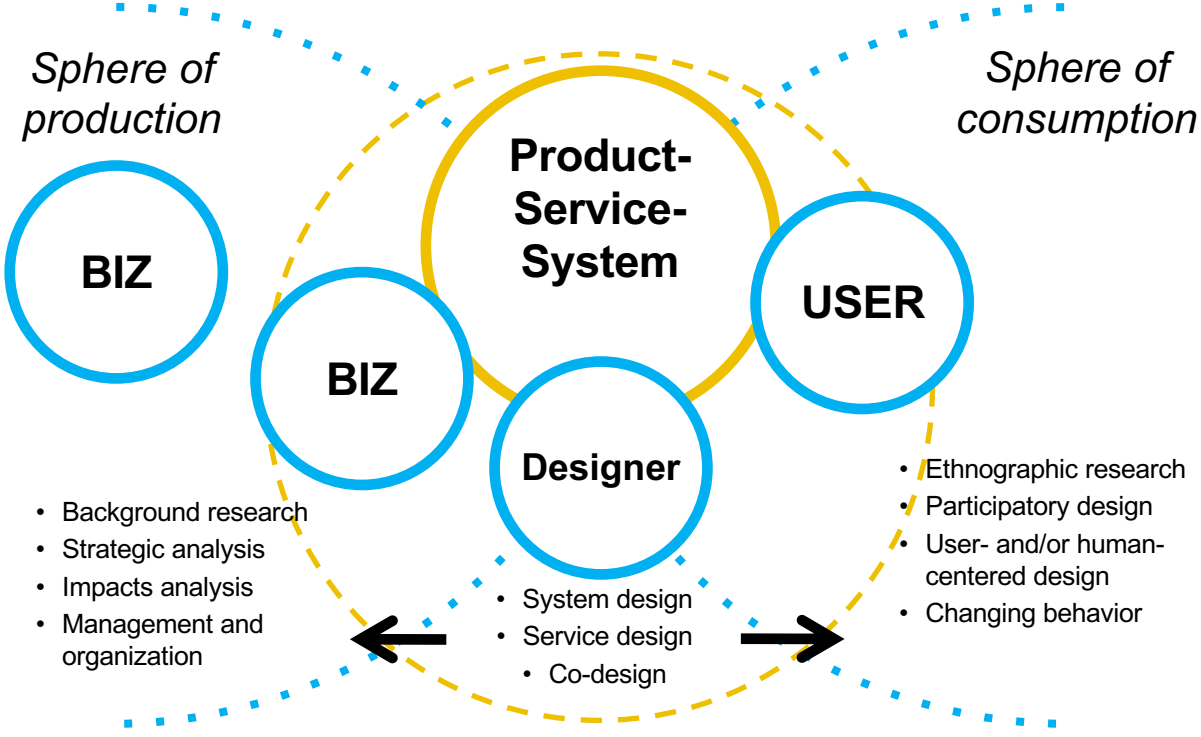


Service interaction blueprinting



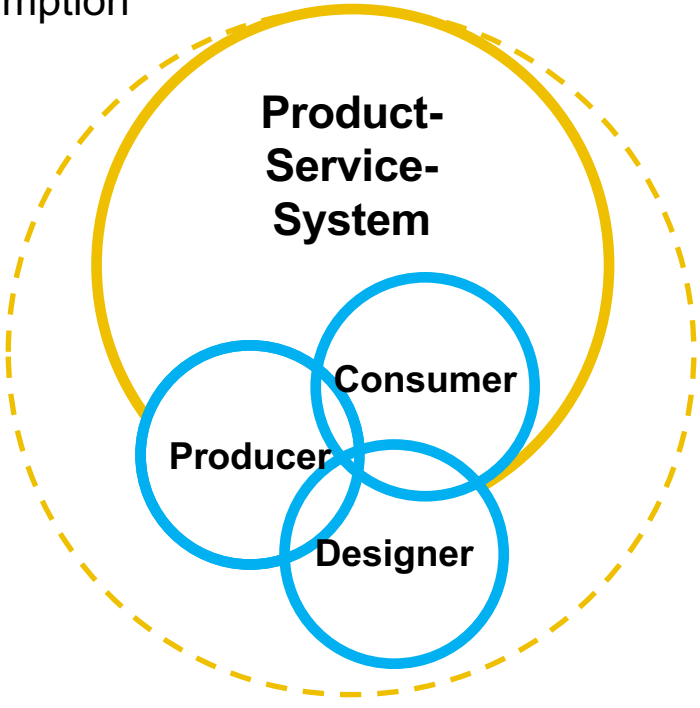
Strategic co-design, collaborative prototyping

Sphere of sustainable PSS design focus



Sphere of sustainable PSS design action

Sustainable consumption and production at the interplay of stakeholders:



Sustainable PSS:

- ✓ Functional results as a goal
- ✓ Expanded stakeholder network
- ✓ Sharing vision
- ✓ New roles for stakeholders
- ✓ Ownership into system processes and components

Circular economy as a context for PSS design

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Circular Economy (CE) as an economic model

Circular Economy (CE) as an economic model builds on the understanding that the linear material flows of global production and consumption systems cannot continue on their current trajectory. Instead, **more circular material systems are to be embraced** (see e.g., Brandão, M., et al. 2019).

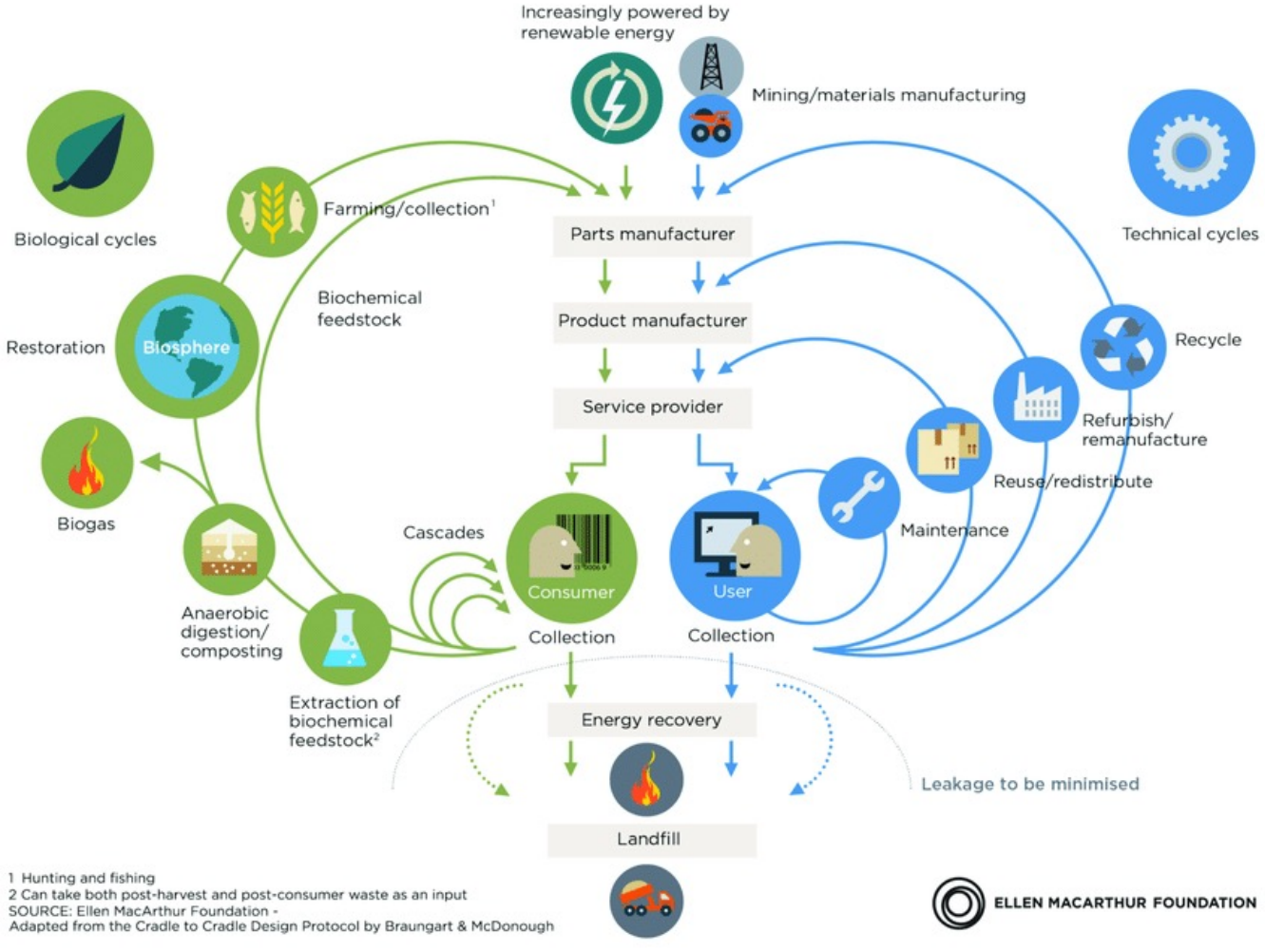
CE seeks changes especially in the way we use (organic and technological) raw materials in production and consumption. It connects to novel offerings and interactions in both **business-to-business (B2B)** and **business-to-consumer (B2C) service domain,** and also to support various actors the CE transition (e.g, research collaborations).

Also the EU has endorsed CE as a model in its Circular Economy Action Plan (CEAP; 2015), with emphasis on improving resource use and recycling, waste prevention, and promotion of more holistic design.

CE closing material cycles

CE entails a systemic view, and focus on various organic and technological material cycles.

PSS design for CE thus seeks possibilities for **closing the loops** on various stages of the value chain, and more efficient, circular and extended use (and reuse) of products and materials.



Focus areas for PSS design in CE context

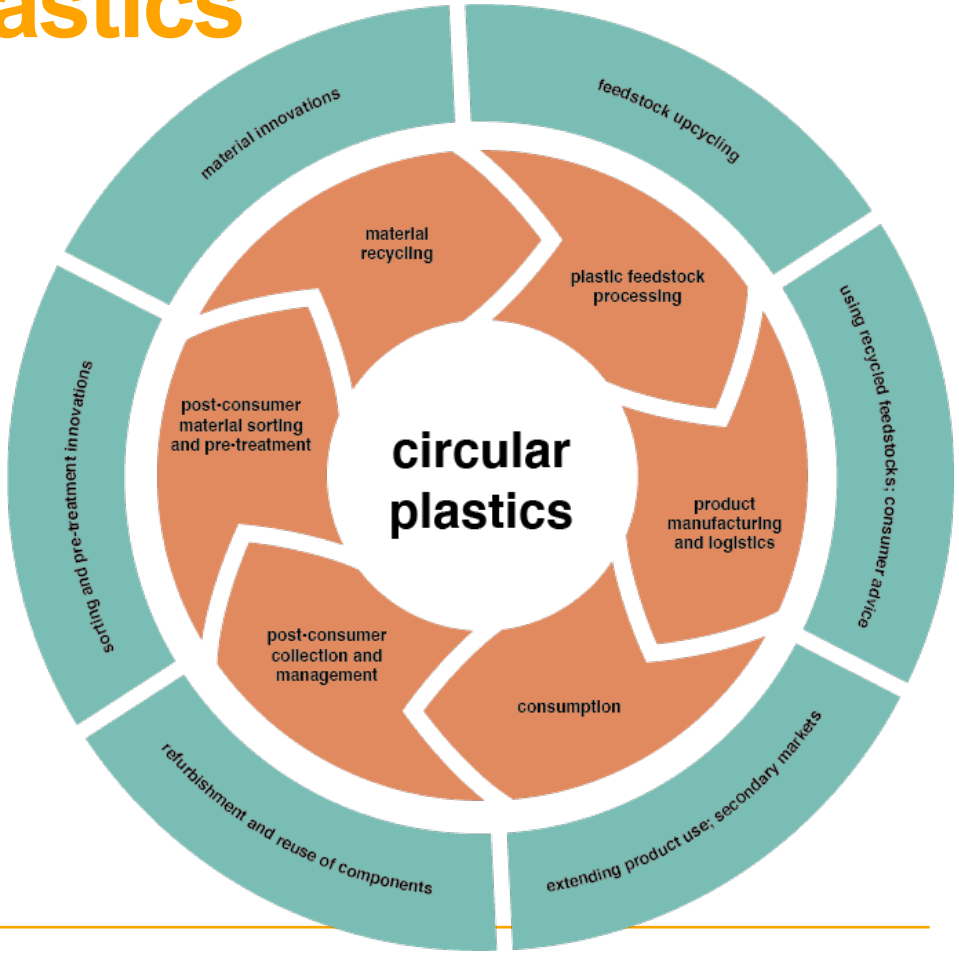
PSS design seeks systemic efficiency, and CE moves focus to efficiency in material use and circularity, empowering changes in consumption and production. **Hence, the focus areas for PSS design in CE context can be as follows:**

- **Improved management of material flows:** PSS designs can offer ideas to both B2C and B2B to enhance material-use efficiency, recycling, and/or reuse of waste and side streams.
- **Services and strategies to extend product life:** To extend product- and material-life, both B2C and B2B, as well as community PSS solutions can be developed (e.g. repair, recycle).
- **Efficient end-of-life systems:** PSS offerings can also help in developing efficient take-back systems to support recycling especially in B2C but also in B2B domain.
- **Visibility to material circularity in consumption and production:** DfS and PSS design for CE is also communicating the urgency and need to change patterns of our material use.

PSS for circular plastics

The EU promotes circular plastics for example with new packaging directives that require producers to collect and recycle plastics from packaging.

Several PSS opportunities can be identified in the circular plastics value chain, especially in B2B domain between recyclers and producers, as well as in B2C domain in relation to product-life extension, and efficient end-of-life services.

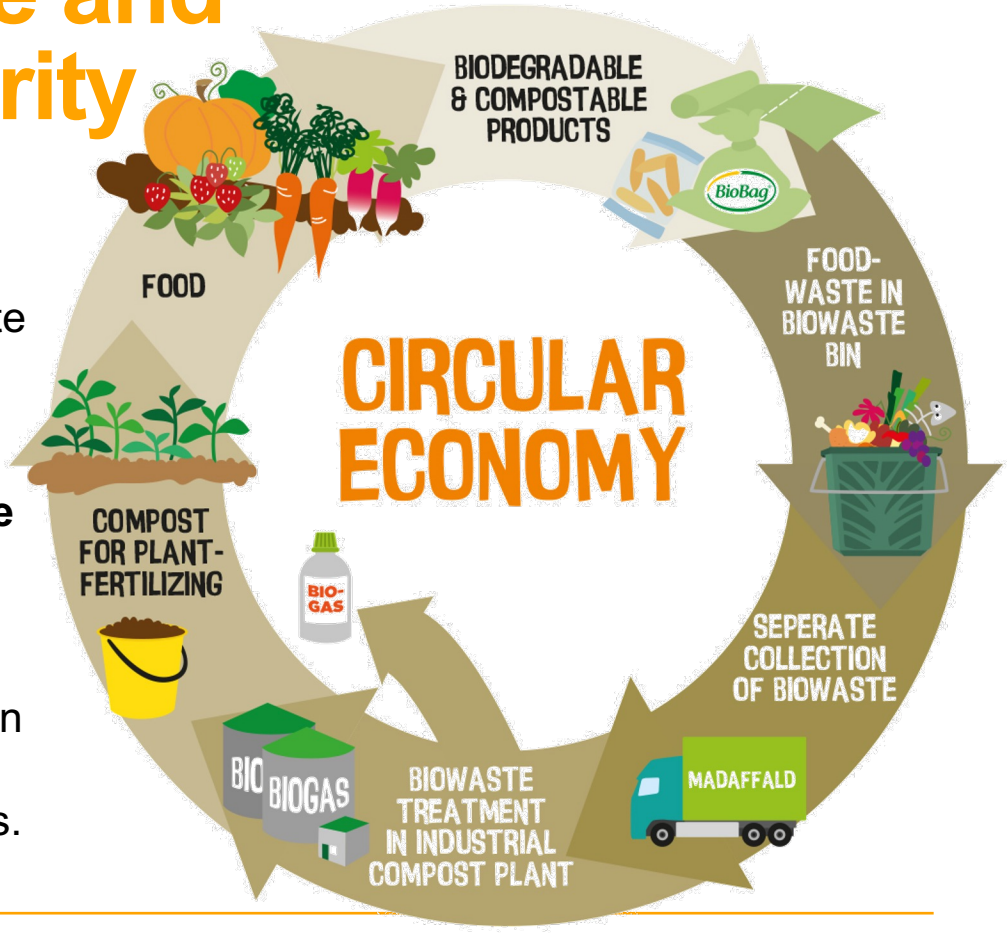


See European Strategy for Plastics in CE. https://www.europarc.org/wp-content/uploads/2018/01/Eu-plastics-strategy-brochure.pdf
See also the NONTOX project and its ecodesign guidelines: https://www.nontox-ecodesign.org/

PSS for food waste and bioplastics circularity

The EC Scientific Advice Mechanism (SAM) also promotes use of bioplastics in contexts where it is challenging to separate plastic from organic material (e.g., food system products).

Several PSS opportunities can again be raised along the material cycle,in B2C domain especially with recycling information, collection systems, and efficient end-of-life use, and in B2B domain in the form of improved use of waste side streams and sales of e.g., energy services.



See SAPEA, Science Advice for Policy by European Academies. (2020). *Biodegradability of plastics in the open environment*. Berlin: SAPEA. https://sapea.info/topic/biodegradability-of-plastics/

Sessions 5–8: Assessment and redesign exercise

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Assessment & redesign exercise (sessions 5–8)

Assessment and redesign exercise consists of two parts:

1. **Assessment of sustainability impacts (of product/material)**
2. **Redesign improvements**

- **Exercise is done independently, assessment followed by redesign;**
- **Final results are communicated on this Friday (DL for uploads on Thursday) with a digital poster and pitch talk**
- **Prsesntations in three groups: see MyCourses announcement on groups and locations after this session!**
- **Reflection on assessment in learning diary after session 8!**

Assessment & redesign exercise: (part 1)

In the assessment part (part 1) of the exercise, you first select a product/material for assessment, and then perform a simple assessment on your selected topic.

- Identify material(s), related processes (production, transport), stakeholders
- Identify major sustainability issues and impacts along the life phases
  - *Raw materials production; Manufacturing processes; Transport/logistics; End-of-Life (EoL) options; and/or use phase itself*
- **Consider dominant phases and sustainability issues, to suggest improvements!**

Assessment and redesign exercise: Redesign phase (part 2)

Based on your assessment, proceed to suggest improvements. You can consider for example:

- **Material alternatives**
- **New ways of production or logistics**
- **Improving societal aspects**
- **Improving efficiency in use**
- **Services and sharing**
- **Communication with design**

Assessment and redesign exercise: Poster & pitch (for next session!)

Communicate your assessment and redesign:

- **Produce a one- or two-page PDF poster; <u>Upload to MyCourses by Thursday midnight!</u>**
  - Layout option 1: Use one-page landscape layout with text and images of existing product on left side, and redesign on right side
  - Layout option 2: Use two pages with landscape format, with existing product on first page, and redesign on the second
- **Describe your topic, assessment and redesign**
- **Communicate sustainability issues and suggested improvements**
- **Present with a max 3 min pitch in this Friday's session!**

Poster example

See session 6 slides for more examples…

Product assessment

LIVERGY® Lidl sneakers
Materials: Nylon, Polyurethane
Sustainability issues:

- *Labor issues in manufacturing location (China)*
- *Material issues (fossil-based plastics)*
- *End-of-Life issues*
- *Focus life phases: Materials & manufacturing*

Redesign idea

Lidl X Ioncell® sneakers
Materials: Ioncell® cellulose fibre, recycled rubber
Sustainability improvements:

- *Improved material selection*
- *Production partner with fair labor conditions*
- *Future focus in end-of-life improvement, in-store recycling?*

Topic selection & redesign idea

Example topics:

- **Product (domestic, leisure)**
- **Electrical device**
- **Clothing/textile**
- **Vehicle/transport system**
- **Material (its usage, production)**
- **Food (product, ingredient)**
- **Etc..**

- *Work with your nearby student(s) and present/discuss your topics to each other (~10 minutes);*
- *What is your topic?*
- *Have you thought of important impacts?*
- *Have you thought already of redesign?*
- ***Let's discuss topics briefly together after 10 min!***

Next session on Friday (17.5.) 9.15 >>

Finalize your assessment and ideate redesign improvements!

Produce a poster, upload to MyCourses by the end of Thursday (16.5.)

Prepare 3 min pitch talk (stick to the timeframe!), ~5 min slots inc. feedback

We will split the class into 3 classrooms in Otakaari 1 BA center:

- **Room 1: U119 (Tatu)**
- **Room 2: M240 (Mikko)**
- **Room 3: M237 (Anu)**

Check your group & classroom from MyCourses announcement after lecture!

Presentations on Friday beginning from 9.15 sharp!

(…and if you are not able to join the session, upload a video/audio talk…)

Groups & rooms at Otakaari 1:

Room 1: U119 (Tatu)	Room 2: M240 (Mikko)	Room 3: M237 (Anu)
1. Aaltonen, Samuli Matias	1. Abdi, Saara Abdirashid	1. Airala, Saija Iiris Anniina
2. Baker, Erica Christina	2. Bhat, Akanksha	2. Blake-Farkas, Lewis
3. Chen, James	3. Chydenius, Ronja Emilia	3. Cabras, Kevin
4. Dán, Katalin Anna	4. Della Salda, Cecilia Giuliana	4. Cordova Castellani, Evelisa Lidia
5. Fadeeva, Iuliana	5. Fagerström, Alex Anders	5. Ekarv, Lisel Else Maria
6. Ferrell, Kristin	6. Fontanot, Fabian	6. Ferm, Noora Julia Johanna
7. Ghurde, Arnav Alok	7. Gliszczyńska, Magdalena	7. Fujimura, Tetsu
8. Hanhijärvi, Arto Aku Olavi	8. Hansen, Stig Martin	8. Gröhn, Enni Olga Aurora
9. Hemmi, Kia Helena Anneli	9. Herranen, Dominika Weronika	9. Hart, Alice Rose
10. Huttu-Hiltunen, Lotta Heta Sofia	10. Hämäläinen, Venla Viola	10. Hirvikangas, Viivi Elina
11. Jansson, Henrik Johannes	11. Jordi Lassenius, Lucas	11. Ilomäki, Eero Juhani
12. Jussila, Saara Vilhelmiina	12. Kainulainen, Sonja	12. Jussila, Katariina Vilma Helena
13. Kalkkinen, Venla Matleena	13. Karhumaa, Kreeta Liisa	13. Kajerdt, Astrid Ulrika
14. Katajainen, Vivian Inga Erica	14. Kauhanen, Lassi	14. Karppinen, Janette Carita
15. Király, Katalin Réka	15. Kirjavainen, Ella Emilia	15. Kimpisalo, Katri Maria
16. Knuutinen, Nina Elisa	16. Koivisto, Elli Ilona	16. Kiss, Anna
17. Kozawa, Sayaka	17. Laakkonen, Henna Iida Emilia	17. Korhonen, Oskari Kristian
18. Lau, Chia-Hsuan	18. Le, Bao Ngoc	18. Lahtinen, Iines Kevättuuli
19. Leppänen, Minella Mia	19. Liimatta, Karoliina Aino Matilda	19. Lebeda, Hugo
20. Lu, Yu-Peng	20. Lyytikkä, Valter Arne	20. Long, Alizée Zheji
21. Majander, Sari Susanna	21. Manninen, Mandy Emma Alexandra	21. Majalahti, Olli
22. Massuda Garcia, Helena	22. Mazars, Justine Lauren	22. Mascher, Camilla
23. Mäki-Rautila, Simon Johannes	23. Mänty, Rasmus Aleksi	23. Mäkinen, Aatu Venni Sakari
24. Najafov, Aykhan	24. Nguyen, Dieu Huong	24. Mäntysaari, Helmi Kerttu
25. Niemistö, Mona Matleena	25. Nikulainen, Ella Annika	25. Nguyen, Ngoc Thuy Duong
26. Pelkonen, Suvi Anneli	26. Perälä, Liisa Alina	26. Njattuvetty Aravind, Vishnu
27. Piekutowski, Nikita Jan	27. Poikkimäki, Aleksi Juhani	27. Petica, Mareike
28. Presnal, Kristian Lee	28. Raasakka, Jussi Petteri	28. Poikkimäki, Kirsikka Alisa Aurora
29. Rantzos, Vasileios Matias	29. Rak, Elviira Anna	29. Rakowska, Matylda Maria
30. Saaresto, Elina Sofia Ting	30. Roinisto, Elisa Maria	30. Ruggeri, Laura
31. Shirur, Malhar Siddharth	31. Šapurova, Natalija	31. Shi, Xuefei
32. Starck, Anna Sofia	32. Sirén, Henry Ilmari Gottlieb	32. Sopenlehto, Salla Sofia
33. Telesiute, Vaiva	33. Svidchenko, Darja	33. Taushan, Daryna
34. van Rijn, Sofia Annika	34. Tikachev, Aleksandr	34. Torgersen, Vibe
35. Wichmann, Erik Kristian Alexander	35. Vepsäläinen, Siiri Maija Matilda	35. Viitajylhä, Ronja Anni Maria
36. Virta, Tytti Juulia	36. Viertola, Vilma Annika	36. Yli-Luukko, Anna Stage
37. Zhang, Biyu	37. Vuorinen, Eeva Emma Susanna	

Thank you!