Aalto University
School of Arts, Design
and Architecture

Sustainable design S9

Kick-off for conceptual design exercise in groups (sessions 9–13)
Monday 20.5.2024

Agenda

13:15 Kick-off for conceptual design exercise in groups

13:30 Groups & themes for the exercise

Break – meet your group

14:00 Discussion on focus themes; Next steps

- Focus themes: Biomaterials, Concrete, Plastics
- Next steps in group work...

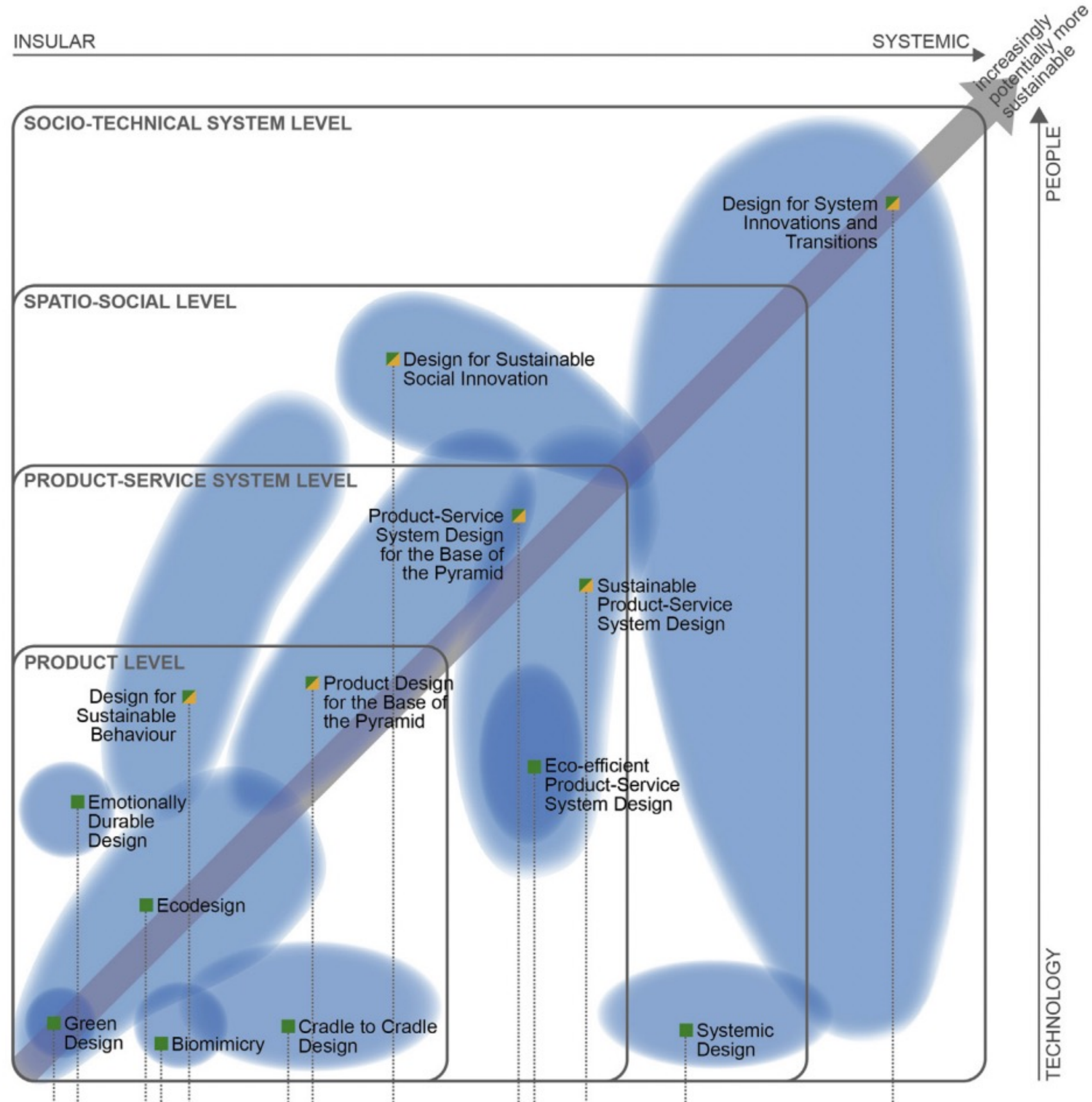
Conceptual design exercise

Conceptual design exercise in groups

Sustainable Design 2024 course's last part (sessions 9–13) focuses on a conceptual design exercise done in groups:

- In the group work, you work together in 4–6 student groups to identify a sustainability challenge within a given material theme, and then ideate and propose a design concept as a solution
- The outcome could be a redesigned product and/or service-system, or a communications campaign, or even some organizational/policy development
- Focus themes: Biomaterials, Concrete, Plastics; See material resources in MyCourses!
- Groups work independently, create some group for communication, agree on roles!
- Group work continues sessions 9–13, presenting outcomes on Monday 3.6.

Finding focus for design actions & interventions:



Group work schedule

Group work sessions (9–13) and locations:

Session 9: Mon 20.5. (Jeti - A208d, A Grid) – Case work kick-off
- Group work: Themes, groups, practicalities

Session 10: Fri 24.5. (Jeti - A208d, A Grid) – Case work continues
- Lectures on biomaterials and policy & business drivers

Session 11: Mon 27.5. (U119 / M240 / M237, Otakaari 1) – Interim check & tutoring sessions for groups
- Shared tutoring session, scheduled sessions with tutors to be agreed, to be announced on Friday

Session 12: Fri 31.5. (only in Zoom) – Final deliverables check-up & tutoring session
- Final tutoring session and check-up on course deliverable

Session 13: Mon 3.6. (U119 / M240 / M134, Otakaari 1) – Final presentations
- Presentations in three locations according to thematic focus

(Fri 7.5. no class – Finalize diary & course feedback, independent work…)

Group work tasks & deliverables

Tutoring sessions (next week):

- On next Monday (27.5.) we will have tutoring sessions in Otakaari 1, see spaces for your group from announcement on this Friday
- Groups will also have 1-on-1 tutoring meetings with tutors of their theme (Monday afternoon or then scheduled for Tuesday–Wednesday)
- On tutoring session, be prepared to present your idea(s) for tutor feedback

Final presentations (Monday 3.6):

- For session 13 on Monday 3.6. you will produce a presentation of the challenge you focused on and the outcomes of your work (PPT or PDF; upload before session)
- You will describe the challenge you chose within your theme, and then your designconcept idea as a solution
- Structure and contents will be discussed on next Monday tutoring session
- Presentations are 15 minutes + feedback
- Then remember to reflect on group work in Learning diary (reflection #6)

Weeks 5–6 (20.5. – 31.5.):

Week	Date	Place	Session no.	Session topic	Session activity plan	Tasks & materials	Teacher in charge	Contact hrs	Readings	Exercises	Groupwork	Reflection	Student workload
Week 5						Readings: These readings are to support the groupwork. Students select one of the following Allwood book chapters 20, 21 or article on biomaterials (TBA).			5				5
	Mon 20.5.	Jeti - A208d, A Grid	9	**Material futures 1 /Group work kick-off**	* Introduce thematic case work in groups *Present focus themes * Assign topics and groups for groupwork (20 x groups of 4 students?)	Session materials: - Allwood book as a basis - Industries self-initiatives (e.g. carbon neutral steel), industrial symbiosis - Introductions to focus themes: Concrete, Plastic and Bio-based novel materials 3x20 min	Tatu Anu	3					3
						Groupwork: Study selected material/project & produce a concept with this material					5		5
						Groupwork: Produce a design concept idea with selected material					5		5
						Reading: Allwood book, chapter 23			3				3
	Fri 24.5.	Jeti - A208d, A Grid	10	**Material futures 2**	* Lecture on material driven design for sustainability (Pirjo K.) * Lecture and discussion on policy and market drivers	Session materials: - Reading and slides on chapters 23-25	Tatu Anu Pirjo	3					3
						Total student workload per week							**24**
Week 6						Groupwork: Prepare short interim presentation					3		3
	Mon 27.5.	Otakaari 1: U119 / M240 / M237	11	**Design with materials**	* Scheduled tutoring sessions with Tatu, Mikko, Anu (detailes schedule to be announced)	Session materials: - Groups prepare a presentation (ie. few slide PPT) of the material and your concept, uploaded to MyCourses	Tatu Mikko Anu	3					3
						Groupwork: Incorporate feedback					6		6
						Groupwork: Finalize concept idea					6		6
	Fri 31.5.	(online)	12	**Tutoring online**	* Online: Final status check, instructions for course finalization for all		Tatu	2					2
						Groupwork: Prepare poster and presentation					4		4
						Total student workload per week							**24**

LEGEND
- Contact
- Reading
- Exercise
- Groupwork
- Reflection

Week 7 (Mon 3.6. + finalisation):

Week	Date	Place	Session no.	Session topic	Session activity plan	Tasks & materials	Teacher in charge	Contact hrs	Readings	Exercises	Groupwork	Reflection	Student workload
Week 7													
	Mon 3.6.	Otakaari 1: U119 / M240 / M134	13	**Design with materials**	* Three groups for presenting: 13.15-13.25 Introduction 13.25-14.25 Presentations (3x20min) 14.40-15.40 Presentations (3x 20min) 15.40-16.00 Course feedback discussion	Session materials: - Groups prepare a presentations, uploaded to MyCourses	Tatu Mikko Anu	3					3
				Course feedback	During week 7, DL 7.6.2	Fill in the feedback form (Compulsory)				1			1
	Fri 7.6.					Reflection 6: How did your group work turn out? Why? How would you improve the concept? Consider also other groups' outcomes, what was most interesting in them?						4	4
						Finalize your learning diary: Structure your diary according to reflection questions 1–6. Try to also cover how your thinking has changed during the course when editing and finalising your reflections.						7	7
						Time to think						10	10
						Total student workload per week							25
													TOTAL
								38	33	25	29	37	162

LEGEND
- Contact
- Reading
- Exercise
- Groupwork
- Reflection

Groups and themes

(see email contacts in the MyCo announcement…)

Biomaterials (Tutor: Anu)

(…some groups below could consider switching focus to their secondary material preference?)

Group 1 (Biomaterials/Plastics):
1. Alice Hart
2. Biyu Zhang
3. Darja Svidchenko
4. Helena Massuda Garcia
5. Fabian Fontanot
6. Simon Mäki-Rautila

Group 2 (Biomaterials/Plastics):
1. Elisa Roinisto
2. Elvira Anna Margaretha Rak
3. Erica Baker
4. Laura Ruggeri
5. Jussi Raasakka
6. Lisel Ekarv

Group 3 (Biomaterials/Plastics):
1. Cecilia Della Salda
2. Le Bao Ngoc
3. Magdalena Gliszczyńska
4. Natalija Šapurova
5. Henrik Jansson
6. Anna Kiss

Group 4 (Biomaterials/Plastics):
1. Nguyen Ngoc Thuy Duong
2. Olli Majalahti
3. Tetsu Fujimura
4. Sayaka Kozawa
5. Sofia Annika van Rijn
6. Matylda Rakowska

Group 5 (Biomaterials/Concrete):
1. Lewis Blake-Farkas
2. Katalin Anna Dán
3. Daryna Taushan
4. Akanksha Bhat
5. Katalin Réka Király
6. Vibe Torgersen

Group 6* (Biomaterials/Concrete):
1. Suvi Pelkonen
2. Nina Knuutinen
3. Enni Gröhn
4. Ilona Koivisto
5. Saija Airala

Group 7* (Biomaterials/Plastics):
1. Iines Lahtinen
2. Janette Karppinen
3. Salla Sopenlehto
4. Sofia Huttu-Hiltunen
5. Viivi Hirvikangas

** Groups marked with a star can work in Finnish, however groups present their results in English.*

Concrete (Tutor: Mikko)

Group 8:
1. Alex Fagerström
2. Anna Starck
3. Camilla Mascher
4. Dominika Herranen
5. Mareike Petica
6. Sari Majander

Group 9:
1. Nikita Piekutowski
2. Vaiva Telešiūtė
3. Hugo Lebeda
4. Petra Hanski
5. Arnav Ghurde
6. Joonas Rimpiläinen

Group 10*:
1. Venla Hämäläinen
2. Vivian Katajainen
3. Ella Nikulainen
4. Vilma Viertola
5. Katariina Jussila

Group 11*:
1. Katri Kimpisalo
2. Helmi Mäntysaari

Group 16:
1. Eeva Vuorinen
2. Aleksi Poikkimäki
3. Kristian Preznal
4. Justine Mazars
5. Lucas Jordi Lassenius

Plastics (Tutor: Tatu)

Group 12:
1. Aku Hanhijärvi
2. Alizée Long
3. Astrid Kajerdt
4. Elina Saaresto
5. Iuliana Fadeeva

Group 13:
1. Kia Hemmi
2. Sonja Kainulainen
3. James Chen
4. Malhar Siddharth Shirur
5. Stig Hansen

Group 14*:
1. Lassi Eemeli Kauhanen
2. Oskari Korhonen
3. Kirsikka Poikkimäki
4. Liisa Alina Perälä

Group 15*:
1. Minella Leppänen
2. Aatu Venni Sakari Mäkinen
3. Ella Kirjavainen
4. Rasmus Mänty
5. Ronja Viitajylhä

Group 17:
1. Anna Yli-Luukko
2. Samuli Aaltonen
3. Tytti Virta
4. Mona Niemistö

Break & meet your group…

Material themes

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Sustainable design course 2024:
Group work theme – Biomaterials

Theme description for the group work on the course (sessions 9–13)
Anubhuti Bhatnagar

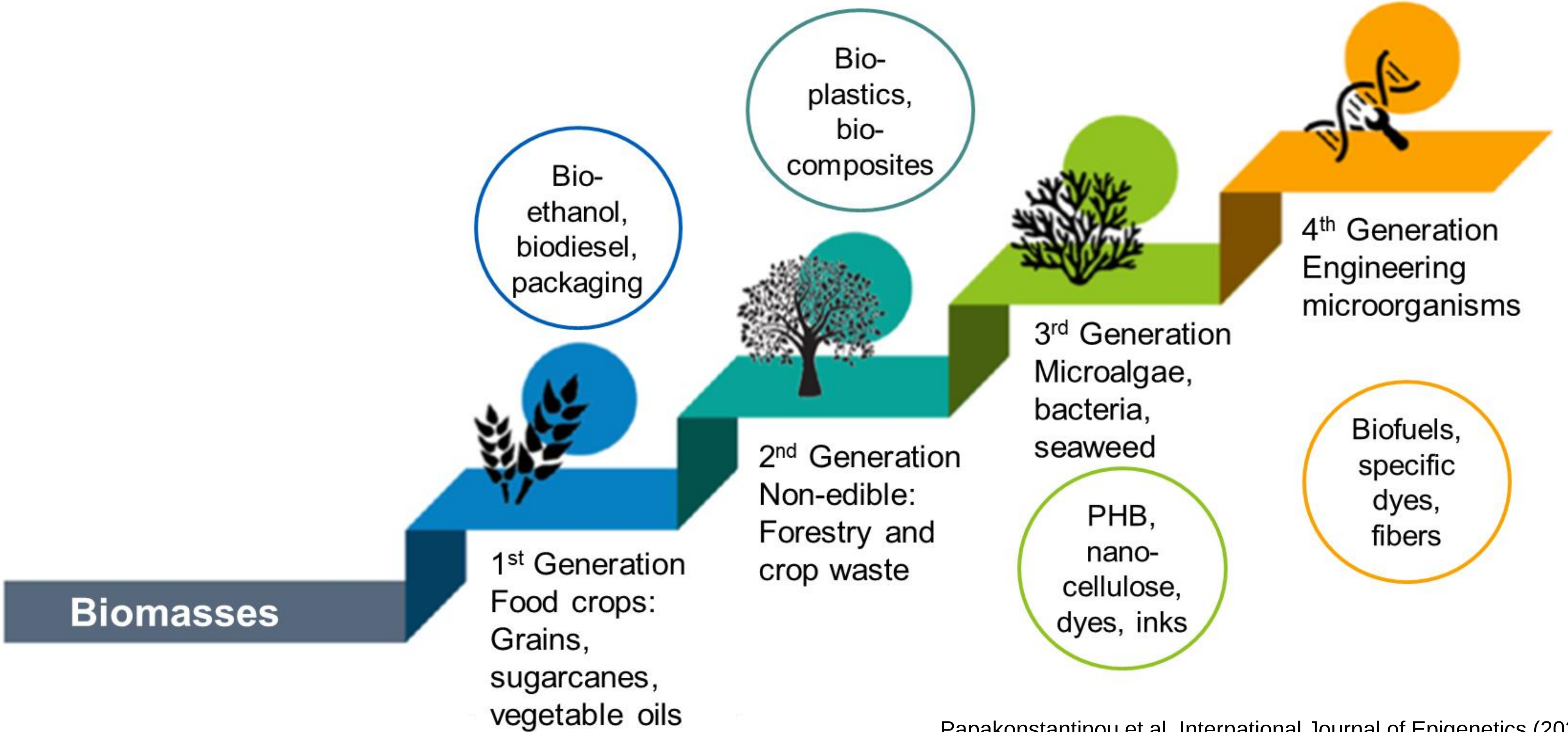
Biomaterials: A definition for this group work

Materials derived from renewable resources, such as plants, animals, or microorganisms, that are intended to have a reduced environment impact compared to traditional materials.

Uses: Packaging, textiles, construction, consumer goods, etc.

NOT INCLUDED are materials created to interact with biological systems for medical/therapeutic purposes or naturally occurring materials found within living organisms, such as bones, teeth, shells.

Biomaterials: 4 generations of feeds



Papakonstantinou et al. International Journal of Epigenetics (2021).

Biomaterials: Advantages

1. **Reduced Environmental Impact:** Replenished if derived from renewable resources
2. **Lower Carbon Footprint:** Plants used to produce bio-based materials absorb carbon dioxide from the atmosphere during their growth phase, making them "carbon neutral" or even "carbon negative" in some cases.
3. **Circular Economy:** If they are recyclable, they can be part of a closed-loop system without causing harm.
4. **Health and Safety Benefits:** Non-toxic bio-based materials with design applications, such as furniture, textiles, or packaging, can promote healthier living environments and reduce the exposure to potentially hazardous substances.
5. **Innovation and Market Opportunities:** The development and utilization of bio-based materials encourage innovation and opportunities for investment and development in this field.

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Examples of biomass-based material and design

Biomaterials for the future

Information sources:

1. Bio-based materials in architecture, design and interiors (↗)
2. How designers are taking up the challenge (↗)
3. Video links (↗)
4. ChemArts cookbook (↗)

Ideation for Biomaterials for the future

1. Hemp-based Sustainable Fashion Brand: Uses the eco-friendly properties of hemp, such as its durability, breathability, and low water usage. Ex: Patagonia Hemp jacket
2. Cork-based Sustainable Home Décor: Cork flooring, wall panels, furniture, and accessories made to showcase the unique texture and natural properties of cork, such as its sound insulation, thermal regulation, and renewable sourcing. Ex: Amorim
3. Mushroom Leather Sustainable Accessories: Explore the use of mycelium to create leather-like materials for accessories like bags, wallets, and phone cases. Ex: Mylo by Bolt Threads
4. Fruit Fiber Sustainable Textiles: Fruit fibers (pineapple leaves or orange peels) have natural strength, moisture-wicking properties, and biodegradability, and are waste materials from existing industry that can be used to make textiles. Ex: Piñatex by Ananas Amam

Biomaterials emerging from the design world: Nanocellulose

BioFaber

Aqueous culture enriched with sugars from food waste such as molasses and olive residues are used by the microorganisms to synthesize the nanostructured cellulose. [Link]

ModernSynthesis

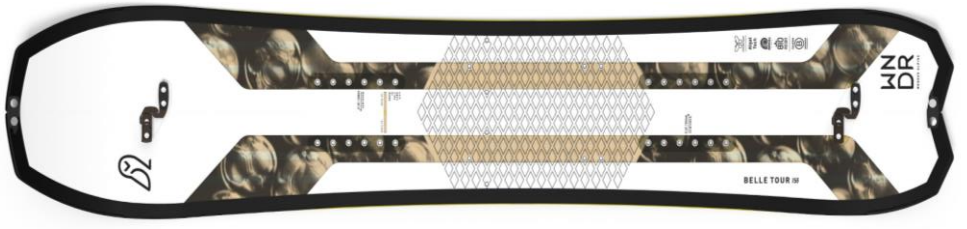
Microbial nanocellulose blended with natural textiles. [Link]

Biomaterials emerging from the design world: Algae-based

We design new molecules for better materials

Checkerspot WING

Algae-based polyurethane for oils for skis [Link]



FlexSea

Seaweed based packaging material [Link]

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Biomaterials emerging from the design world: Direct air capture and microbial digestion

PANGAIA x AIR-INK®

Captures air pollution particles that are turned into different grades of safe, water-based inks, dispersions and coatings. [Link]

NEWLIGHT

Uses natural ocean microorganisms to make PHB (polymer) from air and greenhouse gas and call it AirCarbon. [Link]

Biomaterials emerging from the design world: From waste

RENEWCELL

Circulose® is a branded dissolving pulp that Renewcell makes from 100% textile waste with high cellulose content [Link]

Eggshell

Waste eggshells mixed with binders and water to create resins for biodegradable disposable cutlery [Link]

Biomass ≠ Sustainable (Dig deeper)

- **DO NOT correlate biobased & ‘green’/ ‘environmentally friendly/ benign/ bio-degradable**
- Examples:
  - ❑ Fossil-based biodegradable materials: Bioplastics (PLA, PHA), lubricants for Agri-machinery, LAS surfactants
  - ❑ Bio-based non-biodegradable materials: bio-PE and bio-PET, Treated wood, Biofibers with synthetic blends
- **REMEMBER!** No solution fits all *[places, people, situations, requirements]*

Questions for checking claims

- How to reach large-scale with these materials?
- Early-stage lifecycle assessments available for new technologies?
- Social impacts of altering supply chains: Known? Unknown?
- Impacts of the grown materials (algae, bacteria, hemp) on ecological balance?
- **Before bio-degradation, can it be reused?**

Checklist for sustainability of biomaterials

1. **Land Use and Competition:** Expansion of biomass crops or harvesting practices can result in land-use changes.
2. **Resource Intensity:** Resource requirements like water, energy, and fertilizers.
3. **Lifecycle Assessment:** Greenhouse gas emissions, energy consumption, water usage, and waste generation associated with the entire lifecycle, including cultivation, processing, transportation, use, and disposal should be assessed.
4. **Feedstock Availability and Sustainability:** Regional variation of biomass feedstocks [sustainably sourced wood]
5. **Chemical and Biological Interactions:** Biomass conversion to materials often involves the use of chemicals, solvents, or enzymes, so proper waste management and disposal practices are needed
6. **Market Demand and Infrastructure:** Expanding the use of biomass-based materials requires supportive market demand, investment in research and development, and appropriate infrastructure.

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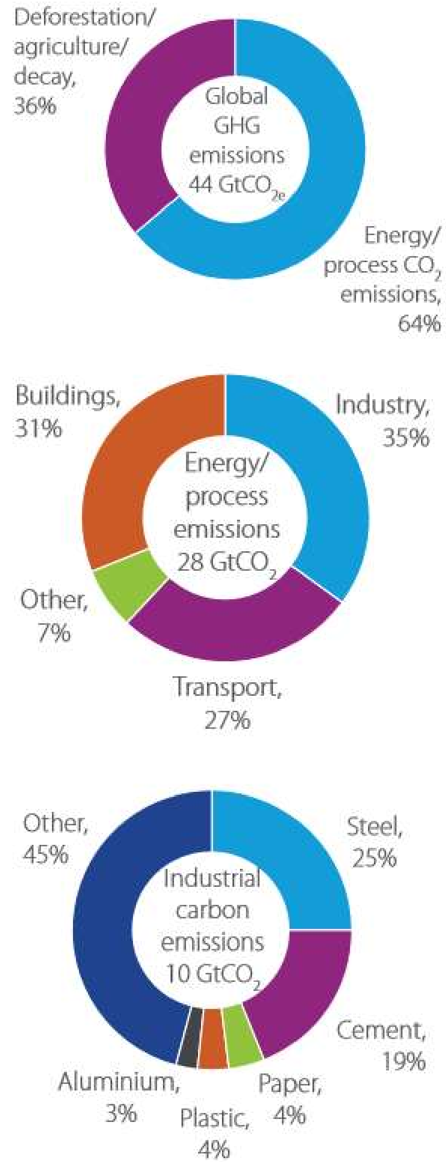
Sustainable design course 2024:
Group work theme – Concrete

Theme description for the group work on the course (sessions 9–13)

Mikko Jalas

Allwood et al ch2

- Most of CO2 emissions are due to energy use and processes.
- Industrial processes are the single biggest source of CO2
- Steel, cement, aluminum, paper and plastics are most important materials ‘behind‘ CO2 emissions.



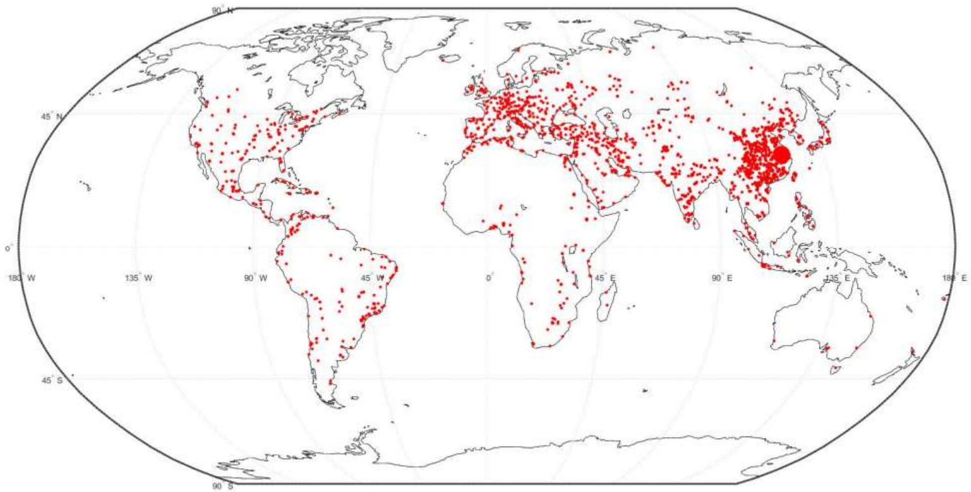
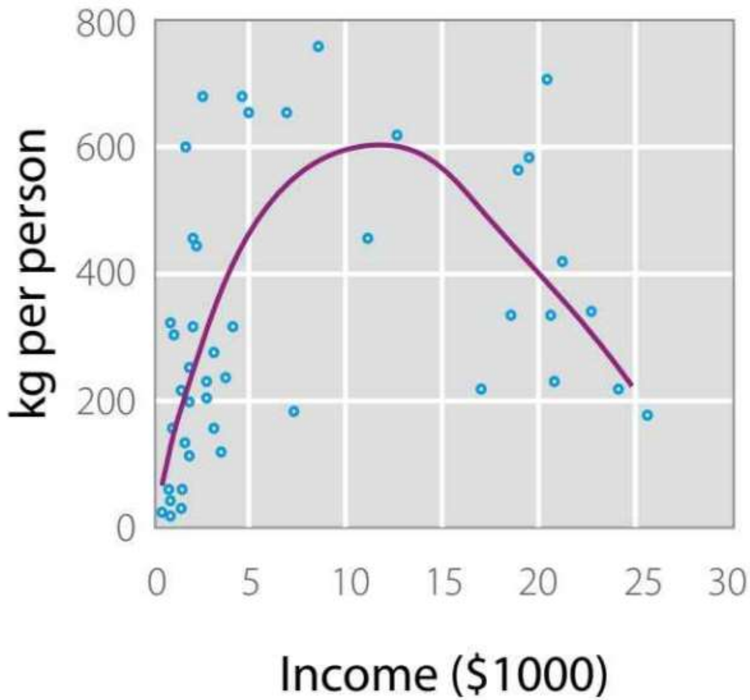


Figure 2: Global cement production sites. Larger circles represent production sites of significantly higher capacity than the others. Data are obtained from [24, 25].

Demand for cement

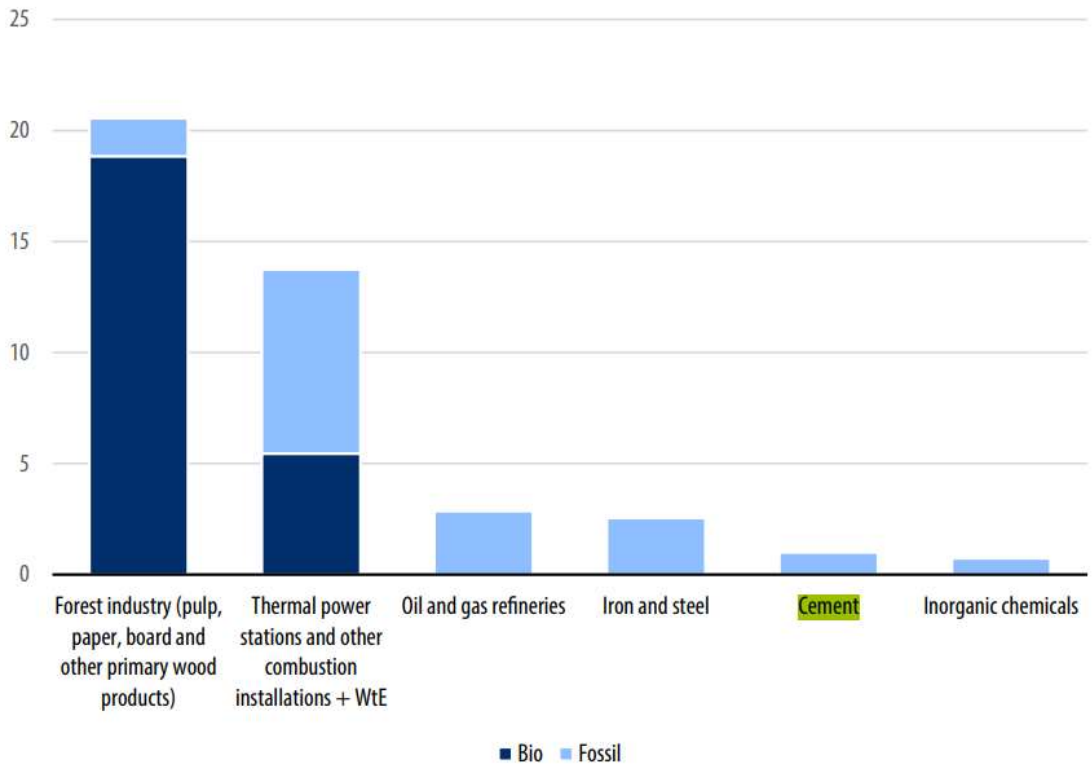


x 3-4 for concrete

Demand for conrete Finland about 1 m3/capita

Globally about 1,5m3/capita

Figure 11. Industrial CO_2 emissions from facilities in Finland 2020. Data from EEA (2023a).



Carbon dioxide use and removal : Prospects and policies (valtioneuvosto.fi)

Manufacturing process

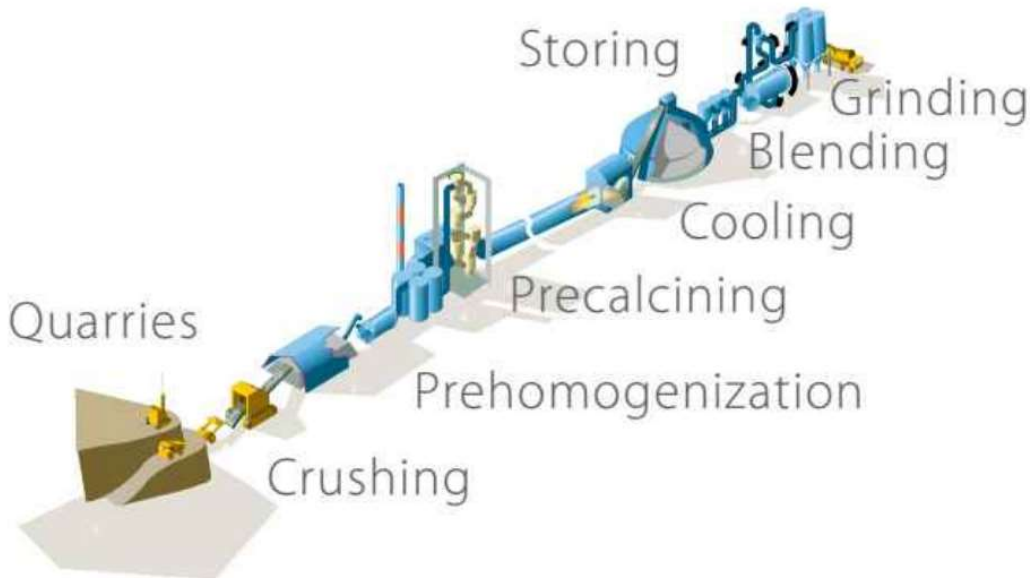


Figure 20.8—**Cement production process**[26]

New directions

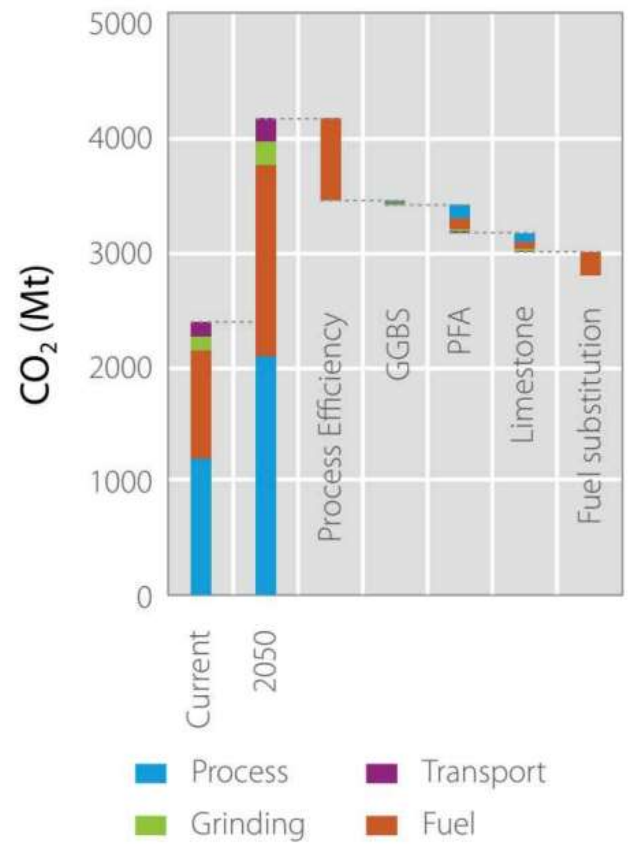
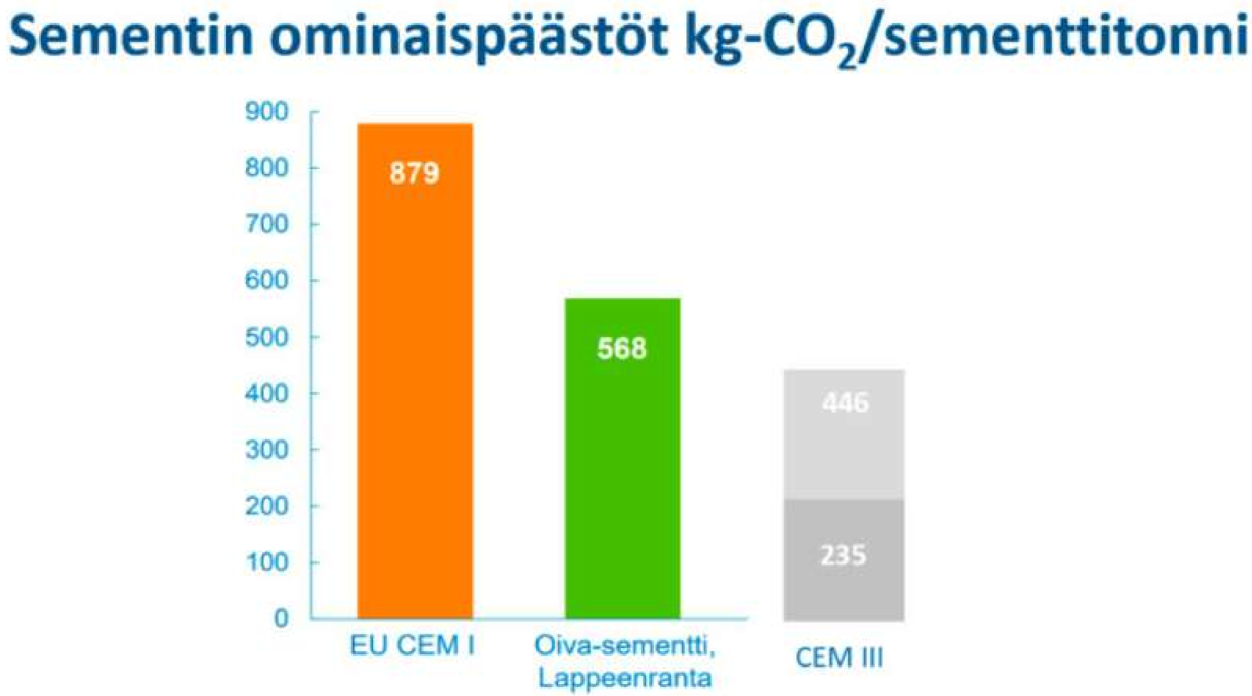


Figure 20.9—**Forecast for emissions reductions in the cement industry**

New directions



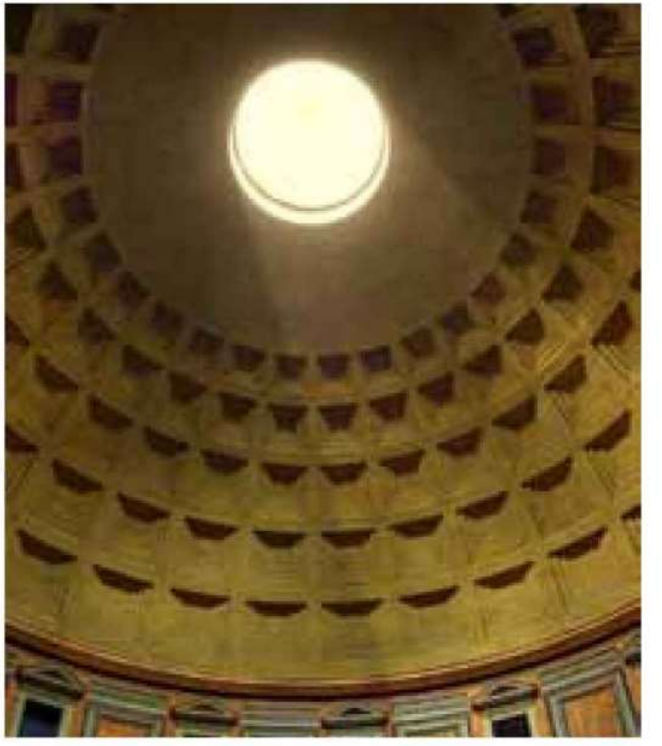
Sementti ja kasvihuonekaasupäästöt - Betoni

Cement

In use for a long time, e.g. the Pantheon

In 1824, a patent for Portland cement

Steel-reinforced concrete is in structural uses coupled with urban infrastructure



The Pantheon Dome

Non-structural use

Opportunities for sustainability improvements in Concrete and cement

Alternative chemistry for concrete

Capture of CO2 from cement manufacturing

Capture of CO2 by mineralizing processes in cement

Uses of concrete –with both eyes open

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Sustainable design course 2024:
Group work theme – Plastics

Theme description for the group work on the course (sessions 9–13)

Tatu Marttila

Plastics as the focus theme

Some notions as plastics as a focus theme:

- **Plastics are often outstanding materials for manufacturing with many properties that can be easily managed**
- **They have, however, obvious issues being fossil based, having a high CO_2 footprint in production (but often low energy footprint), and severe issues with EoL scenarios (CO_2, pollution, micro-plastics, etc.)**
- **There is a clear momentum to increase the use of recyclates as a non-fossil option, but difficulties in quality management, economic feasibility, scale, etc.**
- **What about bio-plastics? To an extent there is also an overlap with biomaterials, however bio-plastics often have issues in high energy for production, and impact on ecological systems (e.g. sustainable scale of material production?)**

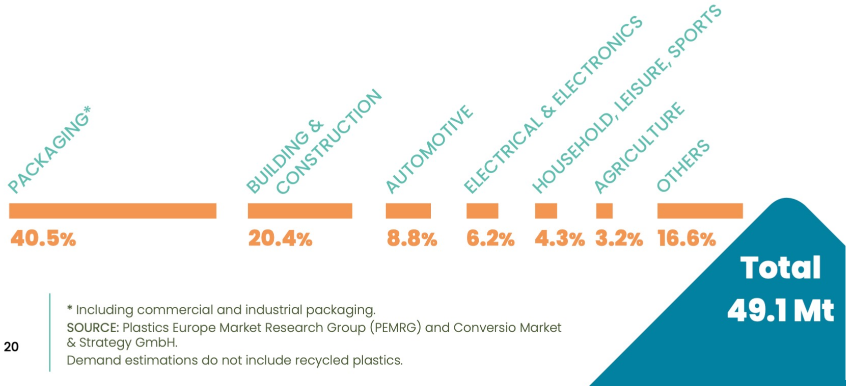
Plastics in the EU (Plastics – the Facts, 2021):

EU27+3 converters plastics demand
BY SEGMENTS 2020

Packaging and Building & Construction by far represent the largest end-use markets.

The third biggest end-use market is the **Automotive Industry**.

"Others" includes plastics for furniture, medical applications, machinery and mechanical engineering, technical parts etc.



* Including commercial and industrial packaging.
SOURCE: Plastics Europe Market Research Group (PEMRG) and Conversio Market & Strategy GmbH.
Demand estimations do not include recycled plastics.

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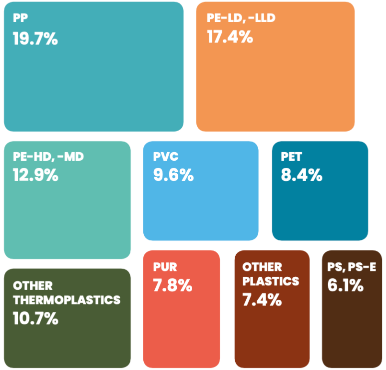
EU27+3 converters plastics demand
DISTRIBUTION BY POLYMER TYPES 2020



PP	Food packaging, sweet and snack wrappers, hinged caps, microwave containers, pipes, automotive parts, bank notes, etc.
PE-LD, -LLD	Reusable bags, trays and containers, agricultural film, food packaging film, etc.
PE-HD, -MD	Toys, milk bottles, shampoo bottles, pipes, houseware, etc.
PVC	Window frames, profiles, floor and wall covering, pipes, cable insulation, garden hoses, inflatable pools, etc.
PET	Bottles for water, soft drinks, juices, cleaners, etc.
PUR	Building insulation, pillows and mattresses, insulating foams for fridges, etc.
OTHER PLASTICS	Includes other thermosets such as phenolic resins, epoxide resins, melamine resins, urea resins and others.
PS, PS-E	Food packaging (dairy, fishery), building insulation, electrical & electronic equipment, inner liner for fridges, eyeglasses frames, etc.
OTHER THERMOPLASTICS	Hub caps (ABS); optical fibres (PBT); eyeglasses lenses, roofing sheets (PC); touch screens (PMMA); cable coating in telecommunications (PTFE); and many others in aerospace, medical implants, surgical devices, membranes, valves & seals, protective coatings, etc.

SOURCE: Plastics Europe Market Research Group (PEMRG) and Conversio Market & Strategy GmbH.
Demand estimations do not include recycled plastics.

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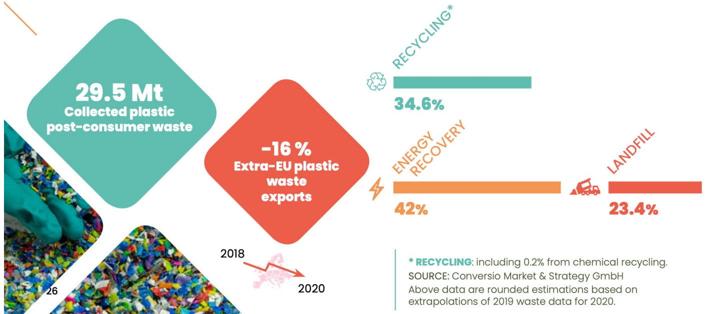


* **RECYCLING**: including 0.2% from chemical recycling.
SOURCE: Conversio Market & Strategy GmbH
Above data are rounded estimations based on extrapolations of 2019 waste data for 2020.

POST-CONSUMER PLASTIC WASTE
treatment in 2020 (preliminary data)

In 2020, more than 29 million tonnes of plastic post-consumer waste were collected in the EU27+3. Because plastics products have different life span (ranginging from 1 to 50 years or more), of post-consumer plastic waste collection figures do not match demand or consumption figures.

More than **one third was sent to recycling facilities inside and outside the EU27+3** but over 23% was still sent to landfill and more than 40% was sent to energy recovery operations.

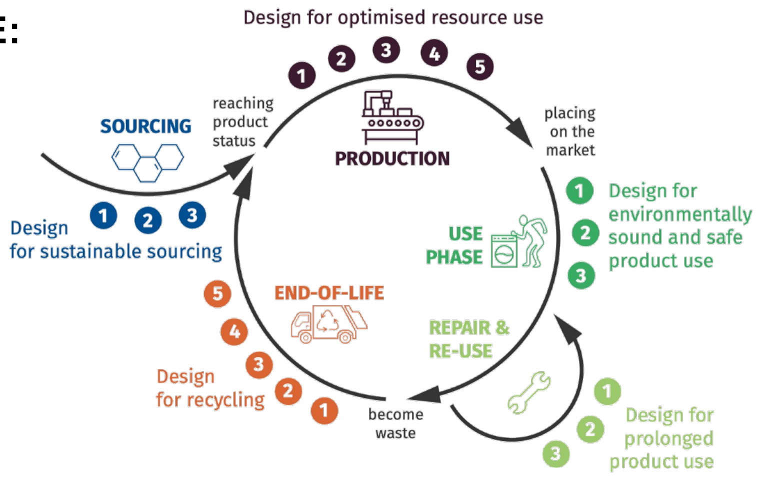
Improving plastics sustainability

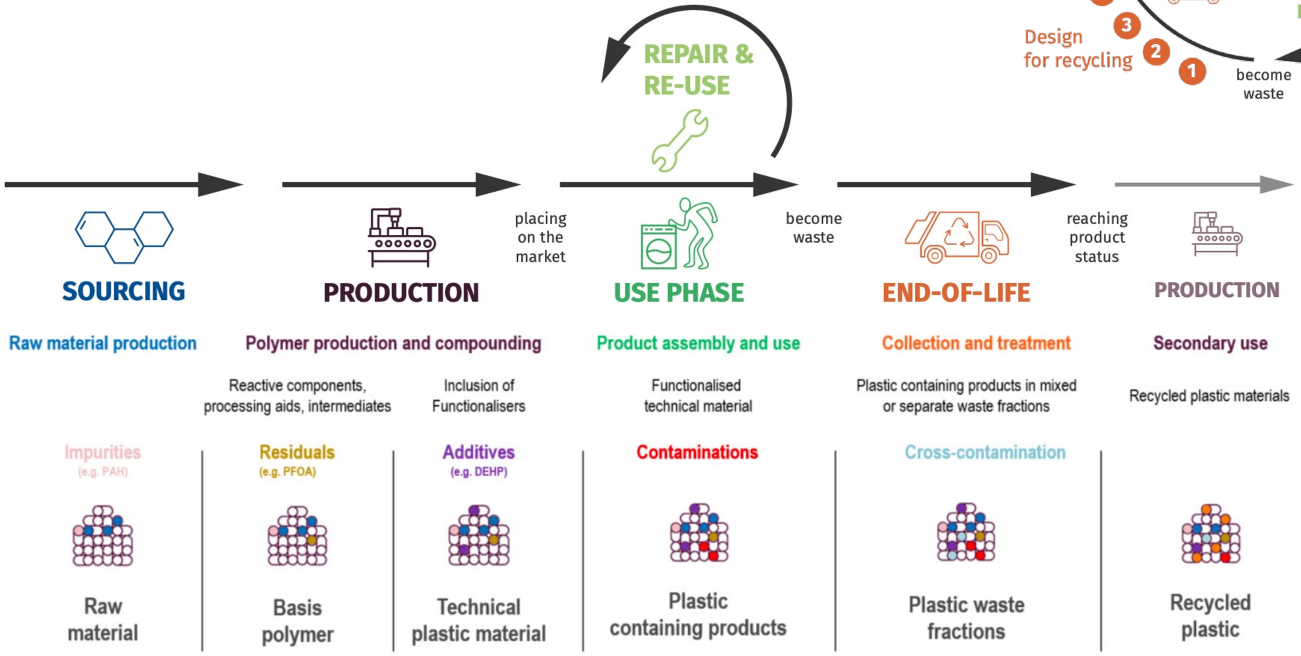
Some strategies or approaches to improve the sustainability of plastics:

- **Product ecodesign (including system redesign)**
- **Extended producer responsibility (EPR policy scheme)**
- **Sustainable product-service systems (PSS)**
- **Circular economy – closing technical loops: Focus not only in material recycling, but also in product/material repair, reuse, redesign**

ECOS (2019) – Policy recommendations for CE:

- *Design products and systems for longer lifetimes;*
- *Make products easier to recycle;*
- *Close the loop through recycled content;*
- *Focus on chemicals for circular products and materials.*





Materials in MyCourses

Check through the materials on this theme in MyCourses (bottom of Readings & materials -page):

- **Allwood & Cullen (2010). Chapter 21 - Plastics**
- **Plastics Europe (2021). Plastics – the Facts**
- **ECOS (2019). Applying Ecodesign to Plastics**
- **King et al. (2022). Circular economy framework for plastics**
  (use this meta review to find several more sources…)

Next steps in group work…

Next steps & session on Friday…

First, exchange contacts contacts with your group and agree on working platforms and schedule some shared working sessions…

Then, start to research your focus material theme, and begin to consider improvements:

- Assess sustainability impacts in production and use of the material, and identify potential issues that could be improved
- Begin to ideate solutions to identified challenges in your group
- In next week's tutoring, you can present a few alternative design solutions to the challenges you identify…

Next session on this Friday (24.5.) at Jeti, A-Grid…
Remember to check the reading (Allwood & McCullen's book, Chapter 23)!

Thanks!