Aalto University

CHEM-E5145
Eco-Design

Workshop 6
14.2.2019

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Workshop timetable

- 8.30-9.30 LCA reflection and poster
- 9.30-10 Poster presentations
- 10-10.15 Sum-up the posters

Break 15 min.

Workshop atmosphere 2016

- 10.30-10.45 Visitor: Roza Yasdani: Biomaterials for PCM application
- 10.45-11.15 Eco-Design
- 11.15- 11.45 Peer-review of Flip reports + videos preparation + Task 3 preparation

Intendent learning outcomes
Workshop VI

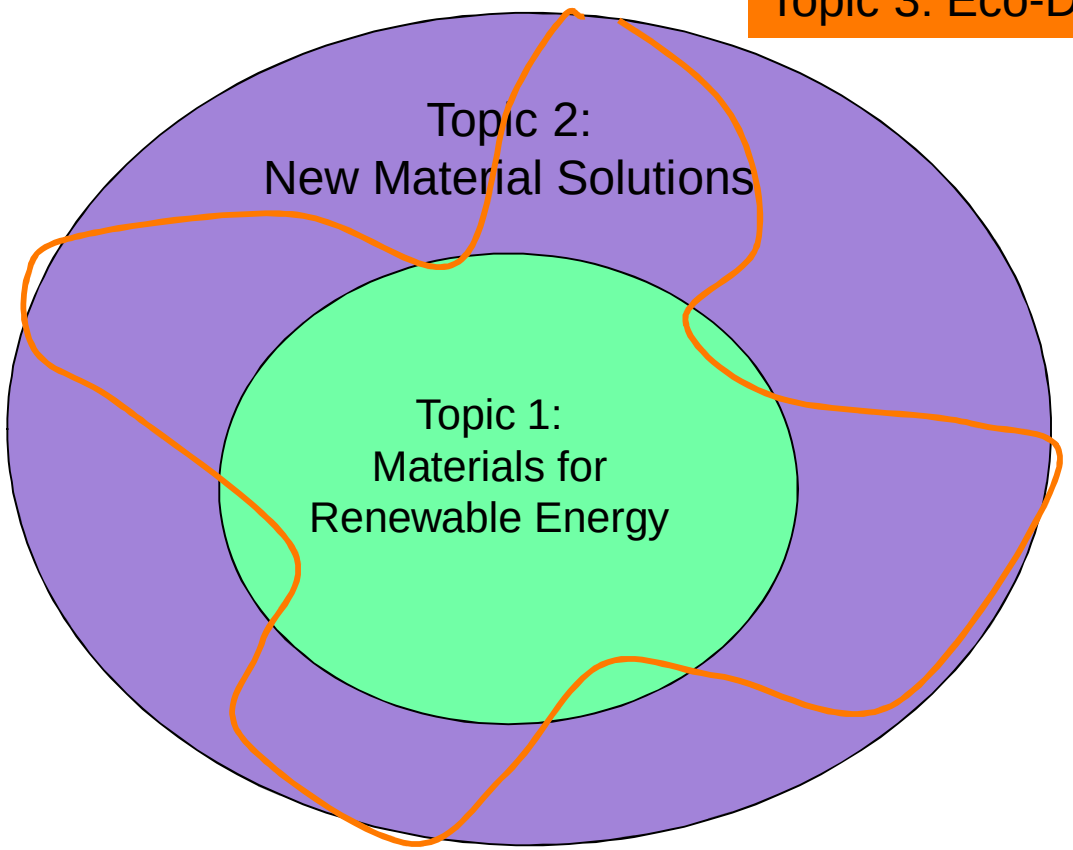
Share the expertise of ones field in a heterogenius team

Recognition of the challenge in eco-design

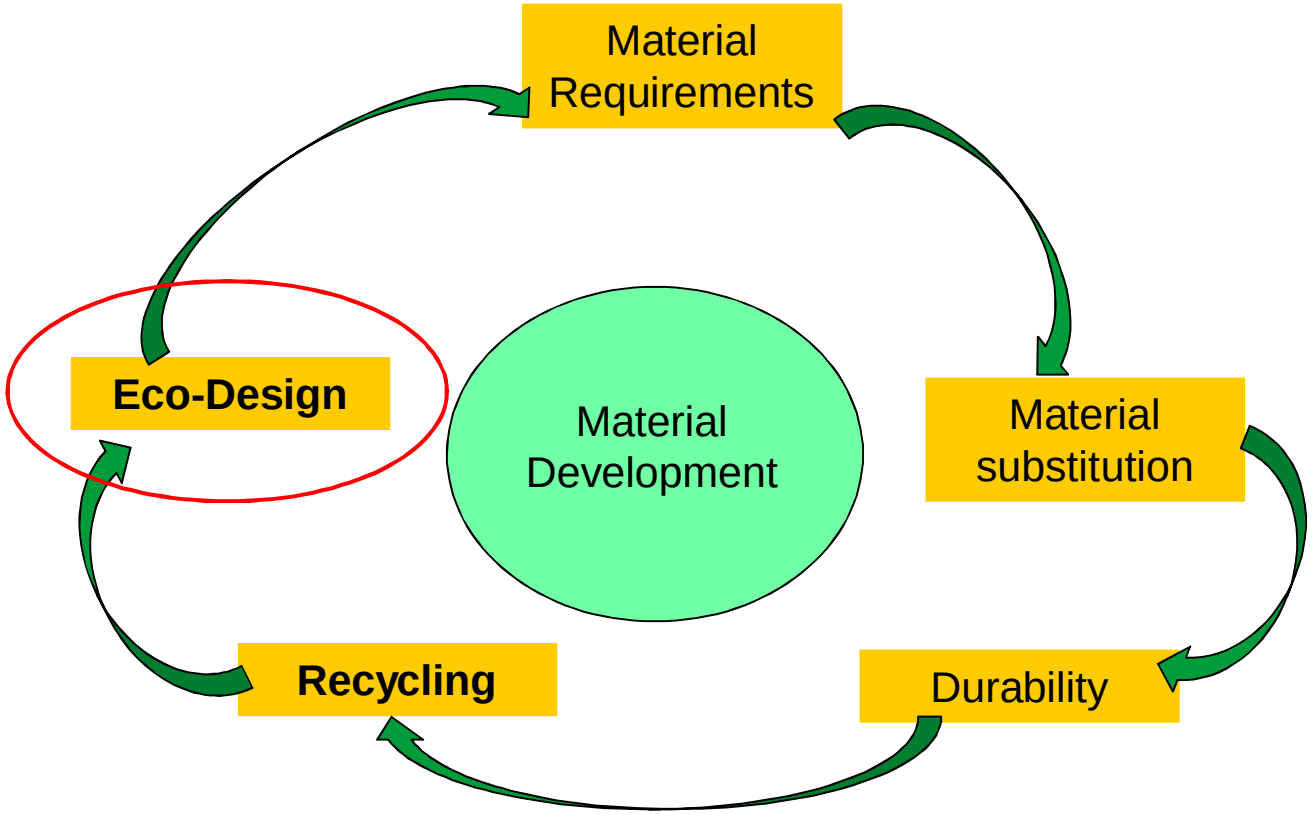
→

Develop new material solutions and eco-designs

Topic 3: Eco-Design



Topic 3 – Eco-Design



Workshop VI - Poster

The poster should include:

LCA analysis of your application?

Who prepared the analysis (university/research center/company) and who provided the **finance behind the study**?

Which are the part that need most improvement?

Where are the largest impact to environment?

Visualization –
to support understanding

Flip Activity

- Poster tour
  - > Each of you will have your own team and you will teach the topic to others (5 min /poster)
  - Make questions, what did you not understand! (if not don't know – ask teacher or make a post-it tag to the poster

- Poster's and their presenting is evaluated
  - You all vote for the best poster (clear message)
  - The best poster, get's automatically 4 p./workshop
  - Others get evaluated by the teacher 0-3 p.


Vote for the
best
poster!

Sum up from the poster's

LCA in action

What type of LCA analysis was provided by different groups?

What were the similarities?

-> Do you trust the LCA analysis

-> As an industrial customer, would this help you in decision of the new energy systems investments?

Break 15 min.

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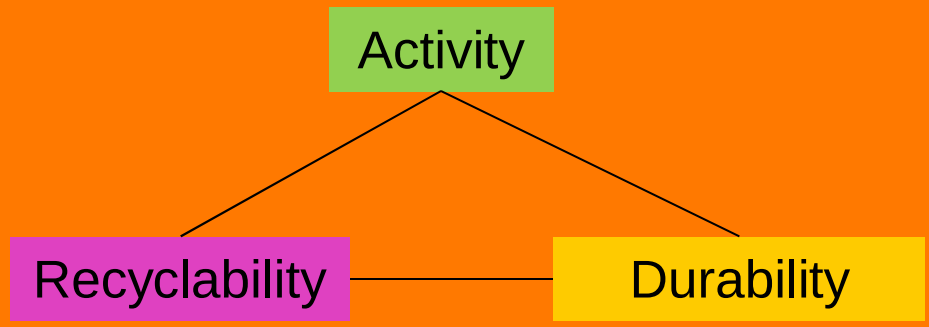
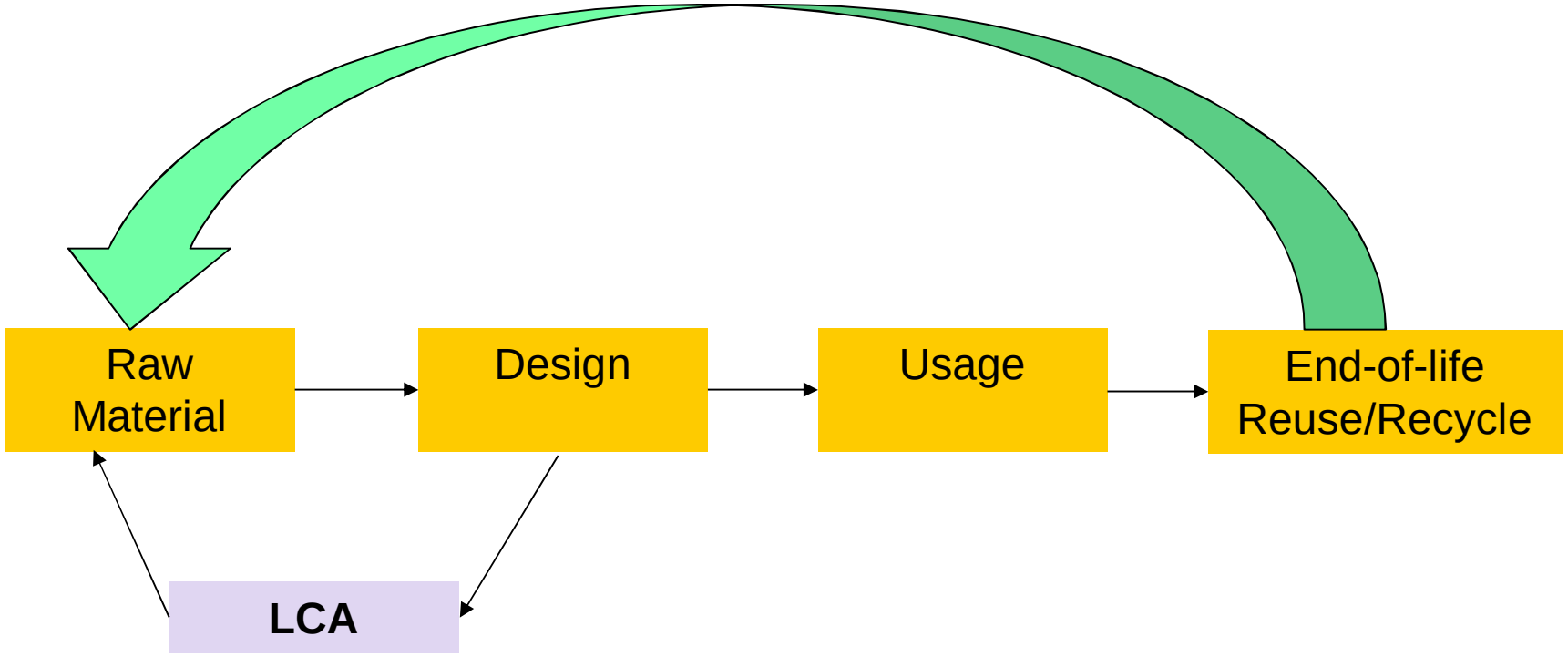
Eco-Design

Where in the value chain changes are needed in order to prepare ultimate material solutions:



Circular economy



Life Cycle Assessment
Case: Polymers

Polymer component are used almost in all applications

- PLA (polylactide), biobased polymer

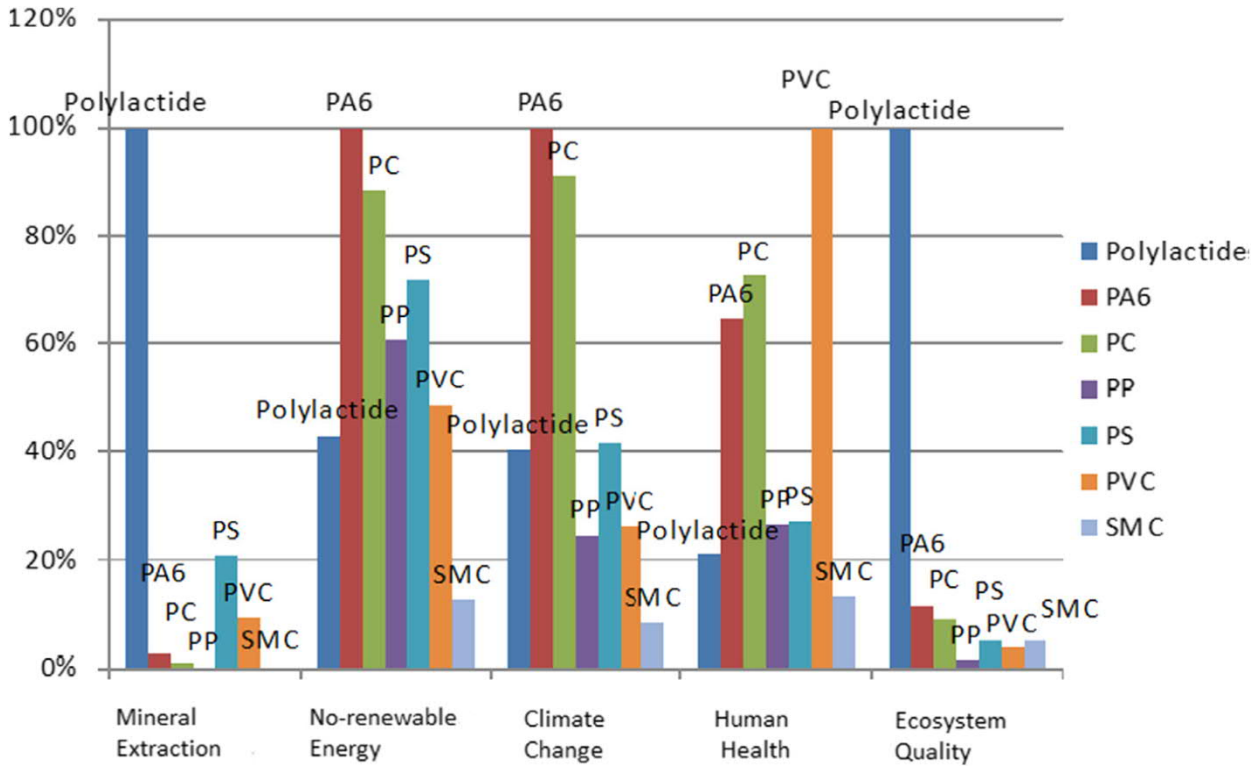
www.technologystudent.com

- PP (polypropane), oil based polymer

www.corporatevending.com

Which one has the lowest effect on environment?

Life Cycle Assessment
Case: Polymers



H. Warrel, M.A. Reuter, *Handbook of Recycling*, Chapter 27.

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Weakness of LCA

Weakness of LCA?

Weaknesses:

- Lack of information
- Is the comparison “fare”, what is reference
- Special conditions
- Activity vs. environmental impact
- Durability vs. environmental impact
- Economics
- How to compare different technologies
- “Who cares?”

Design - Conflict

High Activity

High Durability

Vs.

Easy to Recycle

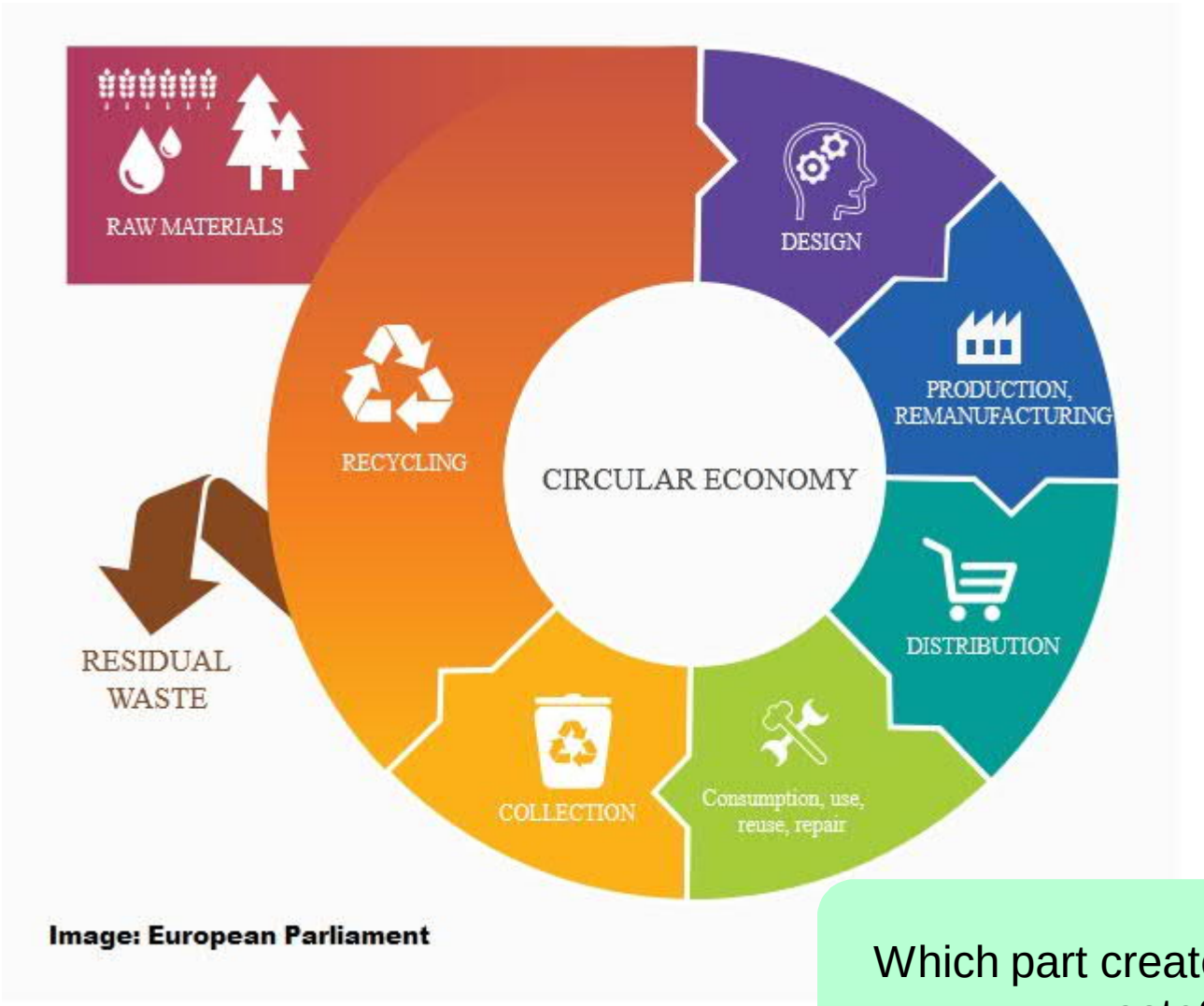
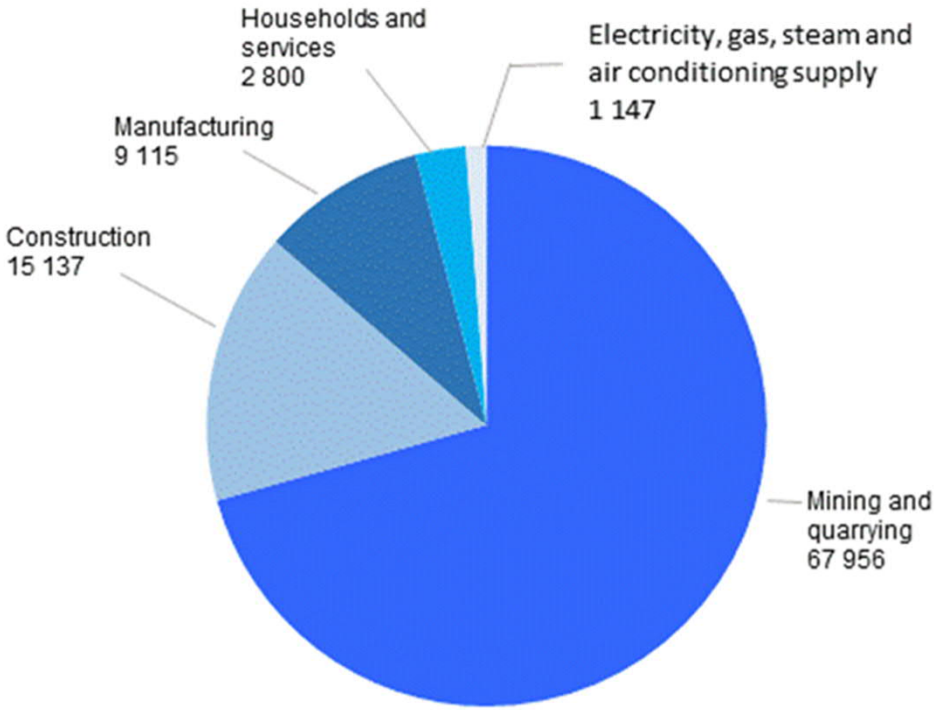


Image: European Parliament

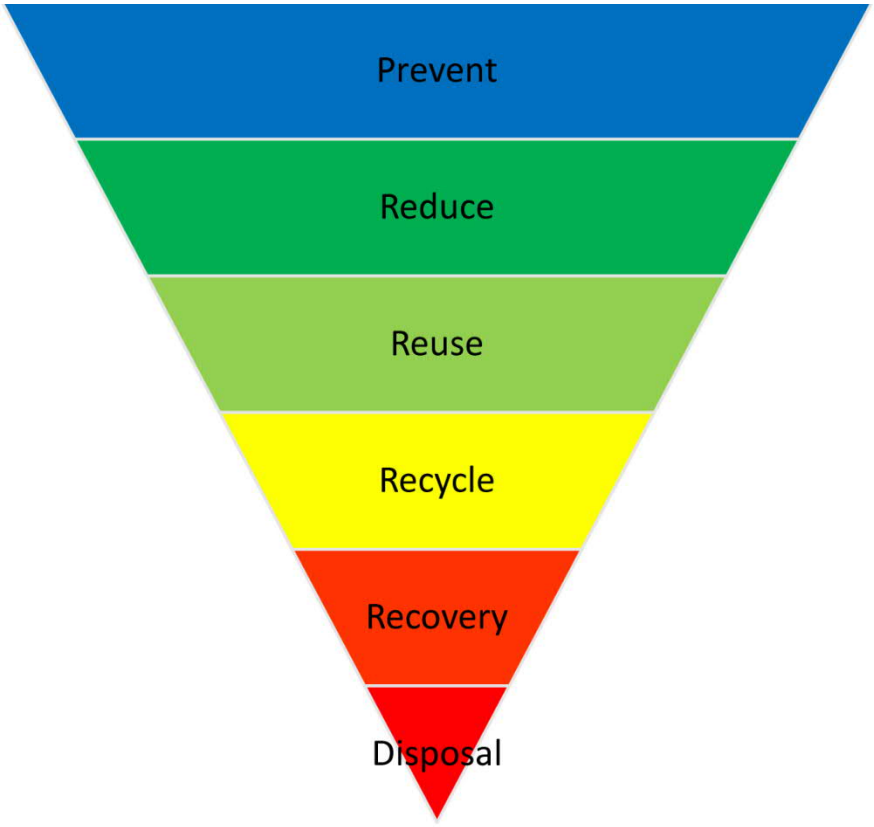
Which part creates the most waste?

Sources of waste



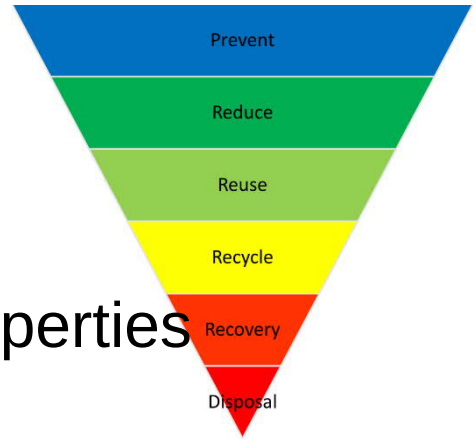
Distribution of waste amounts per sector in 2013, 1000 tons.
(Statistics of Finland 2013)

Waste pyramid



http://quotesgram.com/quotes-on-reducing-waste/#aAGCbDtHIN

Secondary raw materials

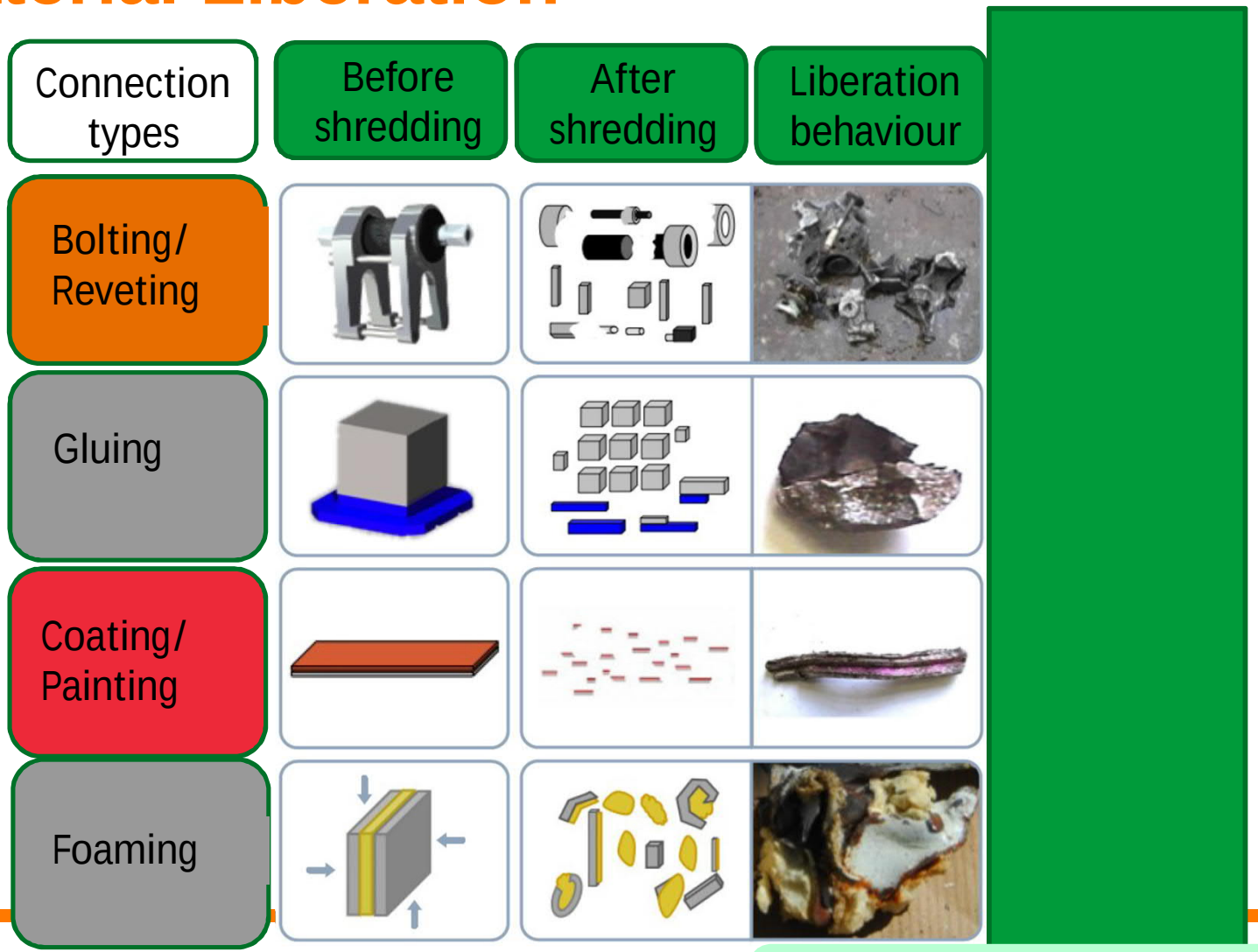


- First – can it be entirely/partly reused?
- Must maintain mechanical and chemical properties
  - During use
  - During dismantling and recycling process
- Secondary raw materials (recycled)
  - Can they be used solely or mixture with virgin materials?
  - Material problems we discover with secondary materials
  - Impurities? What is not tolerated?
  - Durability issues? For instance secondary Li source

-> A lot of research still to be done ☺

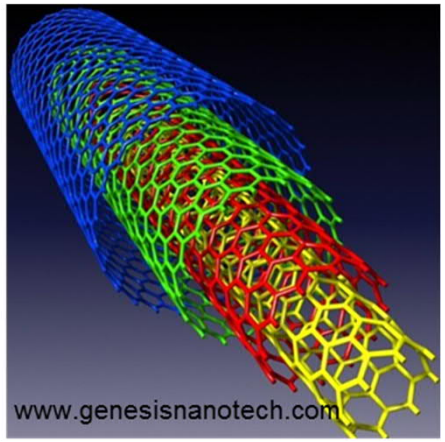
Material Liberation

Reuter, M.A.; Hudson, C.; van Schaik, A.; Heiskanen, K.; Meskers, C. & Hagelüken, C. 2013. UNEP Metal Recycling: Opportunities, Limits, Infrastructure, A Report of the Working Group on the Global Metal Flows to the International. United Nations Environment Programme. 320 s. ISBN: 978-92-807-3267-2.



How easy are these different liberation steps?

Waste: Nanowaste



Utilization of high activity nanomaterials

-> What happened after the lifetime?

No studies done on how effect on environment (yet)?

No LCA possible (no data exist)

Only thing known that have some effects on human/animal health

Recycling will be part of legislation

- EU legislation
  - Design to facilitate proper disabling
  - Allow components and materials to be reused/recycled/recovered

- What should be avoided:
  - Hybrid materials (especially mixture of different material classes)
  - Especially metal parts in plastics (can not be recycled as plastics nor as metals)
  - Black colour plastics (can not be detected in plastic separation)

Mechanical separation - sorting

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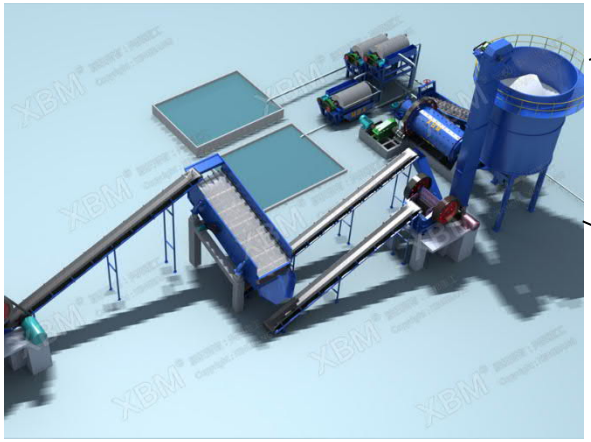
STEINERT Mixed plastics sorting
– Youtube:
https://www.youtube.com/watch?v=zIPGUv35A5E,31.1.2018

Recycling

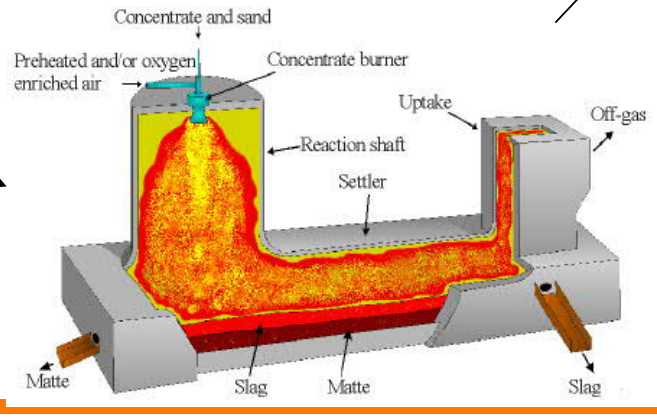
- Must be economically viable (business/legislation)
- Needs large volumes

Hydrometallurgy

Mechanical separation



Pyrometallurgy



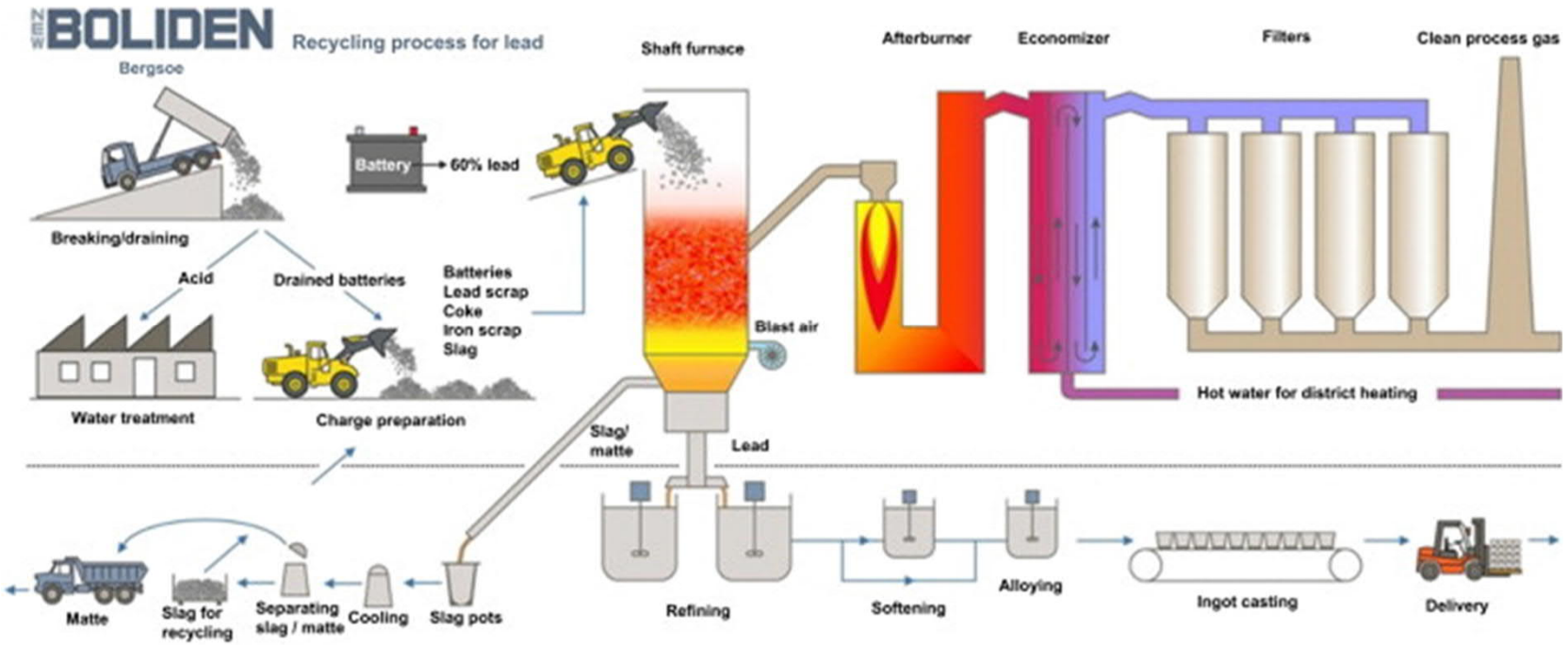
www.totalmateria.com

What is the conditions of the materials at the recycling?

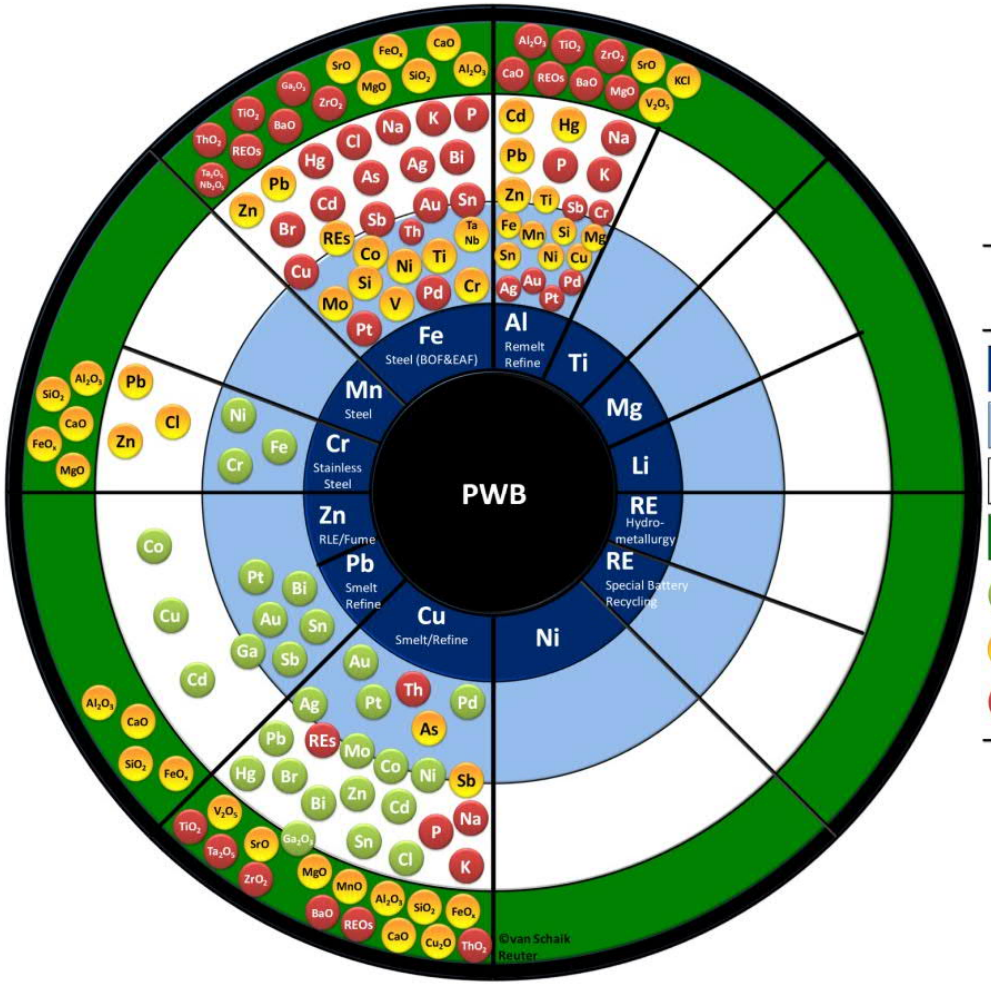
Recycling of lead acid batteries (1)

- An example of well working system
- Lead acid batteries can be simplified as a three component product
  - Lead electrodes
  - Sulphuric acid electrolyte
  - Plastic casing
- Separation can be done easily
  - Batteries are broken by, for example, dropping them
  - Acid directed into a drain
  - The rest into a lead smelter

Recycling of lead acid batteries (2)



The metal wheel



The Main Thermodynamic and Economic Destination of Metals, their Alloys and Compounds from EoL Products for the Best Available Technology Processing Routes (Segments in Figure)

Society's Essential Carrier Metals: Primary Product
Extractive Metallurgy's Backbone (primary and recycling metallurgy)
The metallurgy infrastructure makes a "closed" loop society and recycling possible.

Dissolves mainly in Carrier Metal if Metallic (Mainly to Pyrometallurgy)
Valuable elements recovered from these or lost (metallic, speiss, compounds or alloy in EoL also determines destination as also the metallurgical conditions in reactor).

Compounds Mainly to Dust, Slime, Speiss, Slag (Mainly to Hydrometallurgy)
Collector of valuable minor elements as oxides/sulphates etc. and mainly recovered in appropriate metallurgical infrastructure if economic (EoL material and reactor conditions also affect this).

Mainly to Benign Low Value Products
Low value but inevitable part of society and materials processing. A sink for metals and loss from system as oxides and other compounds. Comply with strict environmental legislation.

El **Mainly Recovered Element**
Compatible with Carrier Metal as alloying Element or that can be recovered in subsequent Processing.

El **Mainly Element in Alloy or Compound in Oxidic Product, probably Lost**
With possible functionality, not detrimental to Carrier Metal or product (if refractory metals as oxidic in EoL product then to slag / slag also intermediate product for cement etc.).

El **Mainly Element Lost, not always compatible with Carrier Metal or Product**
Detrimental to properties and cannot be economically recovered from e.g. slag unless e.g. iron is a collector and goes to further processing.

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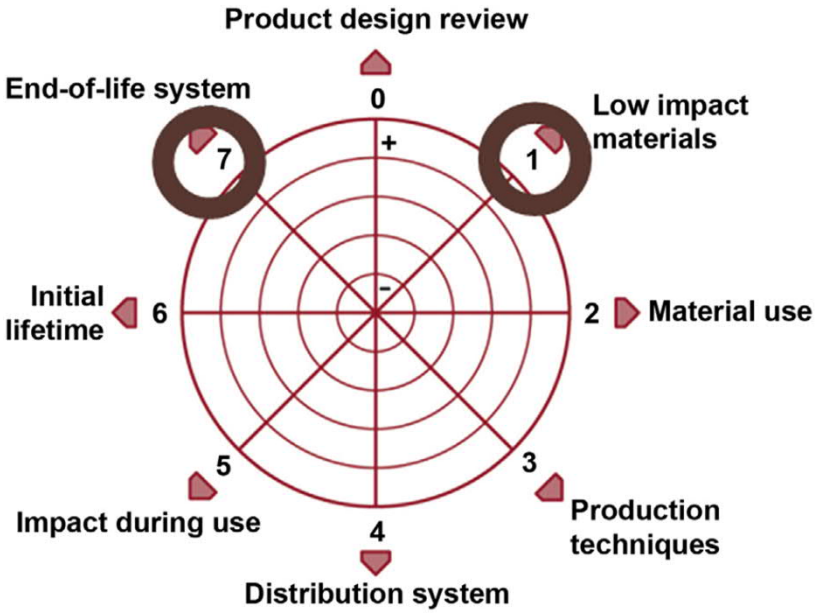
By von Schaik and M.A. Reuter

Eco-design

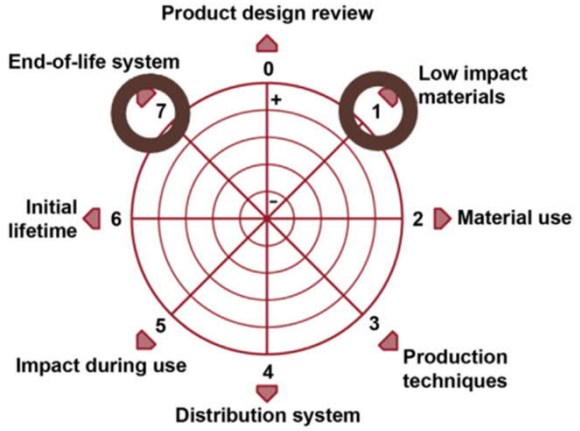
- Eco-design (currently) is a design that take into consideration more ecological design at any part of the product life:



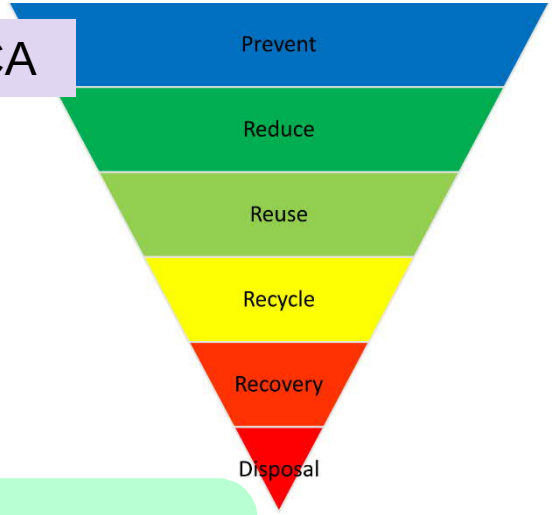
M.R.R.R Crul et al. (2009) Division of Technology, Industry and Economics.

Eco-Design
Product preparation

1) Prevent (use of any material)
2) Reduce (amount of materials)
3) Replace
   - Less environmental hazardous (Pb, Hg…)
   - Lower environmental footprint materials
   - Difficult to recycle (the metal wheel)
4) Reduce Complexity (hybrid materials)
5) Easy dismantling for recycling
6) Guidelines for dismantling



LCA



Where can we use LCA?

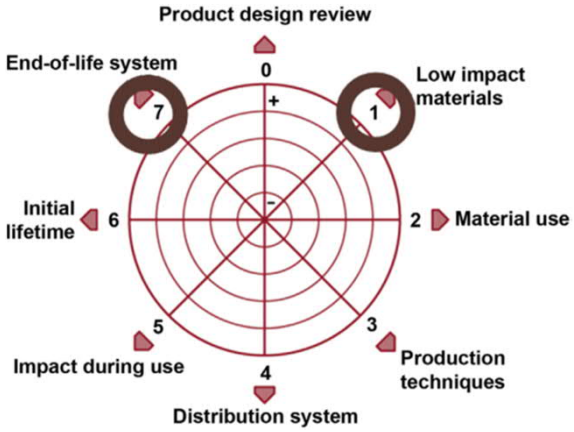
Eco-Design
Product lifetime

1) Increasing the product lifetime (durability)
2) Select process technology LCA
3) Transport
4) Usage

   knowledge to the customers how to use

   Equipment properly
5) End-of-Life LCA

   easy reuse/recovery/dismantling



Where can we use LCA?

Reflection

1. What was most interesting today?
2. I would have wanted to hear more on?

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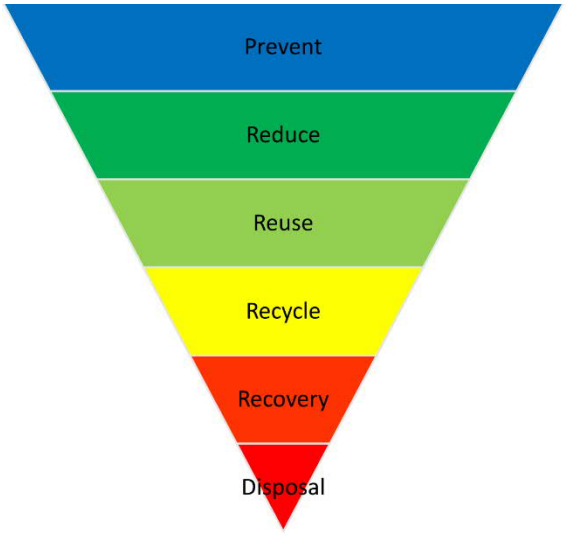
Task 3 brainstorming

In your application

What would be the starting point of the Eco-Design in your application?



Write down at least 20 ideas on post-it notes

Re-group them

Have max. 5 ideas for your application

VTT Excursion at 14.2

Location: -> Biologinkuja 5A (Behind Abloc)

Two groups 13-14 and 14-15 (MyCourses questioner)

You **need to have ID** with you

- For Finns
  - Driver's license
  - Official ID card with image
- For non Finnish citizen it needs to be
  - **Passport** (preferable), they will be fotographed
  - European Union ID -card

Excursion report

- DL 25.2.2019 at 12.00 submit to MyCourses and

- Peer reviewed online (You will get also points by preparing the peer review). Peer review timetable next week

Reflective report

- Write report on energy system research at VTT:
  - What was new to you?
- What topics (discussed at the course) were presented?

Max. 1 page

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Task 3 presentations 28.2.2019 14-17 (“Exam”)

This is the final assessment of the course

You need to understand all the components in order to prepare excellent Eco-Designs

Lecture hall Y307a (Otakaari 1)

Task 3 – Eco-design

- Eco-design is material design taking into account the recyclability of the application at end-of-life

- This can be:
  - new material solution
  - new design
  - reselection of materials
  - New concepts
  - New way’s of doing
  - New logistics

Task 3: Eco-Design

- You prepare an Eco-Design for your application
  - Can be various ideas/solutions for different stages of the product lifetime
  - Presentation of max. 10 min. including:
    - Life cycle of the product
    - Current challenges in recycling
    - Eco-Design improvements (1-3 solutions at different parts of the value chain)
    - Scientific argumentation (why?)
  - 5 min. for questions

Each of the group members will present part of the presentation.

Task 3 Grading (25 p.)

- Entire life cycle of the application and it's bottlenecks 6 p.
- Innovation potential of the solution/(s) 6 p.
- How this help commercialization of the product 4 p.
- Scientific justification 4 p.
- Clarity of the presentation and answering to questions 5 p.

25 p.

Flip reports – peer review

- Student number to your task

- Select one flip that is from other topic than your own
- Read and evaluate the report (15 min.)
- Write at least 2 sentence of feedback
  - What was good/interesting or/and what could be improved
- Grade
  - 3 p. Excellent work
  - 2 p. Good work
  - 1 p. Some parts missing/ Unclear text
  - 0 p. No submission