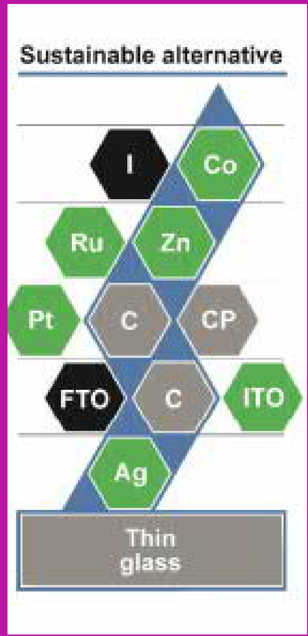
Module D2:
Eco-Design –
Energy Applications

AAE-E3120 Circular Economy for Energy Storage

Prof. Annukka Santasalo-Aarnio



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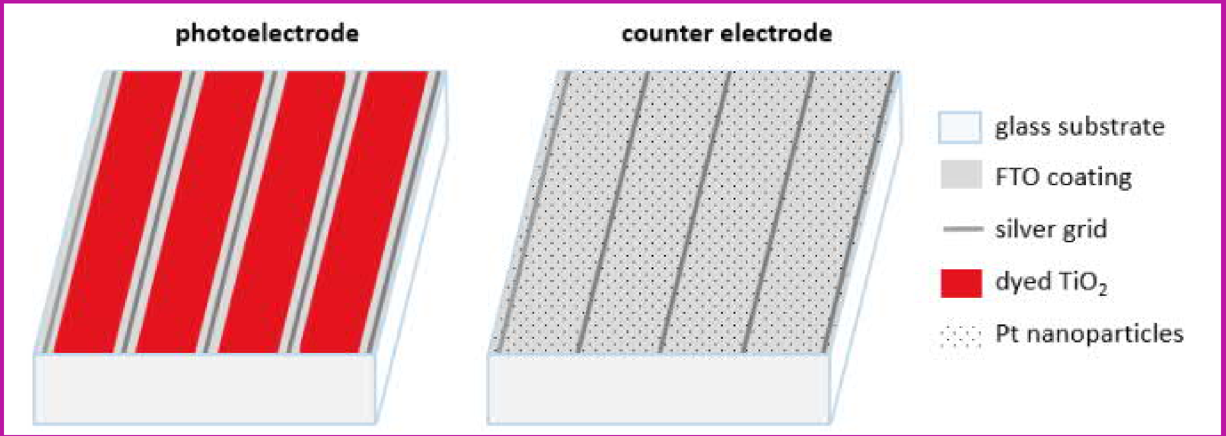
K. Miettunen, A. Santasalo-Aarnio, “Eco-design for dye solar cells: from hazardous waste to profitable recovery” J. Cleaner Production. Submitted

Learning outcomes

- **Develop new design for recycling approach for energy storage application and justify with scientific argumentation**
    - Case study -> multicomponent energy system
        - What are critical materials/what can be lost?

    - Conflict of material selection and design

Eco-design for dye solar cells: from hazardous waste to profitable recovery



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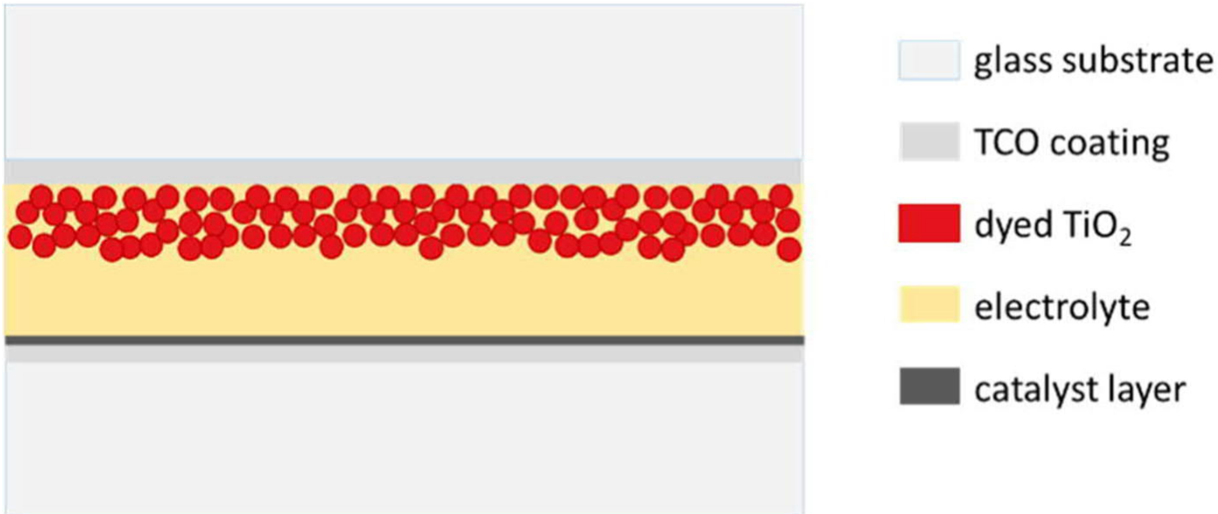
Dye sensitized solar cell



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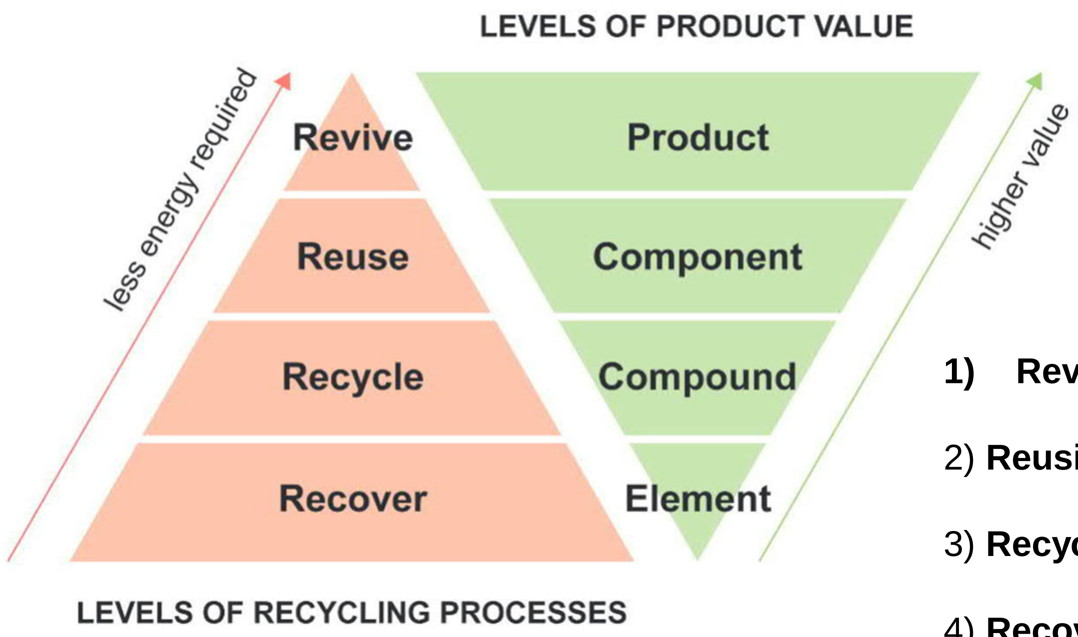
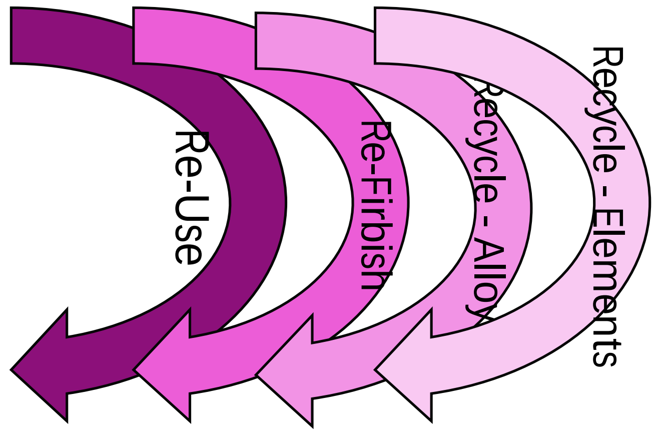
Levels of Recycling Processes





1) **Reviving/restoring** performance
   (e.g. adding electrolyte to the cell)
2) **Reusing components**
   (e.g. reutilizing counter electrode or FTO glass)
3) **Recycling materials**
   (e.g. recycling dye molecules)
4) **Recovering raw materials**
   (e.g. extracting Ru from the dyes)

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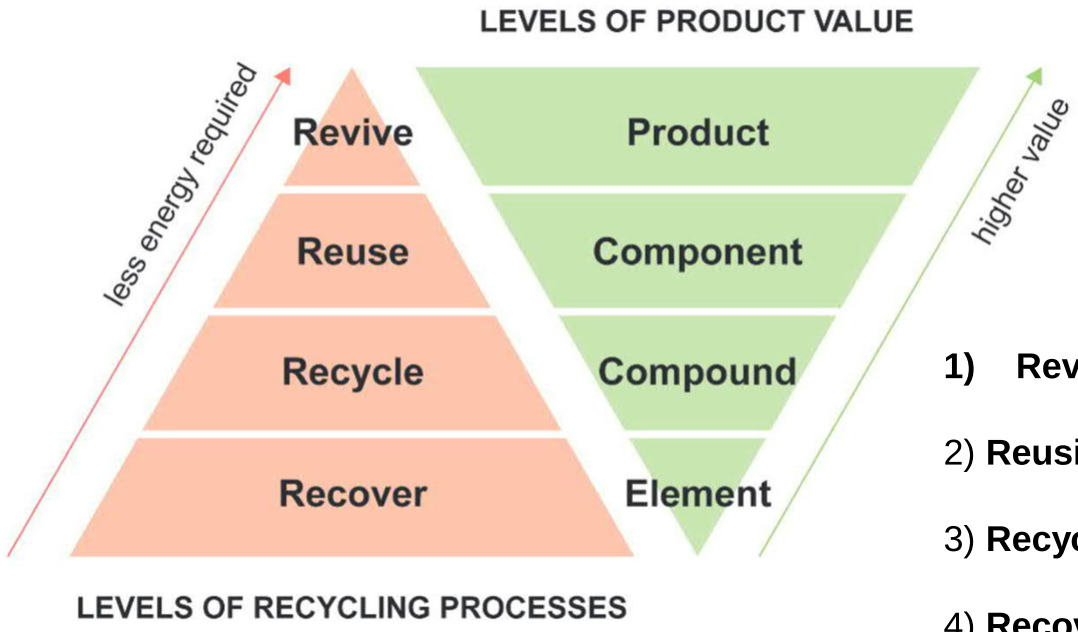
Levels of Recycling Processes



Lecture Journal

Reflect these different levels for your own application – what could these be?

1) **Reviving/restoring** performance
   (e.g. adding electrolyte to the cell)
2) **Reusing components**
   (e.g. reutilizing counter electrode or FTO glass)
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   (e.g. recycling dye molecules)
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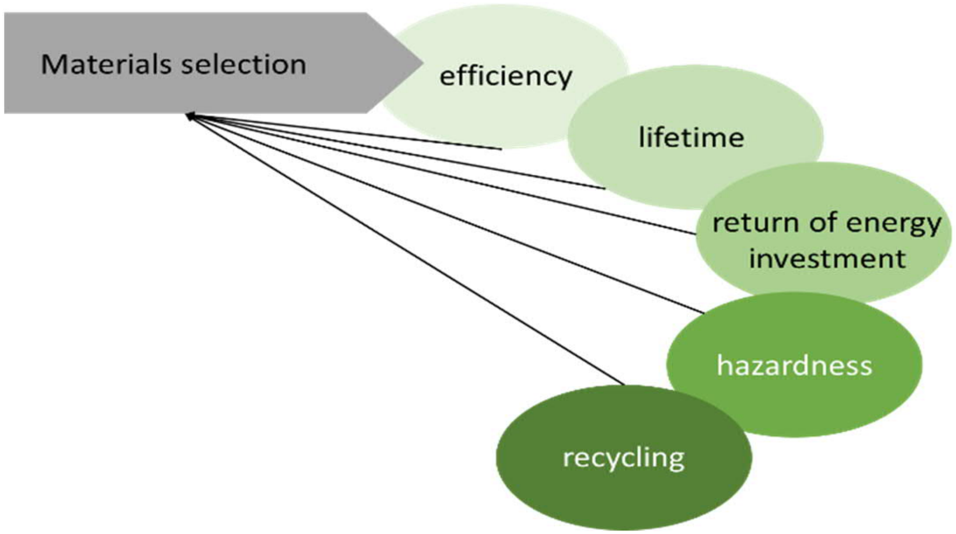
Material selection for Energy Systems



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Material selection for Energy Systems

1) **Recoverable** – indicating that this component is critical and is possible to recover with current recycling processes;
2) **Unrecoverable** – indicating that this component is critical but is not possible to recover in this energy system with current methods;
3) **Unrecoverable but abundant** – indicating that this material cannot be recovered with current methods, however, the material itself is not critical and can be lost in the recycling process;
4) **Hazardous** – indicating that this material can cause hazard during the recycling process and its use should be avoided.

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Classify the state-of-art materials in your application with this analysis.

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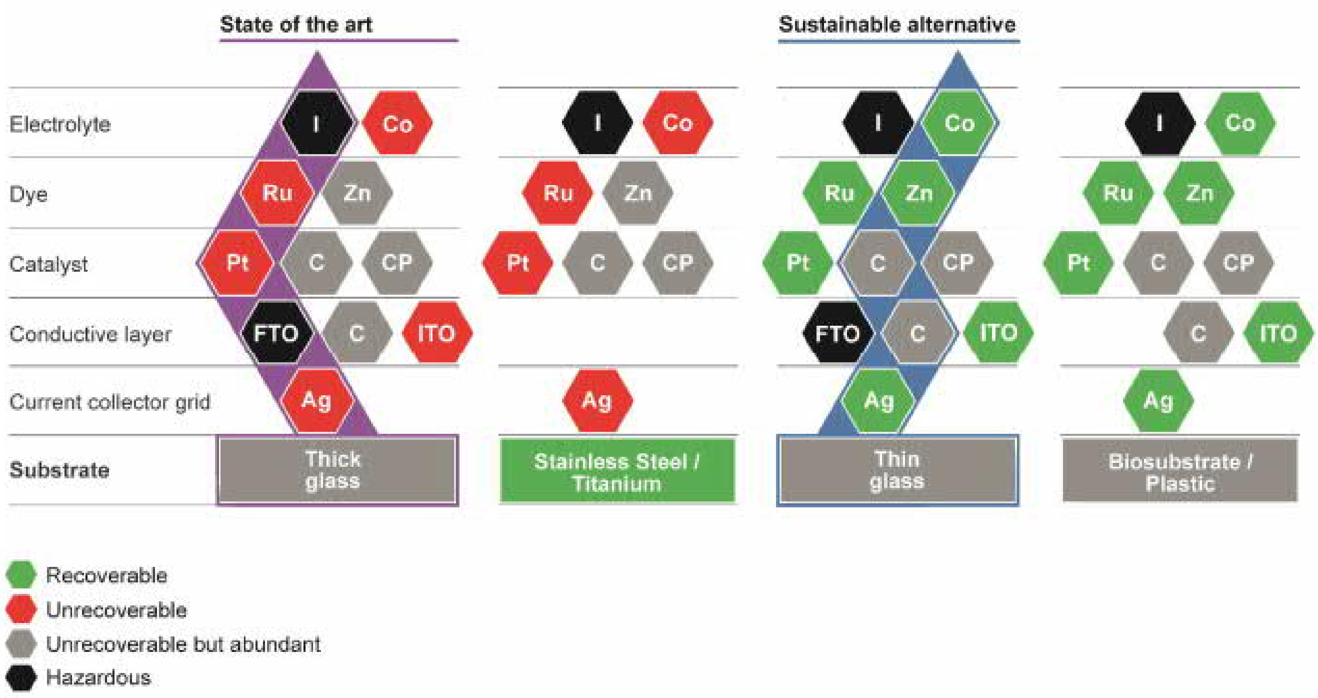
Eco-design on material combinations



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Conflict of Recycling

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Energy Storage Applications

How is Circular Economy related to Energy Storage?

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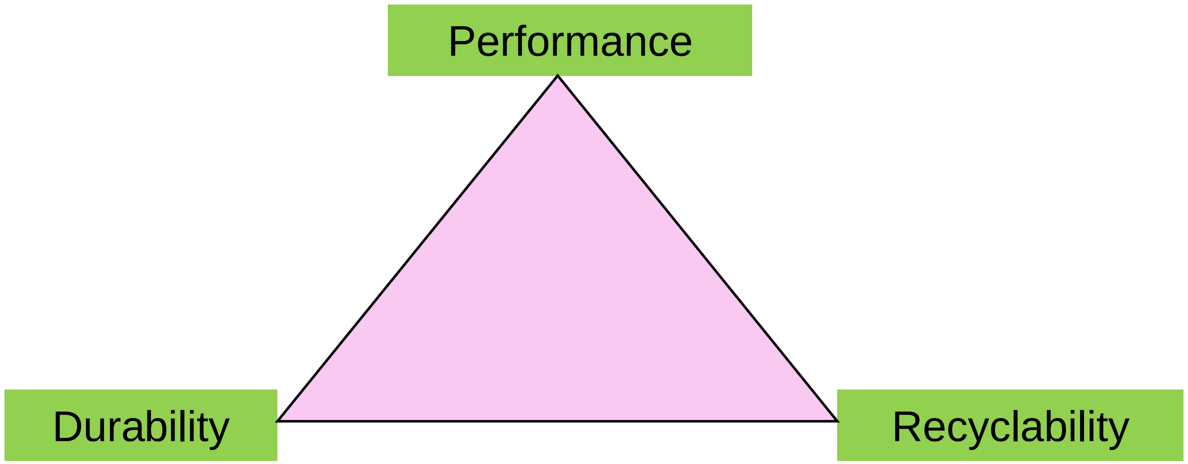
Reflect now at the end of course to these statements

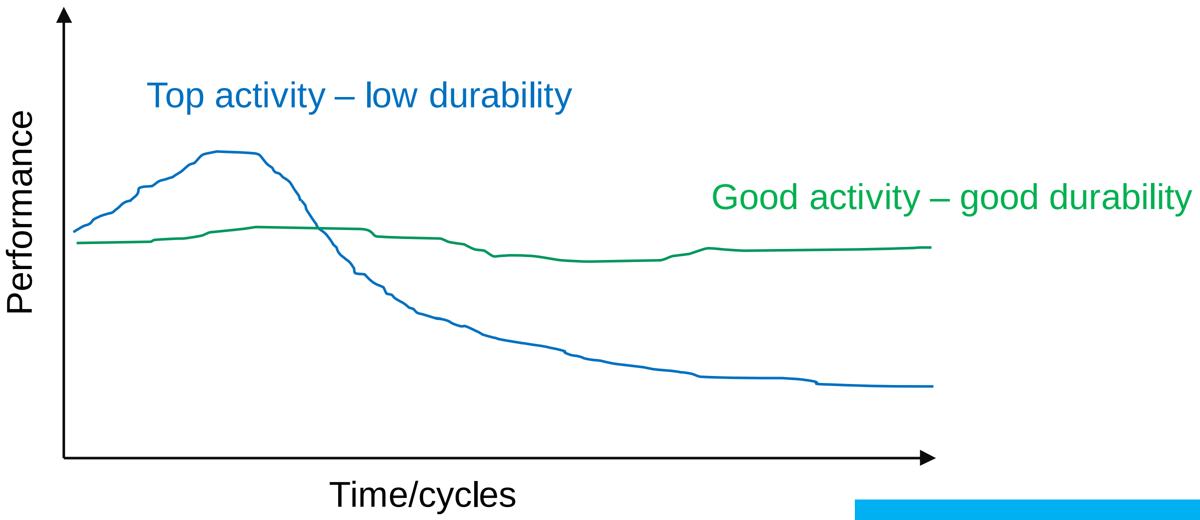
Energy Storages do not have emissions?

Circular Economy has to do with materials – not with Energy!

Conflict of material design



What is valued in the field?



Performance

Durability

Recyclability

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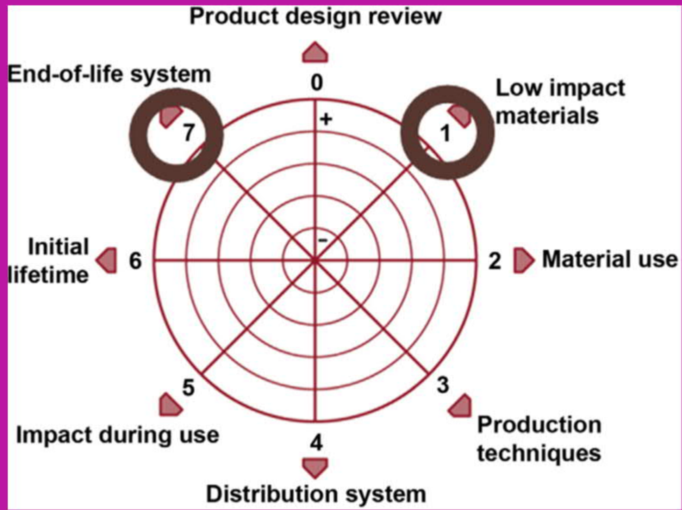
Reflect now at the end of course to these statements

Eco-Design

For your own application



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

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Take a home message

For Sustainable Energy Storage devices eco-design from materials and whole value chain must become ONE of the design parameters.