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Ecodesign of Li-ion batteries

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Current issue

-  **Resource scarcity**
Certain materials are expensive, e.g. cobalt or nickel.
-  **Demand for Li-ion battery is increasing**
Mainly due to electric vehicle applications. We need to secure supply.
-  **Absence of Li-ion recycling network**
Logistic chain is not yet developed.
-  **Recycling for economic purpose**
Recycling methods are not necessarily environmentally friendly.


Our objectives

-  **Integrated Design process**
That tool would bring together all the stakeholders' constraints, i.e. designers', manufacturers' and especially recyclers' implications along the design process.
-  **Identification of the key design parameters**
A key design parameter is a parameter used in the design process, influencing a lot the environmental impacts variations when it is subject to variations (either if they are low).
-  **Create a tool to help in the Li-ion battery ecodesign process**
It includes a model to highlight environmental hotspots of the battery lifecycle.
-  **Help to develop Li-ion recycling network in France**


Future work

-  **Procurement of end-of-life experimental data**
Primary data measured in laboratory, describing the recycling processes from our partners in LEPMI-Grenoble. These data will refine our battery model.
-  **Understanding relationship between parameters and design issues**
Some parameters (variables in the battery model) seem to have connections with other constraint levels. Specify these links is essential to develop the ecodesign tool.
-  **Make the tool accessible to everyone**
The approach must be understandable and easy to use by each stakeholder in order to implement a right Integrated Design process.

Context and state of the art

-  **Current studies are mostly based on manufacturing stages**
Few studies are focused on the battery end-of-life phase nor in the whole lifecycle. (*Dunn et al. 2012; Laboratory Argonne National et al. 2012*)
-  **Few specific databases for Li-ion batteries**
Batteries are modeled with non dedicated databases, using similar industrial activities data. It means inaccuracies of the studies. (*Ellingsen et al. 2013*)


Our work

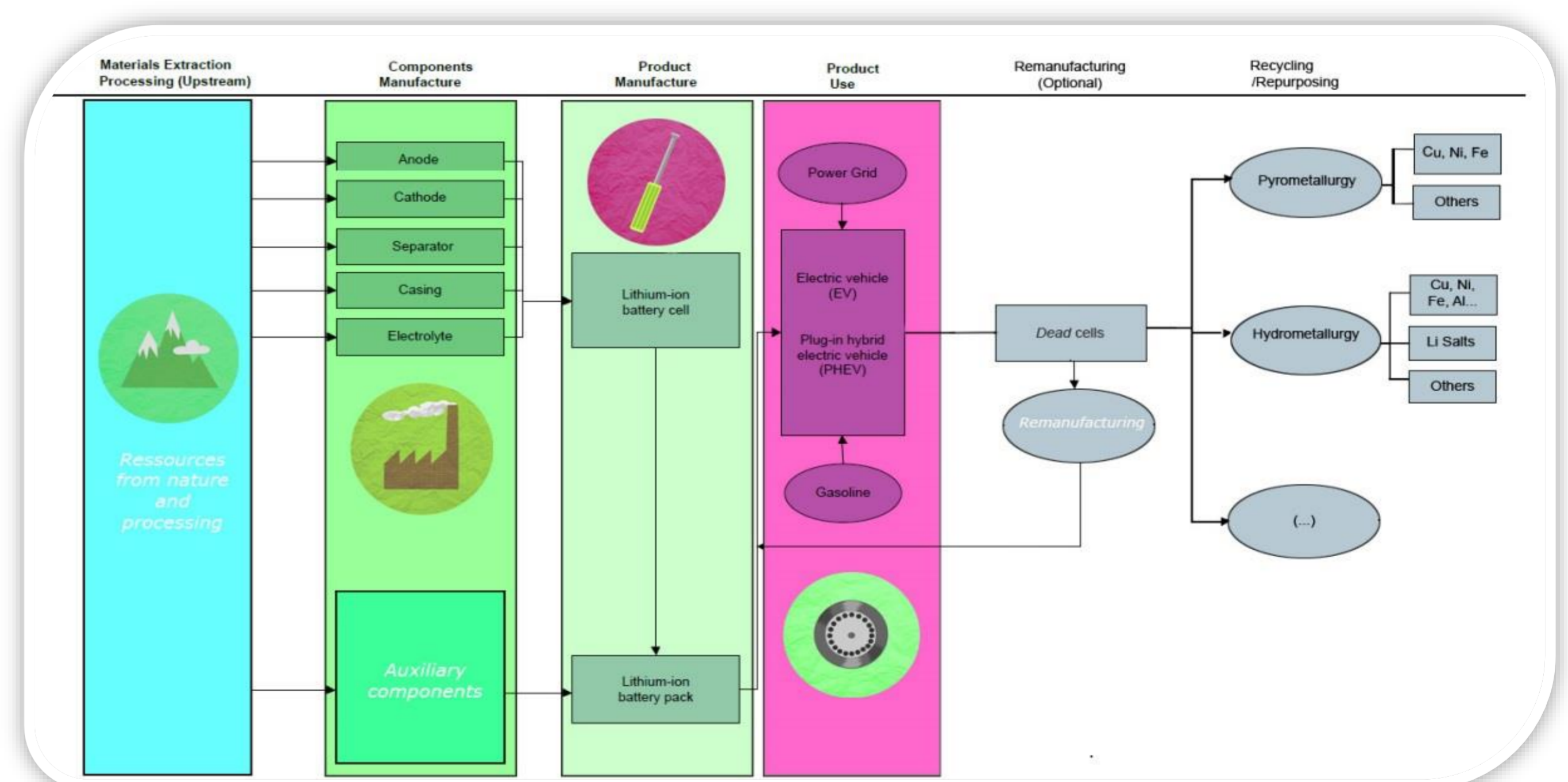
-  **LCA model of a Li-ion battery**
Parameterized and adaptable to each case study. It includes several end-of-life scenarii and battery technologies.



Li-ion battery pack

Our LCA system boundaries includes the battery auxiliary elements: passive cooling system, battery management system and the packaging.

-  **LiFePO₄ and Ni-Co-Mn batteries case study**
Batteries were modeled, analysed and environmental hotspots were highlighted. Then, we proposed some guidelines to reduce their environmental impact, for instance:
 - Use of recycled copper instead of primary copper.
 - Maximize copper recovery when recycling.
 - Reduce 'dry room' electricity consumption.
 - Use a 'greener' electricity grid during manufacturing stages.



Simplified model of Li-ion battery lifecycle

Two recycling methods were included in this case study: hydrometallurgical and direct physical recycling.