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## **Ecodesign of Li-ion batteries**

Daniel Daniel Belchi-Lorente, Peggy Zwolinski, Guillaume Mandil

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# Ecodesign of Li-ion batteries

PhD. Student: **BELCHI LORENTE**, Daniel





PhD. Director: **ZWOLINSKI**, Peggy

PhD. Supervisor: **MANDIL**, Guillaume




## 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 accesible 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

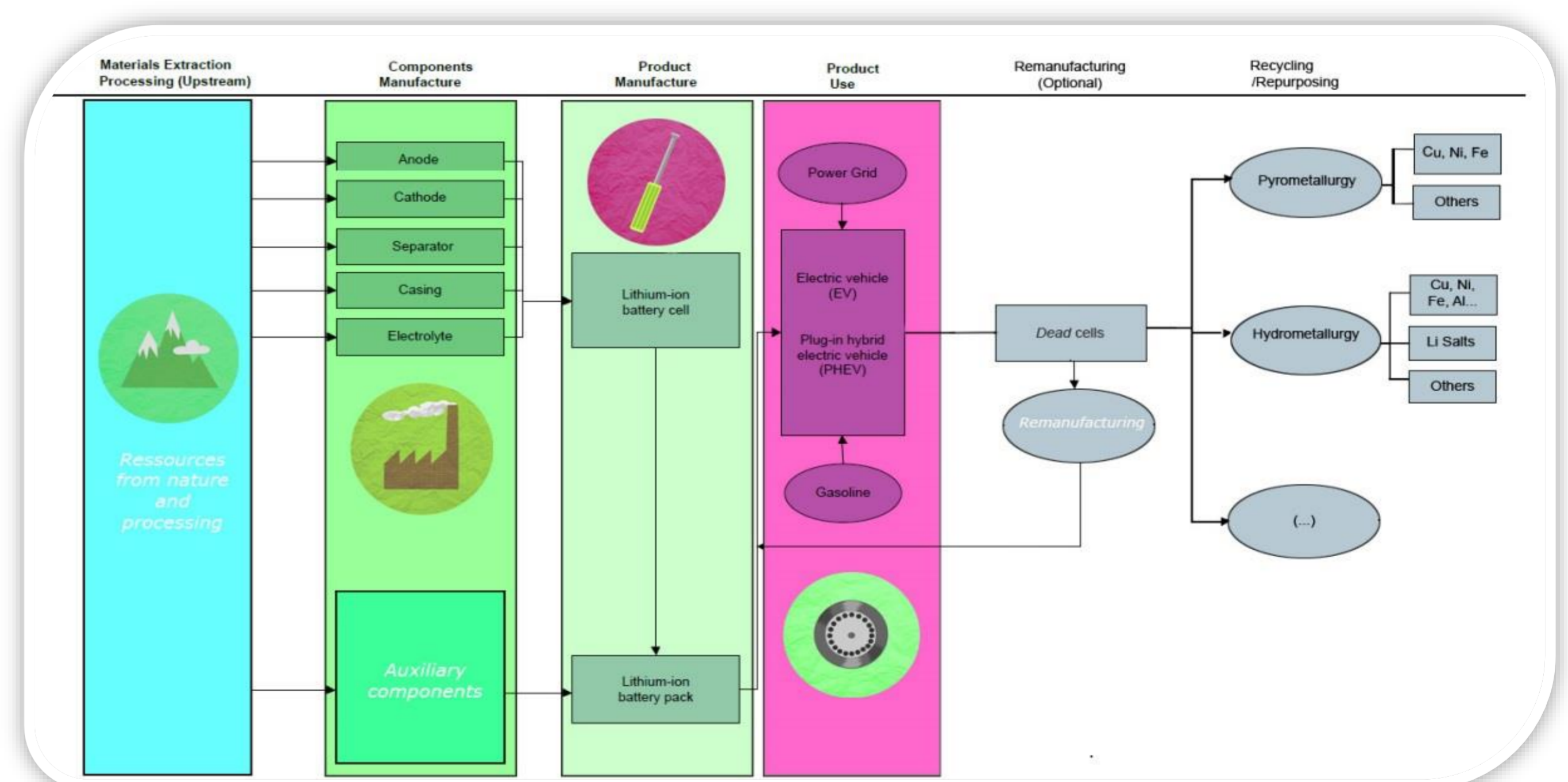
-  **LCA model of a Li-ion battery**  
Parameterized and adaptable to each case study. It includes several end-of-life scenarii and battery technologies.



### Li-ion battery pack

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

-  **LiFePO<sub>4</sub> 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.