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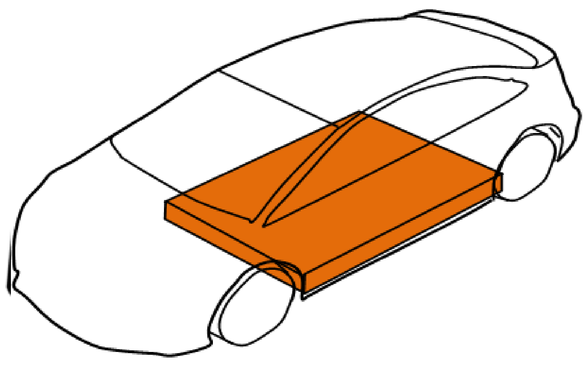
Sustainable Resource Management for Lithium-Ion Batteries for Electric Vehicles

Full study available: Pehlken, A., Albach, S., Vogt, T.; Is there a resource constraint related to lithium ion batteries in cars?, Journal of LCA, available online since July 2015

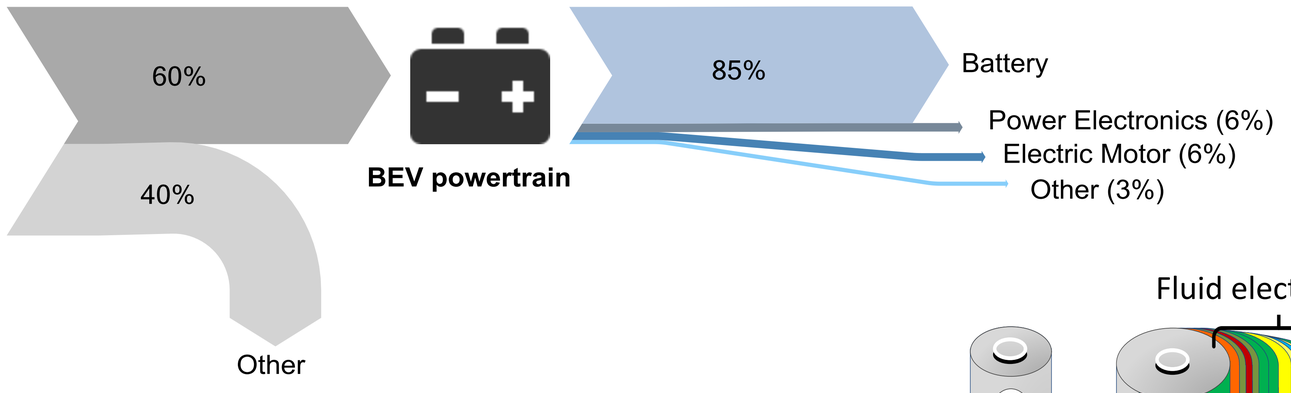
Approach and Needs

Due to the electrification of the powertrain, the demand for strategic non-renewable resources will increase significantly in the next years.

Electric mobility seems to be the ideal solution for a more sustainable lifestyle with less CO_2 emissions. It uses highly complex technologies and thus a higher amount of strategic resources is needed compared to vehicles with combustion engines. Batteries hold up to 50% of the added value share in battery electric vehicles (BEV) due to the amount of strategic metals inside. Lithium-Ion Accumulators are the most promising electricity storage technology in the short and medium term, but require lots of strategic resources.



BEV



Components and their values in Battery Electric Vehicles

Data Source: ENEVATE

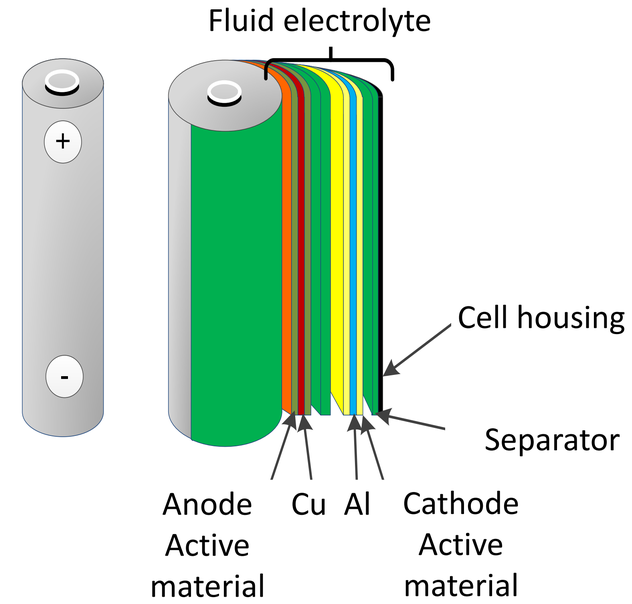
Methods and Battery Chemistries

Lithium-Ion Batteries consist of four main components: Anode (negative electrode), Cathode (positive electrode), Separator and Electrolyte. While the Anode consists of Graphite in most cases, different materials are used for the Cathode. Limiting factors, such as cost, life span, safety or performance, vary depending on which battery chemistry is used, as shown in the table below.

Battery chemistry (cathode/ anode:graphite)	Power	Energy	Lifetime	Safety	Cost
$LiCoO_2$	3	3	1	1	0
$Li(Ni_{0,85}Co_{0,1}Al_{0,04})O_2$	3	3	3	2	2
$LiFePO_4$	3	2	3	2	2
$Li_{1-}(Ni_{0,33}Mn_{0,33}Co_{0,33})O_2$	2	2	0	2	2
$Li_{1,2}Mn_{0,6}Ni_{0,5}O_2$	4	4		4	2

Performance Explanation: 0 - very low 1 - low 2 - middle 3 - high 4 - very high

Source: Dörr 2011, Ketterer et al. 2009



All of them contain strategic metals such as Lithium or Cobalt.

It is questionable whether metal reserves will suffice the upcoming demand in the future. Therefore we performed a MFA study with different market scenarios and battery chemistry related to electro mobility.

Selected Results

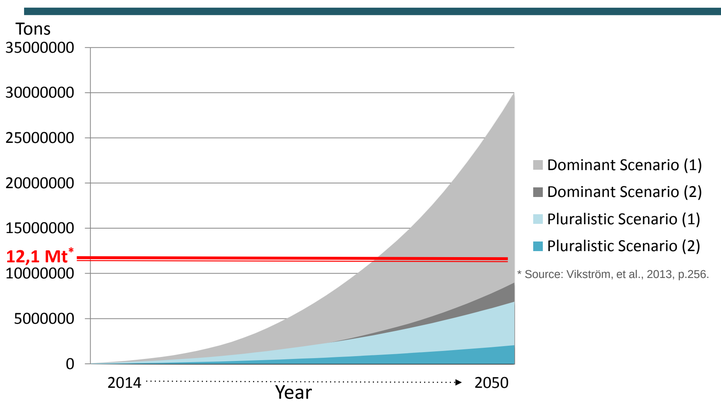


Figure: MFA results of cumulative Li-metal demand against lithium reserves

Results are highly afflicted to uncertainties at various levels. e.g. Lithium could only in part be covered by secondary supply, hence they will have to be largely covered by primary production.

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