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LCA Boundaries

Analysis will look at the environmental impact of one metric ton of lithium-ion and lead-acid batteries. They will be produced at a hypothetical battery pack manufacturer in Dayton, OH. It is assumed that the battery manufacturer has all necessary raw materials for the production of the battery cell. Therefore, analysis will consist of the associated environmental impact of raw material preparation, assembly of the cell packs, and transport of packs to an automotive manufacturing facility in Shanghai, China.

Objective

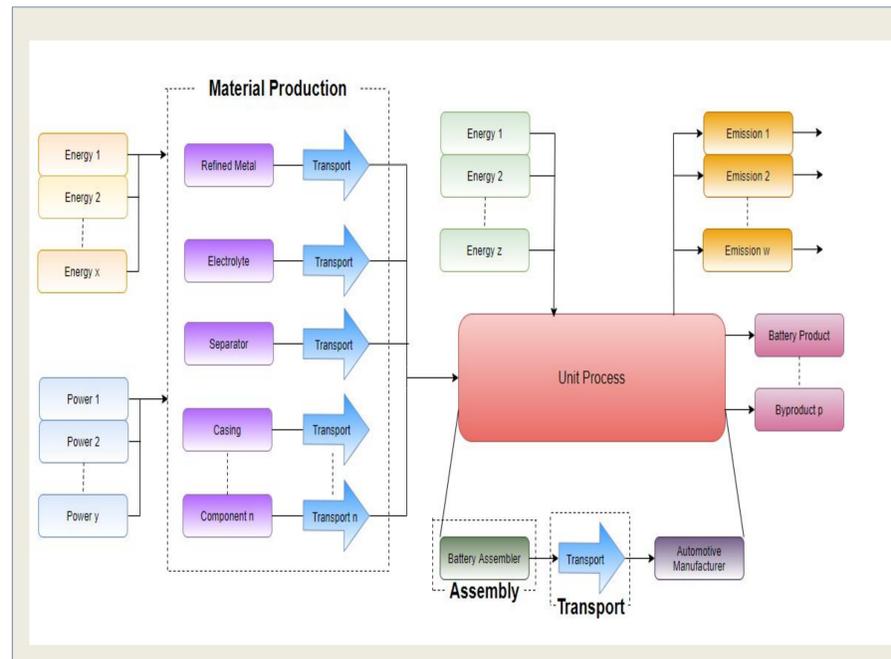
Execute a hybrid input-output life cycle assessment to calculate the environmental impact of lithium-ion versus lead-acid batteries. This should inform the public how battery selection is coupled with environmental impacts. Success means researching and hypothesising on how to lessen environmental impact of the process.

Problem Statement

- Society does not consider impacts of batteries in a device enabled world. There are considerable ethical and environmental implications of using a battery enabled device.
- Although performance can depend on application, Lead-Acid or Lithium Ion chemistries differ in many ways and we wish to understand how.
- To assess we will consider the hypothetical production of 1 metric ton of complete battery packs, using other scholarly research data.

Social Justice Discussion

A major concern for future generations is the lack of resources necessary to make Lithium-ion batteries. The metals used to make these batteries are scarce. The current rate of consumption of some of these materials, such as cobalt, is going to prevent future generations from using these materials. Two options for avoiding this scenario would be to decrease the amount of cobalt used in batteries or find alternative materials that are larger in supply.



Select References

1. Amarakoon, Shanika, et al. "Application of Life Cycle Assessment to Nanoscale Technology: Lithium-ion Batteries for Electric Vehicles." EPA 744-R-12-001, April 2013, Accessed 24 March 2020
2. Dai, Qiang, et al. "Life Cycle Analysis of Lithium-Ion Batteries for Automotive Applications." Batteries, vol. 5, no. 2, 2019, p. 48., doi:10.3390/batteries5020048
3. Ma, Yongxi, et al. "LCA/LCC Analysis of Starting-Lighting-Ignition Lead-Acid Battery in China." PeerJ, vol. 6, 2018, doi:10.7717/peerj.5238

Data, Conclusions, and Implications

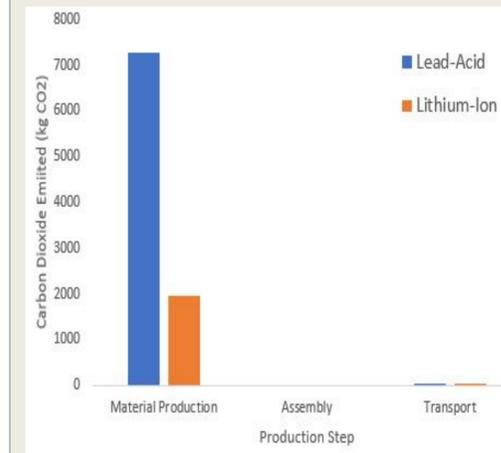


Figure 1: CO₂ Emitted

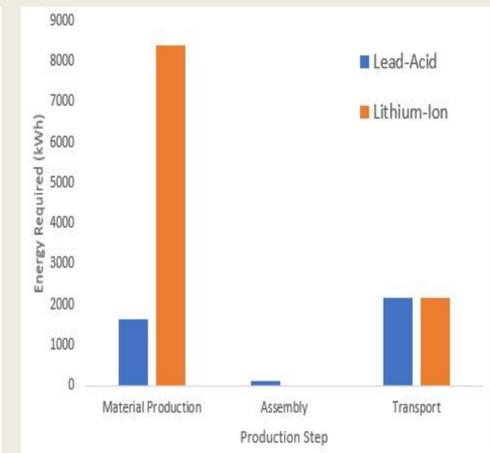


Figure 2: Energy Consumed

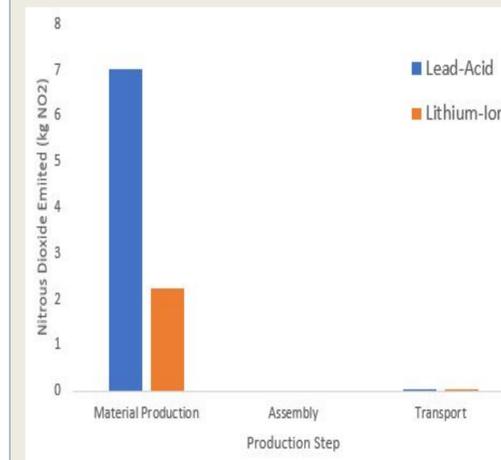


Figure 3: NO_x Emitted

Molecular structure of lithium metal is intrinsically better suited for batteries. Lithium outperforms lead but at higher energy consumption costs. Lead is cheap, more plentiful, and less expensive. Advancements in technology have allowed lithium-ions to surpass any performance barrier of lead-acid.

- Lithium-ion batteries overall are more efficient, while also producing less carbon emissions and nitrous oxide emission. The production of lithium-ion batteries is very energy intensive, therefore it may contributing more to carbon emissions from energy sector.
- As the power grid goes renewable, battery powered devices become exponentially more efficient due to recharging becoming renewable. Benefits lead acid type due to prolonged cycle life. This will reduce overall emissions associated with necessary energy required for each battery chemistry.
- To reduce environmental impact, materials must be improved, production should be regulated, and consumers must consider environmental impact of production with their product in use.