Lithium-Ion Batteries: An Emissions and Life Cycle Analysis

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Problem

Due to the growing demand of lithium ion batteries worldwide there has been a major increase of the battery production. But the production process is one that creates large amounts of carbon emissions while expending large amounts of energy. Our goal for this project was to create a database showing the CO2 emissions and energy usage of the whole lifecycle process.

Our Goals

Perform a lifecycle analysis of Lithium ion Batteries and compile the energy input and emissions associated with the steps for their production.

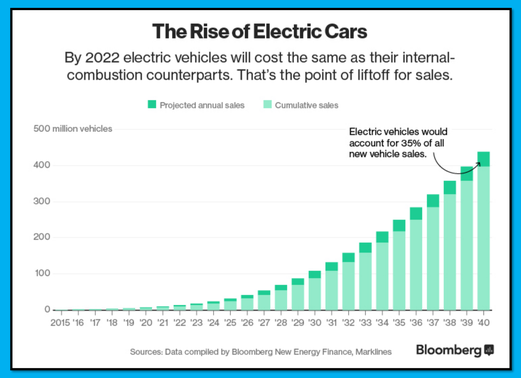


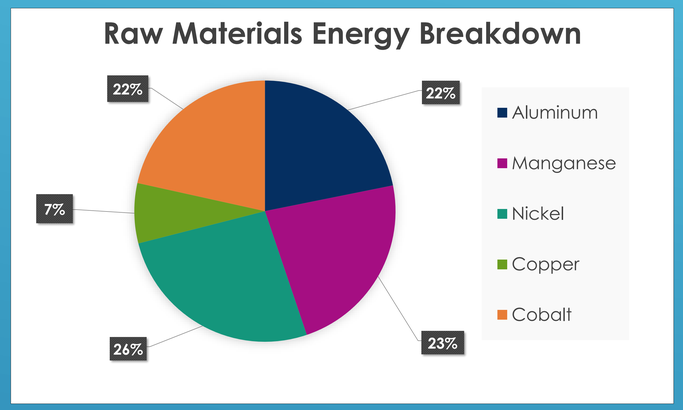
Figure 1.

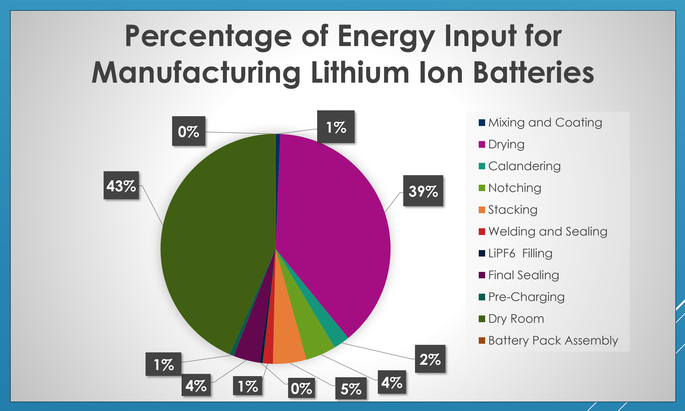
Lifecycle

The lifecycle of lithium ion batteries starts with the extraction of raw materials. Then those materials are processed and manufactured into batteries in an energy intensive process. At this point the batteries find their way into consumer electronics and electric vehicles where, once they reach end of life, these devices will need to be disposed of. Most end of life lithium ion batteries make they way into landfills, but more and more are being recycled extracting valuable materials. These reclaimed materials can then find their ways into new lithium ion batteries, completing the cycle.

Raw Materials and Manufacturing Energy breakdown

Below are two charts that help visualize how much energy is used in each step of the two main lifecycle processes. Those being the harvesting of the raw materials and the manufacturing process. Each graph shows the energy spent in KWh/ kg of product.





Breakdown of Carbon Emission and Energy Requirements For Each Stage of the Life Cycle

•Raw Materials

- •Manganese uses 12.866 KWh for every Kg that is produced
- •Aluminum uses 14.993 KWh for every Kg produced
- •Nickel uses 18.732 KWh for every Kg produced
- •Copper uses 5.313 KWh for every Kg produced
- •Cobalt uses 15.389 KWh for every Kg produced

Manufacturing

		MJ per kWh battery
1.	Mixing	]3.98
2.	Coating	6.98
3.	Drying	641.18
4.	Calendaring	38.22
5.	Notching	71.13
6.	Stacking	78.44
7.	Welding and Sealing	23.93
8.	LiPf Filling	6.65
9.	Final Sealing	62.16
10.	Pre-charging	9.97
11.	Dry Room	723.94
12.	Battery Pack Assembly\	1.00
	Total	1667.59

Battery Usage

The average Electric Vehicle (EV) consumes roughly .33 kWh/mile

Average CO2e average about ~20 tons over the lifetime of an EV (sans manufacturing)

Recycling

Some recycling methods include, Dissolving the batteries in acid, using a centrifuge to extract all liquids, leaving only the raw materials, smelting the batteries, and re-energizing the cathode material.

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Conclusion

Through the research we conducted for this project we were able to determine the carbon emissions as well as the energy consumption of the lifecycle of a lithium ion battery. By looking at the results it becomes more clear that the current methods of battery production are ineffective and wasteful and more efficient methods can be found.