Industrial Life Cycle Assessment for Radical Emissions Reductions

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Veloz: Creating Sustainable Practices from Mine to Wheel and Beyond
29 October 2020
My city on 9 September 2020. This is real.
“The embodied emissions of the materials you use to make the batteries are **significant and need to be understood.**

If you were to power all your EV manufacturing using coal, **it would make no difference** at the end of the day.

One thing we did when we built the Nevada Gigafactory was to **make it all electric,** there is literally no natural gas line, so there is little to no local emissions at that factory. When you weave natural gas through your facility, it makes it **much harder to chase it out.**

The emissions **all the way back up to the mine** are significant too.

When we look at TWh scales of production, we need to make sure we are not creating unintended consequences as we go through this industrial shift. **That is why we are in this situation in the first place,** and we need to rapidly remediate that.”

- JB Straubel
Former Tesla CTO & Current Redwood Materials CEO

Quote from the Stanford Storage X webinar on 16 October 2020

**Stanford Energy**
StorageX Initiative
The embodied emissions of the materials you use to make the batteries are **significant and need to be understood.**

Buyers at battery companies have **massive power today to guide their future** CO₂ emissions (which 97% do not yet exist) because there is **massive variability** in the CO₂ emissions of manufacturing chemicals from different resources/processes.

<table>
<thead>
<tr>
<th>Clean Product</th>
<th>Dirty Product</th>
<th>Ratio of CO₂ Intensity for Dirty/Clean</th>
</tr>
</thead>
<tbody>
<tr>
<td>LiOH·H₂O</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>NaOH</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>NiSO₄·6H₂O</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>MnSO₄·H₂O</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CoSO₄·7H₂O</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Graphite</td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

Considering only the materials above, what would be the **delta in CO₂ intensity** of manufacturing if a procurement team bought all the **lowest CO₂ intensity** chemicals vs. all the **highest CO₂ intensity** chemicals to make an NMC 811 cell?

\[ \Delta \text{CO}_2 = 55 \text{ kgCO}_2/\text{kWh} \]

This represents ~50% of the total embodied emissions of making the cell, and at 3TWh/year production, is equal to Ireland + Switzerland + Portugal's annual CO₂ emissions combined.

So, a team of **10 people in California have the power today** to eliminate the emissions of three entire small European countries in 2030 using only their 2020s' procurement policy.
If you were to power all your EV manufacturing using coal, **it would make no difference** at the end of the day.

**Source:** Major Chinese Lithium Company’s Sustainability Report

**Statistically meaningless difference** presented deceptively for greenwashing

One of the world’s major LiOH·H₂O suppliers, whose lithium values go into Tesla’s cathode, burns > 2 tonnes of coal per tonne of LCE to process spodumene concentrates from **Australia**.

China’s domination of the lithium chemical manufacturing section of the value chain would be weakened if the price of their products included the price of dumping CO₂ in the atmosphere… **So why do Western lithium buyers representing the EV revolution buy Chinese lithium chemicals?**
One thing we did when we built the Nevada Gigafactory was to **make it all electric**, there is literally no natural gas line, so there is little to no local emissions at that factory. When you weave natural gas through your facility, it makes it **much harder to chase it out**.

**Be deliberate** about “chasing out” fossil fuels from your processing flowsheets

**Electricity** is much easier to decarbonize than heat – Solar and wind energy project development is **much more straightforward** than mineral project development

**How does a heat pump work?**

**Mechanical Vapor Recompression** (MVR) evaporators shift energy input from heat (harder to decarbonize) to power (easier to decarbonize)
The emissions all the way back up to the mine are significant too.

There are a number of options for electric mining (and if battery metals are mined electrically, it's like the metals are mining themselves!)

That energy can be decarbonized using wind, solar, and other low carbon sources.
When we look at TWh scales of production, we need to make sure we are not creating unintended consequences as we go through this industrial shift. **That is why we are in this situation in the first place, and we need to rapidly remediate that.**

Battery and EV industry, **let this be your canary in the coal mine:**
1. LCAs of LIBs are **dramatically underestimating** CO\(_2\) emissions of your supply chains
2. The efficacy of LIBs for reducing CO\(_2\) emissions and avoiding climate change is **not guaranteed** unless we change the way we mine and process chemicals
3. **Decarbonizing cell/battery assembly plants is almost irrelevant** compared to decarbonizing battery chemical mining and processing – the canary chirps “SCOPE 3”!

Why would we care about the CO\(_2\) emissions of battery chemical manufacturing if we didn’t care about scope 3 emissions? **One woman’s scope 2 is another woman’s scope 3.**

*Data From: Argonne National Laboratory, MINVIRO*

<table>
<thead>
<tr>
<th>Data From:</th>
<th>Pack Assembly</th>
<th>Cell Assembly</th>
<th>Active Materials</th>
<th>Mining &amp; Chemical Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CO(_2)</strong> intensity bill of materials</td>
<td>2 kgCO(_2)/kWh</td>
<td>20 kgCO(_2)/kWh</td>
<td>21 kgCO(_2)/kWh</td>
<td>95 kgCO(_2)/kWh</td>
</tr>
</tbody>
</table>

\[ \Delta \text{CO}_2 = 55 \text{ kgCO}_2/\text{kWh} \]
We can kill two birds with one stone by producing low carbon energy and lithium chemicals simultaneously.

Assuming they are technically feasible (e.g. economic):
1. Buyers need to give these projects off-take agreements
2. Investors need to finance these projects
3. Engineers need to build these projects

Case Study 1: Geothermal Lithium Projects
Everyone in the Lithium Industry Has a Role to Play

There are three classes of mining and chemical industry *homo sapiens* who can **make a big difference to avoid CO\textsubscript{2} emissions** of battery chemical extraction and processing:

1. **Engineers**
   - Reduce the fossil fuels you weave into your process by **electrification** (e.g. MVR, electric calcination, heat pump)
   - Tap into concentrated solar, photovoltaics, geothermal, and wind for **low CO\textsubscript{2} heat and power**
   - Don’t design your process the same way your old employer did it: **revisit 1\textsuperscript{st} Principles** to find better solutions

2. **Institutional Investors**
   - Don’t invest in or lend to any new project that would produce LiOH·H\textsubscript{2}O emitting >5tCO\textsubscript{2}/tonneLCE
   - Work with independent, professional life cycle assessment (LCA) practitioners to **guide investment decisions**

3. **Battery Chemical Buyers**
   - Require **ISO-compliant life cycle assessments** for the manufacture of all materials you buy to make your batteries and **set yourself targets** for supply chain CO\textsubscript{2} emission reduction (e.g. don’t buy >10tCO\textsubscript{2}/tonneLCE after January 2023)
   - Modify your procurement decision making process by applying a **synthetic $100/tonne carbon tax** to yourself
   - **Chase coal out of your battery supply chain** by not buying any battery chemical with coal in its supply chain from 2023
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