Charge!

by Gabrielė Vilemo Gotkovič

Rechargeable lithium-ion batteries could become the 'new gold' in the carbon-neutral future. In fact, the decarbonisation of cars, trucks, and power grids depends on this fast-improving technology. Batteries are expected to become one of the 21st century's key developments, and the market looks forward to being worth tens of billions of euros by the middle of the 2020s. One million plug-in cars are needed to be sold in 2020 to meet the EU's car CO_2 standards, and achieving the bloc's 2030 goals requires sales to go up by 40%. As a result, the European Commission has launched the EU Battery Alliance, championed by 16 gigafactories, to support the creation of a green battery value chain catering to Europe's demand.

Unlike combustion engines that literally burn oil, batteries do not combust lithium or other minerals such as cobalt and nickel, which can be fully recovered and used again. As such, battery-powered vehicles are already, from a life-cycle perspective, better than traditional ones. However, they still have an environmental impact, which should (and can) be minimised in order to achieve the EU's climate and environmental objectives. Successful policy design has to consider sustainable battery production, reuse and recycling, as well as responsible sourcing of raw materials globally to maximise industrial, climate, and societal benefits.

A market-driven by regulations towards sustainability

Just as for conventional cars, upstream emissions in electric vehicles (EVs) are associated with their production phase, notably of lithium-ion batteries (LIB). Unfortunately, little robust, primary up-to-date data is available on the 20 odd materials, as well as complex and fast-evolving processes used in LIB cell, module, and pack manufacturing. The recent report by Circular Energy Storage, commissioned by the Brussels-based NGO Transport & Environment (T&E), highlights the current climate impact range of LIB batteries to be between 39 kg $CO_{2equivalent}$/kWh and 196 kg CO_{2e}/kWh, roughly the same as driving a diesel car 11,800-to-89,400 km.

The T&E's policy brief on battery regulations in Europe outlines the following reasons for this wide spectrum. First, there is a significant absence of current primary data, with much modelling based on studies dating back as far as 1999. While the earlier pilots have a higher per kWh energy input, the new gigafactories demonstrate a significantly lower energy use due to economies of scale and process efficiency gains. Secondly, the lack of a consistent calculation methodology often completely ignores the reuse and recycling potential. At the moment, industrial LIB recycling is mainly limited to portable batteries, excluding the volumes of batteries from end-of-life EV vehicles. Consequently, this makes it significantly more challenging to accurately account for the real-life impact of different recycling processes.

On this account, the urgent first step for the EU battery regulations needs to be put in place to maintain a robust and up-to-date database of emission factors for different battery materials and processes which are at the cell level and are factory-, process-, and location-specific.

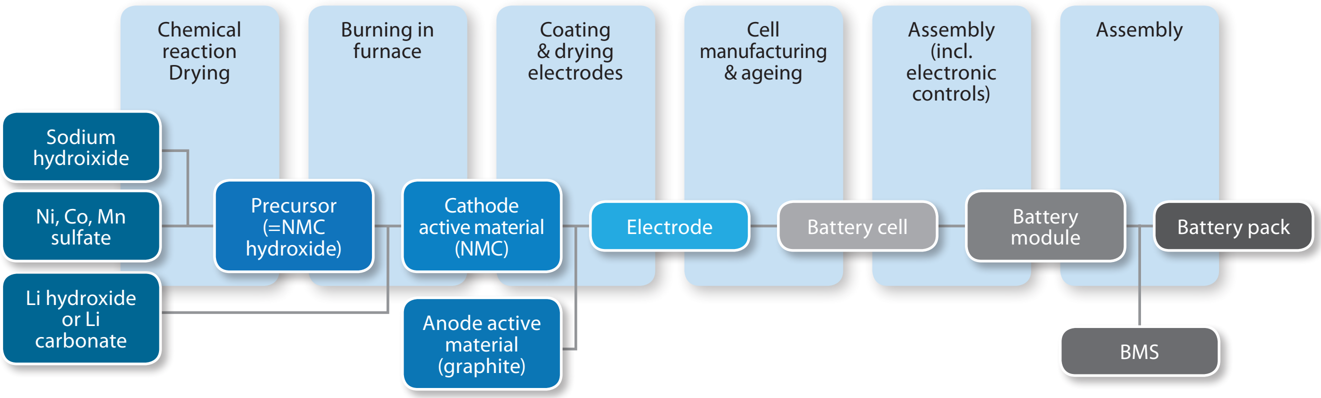
The production of battery cells is the most energy and carbon-intensive part of making LIB, responsible for as much as 75% of energy consumption. Figure 2 shows an exemplary breakdown of different steps for Nickel-Manganese-Cobalt 111 cell chemistry (currently on the market but getting fast outdated). The detailed data on the latest chemistries, such as NMC811 (eight parts nickel, one-part manganese, and one-part cobalt), is not readily available, yet these are expected to have lower carbon footprints. Nonetheless, the figure pinpoints the general battery emissions 'hot spots' that should be taken into account when legislating future EU battery regulation.

To reduce carbon and environmental footprint of battery production, the EU sustainable performance requirements should incentivize, support, and foster deploying waste heat recovery processes, along with technologies to green the preparation of precursors. Huge improvements can come from better cathode coating techniques that would make the cathode powder mixing and coating processes more efficient. The design of the future EU regulations should also seek to incentivize the set-up of vertically-integrated local supply chains in order to drastically reduce transport emissions as well as stimulate the future battery production facilities to be located near low-carbon energy sources.

It is important to speed up this process so as to lower the overall carbon footprint of batteries. This much-needed acceleration can gain momentum via a comprehensive regulatory strategy. Mandatory requirements on all battery manufacturers whose products are found on the EU market are necessary to measure and report each battery's carbon and energy footprint. Next, once accurate data have been collected and data verification process established, a mandatory CO_2 threshold should

Photo: Volvo

Fig. 1. Key chemistry phases in Nickel-Manganese-Cobalt 111 (NMC) battery manufacturing



Source for figs. 1-2: T&E's GREEN POWERHOUSE. T&E blueprint for battery regulation in Europe *(2019)*

be considered in order to ensure that all future batteries follow manufacturing best practise. Finally, EU research & innovation funding should focus on improving battery manufacturing processes, e.g., better coating techniques, industrial waste heat recovery processes, and environmentally-friendly and efficient recycling.

It is as equally important to ensure a sustainable battery design strategy. For instance, the use of hazardous materials in manufacturing should be phased-out and tightly controlled to spur innovation into better methods, materials, and toxic-free battery value chains. Batteries should also be durable and have a long lifecycle, where the design of battery cells and packs incorporates circularity from the outset to facilitate disassembly, repair, and recycling.

Ultimately, innovative technologies should be incorporated into battery management systems to provide standardised access to key battery parameters and usage data. A 'battery passport' would enable innovative and smart services by providing comprehensive and extensive information on the product. Both static (i.a. battery production date & location, carbon footprint) and dynamic data (remaining capacity & fade and voltage drop, charging history, etc.) could be used to make the most of batteries, especially if we consider their multifunctionality, when, e.g., EVs could serve as energy storage points for the power grid.

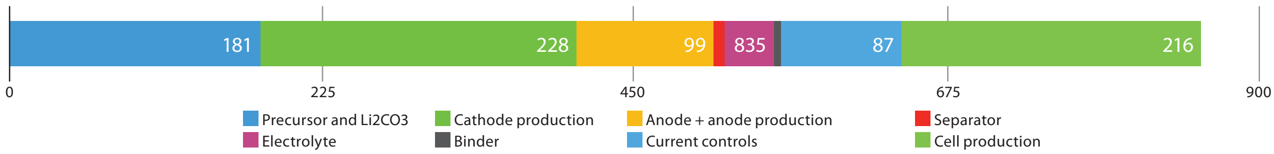
The circular battery

When battery performance is no longer good enough for a car or a truck (less range, worse acceleration, etc.), it should be reused in less demanding applications like in forklifts or as a stationary energy storage/buffer in high power charging stations (to reduce peaks). Such second-life batteries will provide extra storage flexibility on the grid, allowing for higher penetration of renewables across Europe. It is therefore important to incentivize longer lifetime and remove any barriers for reuse applications.

The ultimate goal is, however, to fully recover all the valuable materials (lithium, nickel, cobalt) found in batteries at the end of their lives. While few people today question the benefits of recycling, as it helps to secure critical materials in Europe, currently the market for LIB recycling is in China where EU batteries are usually sent. An important finding from one of the studies conducted by Element Energy indicates that Europe has inadequate recycling capacity, estimated today at 33kt/year, deemed insufficient should currently in use EVs reach the end of their lifecycles in 2030 onwards. Similarly, there is almost no commercial-scale LIB recycling in Europe as things stand today, the majority of "recycling" companies providing low-value collection or shredding only. Europe should perceive battery recycling as an asset, not a burden, and an opportunity to create local industries and jobs.

Photo: Tesla

Fig. 2. Energy used in MJ per kWh of Nickel-Manganese-Cobalt 111 (NMC) battery cell (excl. casting)



Batteries made responsibly

The growing battery demand for mobile and grid applications has put into spotlight the key metals used in lithium-ion technology, namely cobalt, lithium, and nickel. The attention has especially turned to the implications of the EV boom has had on cobalt, particularly the working conditions in the mines of the Democratic Republic of Congo (DRC), where around two-thirds of the global cobalt production are situated at present.

The transition to a zero-emission economy in Europe should not come at the expense of others. On the contrary, if done responsibly, increased demand for minerals mined in countries such as the DRC could help support much-needed development. Nonetheless, this necessitates socially- and environmentally-responsible ways of sourcing materials. It is important to acknowledge that mining challenges in places like the DRC are much deeper and older, which makes them no better than widely criticised practises in oil and gas industries. Instead of bashing electric cars, the European community should use their increasing market share as a leverage to put pressure on downstream companies to clean up their supply chains as well as on governments, to put solid governance structures in place to solve problems in both large-scale and artisanal mining in a comprehensive and pan-industry manner.

Various certification schemes have sought to improve sourcing of materials (copper, tin, gold, and cobalt), e.g., the voluntary OECD Due Diligence Guidance for responsible supply chains, supported by the Responsible Business Conduct guidelines, acknowledged by many as the best practice example in the field. T&E's comparative analysis of the six largest global supply chain certification schemes applicable to the industrial cobalt production in the DRC shows that while most schemes are comprehensive in their design and sustainability criteria, they nonetheless lack rigorous and independent enforcement. Crucially, traceability on where cobalt is extracted and access to transparent information on mining conditions remain most schemes' Achilles heel.

The focus, therefore, should be on better enforcing of what is already in place. Fortunately, the previous OECD guidelines on responsible supply chains have already been integrated into national or supranational legislation on conflict minerals (tin, tantalum, tungsten, gold), such as the US Dodd-Frank Act or the EU Conflicts Minerals Regulation – but do not currently apply to cobalt, nickel, or lithium.

A single, reliable, and enforceable mechanism on which to base supply chain due diligence, and the choice of suppliers across all the materials, will also benefit the EU battery industry, which often gets lost in the myriad voluntary schemes applicable to individual metals. Companies should not be pulling out of, e.g., the DRC completely or blankly refusing to buy from small-scale miners; instead, downstream companies should work with and require their suppliers to improve mining conditions and refining practices. In other words, the EU trade and development policy should help European companies source materials sustainably via smart investment to improve safety, health, and working conditions in developing economies.

'round the corner

Batteries – whether in vehicles or, at the end of their life, as second life storage applications – offer a readily-available distributed energy resource and can store electricity cheaply, facilitating far greater integration of renewables into Europe's energy market. The EU has the chance to ensure responsible corporate behaviour across the supply chain by making green objectives mandatory instead of voluntary.

The e-mobility revolution is just 'round the corner, and Europe is rightly prioritising battery value chain development in its industrial strategy. ■