How to guarantee green batteries in Europe

Making sure the EU's battery carbon footprint rules are fit for purpose

April 2023

Summary

In December 2022, EU negotiators reached an agreement on new rules for the design, production and recycling of batteries. As part of the new rules, battery manufacturers who want to sell in Europe will have to calculate and report the product's entire carbon footprint, from mining to production to recycling. This data will then be used to establish different performance classes, and ultimately set a maximum CO2 limit for batteries coming into and produced in Europe, the idea being that producers make them using clean energy instead of fossil fuels.

While the EU has made a clear commitment to green batteries, the devil remains in the detail of how companies will calculate the carbon emissions of their batteries, including how they are allowed to account for the use of renewable energy. These details are now being worked out and will be adopted by the European Commission under a delegated act later this year. If designed well and without loopholes, the new battery carbon footprint rules will ensure that the expected massive deployment of batteries (for example in electric cars and for renewable energy storage) will be associated with minimal and decreasing overall carbon emissions.

Location matters when it comes to the carbon footprint of battery production. T&E estimates that the most common lithium-ion battery (NMC-622 chemistry) produced with the EU grid in 2022 would have a 78 gCO2e/kWh carbon footprint. Producing a battery on a lower carbon grid, such as Sweden, results in a carbon footprint of 64 gCO2e/kWh, whereas the footprint increases to 85 gCO2e/kWh if produced in a higher than EU average carbon grid in Germany (in Hungary and Poland, where most batteries are produced in Europe today, the carbon footprint is 76 and 109 gCO2e/kWh respectively). Batteries produced using the average Chinese grid yield a much higher carbon footprint of 105 gCO2e/kWh (though there are regional differences). It is crucial, therefore, that **new calculation and verification rules for battery carbon footprint incentivise locating battery production facilities near low carbon energy sources or bringing online new sources of renewable energy generation**.

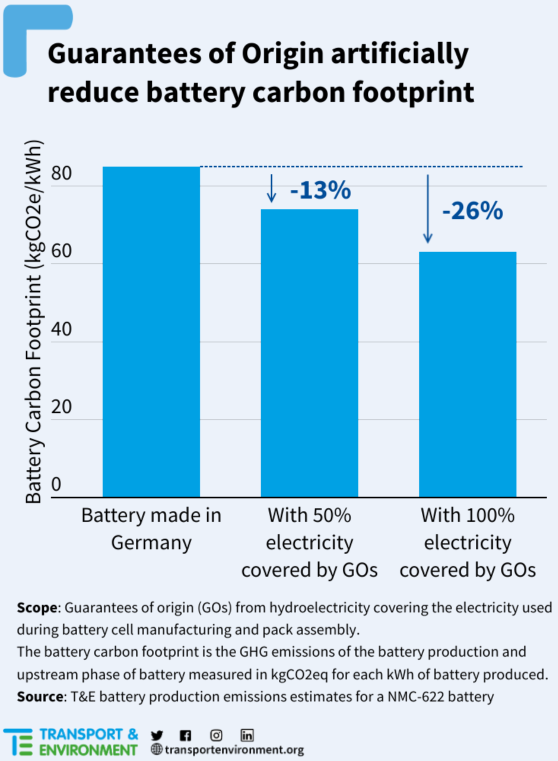
When calculating their carbon footprint, battery makers can always choose to use the average grid emissions of the country where their batteries are produced. Alternatively, they can use the plant specific values, but the rules of how to calculate these - whether based on a physical connection or some sort of contractual agreement - will be crucial to the credibility of those claims.

Unfortunately, the draft report by the European Commission Joint Research Centre (JRC) - responsible for preparing the draft carbon footprint rules - would allow battery makers to purchase green energy certificates throughout the entire EU market and over a 12 month period: designed specifically to allow **the purchase of Guarantees of Origin (GOs)**. This is a problem as the current GO system does not account for real-time energy sourcing or actual energy feeds between consumption and production and therefore **cannot demonstrate cleaner battery production in the real world**. For example, there is significant risk that battery makers would be able to set up production in regions with a carbon intensive energy grid (e.g. Germany) and then buy their way to a low carbon footprint through cheap green certificates (e.g. solar GOs generated in Spain), instead of encouraging low carbon generation in those countries.

Furthermore, when producing batteries with renewable energy, competition with decarbonisation of the grid must be avoided, as deviating existing renewable capacity from the grid will lead to indirect emissions by bringing more fossil generators in to fill the gap. Therefore it is important that battery producers claiming green energy are bringing additional renewables onto the system. However, as the sale price of GOs is not guaranteed, and there is no direct link between the market value of GOs and the revenue required to make investments in renewable power attractive, **requiring GO purchases as proof of renewability will do nothing to bring additional renewable electricity capacity to the system**.

As it stands, **the JRC's draft report would open the door to significant greenwashing by battery makers who would be able to offset their real world emissions by reporting and claiming renewable energy use via the purchase of GOs, with no link to the real world.**

T&E estimates that **battery makers in Germany, for example, would be able to artificially reduce - or greenwash - their carbon footprint by up to a quarter (26%) if they use GOs** to claim and report 100% of their energy consumption as renewable for the production of the battery, even if they are connected to the grid.



The only way to prevent this from happening, and reward industry front runners who are investing in new renewables generation, is to require:

- **hourly matching between energy generation and use** (instead of 12 months) - or at the very least over a 6 hour period - to ensure a direct connection between energy that is being sourced and consumed.
- **a clear geographic link between the energy generation and use**, including that the battery producing plant be located in and connected to the **same bidding area** (a region in which the same electricity price is applied) or adjacent interconnected bidding areas, **or in the same country** as the energy generating plant.

1. Introduction

In December 2022, EU negotiators reached an agreement on new rules for the design, production and recycling of batteries. Under the new EU Battery Regulation, the impact of electric vehicle batteries on the environment and communities is set to significantly improve.

Although batteries are already better for the planet than burning oil in our cars, they can be much better. As part of the new rules, battery manufacturers who want to sell in Europe will have to report the product's entire carbon footprint, from mining to production to recycling. That data will then be used to establish different performance classes, and ultimately set a maximum CO2 limit for batteries, ensuring that producers make them using clean energy instead of fossil fuels. Ultimately, the Regulation will ensure that the expected massive deployment of batteries (for example in electric cars and for renewable energy storage) will be associated with minimal overall carbon emissions.

While the Battery Regulation provides a general framework, a raft of technical aspects, known as implementing rules, now need to be decided in secondary legislation – in so-called delegated and implementing acts.

Under the agreement - still to be given the final green light by both Parliament and Council and likely to enter into force later this year - the Commission must adopt a delegated act establishing the methodology for calculation and verification of the carbon footprint of the battery, no later than 6 months after the entry into force of the regulation. Although technical in nature, these rules - if designed poorly - have the potential to allow some battery makers to greenwash their products by claiming the use of green energy without any actual link between the energy generated (and claimed) and that which is used for production of the battery.

In preparation of this delegated act, the European Commission's Joint Research Centre (the JRC), has published a draft Technical Report on Carbon Footprint Rules for electric vehicle batteries, in line with elements included in the Annex II of the Battery Regulation and building on methodological aspects in the latest version of the relevant Product Environmental Footprint Category Rules (PEFCRs) for batteries. Following an initial consultation with stakeholders in February, the JRC is expected to publish a revised draft report, which will be used by the Commission to prepare its delegated act.

This short paper first gives an overview of the latest data on the carbon footprint of EV batteries, looking at prospects for further reducing battery carbon emissions, and then a critical analysis of the draft JRC Technical Report, including our recommendations for ensuring the future carbon footprint rules are fit for purpose and do not leave the door open to greenwashing.

2. How carbon intensive is making a battery

Battery manufacturing is a complex electrochemical process that, in a very simplified form for a common Nickel-Manganese-Cobalt (NMC) LIB chemistry includes:

Upstream:

- Extracting ores;
- Refining extracted ores into battery grade materials, e.g. lithium hydroxide or cobalt sulfate;

Cell making:

- Producing precursors and, following a reaction with lithium, cathode active material. Anode active material using graphite and/or silica is produced separately;
- Anode and cathode active materials are coated on copper and aluminium foils to produce electrodies, dried and stacked;
- Production of liquid electrolytes;
- All the above components are assembled into cells;

Final battery assembly:

- Cells turned into modules and battery management systems (BMS) added;
- Finally, packs are assembled, often by carmakers at this stage as they are sized and calibrated for individual EV models.

These key steps for an example NMC chemistry are shown below.

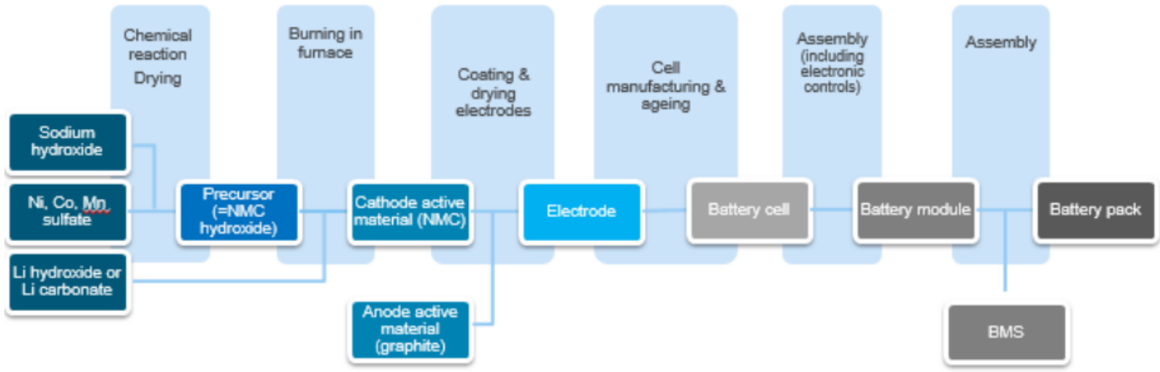


Figure 1: Key steps in battery production process

2.1. Carbon emissions from battery production depends on various elements, but location is crucial

Exactly how much CO2 is emitted in the long process of making a battery can vary a lot depending on which materials are used, how they're sourced, and what energy sources are used in manufacturing.

The most energy and carbon intensive part of LIB manufacturing is the production of battery cells, responsible for as much as 75% of energy consumption. As cell production is mainly powered by electricity, these emissions can easily be reduced. The type of electricity used is therefore crucial to determining how green a battery actually is. How battery makers are allowed to account for electricity sourcing will be important and must reflect the actual real world use of renewables (see section 4).

Recent evidence shows that the **carbon impact of production of batteries ranges from 61 to 106 kgCO2e/kWh** (maximum of 77 kgCO2e/kWh when the heating source is optimised, see below 'How to further reduce the carbon footprint of batteries') according to the 2019 updated study[1] from IVL Sweden. Their previous estimate[2] - from 2017 - ranged from 150 to 200 kgCO_2e/kWh, however this relied on scarce data from small scale production, with some dating back to 2010.

T&E has made its own battery carbon footprint model, which was calibrated based on results from the IVL study and an LCA report that T&E commissioned from Minviro. In this report, Minviro calculated a 77 gCO2e/kWh carbon footprint for a NMC-811 lithium-ion battery (LIB) produced in 2021 with the average EU27 electricity grid. Based on this data, T&E estimated that an NMC-622 battery produced with the EU grid in 2022 would have a 78 gCO2e/kWh carbon footprint. Producing a battery on a lower carbon grid, such as Sweden, results in a carbon footprint of 64 gCO2e/kWh, whereas the footprint increases to 85

1 https://www.ivl.se/download/18.34244ba71728fcb3f3faf9/1591706083170/C444.pdf
2 https://www.ivl.se/download/18.34244ba71728fcb3f3fa2f/1591705755278/C243.pdf

gCO2e/kWh if produced in a higher than EU average carbon grid in Germany. Batteries produced using the average Chinese grid yield a much higher carbon footprint of 105 gCO2e/kWh (though there are regional differences), highlighting the **competitive advantage European manufacturers can gain from strict and ambitious new rules on battery carbon emissions**.

These results clearly show that **location matters when it comes to the carbon footprint of battery production**. The new calculation and verification rules must therefore incentivise locating battery production facilities near low carbon energy sources or indeed establish new sources of renewable energy generation.

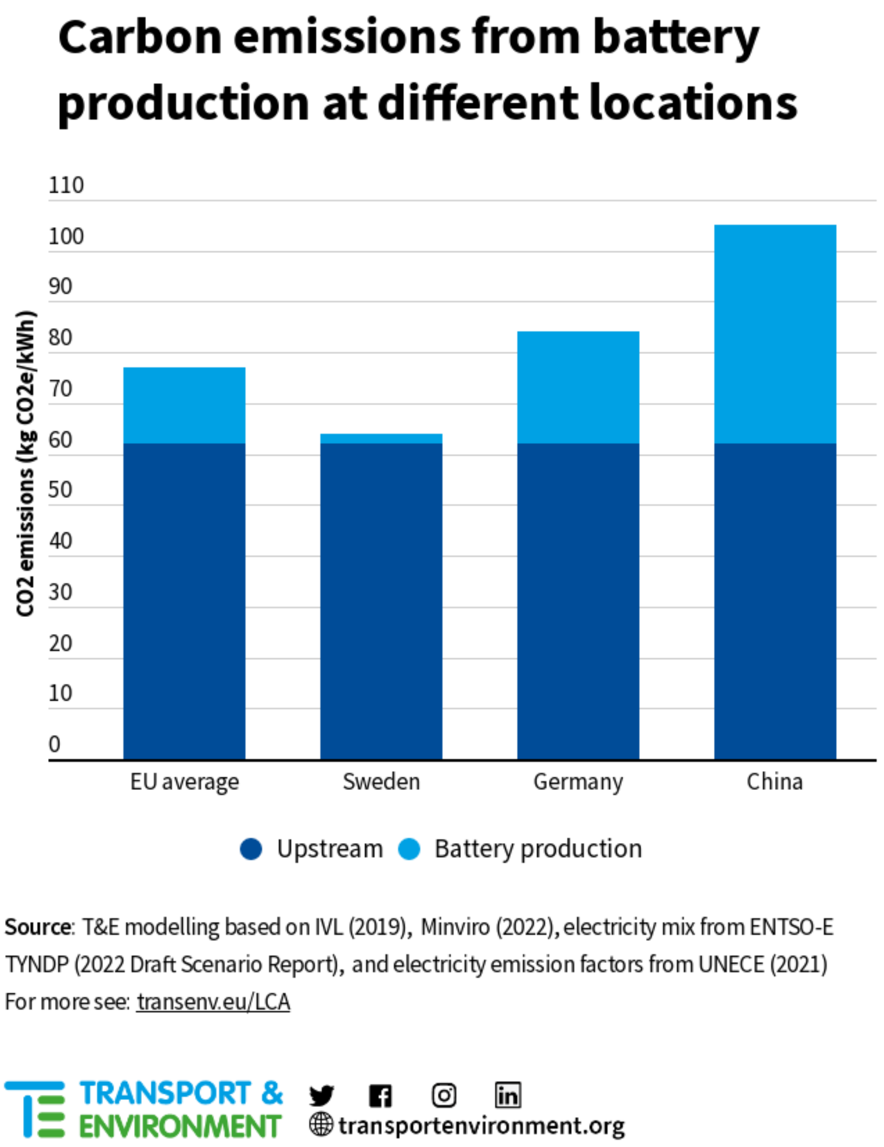


Figure 2: Carbon emissions from battery production at different locations

2.2. How to further reduce the carbon footprint of batteries

Several factors are likely to have an influence and further lower the impact of battery production and it is important that the new battery carbon footprint rules and future emission limits incentivise these:

- **Technological progress or breakthroughs in battery chemistry.** The energy density of batteries increases constantly, which reduces the amount of material needed for one kWh and thus reduces in the same proportion the impact per kWh of battery. Mass adoption of chemistries, such as LFP (Lithium iron phosphate), will also reduce the usage of the most impactful materials such as cobalt. Moreover, Minviro has estimated the carbon footprint of future battery technologies such as solid state batteries (SSB)[3]. The SSB formulation with the lowest carbon footprint would be based on a NMC-811 cathode, lithium metal anode and an oxide-based solid electrolyte. T&E has estimated that this formulation would achieve a carbon footprint of 43 gCO_2e/kWh with the 2030 electricity EU grid[4].
- **Efficiency and scale of battery production.** As the scale of battery production factories has increased in recent years, the overall factory energy efficiency to produce one unit of battery capacity (kWh) has greatly improved and will continue to improve as more large battery production plants are deployed in the near future.
- In locations where coal-intensive electricity generation increases significantly the carbon footprint of the battery, **battery producers can switch to natural gas boilers for the energy-intensive heating and drying processes**. This optimised heating is feasible today and would in some cases provide significant benefits on the carbon footprint of the battery production (however primarily in locations where the grid is very carbon intensive). Deploying waste heat recovery processes and technologies will significantly reduce emissions even further from this phase.
- Huge improvements can come from **better cathode coating techniques** that would make the cathode powder mixing and coating processes more efficient. For example, **dry electrode coating technology** that will be used by Tesla[5], can significantly improve a battery's CO2 and energy footprint.
- **Decarbonisation of the upstream supply chain of battery production.** Minviro analysed the impact of using best-in-class material sourcing for key materials of an NMC battery[6], for instance by using lithium from geothermal sources, nickel from a bioleaching process and synthetic graphite produced in Europe. By integrating Minviro results into T&E's LCA model, it was estimated that an NMC-622 battery produced with the 2022 EU27 electricity grid and a low impact supply chain would have a 48 gCO2e/kWh carbon footprint, falling to as low as 33 gCO2e/kWh in 2030[7].

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3 https://www.transportenvironment.org/wp-content/uploads/2022/07/2022_07_TE_solid-state-batteries_study.pdf
4 https://www.transportenvironment.org/wp-content/uploads/2022/05/2022_05_TE_LCA_update-1.pdf
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7 https://www.transportenvironment.org/wp-content/uploads/2022/05/2022_05_TE_LCA_update-1.pdf

- Given complex global supply chains, transportation emissions are a significant proportion of battery production as materials are shipped between mines in Africa, processing in China and final assembly in Europe or the US, representing up to 10% of overall carbon emissions. The current industrial trend for **vertically integrated and local supply chains** - which should be incentivised by the new regulation - will drastically reduce those movements and therefore the associated transport emissions. For example, Northvolt gets some of its refined materials close by in Scandinavia (e.g. nickel is refined in Finland), while preparing active cathode material, manufacturing cells, assembling packs, and even integrating recycling facilities on site.
- **Cleaner electricity.** Ultimately, the battery production is as clean as the energy used in the various processes requiring both a lot of electricity and heat (e.g. for electrode drying). The location of battery cell manufacturing therefore has a crucial and direct impact on its carbon footprint. **Placing the battery factory in areas with high renewable energy production** - like Northvolt is doing in Sweden - **or adding on-site renewable electricity production will drive down emissions of battery production**.

3. Green batteries: a competitive advantage for Europe

With demand for batteries set to soar, many European countries are aiming to take advantage and attract investment into new battery gigafactories and are prioritising battery value chain development as a key part of their industrial and climate strategies.

The new Battery Regulation is good news for Europe's growing battery industry. The law will ensure products made by new European players cannot be undercut by imported batteries made with coal-heavy energy and with little regard for human and workers rights. It will also spur the investments needed to establish more recycling capacity and create local jobs in Europe.

Although today China is home to roughly 80% of the world's lithium-ion battery (LIB) cell production, Europe's share is set to expand quickly. One of the ways policy makers can accelerate the development of a new domestic battery industry is to put in place rules that will ensure a sustainable transition to electromobility and at the same time help level the playing field by ensuring new European players through ambitious sustainability requirements, including on carbon footprint.

Europe has the opportunity to become a world leader in battery manufacturing, thanks to its relatively competitive, low impact electricity grid mix compared to other continents and strong technology infrastructure. Manufacturing of low carbon batteries, underpinned by strict and ambitious rules on the calculation and verification of battery carbon footprints, will benefit both the environment and European industry, before larger Asian players can catch up to new ways of producing.

4. Guarantees of Origin (GOs) cannot ensure battery carbon emissions are reduced in the real world

As was outlined previously in section 2, the type of electricity used by battery manufacturers is crucial to determining how green a battery actually is. When calculating their carbon footprint, battery makers can choose to use the average grid emissions of the country where their batteries are produced. Alternatively, they can use the plant specific values, but the rules of how to calculate these - whether based on a physical connection or some sort of contractual agreement - will be crucial to the credibility of those claims and must reflect the actual real world use of renewables. Unfortunately, the rules proposed in the JRC draft rules for energy supplied via contracts miss the mark and would only require battery makers to report so-called **Guarantees of Origin (GO)** certificates as the sole proof of renewable energy sourcing. By doing so, the EU would open the door to substantial greenwashing.

Guarantee of Origin (GO) certificates alone should not be accepted as valid proof for sourcing and use of renewable electricity. The current GO system does not account for real-time energy sourcing or actual energy feeds between consumption and production. Furthermore, as the sale price of GOs is not guaranteed, and there is no direct link between the market value of GOs and the revenue required to make investments in renewable power attractive, requiring GO purchases as proof of renewability will do nothing to bring additional renewable electricity capacity to the system. This could instead result in significant indirect emissions from fossil fuel power plants as other sectors shift[8] away from the limited supply of renewables.

Furthermore, as the market for GOs is EU-wide, there is a significant risk that battery makers can set up in regions with a high carbon intensive energy grid and then buy their way (via GOs) to a low carbon footprint through cheap green certificates (generated from another market or country), instead of encouraging low carbon generation in those countries.

On the other hand, **Power Purchase Agreements (PPAs)** offer the best way forward. A PPA is a legal contract between an electricity generator (provider) and a power purchaser (buyer). The PPA defines all of the commercial terms for the sale of electricity between the two parties, including when the project will begin commercial operation, schedule for delivery of electricity, payment terms, and termination. PPAs therefore ensure a direct and real world link between the energy generation and use and also provide a price certainty for developers of renewables projects.

4.1 Battery makers should match energy generation and use on an hourly basis

The JRC draft report outlines a set of minimum criteria "*to ensure contractual instruments from suppliers are reliable*" (section 6.8.3) for cases where battery manufacturers source their electricity from a supplier

[8] Chris Malins, 'What does it mean to be a renewable electron? Regulatory options to define the renewability of electricity used to produce renewable fuels of non-biological origin', 2019

(as opposed to the grid or a direct connection to a renewable energy source). Under section 6.8.3.3, the report states that the contractual instrument must "*be as close as possible to the period to which the contractual instrument is applied*". This so-called **temporal link** between the production and the use of the electricity is key to ensuring a real world and direct relationship between the two.

Unfortunately, the JRC proposes a cut off period of one year so that "*certificates are valid no longer than 12 months after the production of the relevant energy unit*", wording that is specifically designed to allow the use of GOs alone as proof of renewable energy. GOs match consumption and production over a year, meaning a battery maker being connected to the grid in December can purchase cheap solar GOs generated in August to offset their emissions and be counted as green.

The only way to prevent this from happening, and avoid punishing industry front runners who are investing in new renewables generation, is to require hourly matching between energy generation and use to ensure a direct connection between energy that is being sourced and consumed. This is what is required under the Global Battery Alliance Greenhouse Gas Rulebook Rule Set 2[9]: Physically Modelled Approach (PMA), which states "*Only the fraction of energy injected into the grid by the contracted asset demonstrated to lie below the load curve of the energy using facility, as demonstrated on an hourly basis by the date/time stamp of each instrument, shall be taken into consideration*".

A reference to hourly matching is also missing from the JRC's proposed criteria for calculating the share of on-site electricity generation (section 6.8.2). Under the GBA Rule Set 2, "*[o]nly the fraction of energy generated by the electricity production asset demonstrated to lie below the load curve of the energy using site (as measured in hourly intervals) shall be taken into consideration for use of the asset specific emission factor*" (see below). This is important for production sites connected to solar plants - as unless the energy generated is measured hourly, or at least over a 6 hour period, then manufacturers can claim use of solar energy even whilst the sun isn't shining.

[9] https://www.globalbattery.org/media/publications/gba-rulebook-master.pdf

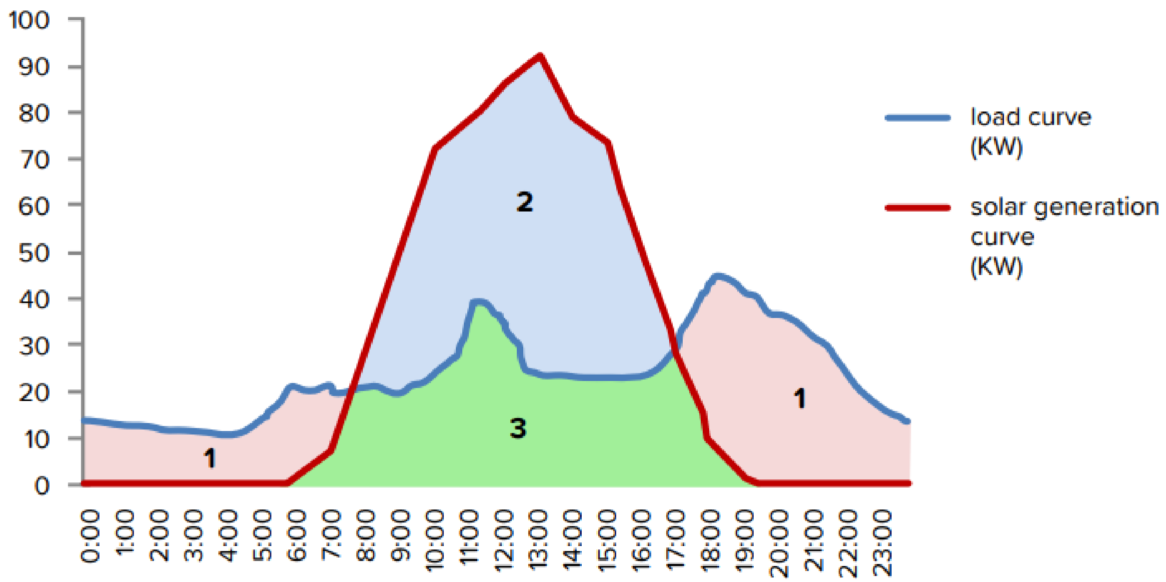

Figure 3: Typical daily solar generation curve and load curve

Source: GBA

In this chart, only "area 3" energy can be counted as used by the site. The energy present in "area 2" is either wasted or injected into the grid, and cannot be associated with the site consumption.

T&E recommends the EU includes a requirement for hourly matching between energy generation and use - or at the very least over a 6 hour period to ensure producers can only claim the green energy they are actually using.

4.2 Battery makers should only claim green energy from the same bidding area or country

In addition to the temporal link between the production and consumption of electricity, the **geographic link** is also important to ensure GOs cannot be used as a means of proving renewable energy use in the production process. GOs operate over an EU-wide market, meaning a battery maker connected to the grid in Poland, can purchase cheap solar generated GOs from Spain or hydropower from Sweden to offset their emissions and be counted as green. Here, the core concept is the bidding zone. A bidding zone is a region in which the same electricity price is applied. In the EU, bidding zones are usually entire Member States, except for Sweden, Italy and Denmark which are divided into several bidding zones.

Again, the GBA's Rule Set 2 provides a good basis to go on as it includes the requirement that "*the contracted asset and the energy using facility shall be located in and connected to the same bidding area or adjacent interconnected bidding areas within the same synchronous area, or to the same subnational grid, or if the country has one single interconnected and synchronous area, shall be located in the same country as the energy using facility*".

Again, unfortunately the JRC's draft report (section 6.8.3.4) is designed to ensure companies can benefit from the cheap market for GOs, as it states "*[t]o claim the use of renewable electricity, companies shall source renewable electricity from within the boundary of the market in which they are consuming the electricity.*" However, GOs make the transfer of green electricity possible through the EU-wide market. The JRC draft includes a further requirement that there is a "*physical interconnection*" between the point of generation and the point of consumption of renewable electricity. However, Europe's electricity market is well integrated and 39 transmission system operators (TSOs)[10] are linked together across the continent by means of nearly 420 interconnections, meaning this requirement could be complied with via a simple GO.

T&E recommends including more specific requirements to establish a clear geographic link between the energy generation and use, including the requirement that the **energy using facility be located in and connected to the same bidding area** or adjacent interconnected bidding areas, **or in the same country as the energy using facility**.

5. Draft EU rules risk significant greenwashing

T&E looked at the potential for battery makers to greenwash their product using GOs that would be permitted under the current draft rules as proposed by the JRC and European Commission. Using figures from our latest LCA assessment[11], which assumes a carbon footprint of 85kgCO_2e/kWh for a battery produced in Germany, we estimate that battery makers would be able to artificially reduce - or greenwash - their carbon footprint by over a quarter (26%) to 63 kgCO2/kWh if producers use GOs to claim and report 100% of their energy consumption for the production of the battery, despite being connected to the German grid.

[10] Mission Statement (entsoe.eu)
[11] https://www.transportenvironment.org/wp-content/uploads/2022/05/2022_05_TE_LCA_update-1.pdf

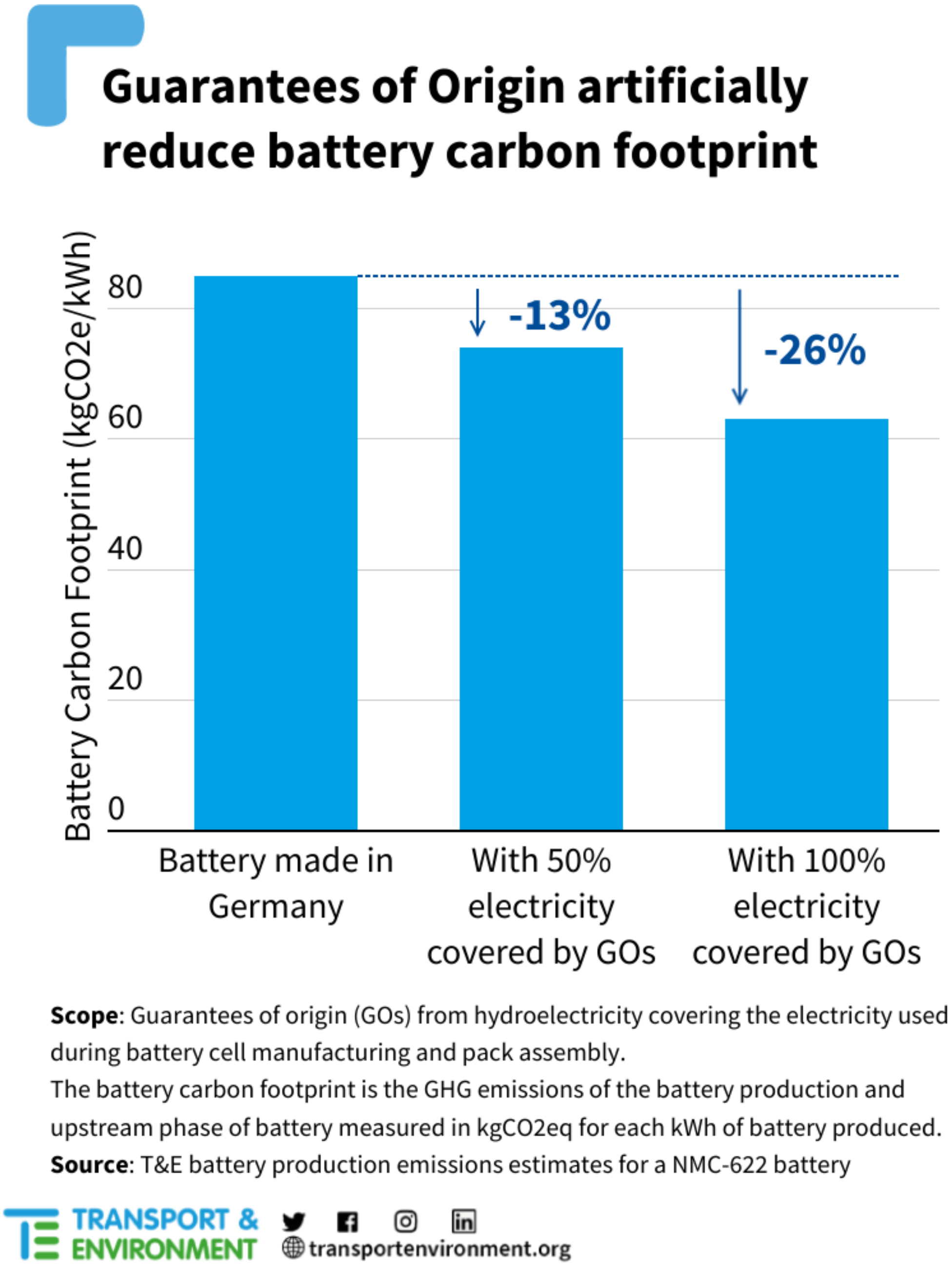

Figure 4: How much battery makers can greenwash their carbon footprint with GOs

Even if battery makers only claim 50% of their energy via GOs, this would still allow companies in Germany to claim a carbon footprint result for their product that is 13% lower, down to 74 kgCO2/kWh, than the real world emissions it produced. The greenwashing impact of GOs could be even higher if they are also used for activities upstream of the supply chain such as mining and pre-processing.

EU policy makers must avoid a situation where future EU batteries are labelled as green or with a low carbon footprint when in reality they are being produced on carbon intensive grids and offset with cheap GOs. Stricter requirements on the temporal link (hourly energy matching) and geographic link (same bidding zone or country) can ensure physically plausible exchanges of energy.

6. Producers should report the battery carbon footprint from production, not just the footprint measured over the service life of the product

In Article 7 of the final Battery Regulation text, battery manufacturers are to report the carbon footprint of their batteries "*calculated as kg of carbon dioxide equivalent per one kWh of the total energy provided by the battery over its expected service life*". Accordingly, the JRC draft report (section 3) includes the same definition as the 'functional unit' to be reported by battery manufacturers. Although such data is an important metric with which to compare the environmental footprint of batteries, it allows manufacturers to amortize the carbon footprint of their batteries over the projected lifetime, and alone it is not sufficient to compare batteries before they are sold and used.

The metric proposed by the JRC would combine the GHG emissions of the production and upstream of the battery with the use phase[12]. This would therefore provide an aggregate value reflecting both production impacts and the lifetime of the battery. For instance, a battery proven to have a lifespan longer than the 160,000km minimum would have lower carbon footprint as the emission production would be amortized over a longer service life. This would therefore reward battery makers with technology providing a longer cycle life and would drive technological improvement toward increasing product durability. However, perversely, this can also incentivise production of larger batteries, which store more energy and provide a longer battery life.

While some battery chemistries would benefit from these durability rules, they would face challenges in the end-of-life phases if they are uneconomical to recycle. Therefore, an additional split of this functional unit would be needed both to provide transparent and comparable results and to support carmakers in their choices depending on their own end-product specification and tradeoff between lifespan and recycling.

It is also important that what is measured and reported as the battery service life is checked against reality. A battery tested under unrealistic conditions, for example using favorable temperature ranges and substantially lower charging currents as compared with, for example, that of fast-charging an EV, will benefit from an artificially lower carbon footprint and undermine the whole point of the provision. Real

[12] This is in direct contradiction with the provisions of the agreed Battery Regulation text, which, in Annex II point 4 explicitly excludes the use phase of the battery from the carbon footprint requirements. The logic being that manufacturers and carmakers alike, have no direct influence over all these emissions, which are inherently related to charging behaviour and grid emissions where the use phase takes place.

world data on energy throughput collected via the BMS (Battery Management System) should be measured to see if what was reported actually correspond to reality. If data (collected by e.g. recyclers or second users of the battery) shows that a battery delivered more (or less) energy in reality than anticipated from initial testing, the EC could allocate a carbon credit to (or impose a malus on) the battery's distributor[13]. This would incentivise design for longer life and help prevent greenwashing.

Using the system boundaries outlined in section 4 of the draft JRC report, the functional unit proposed by the JRC would require battery makers to calculate the total GHG emissions from the raw materials acquisition and pre-processing, the battery cell and pack manufacturing, the distribution phase as well as the end of life phase. Then, the sum of GHG emissions for each phase would have to be divided by the total amount of electricity provided by the battery over its service life, assuming 160,000 km by default while battery makers could provide additional data to justify a longer lifetime. To allow more detailed comparison and transparency for all stakeholders, however, battery makers would need to provide disaggregated values for the following:

- The production carbon footprint calculated as kg of carbon dioxide equivalent per one kWh of battery produced and put on the market (covering the the raw materials acquisition, pre-processing and the battery cell, pack manufacturing and distribution);
- The impact of the end-of-life processes on the battery carbon footprint (kgCO2e per kWh of battery put on the market);
- The battery pack capacity (kWh) and mass (kg);
- The expected total energy provided by the battery over its service life, including the expected service life (expressed in km) when this would differ from the default value.

This additional information would enable policy makers and stakeholders to effectively understand the origin of GHG emissions, be it in the production phase, use phase or end-of-life phase. These detailed values could also be used to:

- Provide clarity and transparency for consumers, as the GHG emissions from production are becoming an important focus from the consumer perspective;
- Define a clear, comprehensive and acceptable taxation system at Member State levels, for instance though labelling systems and fiscal measures;
- Facilitate future policy measures regarding the need to decarbonise the battery production, independently from the expected battery lifetime and chemistry.

T&E therefore proposes that:

- **Manufacturers are required to report both the battery carbon footprint per energy delivered and the carbon footprint per kWh of battery produced**.
- **Real world data is collected via the BMS to calculate whether a battery delivered more (or less) energy in reality than anticipated from initial testing, with carbon credits or malus applied accordingly.**

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[13] Leopold Peiseler et al., Toward a European carbon footprint rule for batteries. Science 377, 1386-1388(2022). DOI: https://doi.org/10.1126/science.abp9505

Conclusions

While the EU has made a clear commitment to green batteries, the devil remains in the detail of how companies will be allowed to calculate the carbon emissions of their batteries, including how they are allowed to account for the use of renewable energy. If the new rules on the calculation and verification of battery carbon footprint are designed well and without loopholes, they will ensure that the expected massive deployment of batteries (for example in electric cars and for renewable energy storage) will be associated with minimal and decreasing overall carbon emissions.

Location matters when it comes to the carbon intensity of battery production and making a battery when connected to the grid in Sweden will lead to much lower emissions than making one in Germany. It is therefore important that the new rules incentivise locating battery production facilities near low carbon energy sources or establish new sources of renewable energy generation. How battery makers are allowed to account for electricity sourcing (when not reporting the energy from the national grid where they are producing or directly connected to a renewable energy plant) is also crucial and must ensure a physically plausible exchange of energy between generation and use.

Unfortunately, as it stands, the draft rules would allow battery makers to purchase green energy certificates throughout the entire EU market and over a 12 month period. Designed specifically to allow the purchase of GOs, there is significant risk that battery makers would be able to set up production in regions with a carbon intensive energy grid (e.g. Germany) and then buy their way to a low carbon footprint through cheap green certificates (e.g. solar GOs generated in Spain), instead of encouraging low carbon generation in those countries. This could lead to battery makers artificially lowering the carbon footprint of their batteries by a fourth.

To prevent this from happening, and avoid punishing industry front runners who are investing in new renewables generation, the new EU rules should require both hourly matching and a clear geographic link between the energy generation and use, including that the energy using facility be located in and connected to the same bidding area or in the same country as the energy using facility.

Further information

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