Jonas Niederberger
Batteries as objects of multiple tensions

Batteries are everywhere

Batteries play an ever more important role in our everyday lives. From the tiny batteries powering hearing aids and pacemakers to the batteries contained in our smartphones and laptops to those propelling electric scooters, bikes, and vehicles, to the large storage batteries that are (to be) used not only in data centres but also to balance renewable energy grids. They both enable individuals to live better lives and form the material backbone of our (knowledge, green, financial, gig, attention) economies, as well as current technological (r)evolutions in transportation, energy, and artificial intelligence. At almost any scale of industrialised societies today, batteries have some incremental function. One could say that they provide flexibility in how our current – and most likely future – societies are powered.

Against the backdrop of the accelerating climate crisis, batteries offer an almost mystical promise when seen as an important technological pillar to mitigate greenhouse gas (GHG) emissions. One need look no further than the European Union's European Green Deal (EGD) with the intent to "transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of [GHGs] in 2050, and where economic growth is decoupled from resource use".[1] Here, batteries, or rather the large-scale production of electric vehicles (EVs) and storage batteries and securing the needed raw materials, have become *strategically important* to reach this overarching goal.[2] Currently, global production capacities are mainly located in China (76%), with the United States (7%), the EU (7%) and South Korea (5%) seeking to catch up.[3] When it comes to the raw materials needed to build these batteries, Europe is highly reliant on imports, with suppliers concentrated in a small number of countries, which heightens the associated risks.[4]

The increased importance of batteries provokes tensions both geo- and socio-politically, as well as ecologically, connected to different environmental objectives such as climate mitigation and an unpolluted local environment.[5] This essay aims to point to some of these

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1 European Commission, '"The European Green Deal (EGD)" (Communication) COM (2019) 640 Final' (Brussels, 2019), 2–3.

2 See European Commission, '"Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation" (Communication) C(2015) 6317 Final' (Brussels, 2015); European Commission, '"Europe on the Move. Sustainable Mobility for Europe: Safe, Connected, and Clean" (Communication) COM (2018) 293 Final, Annex 2: Strategic Action Plan on Batteries' (Brussels, 2018); European Commission, '"A Green Deal Industrial Plan for the Net-Zero Age" (Communication) COM (2023) 62 Final' (Brussels, 2023).

3 International Energy Agency (IEA), 'Global Supply Chains of EV Batteries' (Paris: IEA, July 2022), https://www.iea.org/reports/global-supply-chains-of-ev-batteries.

4 European Commission et al., *Study on the Critical Raw Materials for the EU 2023 – Final Report* (Publications Office of the European Union, 2023), https://doi.org/10.2873/725585.

5 I would like to acknowledge the guidance of my thesis supervisor at the Geneva Graduate Institute Prof. Marc Hufty who stressed many of these tensions in our discussions and led me to further explore this topic.

tensions– particularly in the context of "Europe"[6] or the EU. By highlighting some of these tense interactions, I seek to emphasise the complexity and interrelatedness, with the understanding that navigating these challenges requires adaptive, context-sensitive, and inclusive approaches that consider diverse perspectives.[7] In the end, seeing these tensions should help delineate where consequential choices are – and have to be – made by specialists, politicians, businesses, scientists, workers, and communities.

But how do batteries work?

As batteries represent a material reality, it makes sense to discuss what they consist of and how they function briefly. Put simply, batteries convert chemical energy into electrical energy. A battery consists of two *electrodes* – a *positive cathode* and a *negative anode* – chosen due to their electrochemical properties. These are separated by an *electrolyte* that allows for the passage of *ions* (electrically charged atoms or molecules) between the electrodes. When a battery is connected to an external circuit, chemical reactions at the anode release electrons, which flow through that circuit to the cathode, creating an electric current powering a given device. Meanwhile, ions move between the anode and cathode to balance the charge.

Batteries can differ significantly in scale and chemical composition. Their application varies depending on energy density, durability, safety, and (fast) charging capabilities. Furthermore, battery technology is an evolving field, with new and specialised chemistries being developed. One common way to differentiate batteries is by whether they can be *re*charged.

Non-rechargeable primary batteries such as Zinc-Manganese-Dioxide, Zinc–Mercuric Oxide batteries, or lithium metal batteries are often used in small portable electronics such as toys, remote controls, or hearing aids. Once a primary battery's chemical reactants are exhausted, it no longer produces electrical energy and must be disposed of.[8]

Secondary batteries are *rechargeable*, meaning the initial composition of the battery can be restored by applying direct current voltage. In this case, electrons move from the cathode to the anode, restoring the chemical energy of a battery while ions flow back through the electrolyte to balance the charge. In the case of the currently most salient battery, the Lithium-ion battery, lithium ions move from the cathode – often made of lithium cobalt oxide

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6 There are as many perceptions of Europe as there are people in it. Given the high salience of batteries at the EU-level, which mediates between the global and the local, I will discuss these tensions as being in a multi-level system, where actors navigate local, regional, national, and international spheres. See also Timothy Garton Ash, *Homelands: A Personal History of Europe* (London: The Bodley Head, 2023); Ian Bache and Matthew Flinders, *Multi-Level Governance* (Oxford University Press, 2004), https://doi.org/10.1093/0199259259.001.0001.

7 Jonas Köppel and Morgan Scoville-Simonds, 'What Should "We" Do? Subjects and Scales in the Double-Bind between Energy Transition and Lithium Extraction', *The Extractive Industries and Society* 17 (March 2024): 101376, https://doi.org/10.1016/j.exis.2023.101376.

8 Eg Brooke Schumm, 'Battery: Composition, Types, & Uses', Encyclopedia Britannica, 10 April 2024, https://www.britannica.com/technology/battery-electronics.

($LiCoO_2$) – to the anode during charging, embedding into the anode material – such as graphite – allowing the battery to store energy for future use.

The *Lithium-ion battery* is currently the champion of batteries as a multi-purpose technology used in smartphones, EVs, and stationary storage due to its high energy density.[9] Other examples of secondary batteries are the cost-effective and sturdy lead-acid batteries used as starting-lighting-ignition batteries in cars, stationary (backup) batteries in hospitals or factories, and traction batteries in forklift trucks or the rare Nickel-Cadmium batteries used in power tools, now added to the list of banned or highly regulated battery materials in the EU because they contain toxic Cadmium. A battery technology as old as the Lithium-ion battery that has recently garnered renewed attention is the Sodium-ion battery, based on the considerably more abundant element Sodium (gained from salt) and using iron and manganese electrodes. Although Sodium-ion batteries' energy density is currently lower than Lithium-ion batteries, they may present a cheap alternative, as Lithium prices have proven volatile and lead times for opening new mines may – notwithstanding their environmental impact – be measured in the decades.[10]

From a Battery Directive to a Regulation – balancing economic growth and sustainability

Batteries are inherently objects of electrical tension due to the voltage they store, but they also lead us to discuss some of the broader tensions that emerge because they are embedded in a specific social and political context. It is a rather recent phenomenon that EV and storage batteries are considered *strategic* in the EU. In 1991, the EU Member States – pushed by the environmental movement and certain "green-minded" Member States – adopted a Battery Directive focussing on limiting the spread of hazardous materials such as Mercury, Cadmium, and Lead contained in batteries into the environment by either fully prohibiting or curbing the use of certain materials and mandating the collection of *consumer* batteries.[11] While this Directive was revised and got more restrictive over time, its main objective remained to address negative externalities related to batteries – as products in the European Single Market – and Member States' implementation issues.[12] The management and disposal of industrial

9 Abhishek Malhotra et al., 'How Do New Use Environments Influence a Technology's Knowledge Trajectory? A Patent Citation Network Analysis of Lithium-Ion Battery Technology', *Research Policy* 50, no. 9 (1 November 2021): 104318, https://doi.org/10.1016/j.respol.2021.104318.

10 Jang-Yeon Hwang, Seung-Taek Myung, and Yang-Kook Sun, 'Sodium-Ion Batteries: Present and Future', *Chemical Society Reviews* 46, no. 12 (2017): 3529–3614, https://doi.org/10.1039/C6CS00776G; Casey Crownhart, 'This Abundant Material Could Unlock Cheaper Batteries for EVs', MIT Technology Review, 9 May 2023, https://www.technologyreview.com/2023/05/09/1072738/this-abundant-material-could-unlock-cheaper-batteries-for-evs/; International Energy Agency (IEA), 'The Role of Critical Minerals in Clean Energy Transitions' (Paris: IEA, 2021), https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

11 See Council Directive 91/157/EEC; Jonas Niederberger, 'When Push Comes to Shove: Tracing the Evolution of the EU's Battery Governance Regime: From the Control of Hazardous Substances and Waste to a Key (Geo-)Strategic Sector' (Master Thesis, Geneva, Geneva Graduate Institute, 2023).

12 See Directive 2006/66/EC; Niederberger.

storage batteries and EV batteries, if they existed, were the responsibility of their respective owners.

During the last decade, a fundamental change in the way batteries are framed has come about. This shift is best exemplified in the most recent Battery Regulation adopted by the European Parliament and the Council in 2023.[13] While it elaborates and widens certain environmental aspects of the previous Directives, the Regulation seeks to cover the entire lifecycle of a battery, defining human rights and environmental due diligence standards for sourcing and production, targets for collection and recycling, as well as procedures for the use of second-life batteries (e.g., old EV batteries used as stationary storage batteries). Furthermore, whereas the previous Directive was subject to implementation in each Member State, this *Regulation*'s contents are binding for all Member States from day one. In a broader perspective, the Regulation could provide a blueprint for future circular economy legislation.[14] However, as observers point out, its goal is also for the EU "to obtain a global competitive advantage, build barriers to entry, and provide incentives to invest in production capacity for sustainable batteries." [15] Of course, what has changed over the past decades is the development of Lithium-ion batteries, as well as the broader ecological urgency (climate crisis) and political circumstances.[16] Through the Regulation, the EU now seeks to leverage the size of its Single Market and shape the standards for products being sold in it while providing the basis for a "European" industry that will be green(er than others') and therefore competitive.[17] This plays into *geopolitical tensions* because the EU seeks to leverage its strengths as it is confronted with competition from Asia, most notably China, which dominates battery supply chains, and the United States, which has unleashed a range of measures including massive subsidies (some linked to local content requirements) and luring investments into battery production away from Europe.[18]

The Regulation thus navigates both geopolitical and wider socio-technical tensions as it seeks to address a core component of a future fossil-free energy system and the linear economic

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13 See Regulation (EU) 2023/1542.

14 Eg Christian Hagelüken and Daniel Goldmann, 'Recycling and Circular Economy—towards a Closed Loop for Metals in Emerging Clean Technologies', *Mineral Economics* 35, no. 3–4 (December 2022): 539–62, https://doi.org/10.1007/s13563-022-00319-1; Robin Barkhausen et al., 'Analysing, Policy Change towards the Circular Economy at the Example of EU Battery Legislation', *Renewable and Sustainable Energy Reviews* 186 (October 2023): 113665, https://doi.org/10.1016/j.rser.2023.113665.

15 Hans Eric Melin et al., 'Global Implications of the EU Battery Regulation', *Science* 373, no. 6553 (23 July 2021): 384–85.

16 See Barkhausen et al., 'Analysing Policy Change towards the Circular Economy at the Example of EU Battery Legislation', 6.

17 Anu Bradford, *The Brussels Effect: How the European Union Rules the World*, First issued as an Oxford University Press paperback (New York: Oxford University Press, 2021); Melin et al., 'Global Implications of the EU Battery Regulation'.

18 International Energy Agency (IEA), 'Batteries and Secure Energy Transitions' (Paris: IEA, April 2024), https://www.iea.org/reports/batteries-and-secure-energy-transitions; See also Victor Jack et al., 'EU Shrugs off Threat from US Inflation Reduction Act — for Now', POLITICO, 24 August 2023, https://www.politico.eu/article/eu-united-states-inflation-reduction-act-subsidies-investment-threat-data/; 'Europe Far behind North America in Securing EV Investments', Press Release, Transport & Environment, 6 June 2024, https://www.transportenvironment.org/articles/europe-far-behind-north-america-in-securing-ev-investments.

model. It also points to the fundamental tension between *"the State" and "the Market"* and to what degree the former should take an active role in the latter. It shows how the relative capacities and governing norms of states – and a "macro-regional state"[19] such as the EU – impact the degree to which "they" can influence such technological developments. An interesting hint at how political dynamics around batteries have shifted can be seen in the Commission's policy formulation process. While previous battery legislation at the European level was defined mainly by the Directorate-General for the Environment, the proposal for the new Regulation was co-written by the Directorate-General for the Environment and the Directorate-General for Internal Market, Industry, Entrepreneurship, and SMEs.[20] These historically opposed departments – one seeking to further environmental protection, the other pushing liberalisation of the market – being put together to write this piece of legislation is remarkable. It shows how certain tensions, such as ideological or departmental tensions can shift in the light of new circumstances, such as the European Green Deal and a new geopolitical and geoeconomic reality.

These socio-technical tensions are well illustrated by having a look at the processes that led to the EV's challenge to the fossil fuel-based automotive-mobility regime.[21] The example of the transformation of the automotive industry is telling because it gives some insights into the stakes, and it is one of the main industries where batteries are currently used. The sector is a key pillar of the EU economy, making up 7% of its GDP and "providing direct and indirect jobs to 13.8 million people, which equals 6.1% of total EU employment".[22]

Europe and the electric car – a tense relationship?

It may come as a surprise to some that the first EVs were developed at the turn of the 20th century, at the same time as the internal combustion engine (ICE). However, EVs remained a niche innovation for a long time, with the battery chemistries of early models unable to compete with the reliability and range of the ICE.[23] The "range anxiety" evoked by the often shorter and sometimes unpredictable radius of the EV persists to this day – although it only affects long drives and not most car use patterns.[24] Certain companies pondered the

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[19] Gavin Bridge and Erika Faigen, 'Towards the Lithium-Ion Battery Production Network: Thinking beyond Mineral Supply Chains', *Energy Research & Social Science* 89 (July 2022): 9, https://doi.org/10.1016/j.erss.2022.102659.

[20] Terese Birkeland and Jarle Trondal, 'The Rift between Executive Contraction and Executive Detraction: The Case of European Commission Battery Policy-Making', *Journal of European Public Policy*, 27 September 2022, 1–23, https://doi.org/10.1080/13501763.2022.2118356.

[21] See Frank W. Geels, 'A Socio-Technical Analysis of Low-Carbon Transitions: Introducing the Multi-Level Perspective into Transport Studies', *Journal of Transport Geography* 24 (September 2012): 471–82, https://doi.org/10.1016/j.jtrangeo.2012.01.021.

[22] European Commission, 'Automotive Industry', 2023, https://single-market-economy.ec.europa.eu/sectors/automotive-industry_en.

[23] Tom Standage, 'The Lost History of the Electric Car – and What It Tells Us about the Future of Transport', *The Guardian*, 3 August 2021, sec. Technology, https://www.theguardian.com/technology/2021/aug/03/lost-history-electric-car-future-transport.

[24] 'Range Anxiety', in *Cambridge Dictionary* (Cambridge University Press & Assessment 2024, 2024), https://dictionary.cambridge.org/dictionary/english/range-anxiety; Jasper Jolly, 'Is It Right to Be Worried about Getting Stranded in an Electric Car?', *The Guardian*, 9 December 2023, sec. Business,

development of more capable batteries during the advent of the environmental movement and the concurrent oil crises in the 1970s.[25] These and additional efforts to promote zero-emission vehicles (ZEVs) through mandates such as in the State of California or state subsidised research programmes (e.g., in Japan and the United States) in the 1990s soon fizzled out and failed to bear fruit.[26] There were also discussions on designing policies such as stricter emission targets for automotive fleets and funding for research and development and innovation (R&D&I) to support the development of ZEVs at the European level.[27] But the discourses were mostly drowned out by calls from industry for "technology-neutral" policies, incremental innovation of the ICE, and promises of self-regulation through voluntary fleet reduction targets.[28]

When the niche EV brand "Tesla" released its first EV model called "Roadster" in 2008, the world's attention was focused on the Global Financial Crisis that ripped through economies around the world.[29] The aftermath of the crisis, however, did offer an opportunity for a concerted push towards greener vehicles in Europe. In an effort to lift the then ailing automotive industry into a greener mode of production, the EU launched the European Green Cars Initiative (EGCI), stimulating industrial R&D&I efforts into electrification.[30] In parallel, a strategy to support the development of *key enabling technologies* – which would later include batteries – was formulated.[31] In both cases, deliberations between the European Commission, Member States, the European Parliament, and industry representatives laid the basis for policy – along with external pressure from environmental groups. Although the post-crisis policies set a direction, it would take until the mid-2010s to more definitely lock in the EU's focus on batteries, leading the Commission to rally European industrial actors in the European Battery Alliance (EBA), an informal stakeholder group representing the interests of

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https://www.theguardian.com/business/2023/dec/09/stranded-electric-car-ev-range-anxiety-charging-network.

25 Henry Sanderson, *Volt Rush: The Winners and Losers in the Race to Go Green* (London: Oneworld, 2022), 14–31; Standage, 'The Lost History of the Electric Car – and What It Tells Us about the Future of Transport'.

26 ibid; see also Louise Wells Bedsworth and Margaret R. Taylor, 'Learning from California's Zero-Emission Vehicle Program', *California Economic Policy* 3, no. 4 (2007).

27 European Commission, 'A Community Strategy to Reduce CO2 Emissions from Passenger Cars and Improve Fuel Economy" (Communication) COM (95) 689 Final' (Brussels, 1995); European Commission, '"Task Force Car of Tomorrow" (Newsletter 1, April 1996)', 1996, https://op.europa.eu/en/publication-detail/-/publication/60c30128-8e9f-43c8-ae93-25f43f60de2b/language-en/format-PDF/source-286961950.

28 Sebastian Hoffmann, Johannes Weyer, and Jessica Longen, 'Discontinuation of the Automobility Regime? An Integrated Approach to Multi-Level Governance', *Transportation Research Part A: Policy and Practice* 103 (September 2017): 391–408, https://doi.org/10.1016/j.tra.2017.06.016; See also Niederberger, 'When Push Comes to Shove: Tracing the Evolution of the EU's Battery Governance Regime: From the Control of Hazardous Substances and Waste to a Key (Geo-)Strategic Sector'; Yvette Taminiau, George Molenkamp, and Svetlana Tashchilova, 'The Pendulum: The Auto–Oil Programmes Revisited', *Energy & Environment* 17, no. 2 (2006): 246.

29 Barbara A. Schreiber and Erik Gregersen, 'Tesla, Inc.', Britannica Money, 1 June 2024, https://www.britannica.com/money.

30 European Commission, '"A European Economic Recovery Plan" COM (2008) 800 Final' (Brussels, 2008); See also European Commission, '"A European Strategy on Clean and Energy Efficient Vehicles" (Communication) COM (2010) 186 Final' (Brussels, 2010).

31 European Commission, '"Preparing for Our Future: Developing a Common Strategy for Key Enabling Technologies in the EU" (Communication) COM (2009) 512 Final' (Brussels, 2009).

a nascent European battery industry as well as launch a "strategic action plan on batteries" defining policy priorities and mapping out investment opportunities.[32] This whole process was characterised by a back-and-forth between actors focussed on economic growth and competitiveness in a free market and those focussed on transforming the industry in favour of environmental objectives.

Various interrelated factors contributed to batteries becoming important on the European agenda. Among them are the EU's ambitious climate targets in light of the 2015 Paris Agreement and the automotive industry's continued inability to reduce fleet emissions, culminating in the "Dieselgate" scandal that is setting the industry in a negative light.[33] Further mounting pressure to develop green industries in Europe became evident as green-tech know-how and industries moved to or sprang up in Asia. Especially in China, a mature market for EV batteries was formed by the mid-2010s as a result of its state-backed industrial strategy to leapfrog the ICE.[34] As these markets began to mature and Lithium-ion technologies were optimised, global battery prices fell.[35] This gave way to a range of policies both at the European level and in the Member States pushing for stricter emission standards, even moving towards a (partial) phase-out of the ICE, as well as incentive schemes for buyers of EVs and for public procurement and infrastructure.[36] In the hope of stimulating private investments in a battery industry located in Europe, the EU has continually loosened its strict state-aid rules and, in 2014, reinvented a hitherto scarcely used funding vehicle – the Important Project of Common European Interest – allowing for more public spending in the

[32] European Commission, 'European Battery Alliance', 13 May 2023, https://single-market-economy.ec.europa.eu/industry/strategy/industrial-alliances/european-battery-alliance_en; European Commission, '"Europe on the Move: An Agenda for a Socially and Fair Transition towards Clean, Competitive and Connected Mobility for All" (Communication) COM (2017) 283 Final' (Brussels, 2017); European Commission, '"Report on the Implementation of the Strategic Action Plan on Batteries: Building a Strategic Battery Value Chain in Europe" COM (2019) 176 Final' (Brussels, 2019).

[33] Katja Biedenkopf, Claire Dupont, and Diarmuid Torney, 'The European Union: A Green Great Power?', in *Great Powers, Climate Change, and Global Environmental Responsibilities*, ed. Robert Falkner and Barry Buzan (Oxford University Press, 2022), 100–106, https://doi.org/10.1093/oso/9780198866022.003.0005; Michael Zhang, Glyn Atwal, and Maya Kaiser, 'Corporate Social Irresponsibility and Stakeholder Ecosystems: The Case of Volkswagen Dieselgate Scandal', *Strategic Change* 30, no. 1 (January 2021): 79–85, https://doi.org/10.1002/jsc.2391; Tommaso Pardi, 'Prospects and Contradictions of the Electrification of the European Automotive Industry: The Role of European Union Policy', *International Journal of Automotive Technology and Management* 21, no. 3 (2021): 162–79.

[34] High-Level Expert Group on Key Enabling Technologies, 'KETs: TIME TO ACT' (European Commission, 2015); Huiwen Gong and Teis Hansen, 'The Rise of China's New Energy Vehicle Lithium-Ion Battery Industry: The Coevolution of Battery Technological Innovation Systems and Policies', *Environmental Innovation and Societal Transitions* 46 (March 2023): 100689, https://doi.org/10.1016/j.eist.2022.100689.

[35] Simon Bennett and Luis Munuera, 'Who Wants to Be in Charge? – Analysis', IEA, 21 November 2017, https://www.iea.org/commentaries/who-wants-to-be-in-charge.

[36] Eg Andrew J. Jordan and Brendan Moore, *Durable by Design?: Policy Feedback in a Changing Climate*, 1st ed. (Cambridge University Press, 2020), 177–83, https://doi.org/10.1017/9781108779869; Sandra Wappelhorst and Hongyang Cui, 'Growing Momentum: Global Overview of Government Targets for Phasing out Sales of New Internal Combustion Engine Vehicles', *International Council on Clean Transportation* (blog), 11 November 2020, https://theicct.org/growing-momentum-global-overview-of-government-targets-for-phasing-out-sales-of-new-internal-combustion-engine-vehicles/.

battery sector.[37] Additionally, temporary state-aid frameworks invoked due to the COVID-19 pandemic and the consequences of Russia's war of aggression in Ukraine allowed for additional public spending.[38] Despite enabling a significant amount of investments into the European battery sector, the current *modus operandi* has some drawbacks, laying bare another set of tensions. Apart from criticism by the European Court of Auditors that the Commission is inadequately monitoring investment streams, the fact that most investments are made by the EU's three largest economies (Germany, France, and Italy) may contribute to some long-term intra-European inequalities or fragmentation, despite funding such as the Just Transition Fund, which seeks to attenuate regions hit by the energy transition, and as countries such as Hungary continue to attract investments from outside the EU.[39] An additional question that remains to be settled is whether and how the public will benefit if subsidies lead to excessive profits. While the Important Projects of Common European Interest contain a claw-back mechanism that should ensure the return of funds, it is unclear whether Member States would follow through.[40]

Many socio-political tensions are already visible around the question of public participation and the "social" aspect of the EU battery project. While the EBA has become a useful forum for players in the battery industry to voice their opinions to EU and Member State officials and recently launched its EBA Academy (now Skills Institute) with the goal of training, up- and reskilling 800'000 workers by 2025 (67'000 trained as of May 2024), NGOs have criticised it as "as a new form of corporate capture," putting industry's interests over those of the public and leading to policies "benefiting companies instead of regulating them".[41] Considering the legacy of how environmental and social concerns and perseverance to "the free market" have been balanced by the industry in the past, it will be interesting to see how these tensions will be manoeuvred this time around.

Social tensions become apparent as unions from Germany to Sweden have locked horns with EV giants such as Tesla over unfair and unsafe working conditions. Observers of

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37 European Court of Auditors, *The EU's Industrial Policy on Batteries : New Strategic Impetus Needed*, Special Report No 15/2023 (European Court of Auditors. Online) (Luxembourg: Publications Office, 2023), https://data.europa.eu/doi/10.2865/580370, 12.

38 European Court of Auditors, 12.

39 European Court of Auditors, 40; European Commission, 'Just Transition Funding Sources', 2024, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism/just-transition-funding-sources_en; Eg Agatha Kratz et al., 'Dwindling Investments Become More Concentrated - Chinese FDI in Europe: 2023 Update' (Rhodium Group and MERICS, 6 June 2024), https://merics.org/en/report/dwindling-investments-become-more-concentrated-chinese-fdi-europe-2023-update.

40 European Court of Auditors, *The EU's Industrial Policy on Batteries*, 45.

41 EBA250, 'About EBA Academy', *European Battery Alliance* (blog), 2024, https://www.eba250.com/eba-academy/about-eba-academy/; Friends of the Earth Europe (FoE), 'EU's Industrial Alliances Are a New Corporate Capture', 4 May 2021, https://friendsoftheearth.eu/press-release/eu-industrial-alliances-a-new-corporate-capture/; EBA250, '8th High-Level Meeting of the European Battery Alliance: Shaping a New Action Plan Amid Geopolitical Shifts', *European Battery Alliance* (blog), 28 May 2024, https://www.eba250.com/8th-high-level-meeting-of-the-european-battery-alliance-shaping-a-new-action-plan-amid-geopolitical-shifts/.

developments in countries such as Hungary note that “the production of electric cars is leading to a *foxconnisation* of the automotive industry, where the share of unskilled jobs is high, wages are low, and employment is highly flexible” (italics added).[42] While the Battery Regulation provides a framework for the nascent battery industry, key policy areas such as social policy remain in the hands of Member States and will mostly have to be negotiated at the national level.

Furthermore, the tension between the national and transnational within this transition emerges in the question of what constitutes a “European” battery industry. As 56% of production is currently done by subsidiaries of non-EU-based companies, it becomes more difficult to assess who wins and who loses out, which is an ironic twist to previous patterns of (Western/-European) globalisation.[43]

As much of the production capacity will still have to be built in the coming years, it remains to be seen whether Europe will reach its ambitious targets for battery production and, in turn, its GHG mitigation goals. Stagnating demand for EVs and the uncertain future of the EGD under the new EU legislature.[44] However, it seems clear that as this new industry seeks to gain a foothold in an increasingly hostile (political) climate, socio-political tensions are set to grow with Europe’s future economic and ecological welfare on the line.

There’s still only one planet.

As if it were not difficult enough to achieve the green transition in the first place, one should keep in mind that resources are limited, and we (currently) only have one planet. The current battery boom creates a flurry of ecological tensions across global supply chains. Just one example: demand for lithium is projected to rise by 1500% by 2050, meaning more than a threefold increase in current production capacities.[45] While it may be possible to extract the resources necessary to achieve this transition, the question remains: How and at what cost?

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42 Victoria Waldersee, ‘Tesla Workers in Germany Join Union as Health and Safety Issues Grow - Union’, *Reuters*, 9 October 2023, sec. Autos & Transportation, https://www.reuters.com/business/autos-transportation/tesla-workers-germany-join-union-health-safety-issues-grow-union-2023-10-09/; William Boston, ‘Tesla Raises Wages for German Workers Amid Union Pressure’, Wall Street Journal, 6 November 2023, https://www.wsj.com/business/autos/tesla-raises-wages-for-german-workers-amid-union-pressure-9f916fe8; Márton Czirfusz, ‘The Battery Boom in Hungary: Companies of the Value Chain, Outlook for Workers and Trade Unions’ (Budapest: Friedrich Ebert Stiftung, February 2023), 10, https://library.fes.de/pdf-files/bueros/budapest/20101.pdf.

43 European Court of Auditors, *The EU’s Industrial Policy on Batteries*, 26.

44 Neil Winton, ‘Europe To Buy Nearly 9 Million Fewer EVs By 2030 Than Expected: Report’, Forbes, 8 April 2024, https://www.forbes.com/sites/neilwinton/2024/04/08/europe-to-buy-nearly-9-million-fewer-evs-by-2030-than-expected-report/.

45 International Energy Agency (IEA), ‘Global Critical Minerals Outlook 2024’ (Paris: IEA, 2024); United Nations Conference on Trade and Development (UNCTAD), ‘Critical Minerals Boom: Global Energy Shift Brings Opportunities and Risks for Developing Countries’, 26 April 2024, https://unctad.org/news/critical-minerals-boom-global-energy-shift-brings-opportunities-and-risks-developing-countries.

Currently, most of the raw materials needed are located in the Global South, while demand is driven by countries in the Global North, risking the replication of colonial patterns of extraction and environmental degradation.[46] While the Battery Regulation's human rights and environmental standards are the first step in shaping companies' conduct across their supply chains – seeking to bridge the sometimes scarce environmental and social protections – its impact remains to be seen.

Lithium mining, for example, currently uses high amounts of water and chemicals and is energy-intensive, leading to GHG emissions (although the latter depends on the energy source used), with effects on the environment and raising concerns among local and Indigenous populations and wildlife.[47] A similar issue comes up after a battery has lived out its life and needs to be recycled, which can be a similarly hazardous process.[48] This stands in tension with the positive benefits that are sought from batteries, be it storage for renewables and a replacement for fossil fuel cars, hopefully leading to low-emission societies in general. As fears of economic dependence and competitiveness – or efforts towards more resilience – are bringing mining, production, and recycling back to Europe, these questions will become even more salient in the coming years.

While technological developments along the battery supply chain may be able to address some concerns and, hopefully, less resource-intensive batteries will be developed, the tensions, both social and environmental, will likely remain. This will require differentiated and transparent dialogue between the actors involved in negotiating these transitions, giving people the opportunity to have their voices heard and understand the impact on local conditions. Batteries do not represent a silver bullet to our current multiple planetary crises, and simply replacing old practices of extraction with new ones will only cause more problems in the long term if energy demand continues to grow, and with that, the need for the supporting infrastructure – including batteries.[49] Batteries *will* play an important part in our future societies, but they will need to be integrated into a system that takes into account

[46] Jason Hickel, *Less Is More: How Degrowth Will Save the World* (United Kingdom: Penguin Books, 2022), 142–44.

[47] Mauricio Lorca et al., 'Mining Indigenous Territories: Consensus, Tensions and Ambivalences in the Salar de Atacama', *The Extractive Industries and Society* 9 (March 2022): 101047, https://doi.org/10.1016/j.exis.2022.101047; Melisa Escosteguy et al., '"We Are Not Allowed to Speak": Some Thoughts about a Consultation Process around Lithium Mining in Northern Argentina', *The Extractive Industries and Society* 11 (September 2022): 101134, https://doi.org/10.1016/j.exis.2022.101134; Iris Crawford, Yang Shao-Horn, and David Keith, 'How Much CO2 Is Emitted by Manufacturing Batteries?', MIT Climate Portal, 15 July 2022, https://climate.mit.edu/ask-mit/how-much-co2-emitted-manufacturing-batteries; MIT Climate Portal Writing Team and Caroline White-Nockleby, 'How Is Lithium Mined?', MIT Climate Portal, 12 February 2024, https://climate.mit.edu/ask-mit/how-lithium-mined.

[48] Ian Morse, 'Millions of Electric Cars Are Coming. What Happens to All the Dead Batteries?', Science, 20 May 2021, https://www.science.org/content/article/millions-electric-cars-are-coming-what-happens-all-dead-batteries.

[49] Katherine Richardson et al., 'Earth beyond Six of Nine Planetary Boundaries', *Science Advances* 9, no. 37 (15 September 2023): eadh2458, https://doi.org/10.1126/sciadv.adh2458.

creating meaningful processes for both people and the planet.[50] Because a traffic jam with electric cars is still a traffic jam.

Illustration 1: Meme posted by Taras Grescoe (@grescoe) on X (https://x.com/grescoe/status/1359146260524056577).

50 Eg Kate Raworth, *Doughnut Economics: Seven Ways to Think like a 21st-Century Economist* (United Kingdom: Penguin Books, 2022).

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