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The Afterlives of Extraction

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1. Introduction

Norway's electric vehicle (EV) rollout has made global headlines for multiple reasons: its all-inclusive incentive packages for electric cars (de Rubens et al., 2020), world-leading battery EV market share per capita (Figenbaum, 2020), and impressive EV charging infrastructure coverage (Funke et al., 2019). Thus far, the rollout remains a largely middle- and upper-class phenomenon (Fevang et al., 2021; Fjørtoft and Pilskog, 2020), relatively limited to electric cars compared to the global leader China with its massive electrified bus fleets (Li et al., 2020). Notably, this is beginning to change, with the procurement of electric buses (Thorne et al., 2021), expansion of light rail systems (Engebretsen, Christiansen and Strand, 2017) and advent of electric ferries along Norway's western coast (Njøs et al., 2020). The expansion of EVs has been criticised for perpetuating over consumption and overshadowing efforts to shift away from automobility and towards walking, cycling and public transportation (Henderson, 2020; Remme, Sareen and Haarstad, 2022). We concur that Norway's EV revolution merits critical attention but will show that critical attention should not be only paid to the effects within the country's cities—the EV revolution has global implications.

The Norwegian case has captured the imagination of innovation and diffusion scholars, notably in economic geography, transition studies and transport policy (see, e.g., Graham, 2021). Accounting for the diverse spatial–temporal implications of the rollout, however, requires holistic analysis of its value chain. This work is underway (see Henderson, 2020; Sovacool, 2019; Chester and Horvath, 2009), and includes a focus on lithium extraction as the colonial shadow of electromobility (Blair et al., this volume; Jerez, Garcés and Torres, 2021; Schlosser, 2020) and the greenwashing of an imperial mode of living (Post, this volume; Anlauf, 2017).

However, translocal aspects of EV rollout remain obfuscated in low-carbon transition narratives (Sareen and Grandin, 2020). EVs come from somewhere (which entails extraction and heavy material transport), exist somewhere (which means occupying limited public space and shaping spatial planning), and go somewhere (which implies end-of-life arrangements and limited material salvage). This necessitates a broader analysis of the implications of Norway's EV revolution. This chapter is based on a preliminary mapping and critically constructive analysis of the EV value chain, from mineral extraction to battery recycling, juxtaposed with popular imaginaries of Norway's EV revolution.

A major focus is lithium-ion (Li-ion) batteries, for which technological and market options are dynamic, but also characterised by persistent constraints: spatial concentrations of reserves, battery production hubs, limited demand centres, and resource-specific bottlenecks (Mayyas, Steward and Mann, 2019), notably involving cobalt (Olivetti et al., 2017). Limited knowledge on socio-environmental impacts is a cause for concern (Agusdinata et al., 2018; Klinger, 2017). Understanding of the recycling and reuse of Li-ion batteries is also only nascent (Rykalova, 2019; Gaines, 2019). Scholars identify value chain integration, involving diverse actors, as a key challenge (Mossali et al., 2020); this recognition has led to calls for circular economy business models and governmental priority-setting (Wrålsen et al., 2021).

We offer an overarching account, admittedly brief, of how the Norwegian EV imaginary mobilises a value chain and metabolises a rollout. Our analysis considers extraction, circular economy principles, translocal equity agendas (Sareen and Grandin, 2020), and disposal (Green, 2017). Situating the rollout in a global perspective, we analyse its implications for sites of extraction, discard and salvage, aspects that remain neglected relative to usage.

The next section reviews the literature on extraction, consumption and the afterlives of EVs, and their discursive construction as a sociotechnical imaginary. It combines longitudinal (life cycle and circular economy) and translocal (value chain) approaches to provide a robust spatial–temporal conceptual basis. Next we present an analytical framework, and employ it to structure the empirical analysis in the fourth section. The final section discusses key takeaways that stem from the empirical analysis and argues for a fuller knowledge base that privileges holistic spatiality over geographical immediacy, to question systemic logics that glorify 'greener' consumption, and to work towards systemic scaling and institutionalisation.

2. Material–Semiotic Mapping: Seeing Upstream, Seeing Downstream

EVs come with unintended socio-environmental consequences that remain understudied and uncertain (Lis et al., 2018; Di Felice, Renner and Giampietro, 2021; Xu et al., 2020). Looking at EVs from a wide perspective, going beyond the narratives of national policy success, reveals a host of unaddressed challenges. These include virtual water export due to lithium extraction in groundwater-reliant communities (Blair et al., this volume; Ma, Opp and Dang, 2020; Liu and Agusdinata, 2020), labour exploitation and worsening inequality due to extraction at remote sites (Sovacool, 2019; Dunlap, this volume), the greenwashing of unsustainable environmental consumption (Swilling et al., 2013; Nguyen and Davidson, 2017), a lack of incentives and reliable monitoring of compliance with circular economy principles related to disposal and planned obsolescence (Velázquez-Martínez et al., 2019) and fragmented examples of sporadic improvisation without a systemic and scalable logic (Wrålsen et al., 2021).

In a more general sense, the drawbacks of extractive industries and the challenges of recycling merit greater attention as well (Olivetti et al., 2017; Bonelli and Dorador, 2021; Schlosser, 2020). Estimates of raw material availability and bottlenecks depend on many factors: how existing reserves are measured (Vikström, Davidsson and M. Höök, 2013), and what assumptions are made when predicting demand acceleration. Life cycle emission assessments vary greatly based on assumptions about electricity mixes (Girardi, Gargiulo and Brambilla, 2015; Moro and Lonza 2017), extraction and manufacture processes (Hawkins et al., 2013), user behaviour (Yuksel et al., 2016), vehicle weight (Nealer and Hendrickson, 2015), battery durability (Ellinsen et al., 2016), reuse potential, recycling (Gaines, 2014) and disposal (Hendrickson et al., 2015).

Furthermore, a transition focused on electric cars requires the massive decarbonisation of electric grids; this relies on extractive industries similar to those that enable electric cars (Kramarz, 2021). The argument for EV rollouts thus routinely goes hand in hand with the larger argument that a transition to 100 per cent renewable energy by 2050, without reducing energy use, is 'technically and economically feasible with little downside' (Jacobsen et al., 2015, 1). This overlooks the wider political ecologies involved in EV production. As BloombergNEF, a key market analyst puts it:

> And what about all the lithium and other finite materials used in the batteries? BNEF analysed those markets as well and found they're just not an issue. Through 2030, battery packs will require less than 1% of the known reserves of lithium, nickel, manganese, and copper. They'll require 4% of the world's cobalt (BNEF, 2020).

This quote illustrates the tendency to reduce these resources to global commodities, removed from the sociocultural and political economic contexts of extraction.

Yet markets are never independent of these wider relations (Callon, 1998). Linking a product and its consumer entails a great deal of work (Tsing, 2005); notably the discursive construction of sociotechnical imaginaries of some products as more just and sustainable, and therefore more desirable, than others. Mainstream economics abstracts the functioning of markets away from such relations and imaginaries of salvation through technological innovation work to construct EVs as 'zero emissions'. This semiotic manoeuvre makes negative externalities disappear, ignoring environmental pollution and social displacement at remote sites of extraction and failing to account for the high carbon and water intensity present in the extraction, manufacture, and discard of Li-ion batteries. Correspondingly, reductive visions of EVs as sustainable obscure the spatially uneven distribution of benefits and burdens.

While some of these uncertainties and gaps in knowledge can be reduced with greater information and quantitative analysis, others are more intractable. Di Felice, Renner and Giampietro (2021, 2) argue that 'the existence of irreducible uncertainties in the EV knowledge base points to a broader question of how science and policy interact in the co-creation of sustainability transition pathways' in ways that legitimise some agendas and foreclose others. Reports that project the demand for EVs and the availability of critical materials, including the initial labelling of some materials as 'critical', co-shape imaginaries that inform societal policies, attitudes, and efforts (Strand et al., 2018). The recursive relationship between imaginaries and policies can be aptly framed using the sociotechnical imaginaries approach (Di Felice, Renner and Giampietro, 2021; Bergman et al., 2017).

Focusing on national policy plans, Jasanoff and Kim (2009, 120) define imaginaries as 'collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological projects'. Scholarship on sociotechnical imaginaries of EVs has mostly focused on imaginaries of and about users, and propagated by policymakers (Skjølsvold and Ryghaug, 2020; Di Felice, Renner and Giampietro, 2021; Bergman et al., 2017; Mutter, 2021; Anfinsen, Lagesen and Ryghaug, 2019; Valdez et al., 2019; Wentland, 2016). These accounts characterise EV imaginaries as linked with ideas of ecomodernism, progress, techno-optimism, prosperity, low-carbon futures, environmental responsibility, green growth, and automobility as individual freedom. Less attention has been devoted to the vested interests that shape such imaginaries, which itself underscores how influential the (significantly Nordic[1]) imaginary of EVs as unequivocally positive has become.

The positive feedback loop between this imaginary and EV rollout policies has reinforced the positing of EVs as a solution and supported knowledge production on acceleration rather than on critical assessment of the justifications for the solution itself (e.g., Kotilainen et al., 2019). Justifications that promote EVs have been challenged by critical mobility scholars and extractivism scholars who have demonstrated the negative socio-environmental effects of car dependence and advocated for collective and active transport solutions and infrastructures (Henderson, 2020; Urry, 2004; Bannister, 2008; Holden et al., 2020; Mattoili et al., 2020). While of interest to municipal planners, such studies seem to have had less impact on EV imaginaries among national policymakers.

This perspective also draws us towards a properly global frame of reference and postcolonial perspectives. Scholars of extractivism offer a direct critique of hegemonic EV imaginaries in relation to lithium operations in Latin America, 'whereby extraction and valorisation of mineral resources is rendered not only compatible with "sustainable development," but necessary to it' (Voskoboynik and Andreucci, 2021, 16). Jerez, Garcés and Torres (2021, 1) argue that the 'green economy in the global north relies on green extractivism in the global south', as do Dunlap and Jacobsen (2020) and Riofrancos (2019). Anlauf (2017) and Schlosser (2020) combine green extractivism and the 'imperial mode of living' to frame the drivers and consequences of EVs. The 'imperial mode of living' signals how 'people's everyday practices, including individual and societal orientations, as well as identities, rely heavily on: (i) the unlimited appropriation of resources; (ii) a disproportionate claim to global and local ecosystems and sinks; and (iii) cheap labour from elsewhere' (Brand and Wissen, 2013, 152). Yet the dominant enthusiasm for electric automobility largely ignores these critiques, which occupy more radical discursive spaces.

The preceding literature review reveals a need for more holistic analysis of the political ecologies that underpin EV rollouts. There are multiple studies that point to aspects of the upstream and downstream effects of EVs. But there is a need for a framing on these analyses that connects the dots of these seemingly separate effects and developments. Therefore, in the next section we will outline an analytical approach that draws on the concept of commodity chains.

3. Towards a Value Chain Perspective on Electric Vehicles

In this chapter we argue for an analysis of the value chains of EVs and the imaginaries that mobilise them, focusing on how value is constructed, extracted, and concentrated along the EV commodity chain. Hopkins and Wallerstein (1977) coined the term 'commodity chains' in order to 'ground abstract-prone analysis of economic globalization in the everyday practices of firms, workers, households, states, and consumers' (Bair and Werner, 2011, 1). A commodity is the outcome of relational processes that connect actors and activities across space; studying processes linked to a particular commodity can thus unpack complex characteristics of the global economy.

Analysing the structure of the hydrocarbons value chain, Bridge (2010) identified key actors and imperatives that perpetuate the oil industry despite widespread recognition that climate change can and should be mitigated through emissions reductions. Scholars of science and technology studies highlight concrete mechanisms such as standards and certification schemes within value chains (Callon, 1998). These efforts clarify how value chains are constituted through material and semiotic transformations that produce commodities, products and pollution. For instance, Hartwick (1998) demonstrates the material–semiotic links between advertisements for gold, jewellery factories in Italy, male gold mine migrants in apartheid South Africa and their 'gold widows' in Lesotho.

Our mapping of the EV value chain is more preliminary than comprehensive, approached as a distributed web of nodes in dynamic relations co-constituted with market and political conditions. A comprehensive accounting of the impacts of EVs would feature detailed insight into different life cycle stages and connections across sectors; here we aim to provide an accessible overview, not an exhaustive one. A key point is that commodities travel in value chains whereas contextual information about labour conditions, environmental costs and other power relations does not. We aim to elucidate the impact of EVs in a manner that lays bare sociotechnical imaginaries reliant on green extractivism that perpetuate an imperial mode of living, curtailing opportunities for more globally just futures.

Our three-part analysis pulls together a wide range of existing work to better understand aspects of EV value chains from extraction, through consumption, to afterlives. To ensure meaningful depth on key selected aspects, we omit the stage between extraction and consumption, which includes multiple steps of transport, processing and manufacture. For instance, refinement requires energy intensive high temperatures and large volumes of water, and produces toxic by-products such as fluoride and sulfuric acid. In addition, the manufacture of semiconductors and battery cells and packs, and vehicle assembly, entail their own shifting geographies and socio-environmental impacts. This limit to scope is commensurate with our current effort and aimed at motivating future research with greater coverage and depth. To balance scale and resolution, we include global and regional trends alongside situated contextual details directed by relevance and representativeness.

Analysts have noted that *extraction* takes place far from the public eye. We hold that this invisibility of conditions of production for end users is essential to maintaining a glossy EV imaginary. The stage of *consumption* includes marketing, sale and usage, and is reliant on the prominence of spectacle and the performativity of the EV imaginary to shape public opinion and to lobby policymakers, in order to make EVs available and desirable to a wide set of publics. Finally, *afterlives* include the used car and spares market, salvage, and discard, categories that are emergent in the least formalised and regulated part of EV rollouts, where actors improvise to fill gaps and gain positional advantages on matters such as refurbishing, recycling and disposal.

To examine these three stages of the value chain for EVs deployed in Norway, we draw on peer-reviewed and grey literature, media reports, and primary observations from industry events, including the Nordic EV summit and Nordic Battery Thursdays during late 2021. The Nordic EV summit is co-organised by the Norwegian EV association (which promotes the interests of EV users and has over 75,000 members) and Norway Trade Fairs (Norway's largest exhibition centre). Nordic Battery Thursdays is co-organised by trade and industry lobby groups Business Finland and Business Sweden, the government funding organisation Innovation Norway, and EBA 2050, an industrial development programme of the European Battery Alliance (EBA). The last of these is driven by EIT InnoEnergy, an independent European Union (EU) body aiming to strengthen European competitiveness in sustainable energy. Both events are geared towards bringing industry actors and policymakers together to develop best practices for the sector and exhibit new technologies and companies.

Our overall mapping exercise is informed by the observation that industry actors continue to routinely refer to 'sustainable', 'ethical', and 'clean' mining, as critiqued by, for example, Whitmore (2006) and later by Han Onn and Woodley (2014). Such desirable forms of mining are to be delivered through 'traceable' and 'transparent' supply chains. The relationship between sustainable/ethical relations and traceability/transparency seems to be taken for granted, indicating that any current lack of accountability is assumed to be the result of incomplete information. The assumption that more data is the key to sustainability is an important element in how private industry actors and policymakers are interacting to co-create sustainability transition pathways.

4. Mapping and Analysis

We now present our analysis of three stages in the value chain of the EV rollout in Norway. Global electric car sales have grown exponentially since 2010 (IEA, 2020). Despite overall car sales slumping by a fifth during the pandemic in 2020, electric car sales continued to accelerate (IEA, 2020). In Norway, electric cars surpassed a 20 per cent share of the total car fleet in 2020. Solidifying Norway's position as the global EV capital, 2021 saw electric cars comprise over 60 per cent of new car sales.

There are more than 140 components in an average car, regardless of fuel type. Electric vehicles contain many of the same materials as internal combustion engine vehicles, including steel, lead, plastics, aluminium, and a variety of chemicals that cause emissions (Hawkins et al., 2013; Henderson, 2020). Here we focus on the elements that are particular to the Li-ion batteries in EVs, rather than the materials they have in common with fossil fuel–powered cars.

4.1 Extraction

> 'Meeting climate goals will turbo charge the demand for raw materials.' (European Battery Alliance Programme Director at the Nordic EV Summit, 2021).

Meeting the projected demand for the raw materials used in EVs is a major topic at industry events and in policy documents such as the EU action plan on the circular economy and the Norwegian national strategy for a green and circular economy. One of the top priorities of the European Battery Alliance (EBA, 2021), a partner in the EU Circular Economy Action Plan, is to 'secure access to sustainably produced battery raw materials at reasonable cost'. At the Nordic EV summit, participants repeatedly used the terms 'ethical', 'clean' and 'sustainable' mining. The moderator declared, 'We can do it if we set our minds to it'. The EBA director claimed, 'development of sustainable, traceable and transparent supply chains [is] a prerequisite to sustain[ing] [...] continued market growth'. Exactly how traceability and transparency contribute to environmental sustainability is left unspecified.

We focus in on cobalt sourcing to explore this imaginary further. Cobalt is currently listed as a 'critical resource' in the EU and is required for the Li-ion batteries found in Norwegian EVs. The Democratic Republic of Congo (DRC) supplies 60 per cent of the world's cobalt and conditions for miners are frequently abhorrent (Niarchos, 2021). As a panel moderator at Nordic Battery Thursdays stated, 'all of us know that there are problems with mining cobalt so removing it will give sustainability benefits'. However, the potential negative consequences of developing battery technologies without cobalt include abandoning commitments to improve conditions at extraction sites and to provide opportunities for economic development (Sovacool, 2019), reducing electric vehicles' range, displacing the demand to other minerals and undermining the economic viability of recycling industries.

While Chinese companies dominate cobalt extraction and refining, they are not the only player. Glencore, incorporated in Switzerland, is the world's largest publicly traded commodity supplier and operates two of the largest mines in the DRC. In June 2020, Tesla signed a long-term contract to source cobalt from Glencore for its factories in Berlin and Shanghai (Stringer and Biesheuvel, 2020). Concomitant with the wider discourse, Glencore consistently links 'responsible' and 'ethical' sourcing with 'transparency' and 'traceability' in their supply chain. Traceability and transparency are further reduced to tracking and certification schemes. Until recently these were supposed to ensure that the cobalt was extracted from officially sanctioned industrial mines rather than by artisanal or small-scale miners. After signing the deal with Tesla, Glencore announced the launch of the Fair Cobalt Alliance, which it claims will work to improve conditions in the informal sector and encourage battery manufacturers not to engineer out Congolese cobalt.

Exposure to cobalt is associated with a number of health risks including DNA damage (Banza Lubaba Nkulu et al., 2009; 2018), higher risk of congenital birth defects

(Kayembe Kitenge et al., 2020a) and potentially fatal lung disease (Kayembe Kitenge et al., 2020b). Studies have found very high concentrations of the element and other metals in the urine of children around mining sites (Kayembe Kitenge et al., 2020b). Cobalt mining in the DRC is notoriously implicated in child labour (Niarchos, 2021; Faber, Krause and Sánchez de la Sierra, 2017; Chohan, 2018). In 2019 a lawsuit was filed in the US against Tesla and other significant buyers of cobalt on behalf of children who were maimed or killed in tunnel or wall collapses while mining cobalt in the DRC. The plaintiffs asserted claims of forced child labour in violation of the Trafficking Victims Protection Reauthorization Act. The companies claimed 'they did not have "requisite knowledge" of the abuses at the specific mining sites mentioned, and that "knowledge of a general problem in an industry [...] is insufficient" to prove they knew about the violations that had injured the plaintiffs' (BHRRC, 2021). In 2021 the case was dismissed, partly because the Judge asserted 'the harm they [the plaintiffs] allege is not traceable to any defendant' (BHRRC, 2021).

Local organisations representing miners claim the big mining companies use subcontractors to avoid accountability (Pettison, 2021). Subcontractors can end contracts with miners at any time, contributing to a climate of fear and attrition that discourages workers from organising for better pay or holding their employers accountable for safety or environmental hazards. Additionally, Glencore has employed other tactics, such as shell companies and jurisdictional arbitrage, to avoid financial accountability (Public Eye, 2017). In 2017 a human rights watch group filed a lawsuit leading to the Swiss Federal Prosecutor's office opening a criminal investigation into Glencore for its failure to prevent alleged corruption in the DRC. In 2019 Glencore lost a landmark case in Australia regarding the legality of using leaked documents as evidence in investigations of financial crimes. Glencore Chief, Ivan Glasenberg, said in a speech following the decision, 'At least in the Congo they need you, they want you there and if they start changing the rules, you may not continue investing' (Chenoweth, 2019).

At COP26, the Congolese Deputy Prime Minister and Minister for the Environment, Eve Bazaiba, announced to the ambassador of Switzerland and the public that the DRC plans to block Glencore from exporting raw materials from the country: 'We can no longer accept these exports. We too must move towards ecological transition. Cobalt cannot be exported, transformed and manufactured into batteries outside the country, while we are reduced to selling our teeth to afford a green vehicle' (Landgrand, 2021). Glencore has not responded to the announcement and its website hosts plans to expand mining operations in the DRC, although in May 2022 the corporation pled guilty to violating the Foreign Corrupt Practices Act and to a commodity price manipulation scheme (USDOJ, 2022). Glencore's actions included more than USD 100 million worth of bribes to officials in Brazil, Cameroon, Ivory Coast, Equatorial Guinea, Nigeria, Congo (DRC), South Sudan and Venezuela between 2007 and 2018. As a result, the African Energy Chamber has requested that Glencore lose its membership of the Extractive Industry's Transparency Initiative (EITI), although the EITI has issued a statement saying that it welcomes recent actions taken by Glencore to remedy the situation and encourages the corporation's active participation in the EITI to ensure that 'we can learn from this unfortunate experience and identify measures that will prevent it from happening again' (EITI, 2022). In April 2022, the governments of the DRC and Zambia signed a cooperation agreement to establish a Battery Council and integrate the EV value chain within their territories, including plans to build processing plants and an EV battery factory (Wansi, 2022).

4.2 Consumption

The dominant narrative about Norwegian EV adoption holds that it is the result of demand-oriented climate change policies. For example, an article in *The Guardian* claims that ‘Norway’s lead on electric cars has been driven by the government backing them with a wide range of generous incentives and perks, as a way of meeting its climate change ambitions’ (Vaughan, 2017). However, EV policies in Norway have evolved over time from their original intent to stimulate industrial development (Skjølsvold and Ryghaug, 2020). Since the turn towards demand-oriented policies, imaginaries of EVs as environmentally friendly and of those who drive them as ‘good’, ‘green citizens’ (Green, Steinbach and Datta, 2012) have been crucial aspects of EV promotion (Ingeborgrud and Ryghaug, 2019; 2017). User surveys have found that EV owners in Norway are often motivated by concern for the environment in addition to economic incentives (Thronsen, 2019; Tvinnereim and Ferguson-Cradler, 2020; Anfinsen, 2021).

A representative for Northvolt, a battery manufacturing company in Norway, stated at an industry event that ‘When we started out “sustainability” was a nice, cute extra bonus but not important for the customers. Now it is central’. Research on consumer motivations reveals that Norwegian EV owners claim to be environmentally motivated (Anfinsen, Lagesen and Ryghaug, 2019); it is, however, difficult to say how ‘real’ these self-reported motivations are. There are a plethora of consumer outreach and awareness campaigns working to promote EV adoption in Norway and the rest of Europe (Jin and Slowvik, 2017). One of the priority areas for the EBA, which is present at most Nordic EV industry events, is to ‘Involve the EU citizens in the journey: inform, educate and motivate’ because, ‘public-sector efforts (education in schools, role modelling and so on) should be invested in the general population’s awareness and understanding of the entire value chain so that there is relevant societal appropriation from the start’ (EBA, 2021). Given the materials present on the Alliance’s website, we take this statement to refer to highlighting EV industry–related economic opportunities in European regions, including with regard to manufacturing and recycling, rather than to informing consumers about the potential negative impacts of EV value chains outside Europe.

While the success of EV promotion campaigns is often measured in Norway by the percentage of the car fleet that is electric, far less attention is paid to how many kilometres are driven in electric vehicles and whether they are purchased in addition to fossil fuel vehicles or replace them. In 2019, less than 10 per cent of the kilometres driven in personal vehicles were driven with electric cars (Moberg, 2020). Reports show that EVs in Norway are usually second or third cars in a household (Fjørtoft and Pilskog, 2020). Drivers use their conventional vehicles for longer drives, for example to vacation homes, which are popular in Norway (RVU, 2019).

There are also concerns about elite capture of the benefits of EV subsidies (Fevang et al., 2021; Wågsæther et al., 2022). As of 2019, 37 per cent of Norway’s electric vehicles were owned by households in the top ten percentile of income earners and 58 per cent were owned by those in the top 20 percentile (Fjørtoft and Pilskog, 2020). In 2018, EV subsidies amounted to approximately USD 883 million (7.2 billion Norwegian kroners, or approximately 739 million euros), and the figure was USD 1.28 billion (11 billion Norwegian kroners, or approximately 1.1 billion euros) in 2019[2] (Fjørtoft and Pilskog, 2020). These subsidies are in addition to exemption from or vastly discounted road tolls, which has raised the cost of tolls for fossil fuel–vehicle drivers (Krehic, 2019). The recent political backlash against road tolls has centred on claims of social injustice and pushing back on depoliticised and moralising sustainable mobility agendas (Wanvik and Haarstad 2021; Wågsæther et al., 2022).

The director of Norway's Institute of Transport Economics (TØI) recently held that the Norwegian government must end the economic subsidies for electric vehicles because they are outcompeting efforts to promote public transportation (Bentszrød, 2021). In 2019, a 'technology expert panel' recommended the government replace the 'zero growth in personal traffic target' currently governing transportation policy and funding in every Norwegian city with a 'zero emissions' target, because of EV adoption. This proposal was written into the last National Transport Plan for review (Regjeringen, 2019). The change would have major implications for the urban planning paradigm that has been guiding development for several decades including compact city building and prioritising walking, cycling and public transport. The national government recently approved several new intercity superhighways, replacing two lanes with four and building mega infrastructure such as bridges and undersea tunnels, signalling that automobility will remain a central element of transportation planning in Norway.

The Norwegian EV imaginary is further shaped by strategic efforts to convince and mobilise consumers through evangelising the desirability and sustainability of EVs. When lobby groups such as the union for electric car owners declare, 'we can do it if we set our minds to it' (referring to sustainable and ethical mining), they are part of constructing the 'ecomodern' discourse that relies on salvation through technological innovation and sustained economic growth. Without more concrete mechanisms that explicate the relationship between 'sustainable' or 'ethical' mining and 'traceable, transparent' supply chains, we interpret these discursive constructions as legitimation practices that remain to be fully operationalised for accountability.

4.3. Afterlives

Circular economy models are increasingly presented as the solution to potential supply shortages and environmental damage related to the electric vehicle transition (Wrålsen et al., 2021; Rallo et al., 2020). The EU is keen for circular economy models to deliver ecological modernisation—reconciling continuous economic growth measured by GDP with reducing emissions and environmental degradation (EC, 2020). New 'regulations for sustainable batteries' under the EU's circular economy action plan began taking effect in January 2022. The aspiration of circular economics is to avoid or reduce the exploitation of raw materials by closing material and energy loops in biological and technical cycles and lengthening the life cycle of goods (Prieto-Sandoval, Jaca and Ormazabal, 2018). Examples include reuse for stationary energy storage (Kamath et al., 2020) and recovering valuable materials through recycling (Baars et al., 2021; Jiao and Evens, 2016). However, analysts are sceptical this will have any impact on expanding primary extraction in the next few decades (Gaines, 2014; Xu et al., 2020).

In 2019, 1,400 electric and hybrid cars were scrapped in Norway and most of these were less than five years old (Myklebust, 2021). This is partially due to insurance industry standards, which dictate if the cost of repairs exceeds 60 per cent of the cost of a new car, the vehicle should be scrapped. However, installing used parts renders new car guarantees void, leading to substantially inflated prices for repairs (Myklebust, 2021; Stumpf, 2021). In Norway, only 2 per cent of the total amount of vehicle repairs are carried out with used parts (Myklebust, 2021; Stumpf, 2021). Right to repair (RtR) legislation may increase the lifespan of electric vehicles by allowing independent repair shops access to the same diagnostic data as automobile manufacturers (Myklebust, 2021; Stumpf, 2021). Car manufacturers have lobbied against RtR proposals, using a variety of arguments including safety concerns related to batteries, cybersecurity, and possible violation of emissions regulations.[3] Tesla, a major EV supplier to the Norwegian market, has punished customers who obtain unauthorised repairs, including by permanently disabling access to its Supercharging network and fast charging using third-party chargers for any ‘unsupported’ repairs (Stumpf, 2021; Edelstein, 2020).

Once batteries are too degraded for use in EVs they retain more than two-thirds of their usable energy storage capacity and may provide five to eight years more service in a secondary application (Ambrose et al., 2020). A second use battery is functional until it reaches 60 per cent of its initial capacity, at which point it is sent for recycling or disposal (Cicconi et al., 2012). Reuse for stationary energy storage is still uncommon but expected to grow (Cicconi et al., 2012; Wrålsen et al., 2021). However, extending the life of batteries through reuse applications delays their entry into recycling, thereby contributing to further primary extraction in the meantime (Gaines, 2019).

The projected massive demand for battery recycling and disposal is increasingly connected to national discourses around ‘new green industries and jobs’ and ‘green growth’ (Grobæk, 2021). State-backed industries for recycling are being established, including Europe’s largest recycling plant, in Poland (Reiserer, 2021), and another in Norway. However, the projected demand far outstrips the projected capacity (Wrålsen et al., 2021; Olivetti et al., 2017; Gaines, 2019). Battery pack designs are not standardised or optimised for easy disassembly and recovery of valuable materials (Harper et al., 2019; Ambrose et al., 2020; Kamath et al., 2020). EV batteries were exported from Norway to China until 2018 when China stopped accepting them. Since then, batteries are stored and dismantled in Norway before some of them are sent onwards to recycling plants in Belgium, Germany or Canada (Brandslet, 2019). Almost no lithium or graphite is recovered because it is not cost-effective compared with primary supplies. Recycling is geared towards recovering cobalt, nickel and copper (EC, 2020). The volume of recovered metals used in battery manufacturing is currently low but new EU battery regulations state that EV batteries will have to declare the content of recycled cobalt, lead, lithium and nickel from 1 January 2027, and by 2030 batteries will need to contain minimum levels of recycled materials (EC, 2020). Alternative battery chemistries, such as LFP (Lithium iron phosphate),[4] that do not require cobalt are attractive to manufacturers but risk undermining nascent industries for recycling because cobalt is what makes recycling economically viable at this stage (Gaines, 2019).

5. Conclusion

The negative consequences of mass EV adoption have largely been neglected within the dominant Norwegian EV imaginary. While the Norwegian EV phenomenon is ostensibly driven by climate and sustainability concerns, it can be characterised as an ecomodernist discourse that wilfully ignores its own limitations. Problems highlighted in our analysis show cracks growing between the sociotechnical imaginary of electric vehicles and the sobering reality. There is a need for a more holistic analysis of the negative externalities of EV rollout. In this chapter we have argued for a commodity chain perspective in order to capture the wide range of effects of EVs and their extensive rollout. We have sought to extend the form of reductionist accounting that dominates both policy and scholarship on EVs to capture more of what is at stake for communities and ecologies during the transition to EVs. This approach reveals the implicit normative claims that make it possible to discursively separate matter from its entanglements and mobilise imaginaries about green electromobility.

It is not that aggregate, quantitative knowledge related to energy and resources is not useful, but that cost–benefit analyses that assume fungible people and places obscure situated injustices and privilege geographic immediacy over holistic spatiality. The materials required for electric vehicles are embedded in global supply chains that outsource emissions and environmental degradation from the Norwegian territory, where these cars are driven. This enables the construction of EVs as ‘zero emission’, and as singularly positive for the climate. Creative accounting that outsources emissions and other environmental degradations to the global South, while promoting a narrative of leading the way in climate change mitigation, perpetuates the colonial exploitation that undergirds modernity’s strategic relations of power and production. This form of accounting is not only unjust, it also ensures that we will surpass the bio-geo-chemical tipping points we are rapidly approaching or, in some cases, have already passed.

This chapter analysed the global social and environmental consequences of the Norwegian EV imaginary and offers three key areas in need of attention from future research and policy design:

1. Industry actors link the terms ‘responsible’, ‘ethical’ and ‘sustainable’ mining with traceability and transparency in their supply chains. These terms are used to legitimise extraction for electric vehicles; however, policies should be informed more by research on how legitimation practices are linked (or not) with long-term accountability towards impacted places and people.
2. Circular economy regulations should prioritise deepening the mitigation potential of EVs and benefiting people and ecologies all along value chains, especially extraction sites, not just benefit the actors who are well positioned to leverage economic opportunities in the global North, perpetuating the imperial mode of living through green extractivism.
3. It is vital to maintain and promote imaginaries of urban sustainable mobility in policy circles beyond EVs. The passionate and dedicated innovators and advocates of electric vehicles as a mitigation effort must be supported by simultaneous and radical reductions in energy and resource use. It is not about technological *or* social innovations, cars *or* no cars; it’s about holistic approaches for deep decarbonisation and global justice.

Although circular economy models aim to lengthen the life of electric vehicles and thereby reduce the demand for extraction, there is a danger that the value added in practice will largely be captured in the global North through new market opportunities in the reuse and recycling industries while extraction in the global South will continue to expand. According to dominant imaginaries, the demand for EVs and other uses for Li-ion batteries is expected to soar far beyond the capacity of emergent reuse and recycling industries to provide the materials for battery production, let alone at competitive prices. If the circular economy is primarily focused on integrating waste streams into economic growth practices in the global North, it perpetuates the imperial mode of living based on green extractivism. Our findings resonate with Anlauf's (2017, 191) argument that green economy strategies, such as the EU Circular Economy Action Plan, rely on 'asymmetries of power, and spatially and temporarily externalise ecological and social costs' and that '[t]herefore, they fail to promote socio-ecological justice, but are rather "greening" the imperial mode of living.'

Despite the socio-ecological costs of extraction, there is an argument that reducing emissions from transportation in wealthy countries benefits everyone because the effects of mitigation are global. From that perspective, the most vulnerable countries benefit even more from the transition to EVs than the countries in which they are primarily driven. However, there are other pathways to mitigating emissions from transportation that require far less resources per person than automobility. Seeing systemic embeddedness is central to our ability to reason about the future. Our analysis demonstrates why rapid technological innovation and deployment that reduce emissions and energy and resource use must be coupled with radical reductions in energy and resource use delivered through political and social change. Limited natural resources, energy and urban space will prevent most of the world's population from ever owning a private vehicle. Those most negatively impacted by the production of EVs are often the least likely to drive one, exemplifying the imperial mode of living linked with green extractivism.

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NOTES

1. A 2021 Super Bowl commercial by General Motors featuring Will Ferrell called on the United States to catch up with Norway's electric vehicle transition, recognising it as a global leader: https://www.youtube.com/watch?v=mdsPvbSpB2Y (accessed on 18 July 2022).
2. The conversions in this chapter use the appropriate historical exchange rates.
3. In 2020, the Alliance for Automotive Innovation, a trade group that includes almost every large auto manufacturer and original equipment manufacturer relevant to the EV space, filed a suit against RtR legislation in the United States. In addition to court proceedings, the group also ran advertisements suggesting that RtR legislation would put women at risk and benefit 'sexual predators' (Gault, 2020).
4. In 2021 Tesla announced it will be using LFP batteries for some of its vehicles and stationary storage, *CNBC,* https://www.cnbc.com/2021/10/20/tesla-switching-to-lfp-batteries-in-all-standard-range-cars.html (accessed on 9 March 2023).

ABSTRACTS

Norway has the world-class ambition to make transport more sustainable and climate friendly. Its electric vehicle (EV) rollout is celebrated by and aspirational for other countries, manifesting the imaginary of technological solutions for sustainable mobility. This chapter undertakes a critically constructive analysis of the value chains of this rollout, tracing the production, usage and discard of EVs. Our point of departure in Norway's EV rollout serves to map broader implications of a rapid, massive shift towards electric transport. We map relevant externalities associated with, for example, the mining of raw materials and with modes of digitalisation that run counter to circular economy principles. The requisite resources for the transition to renewably powered, electrified transportation—notably batteries—are sourced in the global South, whereas their consumption and industries that reuse and recycle valuable minerals are emerging in the global North. The uneven distribution of benefits and burdens is increasingly being criticised as green extractivism for an imperial mode of living. By paying attention to site-specific struggles over resources, our mapping demonstrates that practices of legitimation have yet to be welded with holistic accountability. By piecing together some major links along the value chains of Norway's EV rollout, we argue for a global perspective on this transition.

La Norvège a l'ambition, à l'échelle mondiale, de rendre les transports plus durables et plus respectueux du climat. Son déploiement de véhicules électriques (VE) et célébré par et constitue une source d'inspiration pour d'autres pays, car il manifeste l'imaginaire des solutions technologiques pour la mobilité durable. Ce chapitre entreprend une analyse critique constructive des chaînes de valeur de ce déploiement, en retraçant la production, l'utilisation et la mise au rebut des VE. Notre point de départ, le déploiement des VE en Norvège, sert à cartographier les implications plus larges d'une transition rapide et massive vers le transport électrique. Nous cartographions les externalités pertinentes associées, par exemple, à l'extraction de matières premières et aux modes de numérisation qui vont à l'encontre des principes de l'économie circulaire. Les ressources nécessaires à la transition vers des transports électrifiés et alimentés par des énergies renouvelables – notamment les batteries – proviennent du Sud, alors que leur consommation et les industries qui réutilisent et recyclent les minéraux précieux émergent actuellement dans le Nord. La répartition inégale des avantages et des charges est de plus en plus critiquée en tant qu'extractivisme vert pour un mode de vie impérial. En prêtant attention aux luttes pour les ressources qui est spécifique aux sites, notre cartographie démontre que les pratiques de légitimation n'ont pas encore été fusionnées avec la responsabilité holistique. En reconstituant certains liens majeurs le long des chaînes de valeur du déploiement des VE en Norvège, nous plaidons en faveur d'une perspective globale de cette transition.

Noruega se destaca a nivel mundial por pretender que allí el transporte sea más sostenible y respetuoso con el clima. Su despliegue de vehículos eléctricos (VE) es celebrado por otros países y constituye para estos un ejemplo a seguir, manifestando el imaginario de que es posible encontrar soluciones tecnológicas para la movilidad sostenible. Este capítulo analiza de manera crítica y constructiva las cadenas de valor implicadas en ese despliege, rastreando la producción, el uso y el desecho de los VE. Examinar el despliegue de VE en Noruega permite identificar de manera más amplia las implicaciones de un cambio rápido y masivo hacia el transporte eléctrico. Aquí trazamos un mapa de externalidades relevantes asociadas, por ejemplo, a la extracción de materias primas y a modos de digitalización que van en contra de los principios de la economía circular. Los recursos necesarios para la transición al transporte eléctrico y que usa energías renovables -en particular las baterías- se obtienen en el Sur Global, si bien el consumo de estos bienes y las industrias que reutilizan y reciclan minerales valiosos surgen primordialmente en el Norte Global. La desigual distribución de los beneficios y las cargas de este despliegue es analizada críticamente ya que constituye una forma de extractivismo verde que sustenta un modo de vida imperial. Al prestar atención a las luchas por los recursos que ocurren en lugares concretos, nuestra cartografía demuestra que las formas de legitimación de estas prácticas no configuran una rendición de cuentas holística. Así, analizar las conexiones con otros contextos presentes a lo largo de la cadena de valor del uso de vehículos eléctricos en Noruega, permite proponer una comprensión global de la transición que ocurre allí.

INDEX

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