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Diverging Paths to Zero-Emissions Mobility

The political economy of building an EV battery industry in Hungary and Sweden

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Diverging Paths to Zero-Emissions Mobility: The political economy of building an EV battery industry in Hungary and Sweden

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Abstract

The European Union (EU) has taken forceful steps to ensure self-sufficiency in electric vehicle (EV) battery manufacturing. As these policies are implemented under increasingly heterogenous institutional conditions, the main question of the paper is the following: how does institutional heterogeneity affect the fulfilment of European objectives? The paper uses the historical variety of industrial policies to assess comparatively the cases of a liberal democracy, Sweden, and an illiberal regime, Hungary, in building an EV battery industry. While both countries are among the largest producers globally, the paper argues that only Sweden aligns with the EU's battery policy objectives. In the absence of adequate mechanisms for transparency and accountability, the Hungarian case exhibits all the possible deficiencies of a voluntaristic industrial policy including knowledge problems, rent-seeking, and the severe misallocation of resources, while it endangers the environment and increases political suppression as well as the dependency on China and Russia.

JEL Classification: L52, L62, O14, O25

Keywords: EV battery policies, illiberalism, industrial policy, Hungary, Sweden

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1. INTRODUCTION

Cars and vans account for 15% of carbon dioxide (CO_2) emissions in the European Union, which makes the transition to electromobility key in the fight against climate change and meeting the 1.5 ◦C target of the Paris Agreement (European Council 2023a). Within the framework of the Fit for 55 package new cars and vans must be emission-free from 2035 implying the transition from internal combustion engine (ICE) cars to EVs. This process significantly increases the demand for EV batteries promising a market with a turnover of EUR 250 billion[1]. To provide a stable and secure supply for the growing demand, the EU has taken forceful steps towards building up a European EV battery value chain – EV battery production is one of six areas, in which the EU should be self-sufficient (European Commission 2021: 12).

While the transition to electromobility is mostly framed in an environmental context, the building up of a European EV battery supply chain is a clear example of industrial policy, which take place in the context of increasing geopolitical tensions. It relates to the idea of strategic autonomy or sovereign Europe, which is primarily a French effort to legitimize French economic policies that advocate for more state intervention than German ordoliberalism (Lavery et al. 69-70, Bora 2023). The argument for autonomy relates to geopolitics as the EU tries to address the rise of China and its divide-and-rule techniques vis-à-vis the EU as well as the threats posed by the Trump presidency to transatlantic cooperation (Meunier and Nicolaidis 2019: 103). The COVID pandemic as well as the Russian aggression against Ukraine increased the sense of urgency to reduce supply chain vulnerability towards China, while a new US president did not alleviate concerns about adverse US policies either – the Inflation Reduction Act (IRA) envisages enormous subsidies for building the domestic EV industry, which could lead to a new great power competition on subsidies (Kamin and Kysar 2023), and necessitates a strong EU response (Transport and Environment 2023).

An industrial policy motivated at least partially by geopolitical considerations might be economically questionable. While the Fit for 55 program expects stronger technological leadership and more jobs in the auto industry (European Council 2023a), the historical record of industrial policy is uneven. With regards to similar efforts of EU semiconductor policy Hancké and Calvo (2022: 591) argue that in the absence of both competitive and comparative advantages, "making mature chips at the low end of the market … strikes us as a poor strategy." They also emphasize the deep institutional embeddedness of industrial policy, which greatly impacts upon whether it is successful in reaching its objectives.

The push towards a European battery industry takes place in an institutionally heterogenous environment, where liberal democracies and illiberal regimes co-exist (Kelemen 2017, Freedom House 2023). This implies that the same European objectives might be translated into very different types of

[1] Estimate of the European Battery Alliance (EBA), see https://www.eba250.com

industrial policy, which impact upon their success or failure. The central objective of this paper is to understand through the contrasting cases of Sweden and Hungary how institutional heterogeneity affects the building of the EV battery value chain and what the implications are for European policies. The two cases represent two very different political systems – while Sweden is a liberal democracy, Hungary is classified as only partly free by Freedom House (2023: 22). Based on a structured-focused comparison, the paper argues that although both countries have developed a strong battery industry, the objectives of EU battery policy are fulfilled only in Sweden. In the absence of adequate mechanisms for transparency and accountability, the Hungarian case exhibits all the possible deficiencies of a voluntaristic industrial policy such as knowledge problems, rent-seeking, and the severe misallocation of resources, while it endangers the environment and increases political suppression as well as the dependency on China and Russia. Disregarding such dangers at the EU level in designing battery policies could contribute to the deepening of institutional cleavages within the European community and undermine climate objectives.

The paper proceeds as follows. The next section explains what EV batteries are, how their value chain works, and what the EU battery policies are. Section 3 gives a historical review of industrial policies over time and discusses the relevance of institutions. This is used as the theoretical framework to analyse the cases of Swedish and Hungarian EV battery manufacturing. Section 5 addresses the implications for the EU and concludes.

2. BUILDING AN EV BATTERY INDUSTRY IN THE EU

2.1 THE EV BATTERY VALUE CHAIN

EV batteries are made up of cells, which are organized into modules then packed with electronic connections and cooling equipment to form a battery. Each cell consists of four basic components: i.) cathode, which is some type of lithium-metal-oxide and could contain nickel, cobalt, manganese, iron, or phosphate; ii.) anode – typically graphite; iii.) electrolyte, which consists of organic carbonate solvents with dissolved lithium salts; iv.) separator, a thin, porous plastic film (Coffin and Horowitz 2018). The value chain of EV batteries is shown on Figure 2.1. Based on IEA (2022a: 154), there is a significant concentration in the market at every point of the process. More than 50% lithium comes from Australia, nearly 75% of cobalt comes from Congo, while 80% of graphite is extracted in China. China also dominates the rest of the value chain, processing more than 50% of all raw materials except nickel. Its share in the production of anode and cathode and batteries is over 70%, while it produces more than 50% of electric cars.

Figure 2.1: The value chain for EV batteries

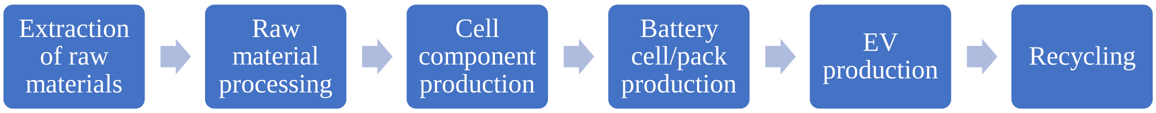

Figure: own editing based on IEA (2022a): 146

Beyond the unequal distribution of raw materials, the production of batteries has significant environmental and social challenges. The joint vision of the Global Battery Alliance and the World Economic Forum (WEF 2019) elaborates on three such challenges:

First, battery production is highly energy-intensive, which means that CO2 emissions are expected to increase significantly – by 2030 estimates show that the emission of the battery value chain will be 182 Mt annually, which is more than the annual CO2 emission of the Netherlands (WEF 2019: 19). The most energy-intensive step of battery production is cell manufacturing, where the energy needed for 1 kWh battery capacity is 41,48 kWh (Degen and Schütte, 2022). The source of this energy crucially impacts upon how green electric cars are although all types of electric cars are expected to have emission benefits (19-60%) compared to ICE cars over their total life cycle (WEF 2019: 20). At the same time Pardi (2021) calls attention to the danger of consumer preferences towards larger and heavier EV cars, which greatly decrease the emission benefits of electrification.

Second, demand for the raw materials of batteries is increasing dramatically, and mining the required materials comes at significant social and environmental costs. Cobalt extraction in Kongo is associated with severe human rights abuses including significant amount of child labour (WEF 2019: 21). Lithium is mainly produced in Australia and South America – in the latter place it is extremely water-intensive with 1 ton of lithium requiring 2,2 million litres of water (Campbell 2022). The availability of raw materials is particularly problematic for the EU as 18 times more lithium and 5 times more cobalt demand is expected by 2030 than the current production of the community (Halleux 2022: 2).

Third, the profitability of the industry is also questionable for several reasons (WEF 2019: 22): high upfront costs of battery packs, lack of charging infrastructure and low utilization of existing infrastructure, as well as limited costumer acceptance of EV cars instead of ICE cars. There are also particular problems associated with recycling. Current recycling technologies are highly greenhouse gas (GHG) emission intensive, while they are not profitable – as also argued by Halleux (2022: 4) in the EU almost no lithium is recovered during recycling as it is not cost-effective compared to primary supplies.

The list of challenges can be extended further. At a time of climate change and regular droughts, production requires a significant amount of water mostly for cell production and cooling – the water depletion potential is between $9m^3$ and $74m^3$ for a 40kWh battery pack (Phillipot et al., 2019, 8). With the increasing number of battery plants, the problems during the production process have also gained attention such as the significant amount of noise from the factories as well as the various accidents affecting workers and the environment (Éltető, 2023). The next section reviews how EU battery policies address these challenges.

2.2 EU POLICIES TOWARDS EV BATTERIES

The European Battery Alliance (EBA), which was officially launched by European Commission Vice-President Maroš Šefčovič in October 2017, is one of the earliest industrial policy projects within the context of an Important Pro-jects of Common European Interest (IPCEI) initiative (Pichler et al., 2021, 145). Collaboration of relevant stakeholders is facilitated by the for the purpose of supporting the build-up of a safe and sustainable European battery for an estimated €250billion market (EIT InnoEnergy, 2020). The alliance is led by EIT InnoEnergy and comprises 120 European and non-European stakeholders representing the entire battery value chain. Through a series of workshops and seminars they have identified key actions to build up a European EVBVC – their recommendations range from supporting R&D, EV infrastructure as well as frontloaded financing for necessary investments .

Beyond brokering collaboration, the EU has taken significant steps towards regulating the industry, which is driven by environmental and social concerns as well as the idea that strict standards would ensure a level-playing field for European companies (Melin et al., 2021). The European Parliament and the Council came to an agreement on the new battery regulations on 9 December 2022 (European Council, 2023b). The regulation sets out harmonised standards for the entire lifecycle of batteries from raw materials production to usage and end-of-life handling. It has labelling and informational requirements about the carbon footprint of batteries as well as rules for replaceability, interoperability, safety, and durability. It contains 100% collection and recycling requirement for EV batteries as well as quantitative targets for recycling and recycled content in new batteries, which become stricter over time. By 2030, 95% of cobalt, copper, lead, and nickel as well as 70% of lithium must be recycled, while by 2031 new batteries must contain recycled material where the targets are 16% for cobalt, 85% for lead, 6% for lithium and 6% for nickel. According to Melin et al (2021, 3) globally these are the most advanced standards, and they might also serve as non-tariff barriers against cheaper imported products.

Targeted financial support for the EV battery sector involves both state aid as well as initiatives for EU-level funding initiatives. In response to IRA the EU loosened and simplified regulations for state aid for battery factories through the Temporary Crisis and Transition Framework (TCTF). While originally these rules applied to the support of the economy in the context of Russia's invasion of Ukraine, in March 2023 it was announced that the rules can also be used to boost clean tech investments in the EU and compete on subsidies with the US (European Commission 2023, 2.8.). This means that large companies can receive 15-35% of their eligible investment costs depending on the region with a cap of EUR 350 million per undertaking per Member State. Further initiatives are foreseen for the medium term such as the Net-Zero Industry Act "to focus investment on strategic projects along the entire supply chain" as well as the European Sovereignty Fund "to boost the resources available for upstream research, innovation and strategic industrial projects" (Von der Leyen, 2023).

Overall, we can observe a strong push within the EU towards establishing a European battery value chain through regulations and financial measures. At the same time concerns and regulations about the process of producing batteries have so far been scarce. This implies that national-level institutions and structures will be relied on to build up an EV battery industry in the EU. To understand the various paths this process could take, the historical thinking on industrial policy provides important insights.

3. INDUSTRIAL POLICY: THEORY AND HISTORICAL EXPERIENCES

Industrial policy can be defined as "a policy aimed at particular industries (and firms as their components) to achieve the outcomes that are perceived by the state to be efficient for the economy as a whole" (Chang 1994: 60). This definition implies the abandonment of sectoral neutrality and selective state interventions to build new industries and activities with dynamic efficiency - implying higher value-added sectors and more advanced technology. The rationale for state intervention could be that market processes are organised based on comparative advantages in activities that do not ensure the country's development in the longer term - extractive industries, labour-intensive sectors, or agriculture (Ocampo 2020). Through direct intervention, industrial policy seeks to create these advantages in advanced industries where higher added value can be achieved. However, as emphasized by Bulfone (2023: 24) defensive industrial policies aiming at restructuring declining industries as well as facilitating response to structural shifts in the domestic or global economy are also possible. Still, the historical experience with industrial policy interventions is rather mixed – sometimes these efforts succeed and other times they fail.

According to Andreoni and Chang (2019: 137) the idea of industrial policy first appeared at the end of the 18th century. During the industrialisation of the 19th century, the debate was about whether it was worth supporting inefficient firms at a given time, not knowing whether they would ever be profitable. The methods suggested to protect young industries became standard instruments of industrial policy later - including subsidies for strategic industries and firms, tariff rebates on imported inputs used for exports, export ban on key raw materials, and the imposition of various product standards.

The next phase of the debate on industrial policy was related to the Soviet industrialisation – a strategy, which was followed not only in Eastern Europe, but also in the post-colonial world such as newly liberated India and the developing Latin America. These countries, which lagged behind, sought to make a rapid industrial transition (Andreoni and Chang 2019: 138). Kornai (1992: 160-180) provides a perceptive description of the reality of industrial policy in the classical Soviet-type system. He points to the impatience that is at once a characteristic of the 'latecomers', as well as the revolutionaries' urgency to realize the promises of rapid change and to justify the superiority of their system. This has given rise to a drive for quantity, overly ambitious investment plans, and an internal expansionist imperative that permeates the bureaucracy. During this period of forced growth, investment took priority over consumption and industry, in particular heavy industry producing machinery and armaments, was prioritized over services. During the implementation of industrial policy, preference was given to new installations rather than old, existing ones, and to large ones rather than small ones, and these were implemented as priority investments. The results were dire: as long as there were extra resources to draw into production, these economies could grow in an extensive manner, but due to the neglect of non-prioritized activities such as infrastructure maintenance and services, innovation was absent thus these systems fell behind in productivity. As Berend (2006: 176) emphasizes the voluntaristic state interventions "reproduced an obsolete industrial structure, technological base, and productivity level."

The experience of the South-East Asian countries (Japan, South Korea, Taiwan, Singapore) is a counterpoint to the failures of socialist industrial policy. Under the banner of the developmental state, the bureaucracy has played an active role in steering the economy towards higher value-added sectors. Andreoni and Chang (2018: 138) identify three new elements compared to previous industrial policies: i) strong coordination among domestic firms; ii) institutionalisation of the coordination mechanism; iii) emphasis on the importance of corporate learning based on improving education and investing in R&D. Wade (2018: 528) adds to these the importance of elite consensus around catching up and investing heavily in high value-added sectors. South-East Asian countries have transformed from agricultural to advanced industrial countries in a few decades, something that very few other countries have managed to do, and these examples are the main empirical argument for the use of industrial policy (Cherif and Hasanov 2019).

In the developed world, after the stagflationary experience of the 1970s, the belief in state intervention faltered, and the 1980s and 1990s were characterised by the strengthening of market mechanisms in line with the ruling neoliberal paradigm. Competitiveness and job creation became the key objectives of economic policy (Bulfone 2023: 28). Still, Mazzucato (2011: 75-88) stresses that even then the US state played a significant role in promoting and diffusing innovation through public tenders. However, explicitly, industrial policy returned to the theoretical and practical mainstream only in the 2000s. This 21st century industrial policy differs markedly from the state-led industrialisation efforts of the 20th century. It no longer separates industry and services and focuses on creating an environment where different actors in the economy can cooperate effectively (Aiginger and Rodrik 2020: 192).

While new types of industrial policy bear slight resemblance to the voluntaristic policies of the Socialist system, those earlier experiences of industrial policy still carry warnings about the drawbacks of excessive state intervention. Chang (1994: 26-30) emphasizes the knowledge problems – insufficient information and informational asymmetry – associated with top-down decision-making as well as rent-seeking due to channelling excessive resources into selected sectors. These problems can ultimately lead to severe distortions in the allocation of resources as it was the case during Socialism.

When comparing countries with heterogenous institutional systems, we can hypothesize that systems lacking transparency and accountability mechanisms will be more prone to the classical drawbacks of state interference – knowledge problems and rent-seeking – than states with strong checks and balances. To illustrate these problems, the next part of the paper will conduct a comparative analysis of the emerging Swedish and Hungarian battery industry.

4. BUILDING AN EV BATTERY IN INDUSTRY IN SWEDEN AND HUNGARY

4.1 CASE SELECTION AND METHODOLOGY

Hungary and Sweden are both among the largest battery producers in the world: between 2022 and 2027 battery manufacturing capacity is expected to grow from 38 to 194 GWh in Hungary, and from 16 to 135 GWh in Sweden (Bhutada 2023)[2]. Both have a strong car manufacturing industry – average number of motor vehicle production between 1997 and 2022 was 276 193 in Sweden (238 955 in 2022) and 216 191 in Hungary (441 729 in 2022)[3]. Building up the EV battery sector is an important factor in saving the auto industry during the transition to electromobility (Szalavecz 2022, Pavlinek 2023).

From a theoretical perspective focusing on the link between industrial policy and institutions, the two countries can be considered as diverse cases, which are "intended to capture the diversity of a subject" (Gerring and Cojocaru 2016: 396) – specifically the diverse paths to build an EV battery industry. While Sweden is a liberal democracy with high-quality institutions, Hungary has become an illiberal regime and experienced a sharp decline in institutional quality since 2010 (Freedom House 2023: 12). Underlining illiberalism is useful as it is the self-definition of the regime (Orbán, 2014) and it also focuses on the key difference from EU basic values, the opposition to liberal constitutionalism: weak protection for human rights, an absence of checks and balances, weak rule of law, insecurity of property rights and repression of civil society (Zakaria, 1997).

At the same time, democracy is the input side of democracy, and illiberalism is just as important at the output side, as it strongly impacts the quality governance and in particular the ability of the state to

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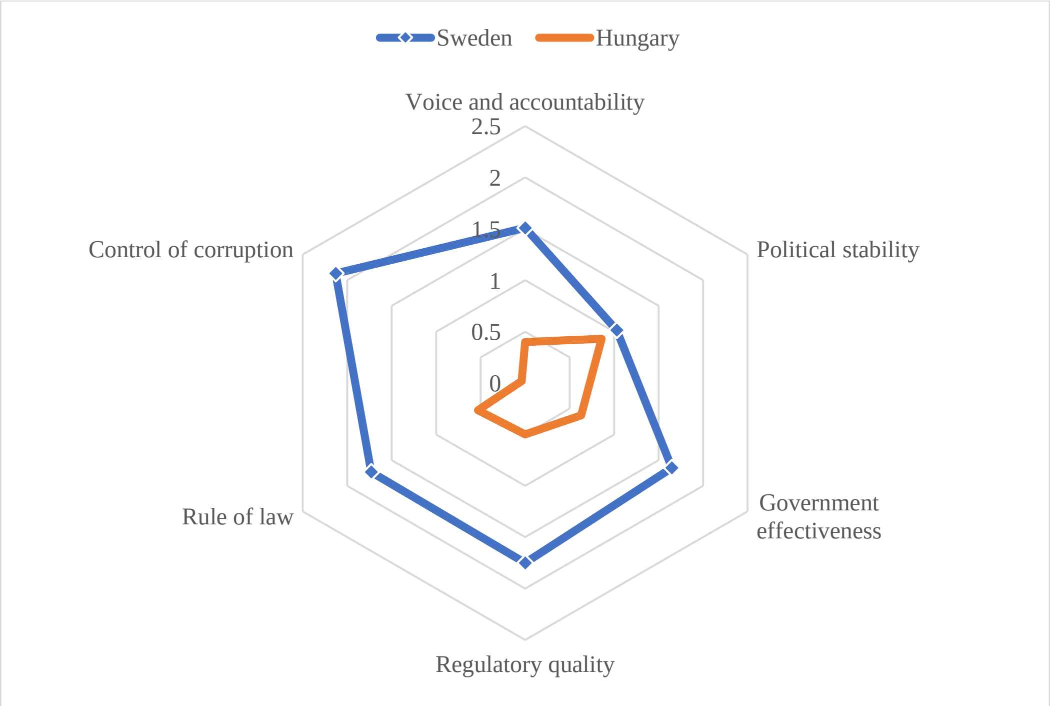
[2] Transport and Environment (2023: 11) has somewhat different numbers, and it predicts that by 2030 Hungarian battery production will be 217 GWh, while Sweden will have 110 GWh, but the report also notes that 180 GWh capacity in Hungary is at medium risk, which means that it "might be delayed, scaled down or not realised at all if further action is not taken" (4).

[3] Data: https://www.ceicdata.com/en/indicator/sweden/motor-vehicle-production and https://www.ceicdata.com/en/indicator/hungary/motor-vehicle-production

impartially serve the public interest (Rothstein, 2011, 12-20). In the absence of liberal checks and balances on the state, private interests are likely to dominate government decision-making. Figure 4.1. shows the differences in institutional quality in Sweden and Hungary based on the World Bank's governance indicators in 2021. The size of the area encompassed by the 6 dimensions (voice and accountability, political stability, governance effectiveness, regulatory quality, rule of law, limiting corruption) represents the quality of governance. While the two countries are similar on political stability, Sweden performs orders of magnitude better than Hungary on all other indicators, and especially on controlling corruption.

Figure 4.1. World governance indictors in Sweden and Hungary (2021)



Note: The scores represent an index between -2,5 and 2,5 with 0 being the world average.

Source: Worldwide Governance Indicators, available at: https://info.worldbank.org/governance/wgi/

A comparison of the two countries can thus also illustrate how weak checks and balances on government policy-making impact on industrial policy. Based on the theoretical considerations of the previous section we can hypothesize that industrial policy is more successful in Sweden, while the problems associated with discretionary state interventions due to informational asymmetries and rent-seeking, are more likely to manifest themselves in Hungary.

To compare the emerging EV battery industry in the two countries, a structured-focused comparison will be conducted – structured to reflect the aims of the research and focused to limit the discussion to the theoretically relevant aspects of the cases (George and Bennett 2005: 67-70). To conduct the analysis, Sweden and Hungary will be compared based on five questions:

- What was the policy process behind designing the national battery strategy?

- What is the role of domestic R&D in the emerging battery industry?
- What type of local comparative advantages the battery sector can build on?
- What is the role of the state and state aid in building up the battery industry?
- What are the expected outcomes of the battery policy on the economy and European objectives?

To answer the above questions evidence is drawn from a wide range of sources including official government policy documents and communications, reports by international organizations, accounts by investigative journalists as well as secondary literature. The outcome of the analysis is a theoretically informed narrative, which shows the relevance of the institutional system for the building up of the battery industry, and which carries implications for EU battery policy.

4.2 THE THE POLICY PROCESS BEHIND BUILDING UP A BATTERY INDUSTRY

As the variety of industrial policy experiences over history show, there are different ways of building a new industry. While in Sweden the process is characterized by strong cooperation among the stakeholders, in Hungary the industry is built via top-down, secretive decisions excluding key groups from the process.

The Swedish battery strategy was drawn up by FossilFree Sweden, an organization initiated by the Swedish government in 2015[4], in cooperation with EIT InnoEnergy, an EU body created in 2008 to foster innovation[5]. Based on the introduction of the strategy (FossilFree Sweden 2020: 5) they relied on a broad reference group, which included stakeholders from the entire EV battery value chain such as companies like Northvolt, Scania, Volvo, as well as academics and representatives of relevant municipalities. The strategy focuses on fostering cooperation among the actors to build a sustainable battery value-chain relying on technological and business innovations as well as risk-sharing (Fossil Free Sweden 2020: 8-9). The collaboration does not stop at the Swedish borders. In response to the assignment from the Swedish Energy Agency, Business Sweden – an organization jointly owned by the state of Sweden and the Swedish business sector[6] – completed a report based on interviews with the relevant stakeholders on a joint Nordic battery value chain, a cooperative endeavour with Norway and Finland. In the report (Business Sweden 2021) they argue that the three Nordic countries have different comparative advantages, but when considered together, they have complementary strengths across the entire value chain, which provides strong incentives to join forces and build the industry together. Okonkowo (2022) provides a thorough overview about the ongoing cooperation among the main actors to build up the Nordic Battery Belt.

[4] See their website: https://fossilfrittsverige.se/en/about-us/
[5] See their website: https://eit.europa.eu/who-we-are/eit-glance
[6] See their website: https://www.business-sweden.com/about-us/organisation--governance/

The process of building up the battery industry is very different in Hungary. Although Samsung SDI in Göd had been producing batteries since 2017 and the number of battery investments had proliferated in Hungary[7], the official strategy for building a battery industry was published only on 29 September, 2022 (ITM 2022). The authors of the strategy are not named, and the report is basically a government communication about the state of the battery value chain in Hungary and the plans for the future. There is no trace of consultation with the relevant stakeholders in the report. The Hungarian public learnt about the plans for making the country an EV battery manufacturing superpower from PM Viktor Orbán's speech in Tusványos earlier in 2022, where he said "[i]n Hungary we are making huge investments in batteries, and in no time we will be the world's third largest battery producer – the third largest battery producer in absolute terms, not in percentage terms – and the world's fifth largest exporter" (Orbán 2022). A month later, on 12 August it was announced that the Chinese CATL brings a €7,5bn investment to Debrecen, building a 100 GWh battery gigafactory[8]. As the announcement of the largest-ever FDI project completely surprised the public, the lack of social consultation came into the focus of the debates on the battery industry. Since the process was shrouded in secrecy, fears about the local environmental impact intensified, especially after the emerging social protests were dismissed by the government as political, financed by foreign lobby groups (Éltető, 2023, 38). Public hearings related to the environmental permits of these factories were highly contested, as the companies did not provide all the relevant information – though they were deemed sufficient by the authorities to issue all the necessary permits (Éltető, 2023, 39-43). In February 2023, due to the debates surrounding the build-up of the battery industry, a public survey showed that 50% of the Hungarian population wants to ban the building of all new battery factories (Cseke 2023). In response to the avid protests, the government announced a new regulation, which makes it possible to hold the relevant public hearings without the presence of the public[9]. Proposals for local referendums on the factories were rejected as well[10].

4.3 R&D IN THE SWEDISH AND HUNGARIAN BATTERY SECTOR

Industrial policy usually aims at fastening technological development through the build-up of domestic innovation system. This is the case in Sweden, but not in Hungary – the situation is even worse than in car manufacturing, where Sweden is a leader in R&D expenditures of the total value of production with 105,2% of the German value, while Hungary is at 10,4% (Pavlinek 2023: 45).

[7] For the list of projects up to December 2022 see Czirfusz (2022: 23).
[8] See the announcement: https://www.reuters.com/business/autos-transportation/chinas-catl-build-new-756-bln-battery-plant-hungary-2022-08-12/
[9] The new government regulation (146/2023) allows for the requirement of public consultation related to local authorities be fulfilled through the posting of relevant information on a website, and the relevant stakeholders need not be present for a hearing. Available: https://magyarkozlony.hu/dokumentumok/79dc6517729cbce68fb360f8b1864cdb529a2f8a/megtekintes
[10] See the reporting: https://www.budapesttimes.hu/hungary/election-committee-rejects-lmps-referendum-bid-on-requiring-local-consent-for-building-battery-plants/

Sweden is an innovation leader according to European Innovation Scoreboard (2022) with continuously improving performance. They have a highly educated population, high productivity, and strong R&D capacity, which the battery industry can build on (Business Sweden 2021: 9). The case of the largest Swedish battery manufacturing company, Northvolt indicates how this matters. The company was founded in 2016 by Peter Carlsson, formerly Vice Preisdent at Tesla. Northvolt's vision is that by 2030, their CO2 emissions from battery production will be 90% lower than the industry average, thanks to their environmentally friendly technology (Northvolt 2021). To achieve this, they have designed their own battery – the prototype was completed in 2018[11]. Building a manufacturing site in Skellefteå started afterwards.

Hungary is an emerging innovator according to European Innovation Scoreboard (2022) with 69,8% of EU average performance. According to the National Battery Sector Strategy (ITM 2022: 19) there is no independent product design; the collaboration between universities and industry is weak as well as the knowledge of advanced battery technology. This implies that there is no domestic R&D in the sector, and Hungary relies on foreign multinational companies to bring in technology. However, whether it is a good idea depends strongly on the presence of comparative advantages for this industry.

4.4 PRESENCE AND ABSENCE OF COMPARATIVE ADVANTAGES

In collaboration with other Nordic countries Sweden has the prerequisites to make the battery industry profitable. Business Sweden (2021: 9) identifies comparative advantages in key dimensions: availability of green and affordable energy; robust grid network ensuring stable energy supply; cold climate reducing the energy needs for the cooling phases of cell production; highly developed digital communication and efficient logistics; availability of important raw materials. Sweden also has extensive experiences with recycling. It has been a leader in energy transition, as it has almost fully decarbonised its electricity generation already by 2019 (IEA 2019). As a result of these advantages the Northvolt Ett factory in Skellefteå draws 98% of energy from renewable sources (Northvolt 2021: 6).

Similar advantages are absent in Hungary. Fossil fuels account for 68% of total energy supply, and 59% of energy is imported (IEA 2022b: 19-20). The main source of imports is Russia, from where 95% of natural gas imports come from (IEA 2022b: 132). 30% of electricity is also imported from neighbouring countries (IEA 2022b: 96). Building a large battery industry implies the need to increase the import of energy – the National Battery Strategy estimates that battery production will increase Hungarian energy needs by at least 50% within 3-5 years (ITM 2022: 27). Fulfilling this need has dominated the government policy agenda including its stance on Russians' war on Ukraine (Government 2023). The country's energy grid network is also in poor condition. This is illustrated by the fact that the electricity

[11] In describing the history of the company, unless otherwise indicated, I rely on the Northvolt website, the information is available at: https://northvolt.com/about/

system is not able to accommodate the energy produced by residential solar panels – the grid needs to be upgraded throughout the country (IEA 2022b: 76-77).

Battery production also requires a significant amount of water – 70-80% of which is used in the cooling processes for battery cell production and a significant amount of which evaporates (Phillipot et al. 2019: 6). The Samsung SDI factory in Göd uses 27 000 m3/day for 40 GWh capacity, which is the water consumption of a city of 112 000 inhabitants (Bodnár 2022). CATL communication regarding water needs is highly inconsistent – while expert assessments estimate 40 000 – 60 000 m3/day, the environmental permit documentation indicates only 3378-6232 m3/day (Éltető 2023: 20). The water network is also highly degraded with 56% of the pipeline classified as risky, with 56% of drinking water supply systems are in a predominantly risky condition, 45% of which are beyond their technically useful life (ITM 2021).

Skilled workers and operators are also missing in Hungary as the country has experienced severe labour shortages given its steadily declining population since the 1980s[12]. This applies to car manufacturing industry already (Pavlinek 2023: 47). To keep the cost advantages, battery factories are expected to provide jobs to foreign nationals – this is already the case in Samsung Göd as half of its workers are from abroad (Czirfusz 2023, 11). Going against his former anti-migrant sentiments, PM Viktor Orbán has announced that Hungary will need 500 000 new workers for its reviving industry[13] – who might be foreigners if Hungarians are not available.

Overall, we can see that while Sweden has the necessary energy, water, and network for building up the battery industry, Hungary is lacking all the necessary resources. Still, battery manufacturing companies flood the country with investment, which necessitate the examination of government support for the industry.

4.5 GOVERNMENT SUPPORT

While both the Swedish and Hungarian governments strongly support the battery industry, the nature of this support varies significantly.

The Swedish government is an important initiator of the collaboration among the actors within the battery value chain. The report by Fossil Free Sweden (2020, 32-38) foresees various supporting role for the government – this includes supporting demand for electric cars, providing credit guarantees for investments as well as funding for basic research, investing in relevant education, and taking part in marketing. At the same time, the sector is foreseen to rely

[12] While in 1980 the population in Hungary was 10,7 million, by 2022 it has shrunk to 9,7 million. See the time series data by the Central Statistical Office of Hungary: https://www.ksh.hu/stadat_files/nep/hu/nep0001.html

[13] See the report: https://abouthungary.hu/news-in-brief/pm-orban-hungarian-economy-to-provide-jobs-for-hungarians-first

on private funding. This is shown by the case of Northvolt. The project has been financed mainly through private capital – while $12 million was raised from investors in 2017, in 2019 $1 billion of shares were issued to build the Northvolt Ett factory in Skellefteå. As the company expands, new funds are drawn in – according to Milne (2023) $8bn in equity and debt have been raised so far, making it the best-funded start-up in Europe. The European Investment Bank's loan of $52 million in 2017 and $350 million in 2019 has played an important role in this development - a successful project the bank enthusiastically reports on its website (Smit 2020). The company is not entirely lacking public funding either: the state-backed Swedish Energy Agency provided a €15 million subsidy (0.375% of the investment) for the planned €4 billion investment in Northvolt Ett - after it was clear that private actors were confident in the project (Clover 2018).

In contrast to Sweden, the Hungarian government supports the battery industry through direct state subsidies as well as lax regulations for environment and worker rights in line with an economic strategy relying on costs-based competitiveness (Aiginer 2018). While the precise amount of support is highly intransparent, subsidies consist of cash grants, tax credits, soft loans, and infrastructural investments. Czirfusz (2023: 17) calculates that battery projects receive 10-20% of their investments as directly paid cash subsidies. An even greater source of support is the infrastructural developments for energy, water, and transport, which are also financed by the state budget. Czirfusz (2023, 18) mentions SK battery plant in Iváncsa, where the value of the investment is HUF 681 billion (~€ 1,8 billion), which received HUF 76,4 billion (~€ 200 000) VIP cash grant as well as HUF 90 billion (~€ 237 000) infrastructure support to develop water pipelines, the local electric power system, roads, and railways – a total of 24% subsidy for the investment. This intensity of support confirms the Hungarian Battery Strategy's finding that the number one strength of the Hungarian battery value chain is "(e)xtreme government support translated into political commitments" (ITM 2022: 19).

In an environment with weak control of corruption (Figure 2), this amount of public spending on direct state aid and infrastructure building carries a high potential for rent-seeking. Indeed, the so-called MGTS+ companies[14], whose owners are close to the government and who received 19% of government public contract value between 2011 and 2021 (Tóth and Hajdú 2022: 237), are also the recipients of the infrastructure building contracts for battery investments (Bodnár and Balogh 2022).

[14] According to Tóth and Hajdú (2022: 259-271) the MBTS+ group includes the companies of 12 businessmen, who have frindship or family ties to PM Viktor Orbán such as his childhood friend and the richest man in Hungary, Lőrinc Mészáros or his son-in-law, István Tiborcz.

Besides direct state aid, the government is assisting the EV battery sector via extremely favorable regulations. Battery plants are typically installed as priority investments, which practically means that the permission process is greatly simplified, and local residents, and municipalities have no say in what happens in their area (Éltető 2023: 21). This provides considerable regulatory relief for the investing companies. Given the low priority of environmental issues in the past decade, there is little public confidence in the environmental authorities in Hungary. A case from Samsung SDI in Göd illustrates the problem. Suspecting a suspicion of water contamination, a civil organization asked the authorities for the water monitoring data – and after a lengthy court case they had to learn in 2023 that the monitoring well was simply buried in 2018, so no data collection was carried out (Bodnár 2023). The fines imposed for damages to the environment or workers' safety have been insignificant compared to the companies' turnover - in the Samsung factory in Göd, 17 fines totalling HUF 47 million were imposed in 4 years, mainly for repeated fire safety violations, but this amount is not a real deterrent in the light of the HUF 759 billion turnover in 2021 (Bodnár 2022).

4.6 EXPECTED OUTCOMES

Based on the above it is unsurprising that the Swedish battery sector is expected to be more successful than the Hungarian battery industry as summarized by Table 4.1. This is also the conclusion of Business Sweden (2021: 11), which predicts that the Nordic countries as the winners of the expected value of the sector, while Poland and Hungary can expect low value from producing batteries. The Nordic advantage is based on both the conditions for production (electricity costs, % of renewable energy, value added of manufacturing, digital competitiveness, raw material deposits) and the operational climate (ease of doing business, reliability of the energy supply, spending on R&D, logistic performance and share of EVs).

There are no similar calculations of expected value in the Hungarian battery strategy (ITM 2022), and there are no other publicly available government forecasts either. Győrffy (2023) attempted to quantify the expected length of return on public subsidies in the case of Samsung SDI in Göd. She showed that the calculations are highly sensitive to initial assumptions such as the number of foreign workers as well as whether the crowding out effect on the Hungarian job market is included into the analysis or not. Still, the range of cutting even on government subsidies is between 7,5 and 17 years, which is extremely long given the speed of technological development in the battery industry. In the meantime, these funds are missing from traditional state functions such as education, health care and social security, which would be necessary to raise human capital and help Hungary out of the middle-income trap (Győrffy, 2022).

Table 4.1. Summary of the process of EV battery value chain building in Sweden and Hungary

	Sweden	*Hungary*
Policy process	Collaborative	Top-down
Motives	Environment, business opportunity	TNC preferences, corruption opportunity
R&D	Domestic	Imported
Comparative advantages	Exist	Lacking
State aid	Mainly indirect	Substantial direct aid, lax regulations
Economic outcome	Competitiveness	Reinforce middle-income trap
Political outcome	Liberal democracy sustained	Reinforce illiberalism
Serving European strategic autonomy	Yes	No

The novelty of examinig the process of building up the EV battery industry relates to the links between the growth model and the political system. While in Sweden the collaborative approach to building up the industry is compatible with liberal democracy, the unpopularity of the battery industry in Hungary and the growing recognition for its environmental and social costs necessitate illiberal means to control. This includes secrecy, limits on referendums, changes to the regulation of public hearings and the clear dominance of private interests over the public good. From a broader perspective prioritizing state support for battery manufacturing over education entrenches the illiberal regime through supporting its own voting bloc – low-skilled workers – with jobs, while preventing the growth of its opposition, who are usually better educated[15].

Beyond the economic and political impact on the two countries, the objectives of European strategic autonomy are served only by the Swedish strategy. While Sweden is building up a battery chain based on domestic innovation and value chain organization, Hungary essentially provides the location for the Asian battery value chain – it remains dependent on Asian technology and raw materials as well as increases its dependency on Russian energy. This

[15] During the April 2022 general election, Pálos and Hajdú (2022) found a 0,65 correlation at district level between the share of population with only primary education and the vote for the ruling party, FIDESZ.

means that the vulnerability of the EU to supply disruptions due to geopolitical tensions is increased rather than decreased by such investments.

5. CONCLUSIONS

On the path towards zero-emission mobility this article has examined how European objectives can translate into diverse national industrial policies. These policies have environmental, economic, and geopolitical aims, but as the contrasting cases of Sweden and Hungary indicate, serving all these objectives is far from assured. While in a high-quality institutional environment like Sweden network-oriented industrial policies can lead to a virtuous cycle of environmental and economic benefits contributing to European strategic autonomy, in an illiberal system without appropriate checks and balances on government decision-making – including procedures for transparency and consultations with the relevant stakeholders – the knowledge problems and rent-seeking dangers of industrial policy can become especially serious. This can lead to severe distortions in the allocation of scarce resources such energy, water, or taxpayers' money as well as greater dependence on Russia and China. These cases have important implications for building a European battery value chain.

In the short-term the increasing capacity of European battery industry might be welcome in any format including the Hungarian approach. For the core it might be even advantageous to have these environmentally challenging factories in the periphery regions. German car manufacturing companies can also benefit from the scale and capacity of the Hungarian EV battery industry. However, from an EU perspective this implies the growing distance between the core and the periphery, which can threaten the integration process through more difficult joint decision-making, further penetration of the system by geopolitical rivals as well as growing social resentment.

In light of the Hungarian case, relaxing regulations on the battery industry (Transport and Environment 2023: 6) is excessively dangerous as it increases the possibility of similar cases and could lead to rising public resistance to the battery sector. Looser rules for state aid also raise serious concerns – they not only open the door for increasing rent-seeking, but also distort companies' business decisions as they shop for more aid over considerations of local conditions for production. Furthermore, the experiences with the battery industry in Hungary add more evidence to the findings of Éltető and Medve-Bálint (2023), who show that state aid in illiberal countries barely contributes to economic upgrading and rather entrenches existing structures –an outcome reminiscent of the Socialist era.

As the EU considers the build-up of a European battery value chain, it should also consider the process of doing so. This means the need for a stronger focus on the process of producing batteries rather than just regulations over the lifecycle and quality of the batteries themselves. Leading European companies, such as Northvolt can offer best practices and clues about standards, which make battery production environmentally and socially responsible. These standards include fossil-free energy supply for production, anti-corruption policies as well as work-environment policies (Northvolt 2021: 14). Rule of law conditionality as well as geopolitical considerations could be also highly relevant for state aid approval by EU authorities. Since a prime interest of the EU is to reduce the energy needs of battery production, public funding should go primarily into improving production technology rather than the direct subsidy of individual companies as suggested by Degen (2023: 11). To avoid further distortions of the internal markets, subsidies for environmentally important tasks should come primarily from the EU level rather than the national governments together with supranational regulations for their use. Rule of law conditionality as well as geopolitical considerations should be highly relevant both for state aid approval as well as the allocation of EU funds.

As industrial policy is experiencing a renaissance in the European Union for geopolitical reasons, the lessons from its earlier failures should be constantly kept in mind – especially during a period of increasing institutional heterogeneity and the growing presence of illiberalism.

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