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# THE TRANSFORMATION OF THE GLOBAL AUTOMOTIVE INDUSTRY

Trends, Interpretations, Socio-ecological Strategies for Action:
A Handbook for Trade Union and Political Practice

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# PREFACE

Mobility is a basic human need. Over the last 100 years, the automobile has revolutionised the transport of people and goods. The automotive industry is a core industrial sector employing millions of people in Germany, Europe and the world. The trade unions in the metal sector are strong and powerful organisations without which the enforcement of social rights would have been impossible. But the costs and irreversible damage caused by the fossil fuel era are now undeniable. The technology based on the burning of fossil fuels is reaching its planetary limits; climate change, or rather climate catastrophe, is being clearly felt. Those who thought there was still time were wrong. The window of opportunity for mitigating the effects of global warming is closing. This century will be a century of adaptation to significantly changing climatic conditions. Modern industrial policy will always be climate policy and thus transformation policy. This means that the pace and direction of this policy is not only a question of social justice, but also of national and international distribution: The term Just Transition, as coined by the international trade union movement, can be heard everywhere. While the idea of a transformation that leaves no one behind is attractive, it is clearly too vague, because the implementation of the goal of decarbonising the mobility industries will bring about profound changes: Supply chains and corporate structures will change; work will be different and also distributed differently; the demand for new raw materials will create new value chains – all this will produce distributional conflicts along the value chains. Without strong trade unions, a just transformation will not be possible, but without a profound change in industry and resource consumption, the climate catastrophe cannot be averted.

These strategic decisions cannot be taken without contradictions. We are all driving by sight at the moment. There are therefore many questions: Is it really right to only extract lithium in the global South or could battery production be moved there? What does it mean that, in addition to international climate policy, China's regulatory policy is the central driver of the transformation and that the most important new producers of electricity-powered passenger cars come from China? Is the internal combustion engine truly in the past and what will become of the communities that are already suffering from energy poverty? With this study, the Rosa Luxemburg Foundation would like to summarise the current state of the transformation in such a way that trade unionists and works councils, but also the interested public in the Global South and North, are given the opportunity to understand the connections and the central points of conflict. This publication formulates the initial answers that will be important for organising in the coming years: It is worth discussing new forms of cross-sectoral organising - for example between the metal and mining sectors. And it is important to look at the source countries of the raw materials. Because one thing is clear: at the end of the Just Transition, jobs, wages and working conditions must be better at all stages of the production and supply chain.

*Geneva on September 2023,*

*Jan Leidecker*
*Director of the Rosa Luxemburg Foundation*
*Geneva Office*

# 1 INTRODUCTION: AN INDUSTRIAL REVOLUTION?

The global automotive industry is experiencing a profound transformation. Trends including the success of the electric drivetrain and digital driver assistance systems, the ever-closer connection and integration of vehicles and vehicle users with digital data networks, and the future of "autonomous driving" mark a turning point in automotive history. Even where, on closer inspection, many aspects of these trends are riddled with unresolved technological, legal, and infrastructural problems: the momentum can neither be ignored nor reversed — or as Georg Leutert, Director of IndustriALL, the Global Union for the Automotive and Aerospace Industry, puts it in an interview: "No stone will be left unturned".

In the world's largest and fastest-growing car market — the People's Republic of China — the decision has been made that the automobility of the medium-term future will be battery-electric. Electromobility — explicitly understood as being the continuation of (individual) automobility with the electric drivetrain — is considered a central strategy to mitigate climate change. It is also supported by corresponding political guidelines, especially in China, the European Union, and the USA.

Capital markets are following the associated profit expectations. This can be exemplified by the soaring price of shares in Tesla. When the company went public on 29 June 2010, stocks were trading at an opening price of USD 3.80. On 4 November 2021, the share price reached its all-time high of USD 1,229.91. Over a prosperous 11 years, the share price has risen more than 300-fold. As of May 2022, Tesla's market capitalization — the total value of all shares outstanding — was USD 786.98 billion. That is almost as much as the stock market value of the nine other top-ten car companies combined: Toyota, BYD, Volkswagen, Mercedes-Benz, BMW, General Motors, Ford, Stellantis, and Honda have a cumulative stock market value of USD 793.85 billion (CompaniesMarketCap.com 2022).

In fact, the prospect of a huge increase in demand for electric cars has triggered an upheaval in the industrial sector structure itself. Coming seemingly from nowhere, new companies have become world renowned in a few years. Parts of the internal combustion engine-based industries, such as gearbox manufacturing, are having to radically downsize their capacities, suppliers that are unable to implement alternative product ideas are disappearing. New key technologies such as the production of automotive batteries are occupying important places in the now shifting value chains and global production networks. As the result of advancing digitization and connection to the internet, electronic components, which until recently played more of a supplementary role, are becoming key vehicle components and raw materials for battery and semiconductor production are experiencing a thus far unprecedented demand.

But it is not just the material side of car production that is changing. In a complex way, the character of labour, industrial relations, and ultimately even the global balance of power between capital and labour are also shifting — and this in an industry that shaped capitalism as a leading industry for over a century. Employees in new sectors — such as the mining sector, the chemical industry, and semiconductor production — are being integrated into the value chains, while other sectors like information technology (IT) are being given a new and specific weight. New global players like Tesla and Geely are emerging in union-free parallel universes and are imposing new "workplace trends" that are (already) spilling over into the areas involving traditional car manufacturers that are (still) seeing high levels of unionization.

The current upheaval in the automotive industry is highly relevant for the social left, progressive social movements, and the global trade union movement: for more than a century, it was the field where the global labour movement found its strongest supporters and where it saw some of its most significant gains.

As such, the upheaval in the global automotive industry is raising a number of questions for trade unions, the Left, and the ecology movement: what will the ecological and social balance of this transformation look like — not as seen in the car glossy car sales brochures but in the reality of a highly globalized world economy? What are the consequences of the growing demand for conflict commodities like lithium, cobalt, and rare earth elements? What will be the impact of as yet unresolved disposal issues? What about the human rights situation along the new supply chains? Will the relocation of production capacities to regions with low wages and weak labour laws that has been ongoing for almost two decades be accelerated by the ramp-up of electromobility? Will core areas of the new leading global industries remain union-free in the long term or are we seeing the beginnings of new class organization? Which progressive social actors are involved in this transformation process, what are their perspectives, political goals, and possible courses of action? This study seeks to approach these questions.

The empirical basis of this study is formed by 30 interviews with experts, works council members, full-time trade unionists from Germany and abroad, industry experts from research and academia, and automotive industry employees, that we conducted between September 2021 and March 2022. We would like to thank all those who contributed to the success of this research through their cooperation, support, and willingness to share their insights with us.

## 1.1 UNDERSTANDING THE TRANSFORMATION: THREE INTERPRETATIONS

Studies and trade articles looking into the transformation of the automotive industry could fill entire libraries by now. It is obvious that change can be interpreted very differently depending on focus, perspective, and ideological tendencies. What follows is the presentation of three of these basic interpretations. All three present the transformation, its drivers, and consequences in different but very well-reasoned and comprehensible ways.

**(1) The new information space paradigm:** One of the most comprehensive studies on the ongoing upheaval of the automotive industry comes from the Munich Institute for Social Science Research (ISF-Munich). The authors, Andreas Boes and Alexander Ziegler (Boes/Ziegler 2021; similarly argued by Daum 2019) argue that a radical paradigm shift is currently taking place in the automotive industry: moving away from the so-called industry paradigm to what they call the 'information paradigm'. What does it mean? By the term "paradigm shift", the authors mean a fundamental change in the conditions that previously led to success in the automotive industry, i.e. the way in which a company, if it wants to survive in the market, organizes itself, how it produces, researches, and develops.

According to Boes and Ziegler, successful business models over the automobile industry's almost 150-year history have been based on the physical product, the automobile. In a nutshell: the successful product, the car, was defined by itself, e.g., by its driving characteristics, the interior, or the material it was made of. In the now dawning information economy, "data and information form the starting point for the development of innovative business models" (ibid.: 16). The automotive industry is no exception and the "permanent connection' to the internet is becoming 'the base condition of the entire vehicle concept" (ibid.: 8) or, as Toyota's Managing Director Jim Adler puts it: "Software is eating the world, and cars are next on the menu" (ibid.: 187).

While Silicon Valley internet companies have been perfecting software skills since the 1990s, they are now preparing to penetrate core sectors of industry like the automotive industry, "whose value chains promise high profits" (ibid.: 9). According to the Boes and Ziegler, the traditional automotive industry is struggling to make this paradigm shift. Companies expect to "remain car manufacturers" (ibid.) and are, at most, gradually adapting to the new paradigm by investing more in IT and digitization. But according to the authors' harsh verdict, this is a strategy that is doomed to fail. The condition for future viability is rather a strategic reorientation of the entire industry towards a new self-image, that of the modern tech industry.

**(2) Modularization of production:** A somewhat different direction is taken by the thesis of the "modular production structure" advocated for by Boy Lüthje, an automotive researcher based in China (Lüthje 2019a, 2019b). The core of Lüthje's thesis is that the automotive industry is developing towards the kind of production structure that we already understand from the computer industry. It is not the manufacturers of the end products — the original equipment manufacturers, OEMs — who dominate the value chain, but the suppliers of the components. Lüthje puts this in terms of "Wintelism", a portmanteau made up of the company or brand names of the computer pioneers Microsoft (Windows) and Intel. The electronics industry was also dominated by vertically integrated companies until the 1980s. Corporations such as IBM, Siemens, or Fujitsu manufactured essential components of their computers themselves and controlled the value chain for a time. But the model was challenged by new players like software producer Microsoft or chip manufacturer Intel, companies that not only "pioneered far-reaching disruptive technologies but also created an entirely new model of innovation and industry organization" (Lüthje 2019a: 8). As control of brand names moved from final assemblers to component suppliers, the "assembly-oriented model of innovation and market control" (ibid.: 7) was fundamentally questioned.

Lüthje also identifies such a process of "vertical fragmentation and centralization" in the automotive industry, where the focus is on battery production, which is becoming significantly more important due to the electrification of the drivetrain, and a new quality of product digitization.

According to Lüthje's forecast, manufacturers of battery electric vehicles (BEV) and battery suppliers are the main drivers of this process which will see traditional OEMs degraded to pure hardware suppliers. The central parts of the automotive value chain are shifting from the final assembly of cars in the factories of the often successfully-unionized and co-determined OEMs to the development centres and factories where batteries and electronic components are produced, and software is developed. And these are, at least for the foreseeable future, not in Germany or the USA, but mainly in China and, to a lesser extent, in Eastern Europe.

**(3) Electric mobility as a dead end:** The third transformation interpretation we would like to present here takes a slightly different perspective because it starts at a macro level. The focus here is not on value chains or key technologies. Rather, the fundamental question is whether the electric motorization of car transport can contribute to the necessary reduction of carbon emissions in the transport sector (Wolf 2019). Winfried Wolf, an expert in the field of transport policy, gives a clear answer: the e-boom is not only a "dead end" in terms of climate policy but also for transport policy. Wolf even argues that electro mobilization is likely to negatively impact the climate.

A single e-car, even when replaced one-to-one with an existing conventional car, makes only a modest contribution to reducing carbon emissions over its entire useful life. As the author explains with reference to numerous studies (see also chapter 4), this amounts to 30 percent at best. And this only applies to countries with a comparatively high share of renewable energy, such as Austria, Switzerland, or Norway. In the average EU country, the share of renewable energy sources is only 15 to 20 percent (Wolf 2019: 112). Accordingly, as Wolf explains, the replacement of a larger number of conventional cars with e-cars will actually increase greenhouse gas emissions over the next ten years, "due to the huge amount of additional carbon emissions that the production of these electric cars already entails compared to the production of conventional cars" (ibid.: 8).

Wolf demonstrates that this level of emissions avoidance could be achieved even without changing the drivetrain: "If speed limits were introduced in Germany and significantly lower speed limits than the existing ones were implemented across the EU (for example, 100 km/h on motorways like in the US and 80 km/h on rural and main roads), broadly similar reductions in carbon emissions could be achieved" (Ibid.: 16).

In addition, the e-boom is associated with a number of new problems and risks. These, according to Wolf, include new dependencies on scarce raw materials such as lithium or the currently still high sales price even of non-premium models. Against this background, Wolf speaks of a "mobility of homeowners" (ibid.: 122).

The author explains that it is not the drive technology that is the key to decisively improving the climate footprint of transport but rather the business model of the major OEMs. Accordingly, the current expansion of development and production capacities for electric vehicles does not serve climate protection even if this is often claimed but functions as greenwashing, intended to allow a business model to continue that is geared towards the mass production of ever larger and more expensive cars.

According to Wolf, the e-car boom is above all a capitalist modernization project. Its starting point is the strategic course set by the People's Republic of China that is based on "hardly any climate policy, but instead primarily an industrial policy to maintain the Chinese car industry on the world market" (ibid.: 15). Wolf explains that there is no primarily technical solution to the climate crisis and that instead people have to be at the centre of change (ibid.: 194) and that means a fundamental change in transport systems.

# 2 DEEP CURRENTS OF CHANGE: THE DOUBLE TRANSFORMATION

As we have seen, the current changes in the automotive sector are about much more than just a different drivetrain concept. The gradual replacement of the combustion engine by the electric motor goes hand in hand with a rapidly advancing use of digital technologies, affecting the actual product and its production, sales, and other dimensions such as the integration of the car into new mobility services. We therefore propose to define the upheavals as a "double transformation" (Bendel/Haipeter 2022b) of **decarbonization** and **digitization**.

In a narrow sense, **digitization** can be understood as the conversion of analogue information into digital information through technical processes (Pfeiffer 2021: 9). In addition, the term today also refers to digital-technological penetration in all areas of the economy, state, society, and everyday life — a process that appears to be primarily technological but in social reality is driven and shaped by a thoroughly capitalist dynamic.

**Decarbonization** is to be understood as the attempt to make the economy and consumption climate-neutral by successively reducing the consumption of fossil fuel energy sources. As opposed to digitization, decarbonization gains its momentum primarily as a result of political decisions and frameworks aimed at reducing carbon emissions, in this case those caused by the transport sector (Bendel/Haipeter 2022a). This is done through devices such as emission certificates, pricing, or government subsidies of green technologies that are used by companies and businesses.

## 2.1 ELECTRIC MOTORIZATION AND DECARBONIZATION

Two major decarbonization drivers can be identified:

**(3) China's registration/licensing and industrial policies** as well as the electric quota for manufacturers producing in the country, this development is discussed in detail in chapter 5.1. The People's Republic was faster than any other car manufacturing nation to consistently pursue the electric drivetrain revolution. The primary concern was not climate policy at all but rather smog prevention in the megacities which is not the same as long as a large part of the charging current is still generated from fossil energy sources (Wolf 2022, 2019). At the same time, the Chinese Communist Party and state leadership recognized that if it succeeded in implementing consistent electric motorization in its domestic market, which is also the world's largest, most dynamic, and most important car market, it could give the Chinese automotive industry a realistic chance of becoming the technology and market leader in global car production (Daum 2019; Köncke 2022; Deutsche Bank Research 2021).

China's demand for BEVs — in China, battery electric cars are called New Energy Vehicles (NEVs) — combined with the "decarbonization paradigm" has led the industry to expect a rapid increase in demand for electric cars worldwide.

**(2) International, supranational, and domestic law:** UN climate protection agreements, EU directives, domestic laws, and new "justification orders" as well as the resulting changes in demand have changed the market for cars worldwide, albeit to varying degrees in different regions of the world (Dörre et al. 2020)[1].

## 2.2 DIGITIZATION

The establishment of technical processes for converting analogue information into digital information is

1 The Sustainable Development Goals (SDGs), for all their shortcomings and despite being relatively non-binding, are seeping into the justificatory orders of contemporary societies.

anything but a new process (Pfeiffer 2021: 9). As early as the early 1980s, the automotive industry was a pioneer for robotization and automation in industrial series and mass production. On the product side, digitization in the automotive industry was a significant factor by the end of the 1980s, with the introduction of engine control and the reduction of exhaust gases: "From the mid-1990s onwards, more and more electronics came into play: controls for ABS, airbags, power steering, infotainment" (Blöcker 2022: 13). However, the process has accelerated in recent years, mainly because of the global influence of big tech companies on the reality of life. As digitization permeates the most diverse dimensions of everyday life, the customers' demands on the digital capabilities of cars are also changing. The explosive entry to the market of new players such as Tesla and also the efforts of the major technology companies to penetrate the automotive market, literally raises the question of whether "in terms of products, the car has to now be constituted as a computer on wheels" (ibid.; see also Boes/Ziegler 2021; Daum 2019).

Digitization is hence not just applied in the networking of operational processes and supplier relationships with the aim of making the production process more efficient but also, and perhaps above all, in the "automotive product" itself (Schadt/Weis 2022) and the associated digital services and new business models (Cacilo/Haag 2018).

We consider there to be three main digitization processes that the automotive industry is currently facing:

**(1)** the networking of vehicles with their environment;
**(2)** assisted, partially, and fully autonomous driving; and
**(3)** new mobility services.

All three areas pose a challenge for the traditional automotive industry in that digitization at this level is not one of its core competencies. As such, companies are forced to either build up these competencies or buy them in. Both entail relevant risks. Yet there is no third way: no car manufacturer can avoid digitization.

### 2.2.1 Networking and Connectivity

Digitally networked technology is now deeply engrained in our everyday lives, making the 'smartphonization' of cars a logical next step. In fact, the number of communication interfaces in the average vehicle has been increasing for years (Cacilo/Haag 2018: 30). When the automotive industry talks about "networking" or "connectivity", it means this for two dimensions:

**(1)** that vehicles are being increasingly networked with each other, i.e. with other vehicles and with transport infrastructure and
**(2)** that the driver is networked with the environment (ibid.: 30).

Prerequisite for networking is appropriate hardware and software that allows a connection with the internet to be established. We consider Cacilo and Haag's (2018) approach of distinguishing between three to four areas of digital networking in the car to be plausible (see Figure 1): these are **(1) basic services** such as the eCall programme, which since 2018 has been mandatory for all newly registered vehicles in the EU and which automatically contacts the emergency services in the event of a serious accident (ifo 2019: 22); **(2) traffic services** such as intelligent parking solutions or navigation systems, and **(3) infotainment systems**. The latter includes the capability of streaming media content as well as (semi)professional office applications in the vehicle. Added to this is the networking of the vehicle with various **(4) smart home systems**.

It goes without saying that the capitalist interest in potentially lucrative fields of business is relevant, even if it is in partly based on seemingly senseless forecasts: according to a number of studies, the global market volume for information and communication hardware up to the year 2030 will be between EUR 60 billion (Cacilo/Haag 2018) and more than EUR 220 billion (ifo 2019: 22).

These profit prospects for the industry are not only a blessing, they are also a curse. This is because the software necessary is sophisticated and neither a part of the traditional OEMs' core business nor of their suppliers. This is especially evident in the Chinese market, which is hugely important for the German industry: the "traditional" manufacturers are struggling greatly to meet their customers' obviously very high expectations regarding the connectivity of their cars. As the German newspaper *Handelsblatt* aptly writes:

> ***"It's not only Volkswagen with its crude equipment that is falling behind Xiaopeng, but also the luxury cars from BMW, Audi, and Mercedes are being made to fear the technological supremacy of newcomers like NIO or Li Auto. While the Chinese lavishly equip their models and network them perfectly, the Germans are still advertising sober functionality.*** *(Heide et al. 2022)*

**Figure 1: Areas of Digital Networking**

| Basic services | Traffic | Infotainment | other |
|---|---|---|---|
| Emergency call system (eCall) | Smart parking | Media content streaming | Networking home – car |
| Maintenance management | Advanced navigation | In-car-office | Remote applications |
| Accident service | Integration of mobility platforms | | |
| Online diagnoses | Location-based services | | |
| Over-the-air updates | | | |

Source: Cacilo/Haag 2018: 31

### 2.2.2 Assisted, Partially, and Fully Autonomous Driving

Fully autonomous driving is the holy grail of the automotive industry. Despite all the technological, transportation, and legal risks, it has been accepted as the industry's guiding principle and the prospects for returns are apparently immeasurable. The concept of "autonomous driving" is closely related to the field of networking but has emerged as a strategy in its own right. In both industry and research discourses, a classification has become established that speaks of five levels of autonomous driving (see text box next page).

Autonomously driving vehicles must be equipped with sensors for environment recognition and the corresponding signal and information processing technology. Manufacturers are still relying on a number of technical processes to do this. Some manufacturers use laser, LiDAR, and ultrasonic sensors, while others, among them Tesla, use only cameras. What is clear is that autonomous driving in cities on regular roads — and without complex monitoring, at least in areas with a high volume of different road users, cars, cyclists, pedestrians, such as at large crossroads — requires high computing power and ultra-fast wireless communication from 5G networks to evaluate the enormous amounts of data in real time, as well as sophisticated cloud networking for both vehicles and infrastructure.

Technically, no car manufacturer has progressed beyond level 2 to as of late summer 2022, the only exception being Mercedes-Benz. The company is the only manufacturer in the world to date to have valid approval for a Level 3 system, the Drive Pilot, that is set to be used on motorways from 2023. However, the approval is initially only valid in Germany and some US states such as California, Nevada, Florida, and New York because they are the only regions that have established the corresponding legal requirements.

The bottom line is that autonomous driving, levels 4 and 5, is currently still a vision of the future. The joke still holds that fully autonomous driving is announced as being a realistic option in five years' time every time it is announced. Or, as a software developer with a large German car manufacturer who we interviewed put it:

> *"That fully autonomous driving will be achieved in five years has been announced again and again for some time and then postponed year after year. I don't think it will happen anytime soon, there are still too many unresolved technical and legal issues for it to happen.*
>
> *(Interview OEM software subsidiary)*

In any case, there is no sign of a qualitative breakthrough in the short or medium term. What is more likely is that in the next few years there will continue to be an evolutionary expansion of various driver assistance systems, semi-autonomous driving, and possibly approaches to fully autonomous driving on special routes such as selected sections of motorways (Hubik 2022a).

### 2.2.3 New Mobility Services

The business model of offering mobility as a service is as old as the stagecoach. Railways, intercity and city buses, airlines, and shipping companies make a living from selling mobility services. Frequently, these **traditional mobility services** are tied to fixed route networks and timetables, but not always, as the taxi and rental car industry and even more so the classic ride-sharing service illustrate.

Today, as part of growing digitization, new technical possibilities are becoming available for conceiving mobility as a service in an even more comprehensive sense: potential customers can be located at any time and provided with real-time information about the location of car-sharing cars, rental bikes, bus and train connections, and reports on the current traffic situation. Examples of these **new mobility services** are car sharing, ride-pooling, ridesharing, ride-hailing, and sharing services for e-scooters and e-bikes.

New mobility services can be roughly divided into ridesharing systems, rental systems, and complementary services (see Figure 2).

It goes without saying that this trend is accompanied by enormous profit expectations. This is exemplified by the numerous mobility services such as Uber, Lyft, or Didi Chuxing. It is virtually impossible to imagine the global metropolises without them and some of these companies have astronomical stock market values, even though their "privileging of

#### The five levels of autonomous driving

**Level 1:**

Level 1 autonomy is the most widely used technology today. Basically, this is not autonomous but rather assisted driving: it is about systems that allow the car and the person driving it to share control of the vehicle. This includes automatic adaptive cruise control (ACC) that adjusts speed and distance to the vehicle ahead, for example, while the driver is still responsible for steering. Another example of level 1 is the parking assistance function: the driver determines the speed of the vehicle while the car takes care of steering.

**Level 2:**

These vehicles have internal systems that basically control all aspects of driving — steering, accelerating, braking — at least in the majority of ordinary situations. A human must, however, be able to intervene if a part of the system fails. Tesla's so-called Autopilot is classified as Level 2 because it automatically keeps the car in the right-hand lane of the road and at a safe distance to the car in front in traffic jams.

**Level 3:**

This technology means drivers can take their eyes off the road. While there still needs to be a person behind the wheel, they no longer have to give their undivided attention to the traffic. It is therefore possible to make a phone call or watch a film while driving. Nevertheless, driving in critical situations — potentially at any time! — has to be taken over at short notice, which comes with a number of issues, especially of a legal and ethical nature. If a dangerous situation arises that the artificial intelligence cannot handle, the person at the wheel may not have enough time to fully assess the situation. The introduction of the Traffic Jam Pilot function for the Audi A8 in the USA, for example, failed due to the resulting complicated legal framework. With this function, autonomous driving is limited to slow speeds and up to 60 kilometres per hour, mainly to stop-and-go traffic, and to routes where a physical barrier such as a crash barrier separates the vehicle from oncoming traffic. The only manufacturer that already has a valid approval for a Level 3 system is Mercedes-Benz with its Drive Pilot (see below).

**Level 4:**

Only from level 4 onwards the term autonomous driving is used in a narrower sense. However, level 4 vehicles only move autonomously under favourable conditions, i.e. possibly not in rain or snowfall. Uber, Lyft, Google, and other manufacturers have been working on Level 4 vehicles for some time, and Honda wants to build a model by 2026. However, in reality all manufacturers so far require "safety drivers" for their vehicles.

**Level 5:**

The model in which the human driver is no longer necessary.

Sources: Carsten 2022; Cacilo/Haag 2018

**Figure 2: Fields of Application of New Mobility Services**

| | ride-sharing systems | rental systems | complementary services |
|---|---|---|---|
| **Organizational form** | taxi, carpooling (ridesharing, carpooling), community buses | rental cars, car sharing (station-based and stationless), bicycle, and e-scooter rental systems | information, navigation, booking platforms, charging stations for e-vehicles, luggage, and delivery services |
| **Companies (examples)** | Uber, Lyft, MOIA (VW), Ridepooling offered by the public transport network | SHARE NOW, MILES, SIXT, Flinkster | Google Maps, Jelbi, omio.com |

Source: own representation

expansion" (Nachtwey/Staab 2020: 292) means that they have thus far made little or no profit.

Their business model is built on orchestrating mobility via a digital platform (Boes/Ziegler 2021). It is not the car that is being sold, "but the mobility that it can provide as a service to the customer" (ibid.: 23). Traditional car manufacturers are also trying harder than ever before to position themselves broadly as part of the new mobility market. The main motives here are not just future profit expectations but also the fear of becoming dependent on large digital corporations or having to give them the data of their customers that they have won via the mobility service. Not doing anything now, the thinking goes, would give tech platforms the opportunity to expand their dominant position in a potential growth market to such an extent that it would become impossible for other companies to catch up in the foreseeable future.

At the same time, participating in car sharing, for example, is still very costly. Therefore, the automobile companies are on the fence between euphoric efforts to occupy the field of mobility services and the sobering realization that these services are by no means a goldmine for them. This was most recently demonstrated when Mercedes and BMW sold their jointly operated subsidiary SHARE NOW to Stellantis (Hubik 2022c).

In no other development sector are the opportunities to solve fundamental mobility problems and the dangers of a future that is being defined primarily in private capitalist terms as close together as in the case of new mobility services. On the one hand, sharing offers are a sensible response to changing usage behaviour, interest in owning a private car has been declining in urban areas for years (dpa 2014). On the other hand, we are already seeing some obvious downsides to privately organized new mobility services that are already becoming apparent: Uber and the like are pushing job insecurity and social dumping in the taxi industry with their ridesharing models, e-scooters are littering city centres, and car sharing services are competing with public transport rather than presenting an alternative to private cars. More recent studies, such as a Gothenburg simulation study in 2022, suggest that digital mobility services may even lead to increased traffic volume in metropolitan areas in the medium term (presseportal 2022). The rule of thumb seems plausibly to be that the greater the weight of local public transport as an integrating anchor of new mobility services, the greater the chance that it could become a central component of a social-ecological transition in the transport system.

# 3 FROM HERE TO THERE: MAPPING A TRANSITIONING INDUSTRY

## 3.1 RISE AND FALL? ECONOMIC CRISIS AS AN ACCELERATOR OF TRANSFORMATION

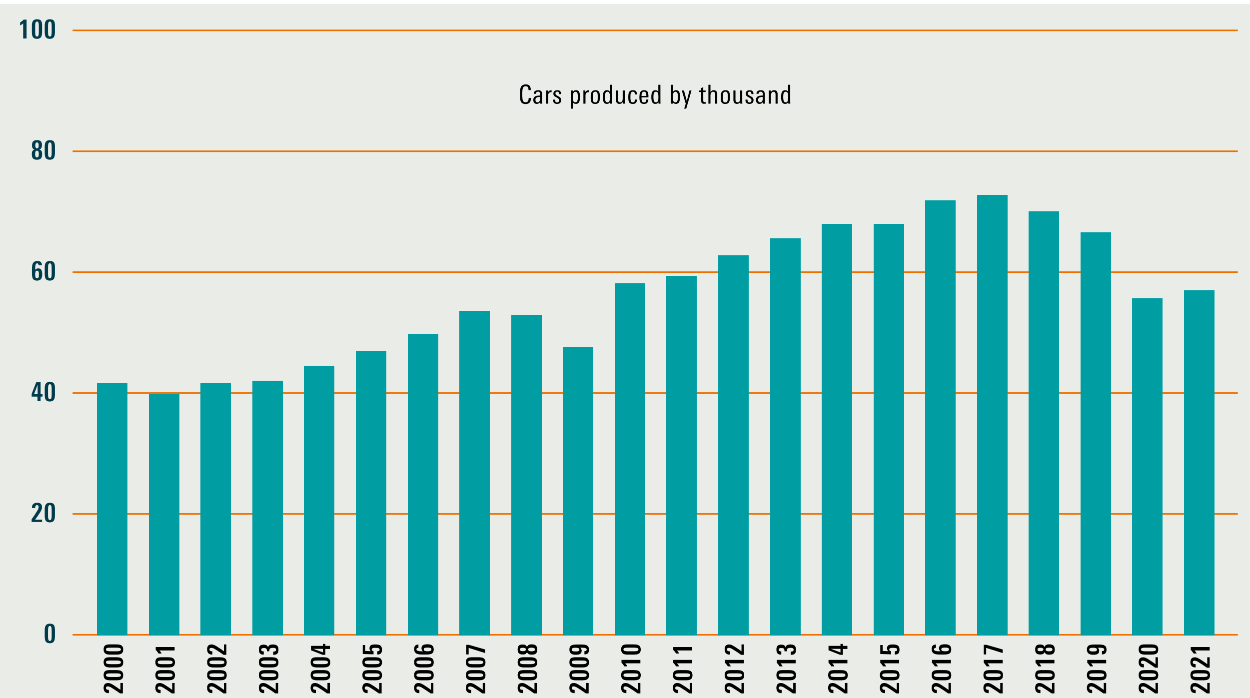
In 1885, German engineer Carl Benz developed his Benz Patent Motor Car No. 1. Within a few decades, Benz's invention had developed into an industry that mass produced automobiles, initially primarily in the USA. At the start of the 20th century, it was the perfection of assembly line production — exemplified by Henry Ford — that saw the car manufacturing industry experience an enormous boom which spilled over to the European continent after WWII. In 1950, more than ten million vehicles were produced, which was already more than 1,000 times as many as in the early 1900s.

Since then, the automotive industry has grown to become one of the most important economic sectors in the United States, Japan, Germany, and South Korea. It was the leading industry of 20th-century capitalism. The automotive industry has left a lasting mark on our cities, transport systems, and culture.

As shown in Figure 3, global automotive production for passenger and commercial vehicles reached its current peak in 2017 at 73,457,000 vehicles produced. Since then, output has fallen year on year to 57,054,295 vehicles in 2020.

Superficially, in 2018–19 a normal economic downturn began which was in keeping with the rhythm of the fairly regular multi-year business cycles that characterize the economic history of capitalism. The crisis

Figure 3: **Number of Cars Produced Worldwide 2000–2020**



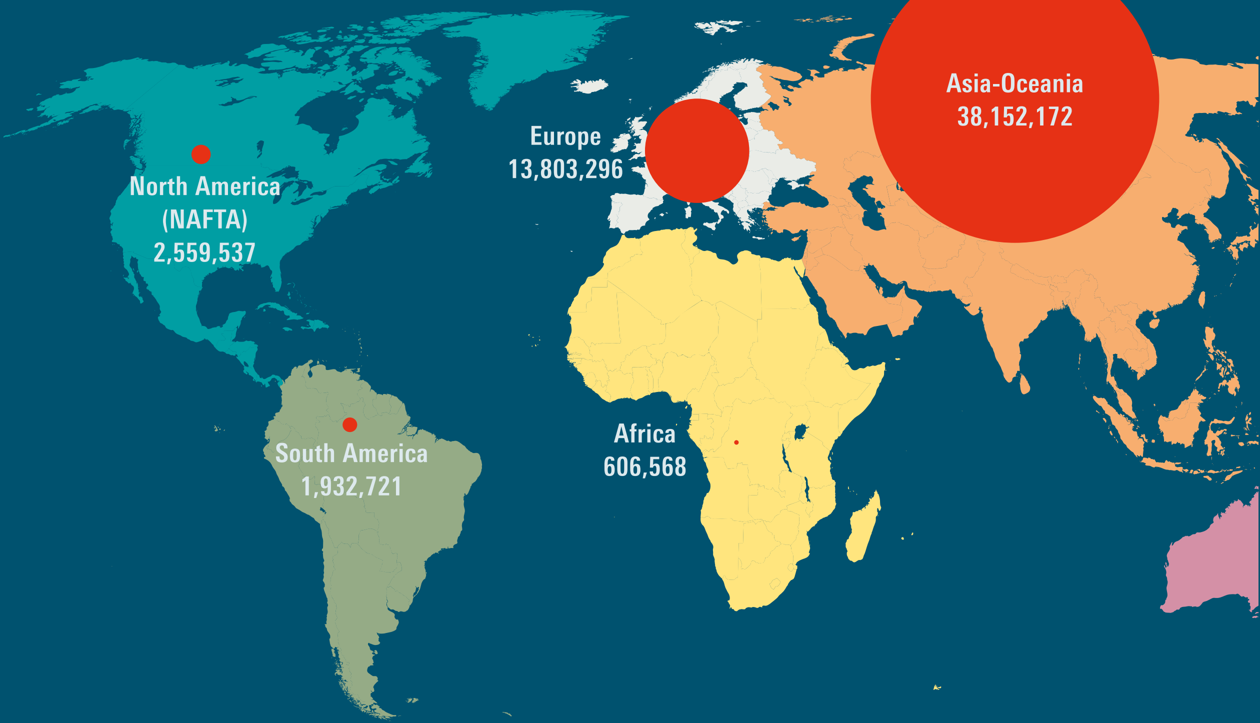

Source: OICA 2022

was exacerbated by a wide variety of factors, among which the outbreak of the global COVID-19 pandemic in early 2020 and its manifold consequences — disrupted supply chains, a semiconductor bottleneck — particularly stands out. In contrast to the previous economic crisis in 2008 and 2009 that started out in the US real estate and financial sectors, this time the downturn had its origins directly in industry. Moreover, some observers (Wolf 2022, 2019; see also Köncke 2022) see it mainly as caused by a slowing of car sales in the most important global car market, China, from 2018 onwards, a slowing that was also significantly exacerbated by the COVID-19 pandemic from 2019–20 onwards (Beutnagel 2021).

## The uneven distribution within automobile production

**Of the approximately 57 million cars manufactured in 2021, almost two thirds (38 million) were manufactured in the Asia-Oceania region. More than half of these (21.4 million) came from China.**

Figure 4: **Producer Regions (2021)**




**The top 10 manufacturing nations (2021)**

| | | | |
|---|---|---|---|
| China | 21,407,962 | Brazil | 1,707,851 |
| Japan | 6,619,242 | Spain | 1,662,174 |
| India | 3,631,095 | USA | 1,563,060 |
| South Korea | 3,162,727 | Russian Federation | 1,352,740 |
| Germany | 3,096,165 | Czech Republic | 1,105,223 |

Source: OICA 2022

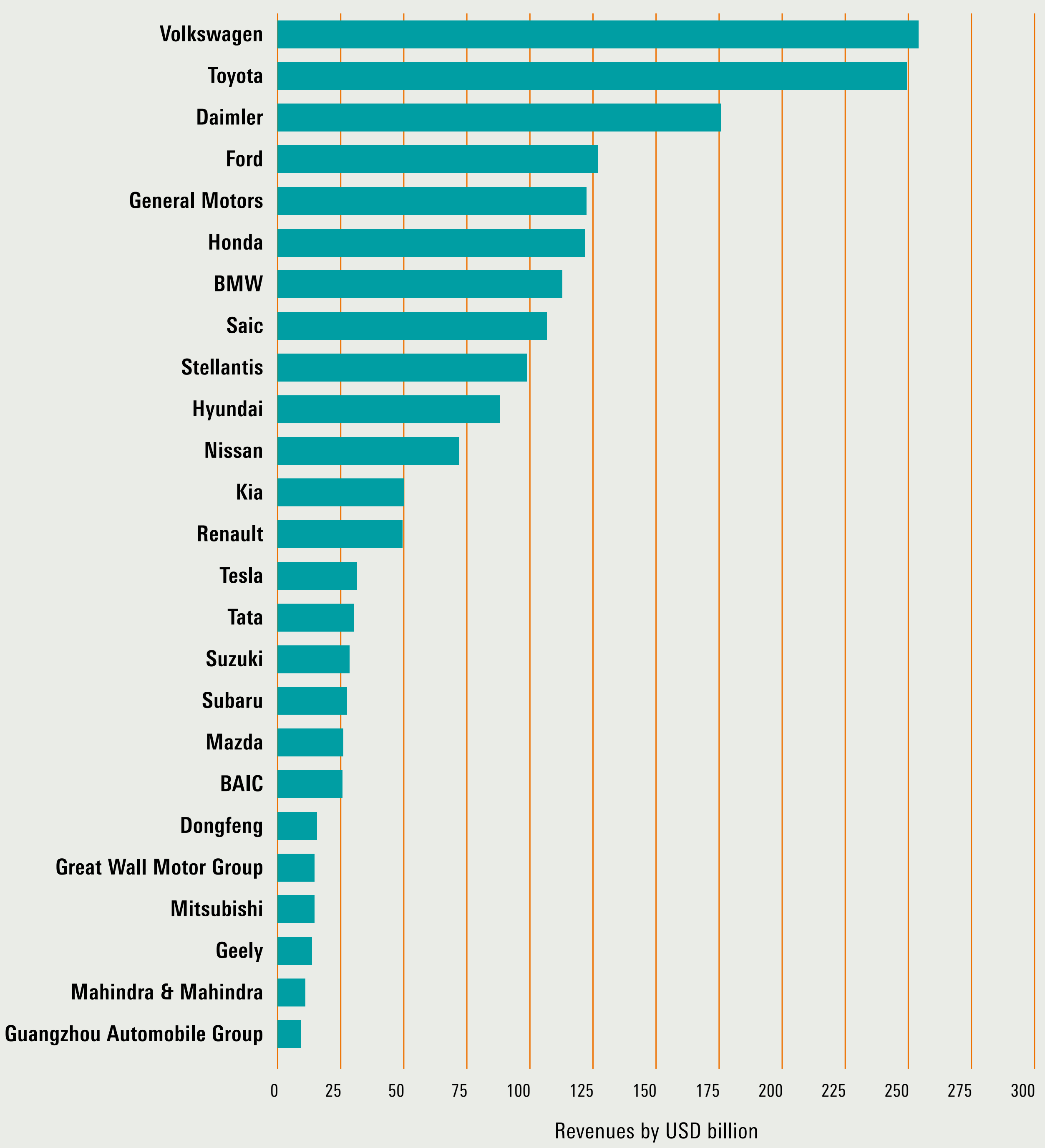
## 3.2 FROM CENTRALIZATION TO CREATIVE CHAOS?

Mergers and takeovers soon took place among the car manufacturers that managed to take the step towards mass production in the early 20th century. This saw, for example, Germany's Adam Opel AG taken over by US company General Motors in 1929. Today, a fairly small number of large corporations dominate the world market (see Figure 5).

A significant supplier industry also developed as part of the progressive division of labour. Greater product specialization means that the supplier industry is less monopolized than that of the manufacturers, though we are still seeing a long-term trend towards concentration here too: the ten largest suppliers control a good third of the global market (see Figure 6).

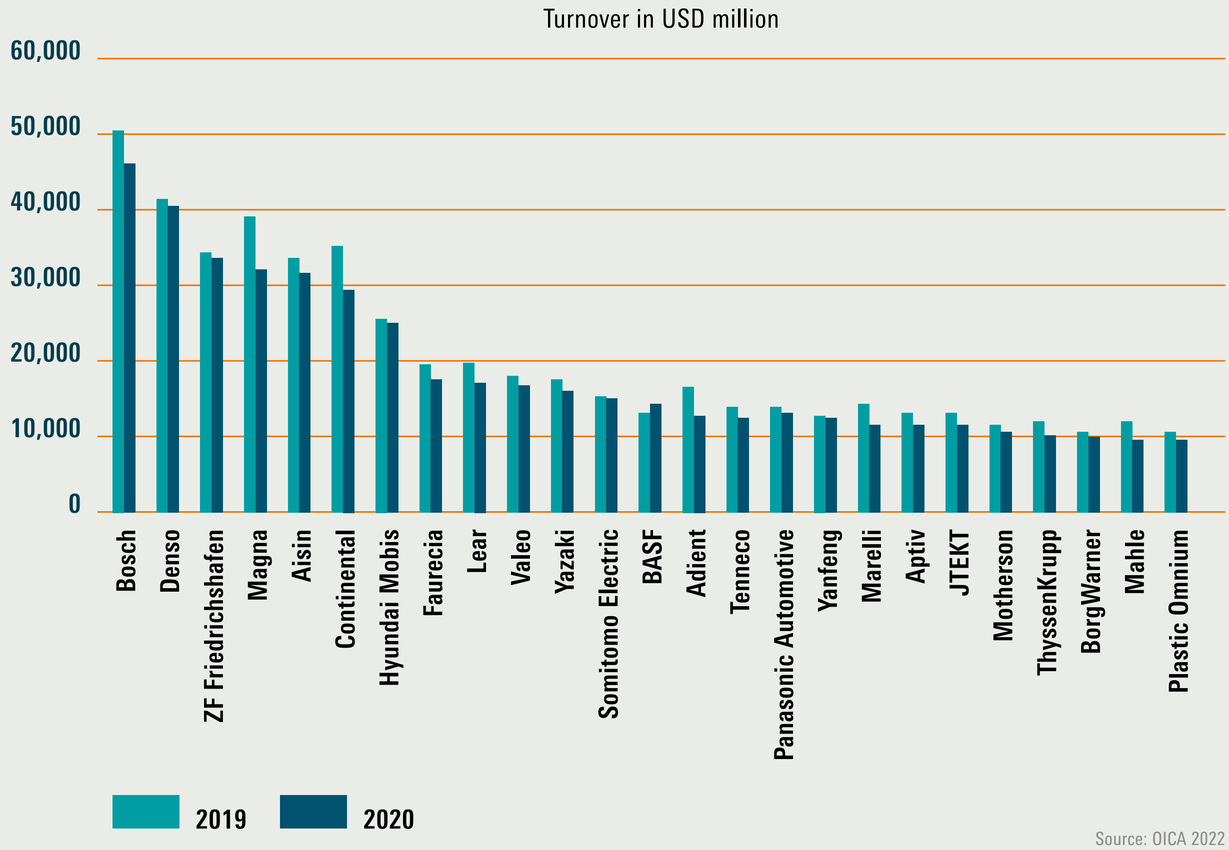
Will this trend towards centralization continue or even be accelerated as a result of the double

Figure 5: **Global Revenues of Car Manufacturers in 2020**




Source: Kords 2022

**Figure 6: Top 25 Automotive Suppliers by Global Revenues in 2019 and 2020**



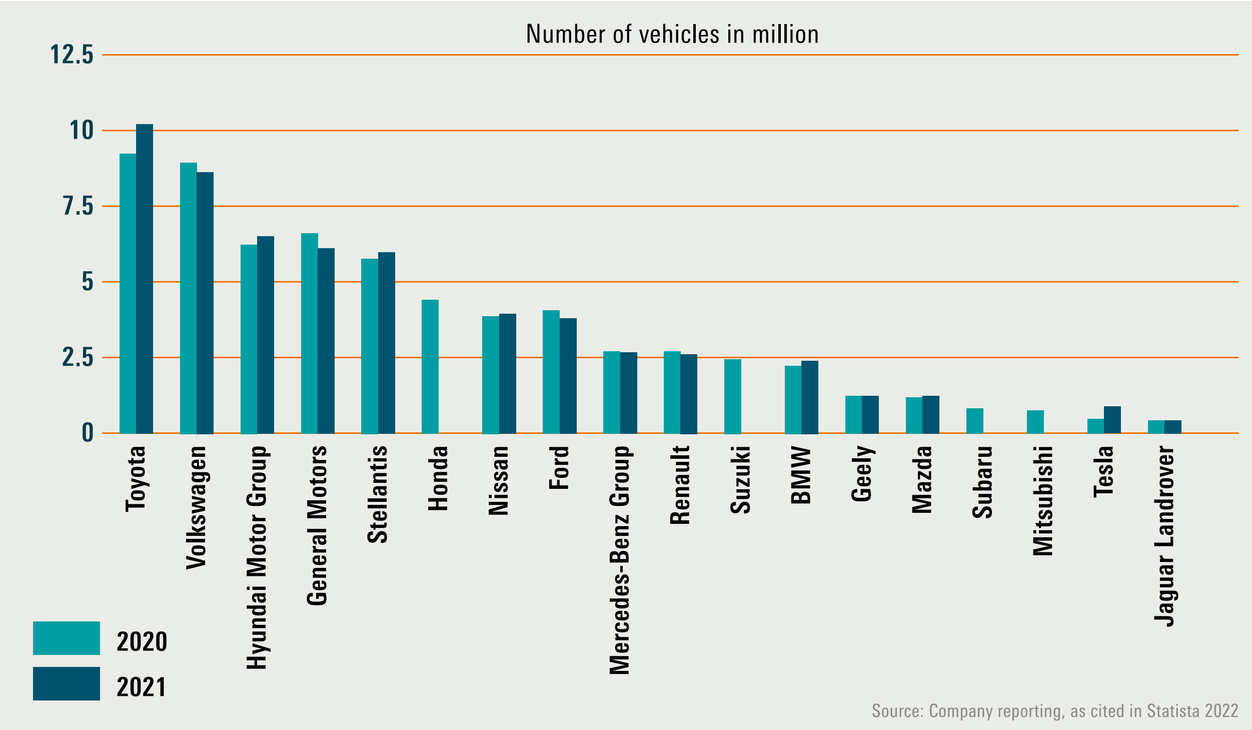

Source: OICA 2022

transformation of the industry? Thus far, it is certainly not a foregone conclusion. In any case, development is not simply linear. On the one hand, the creation of the Stellantis Group in 2021 is the latest of the major super mergers. To date the holding company that was formed following a merger of the French Groupe PSA and the US-Italian Fiat Chrysler Automobiles and is headquartered in the Netherlands, currently unites 14 different brands and is the fifth-largest manufacturer in the world in terms of the number of vehicles produced (Statista 2022e). On the other hand, market entry barriers are being lowered as part of the technological upheaval and new players are entering the field. These companies pose a serious challenge to traditional manufacturers for a number of reasons: they are making proactive use of the upheaval, are more agile since they are not trapped within their own outdated structures, can often master new requirements such as communicativity and battery technology faster and better than the old automotive industry players, and frequently have a high market capitalization like Tesla or industrial policy backing like BYD. This is particularly evident in China (see chapter 5.1) but not only there. Large traditional manufacturers and suppliers are trying to react to the new situation by, among other things, cooperating and entering into strategic partnerships. The field is nevertheless still characterized by regroupings: in 2021, for example, the Mercedes-Benz Group sold off its commercial vehicle division Daimler Trucks in order to secure new capital, partnerships were formed, dissolved again, and realigned. This is demonstrated, for example, by the joint venture established in 2019 between Daimler and the Chinese car manufacturer Geely: Geely is taking a 50 percent stake in the production of the small Smart car, which is set to be relocated from France and Slovenia to China from 2022. With just over nine per cent of shares, Geely is Daimler's second largest single shareholder, just behind BAIC, another Chinese car manufacturer that holds a ten percent share (Hubik 2022b; Manager Magazin 2021; Daum 2022).

**Car manufacturers — front runners and newcomers**

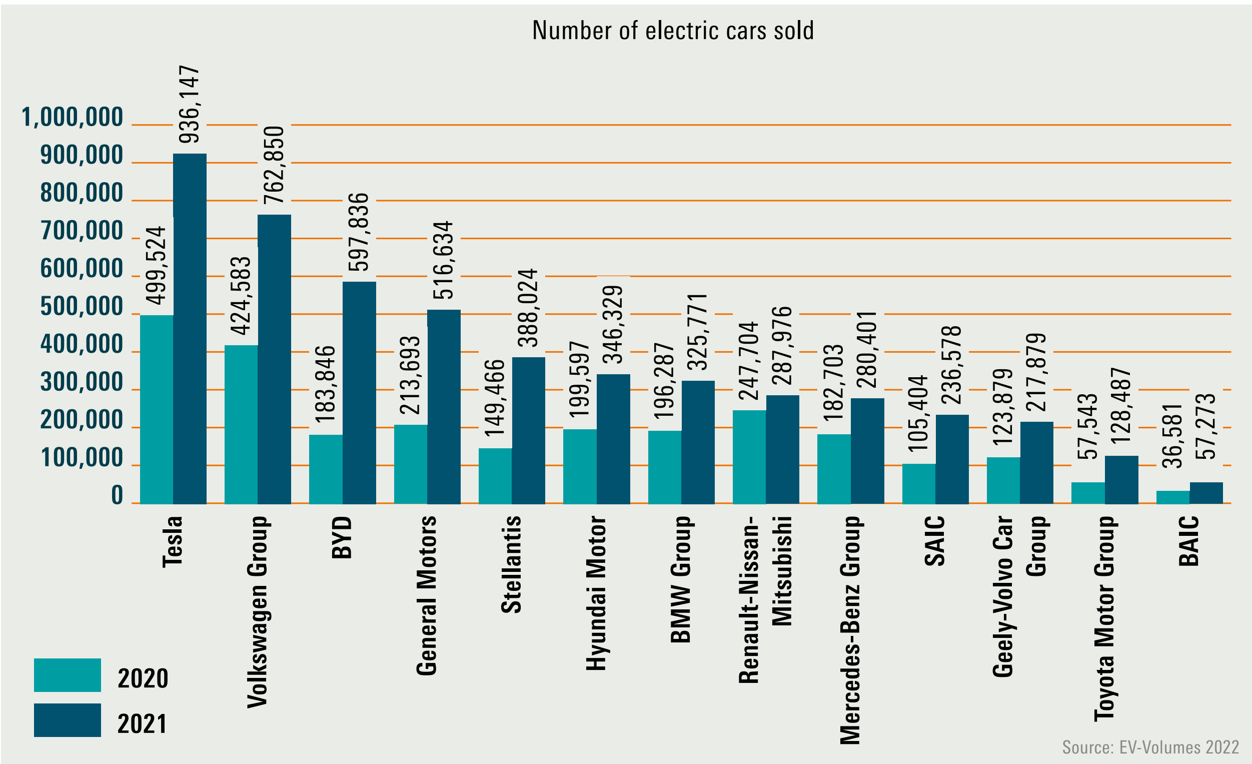
Looking at global car sales by manufacturer in Figure 7 (next page), it looks at first glance as if not much has changed. Toyota and Volkswagen (VW) have been neck-and-neck at the top for decades, with Toyota usually number one by unit sales and VW usually number one by turnover. Newcomers like Tesla or the Chinese manufacturer Geely are still way behind.

Figure 7: **Largest Car Manufacturers Worldwide by Vehicle Sales in 2020 and 2021**




However, if we look at the trend in the production and sale of electric vehicles, especially purely battery-electric cars, we get a completely different picture (see Figure 8). Here, the position that Tesla and a number of Chinese manufacturers such as BYO, SAIC, or Geely occupy is much stronger.

Figure 8: **Largest Manufacturers of Electric Vehicles Worldwide by Vehicle Sales in 2020 and 2021**



New manufacturers and suppliers are pushing their way forward in the BEV growth market. But will these companies be able to seriously compete with the traditional automobile groups in the long term or even relegate them to the back row? And who are these "newcomers" actually? We will explore these questions in the next two sub-chapters. First, we will explore the field of newcomers, before looking at the dynamics of the BEV market in the context of the overall car market. What is the share of BEVs in existing fleets and how is it expected to develop? Will the electric motor largely displace combustion engines in the medium to long term or will it remain one drivetrain concept among several and ultimately not grow beyond a limited market segment?

## 3.3 THE NEWCOMERS: ARE THEY HERE TO STAY?

"Vinfast, Geely, NIO, and the like. These young car manufacturers are pushing their way into Europe" (Manager Magazin 2022), "Tech companies occupy the future fields of the auto industry" (Focus 2017), "E-car made in Turkey: 'TOGG' — Competition for Tesla and VW?" (Brase 2021), "Rivian plans European launch in early 2022" (electrive.net 2021c): the double transformation has set an industry that previously had high market access barriers in motion. Hardly a day goes by without an announcement that new players are claiming space for themselves in the automotive sector. At the same time, the field of newcomers is quite confusing. Among them are technology companies such as Amazon, Microsoft, NVIDIA, or Google, and also large mobility service providers like Uber or Lyft, and start-ups with a lot of venture capital such as NIO or Rivian. The newcomers also include long-established but very innovative Chinese car manufacturers that are looking to use their technological edge to conquer the international market, often in cooperation with established manufacturers. The previously mentioned scientists at the ISF Institute in Munich have broken down this field of new competitors into five groups.

**(1)** According to their categorization, the first group is made up of companies that are car manufacturers, but that organize and operate like technology companies. Boes and Ziegler speak of **car manufacturers in the new information paradigm**. Tesla is archetypal for this group, but it also includes Chinese start-ups such as NIO or the Geely-Volvo spin-off Polestar (Boes/Ziegler 2021: 18).

**(2)** Another group of companies that is likely to enter the automotive market sooner or later are companies that come from the world of **mobility platforms**. They are not interested in manufacturing their own cars. Rather, the principle of the platforms is transferred to a certain extent: autonomously driving vehicles — in theory — are sourced from contract manufacturers that produce the vehicles according to the client's specifications and under the client's brand name. In the long term, they intend to offer mobility services, "robo taxis" and the like, via online platforms. This group includes Google subsidiary Waymo, that has already invested billions in the development of autonomous driving systems, but also companies such as Lyft from the USA, Didi Chuxing from China, or Ola from India (ibid.: 19).

**(3)** A third important group of new competitors does not even focus on building or operating vehicles but instead, on making money in the field of exploiting data and information. **Data processors** at the interface of infotainment such as Google, Apple and, in the foreseeable future, Chinese internet companies like Baidu, Alibaba, or Tencent are already providing customers with useful applications today by connecting the car to the information space (ibid.).

**(4)** The fourth group — that overlaps with the third to a certain extent — is made up of **providers of Internet infrastructures and technologies**. These include a large number of companies from cloud providers like the services offered by Amazon, Microsoft, or Alibaba, to manufacturers of telecommunications infrastructure such as the Chinese global market leader Huawei, and producers of high-performance semiconductors like the US companies Nvidia, Intel, or Qualcomm. It is a group united by the fact that demand for their products is growing significantly as a result of the ever-greater importance of driver assistance systems, control units, navigation, and entertainment technology in modern cars and a lack of competition from the traditional suppliers in the "old automotive industry". And unlike these traditional suppliers, newcomers are not in the position of "subordinate partners, but instead specialists with a high degree of autonomy and great potential to expand their position within the automobile industry's value creation systems and to take up dominant positions in the value creation systems we expect to see in the future" (ibid.).

**(5)** The fifth group is made up of large **contract manufacturers** from the IT industry. Apple manufacturer Foxconn occupies an important place among them. Thanks to the skills they have gained in recent years in highly flexible mass production, there are many indications that these types of companies are also pushing their way into the value chains of the automotive industry. These are companies that could be part of a development like that already seen in the IT and textile industry: a company with a strong brand and "efficient contract manufacturers in the background" (ibid.).

## 3.4 IS THE ELECTRIC MOTOR SET TO DISPLACE THE COMBUSTION ENGINE? TRENDS AND SCENARIOS

Sales of battery-electric cars have been rising exponentially since 2012. Nevertheless, in both absolute terms and in terms of its share of the total number of cars, it is still a very small sector of the market (see Figure 9).

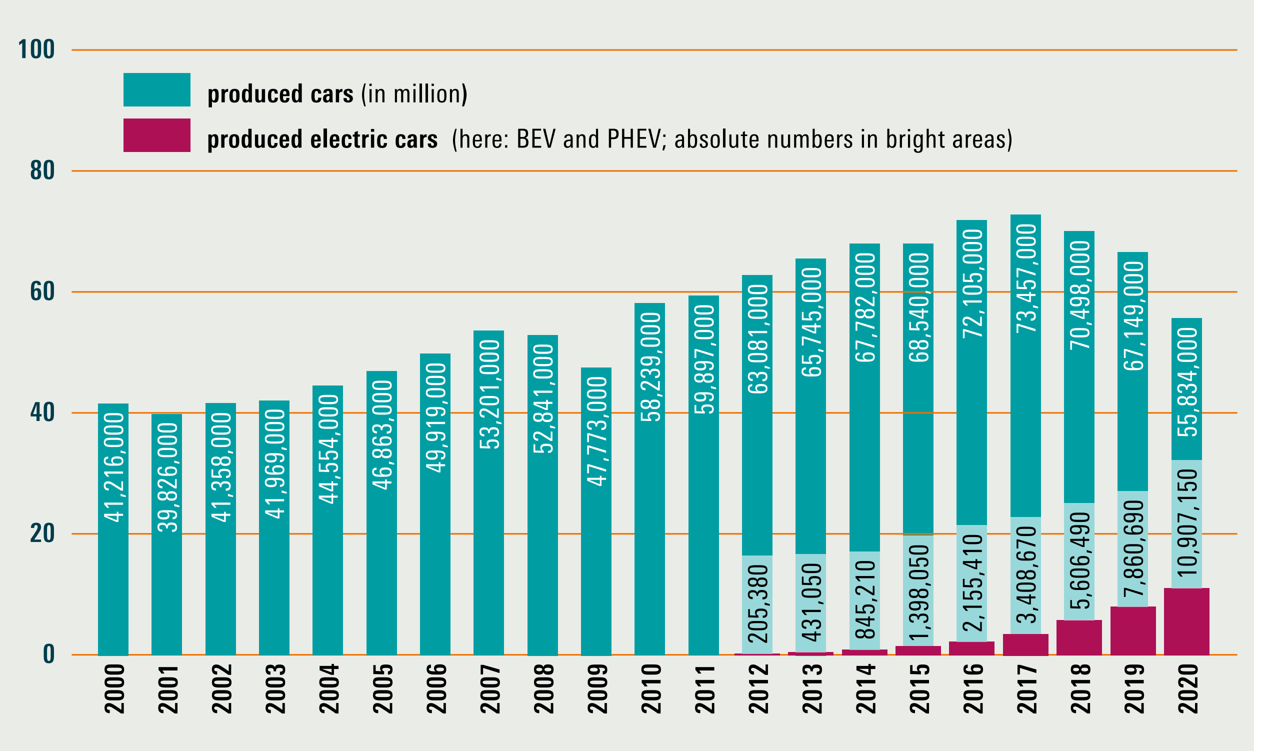
According to the chart above, the number of purely electric cars sold worldwide in 2012 was still around 110,000 (IEA 2021a). Measured against the annual worldwide production of 63 million cars at that time, this is a share of 0.17 percent of the market. Nine years later, in 2021, 57 million cars were produced worldwide (OICA), including 2.4 million BEVs. Within less than a decade, the share of purely battery-electric cars, excluding hybrids and plug-in hybrids, of the cars produced globally has therefore risen to 4.2 percent.

Naturally, the share of electric vehicles among the total car population is growing much more slowly. According to the German Association of the Automotive Industry (VDA) and the German Environmental Agency, the number of cars worldwide in 2021 was around 1.25 billion. According to estimates by the VDA and other industry associations, around ten million of these were "electric vehicles" — although this figure also includes plug-in hybrids. Purely battery-electric cars are likely to only account for a good half to a maximum of two thirds of this and whichever way you look at it, the share of electric cars out of the total number of cars worldwide is below one percent.

The use of electric cars — defined here due to a lack of statistical data as BEVs and plug-in hybrids — is very unevenly distributed across the various regions of the world: Asia has a total of 4.7 million fully electric vehicles and plug-in hybrids (PHEVs) registered, of which 4.2 million are in China. Europe follows with 3.2 million, of which around 703,000 are in Germany, and North America is third with 1.9 million, of which 1.7 million are in the USA (VDA 2021).

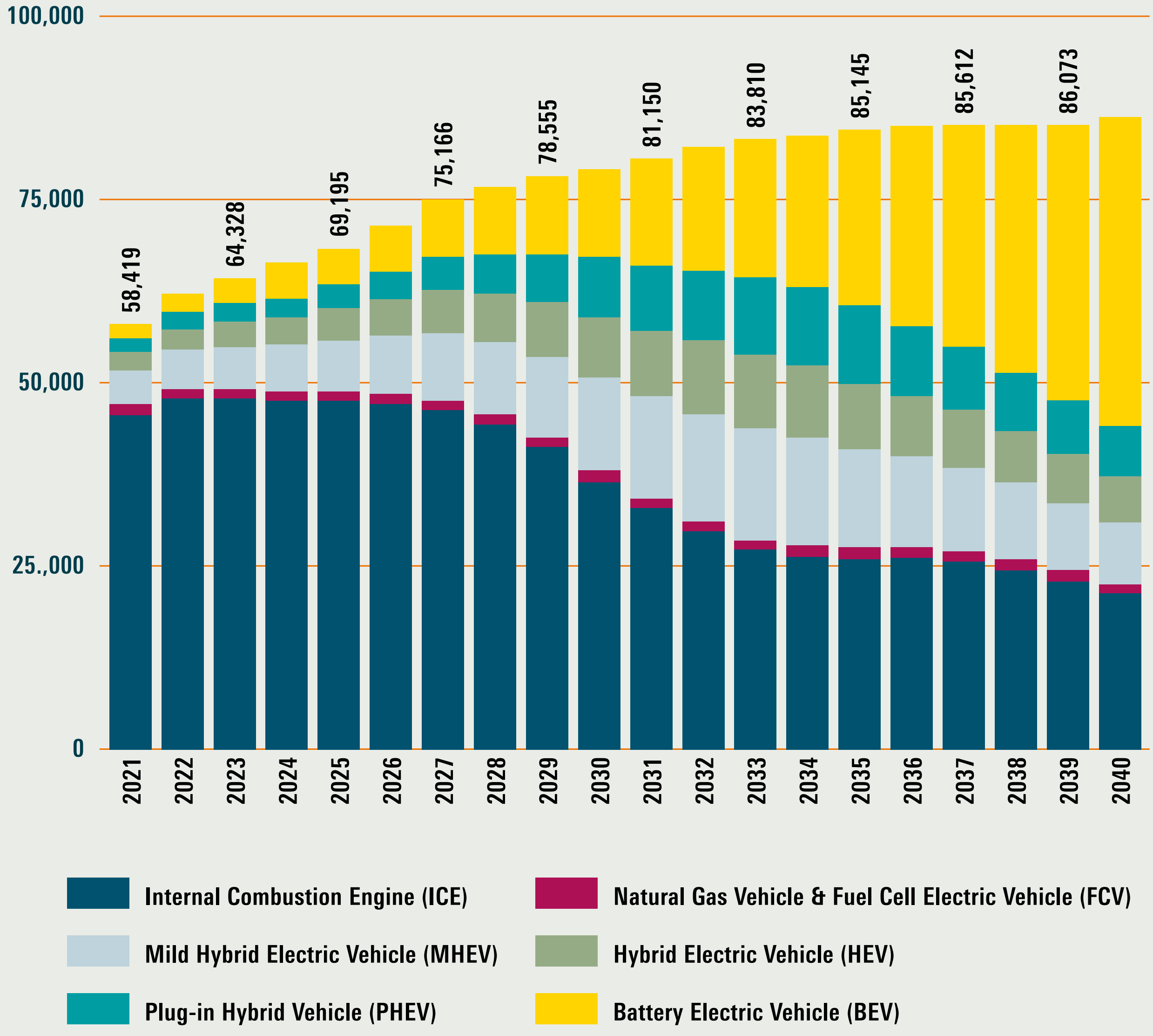
Even if obtaining precise figures on the development of the BEV fleet is problematic due to the lack of differentiation in most statistics between BEVs and PHEVs, there is a clear trend: while, on the one hand, battery-electric cars still make up a comparatively small segment of the global car fleet, the growth

Figure 9: **Share of Electric Cars (with Plug-in Hybrids) in Global Production from 2000–2020**




Source: OICA 2022/own calculations based on ZSW 2022

**Figure 10: Global Sales Forecast of Cars by Drivetrain from 2021–2040, by 1,000 Vehicles**




Source: Harrison 2021

momentum in both production and new registrations is impressive. In most scenarios assumed by not only consulting firms close to manufacturers but also by more or less independent institutes, there is no longer any doubt that in the medium to long term battery-electric drivetrain will displace combustion engines that run on fossil fuels from being the most widespread drivetrain concept to date. At the same time, however, it is clear that internal-combustion-engine-powered vehicles will be around for a long time to come in some regions of the world, though how long and to what extent is still unknown.

Figure 10 shows the results of a study commissioned by the power technology group ABB that assumes that global sales of BEVs will grow to about 50 percent by 2040 and that about twice as many BEVs will be sold as vehicles with combustion engines.

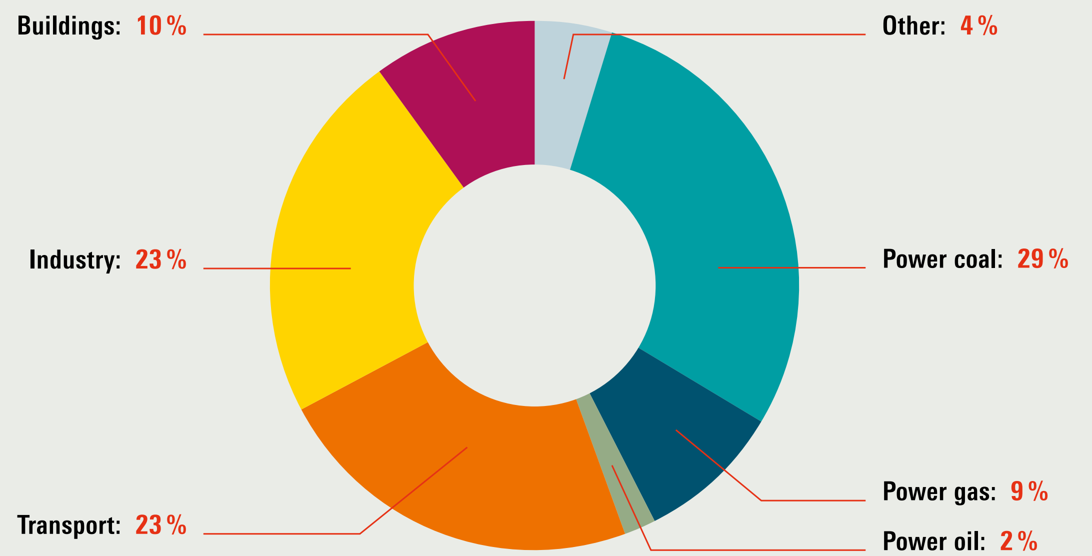
In its current Global EV Outlook, the International Energy Agency (IEA) presents two scenarios in terms of the development of the stock of fully electric vehicles in different market segments and world regions. According to their conservative scenario, the global stock of fully electric cars and light commercial vehicles could grow from ten million today to 140 million by 2030. This would see the fleet share of BEVs increase from today's roughly one percent to eight percent. According to the optimistic scenario, the IEA expects 220 million fully electric cars and light commercial vehicles by the end of the decade, i.e. a share of 15 percent (IEA 2021d). ◂

# 4 SUSTAINABLE TRAVEL? E-MOBILITY'S ECOLOGICAL BALANCE

Road traffic as a cause of ecological crises is not a phenomenon that just affects the present, or even of the automotive age. The late 19th century saw many large cities around the world experience serious issues with horse manure and slurry. Horses pulled loads, carriages, horse-drawn buses, and trams, producing about 15 kilogrammes of manure per horse per day. The excrement attracted flies that multiplied in huge numbers and transmitted diseases. In 1894, the London based *Times* predicted that the streets of London would be buried under a nine-foot layer of horse manure within half a century. An 1898 international planning conference in New York attempted to find a solution to the ever-growing problem but the discussion was abandoned without results after three days. The seemingly insurmountable problem of the "horse manure crisis" vanished within a few years of the invention of the combustion engine and the advent of the automobile (Peugeot pre-war register 2022).

A century later, we recognize internal-combustion-engine-based automobility as an important contributor to a much larger ecological crisis: anthropogenic, greenhouse gas-induced global warming. And as on the eve of the triumph of the combustion engine, the question is whether an innovative, clean drivetrain technology can provide a way out of the crisis. According to data provided by the IEA, traffic and transport are responsible for around a quarter of all carbon emissions from fossil fuel combustion globally (see Figure 11).

**Figure 11: Global Energy-Related Carbon Emissions by Sector in 2022**




Source: IEA 2022a

Road traffic alone, including both passenger and freight transport, accounts for a good 18 percent of this (see Figure 12).

In Germany, the numbers are similar. Following the energy sector and industry, at around 20 percent of carbon emissions, the transport sector is the third biggest emitter of greenhouse gases (see Figure 13, next page). By far the largest share of transport emissions is caused by road traffic which is 96 percent, as of 2019. Petrol and diesel cars make up 61 percent and heavy goods vehicles make up 36 percent of carbon emissions.

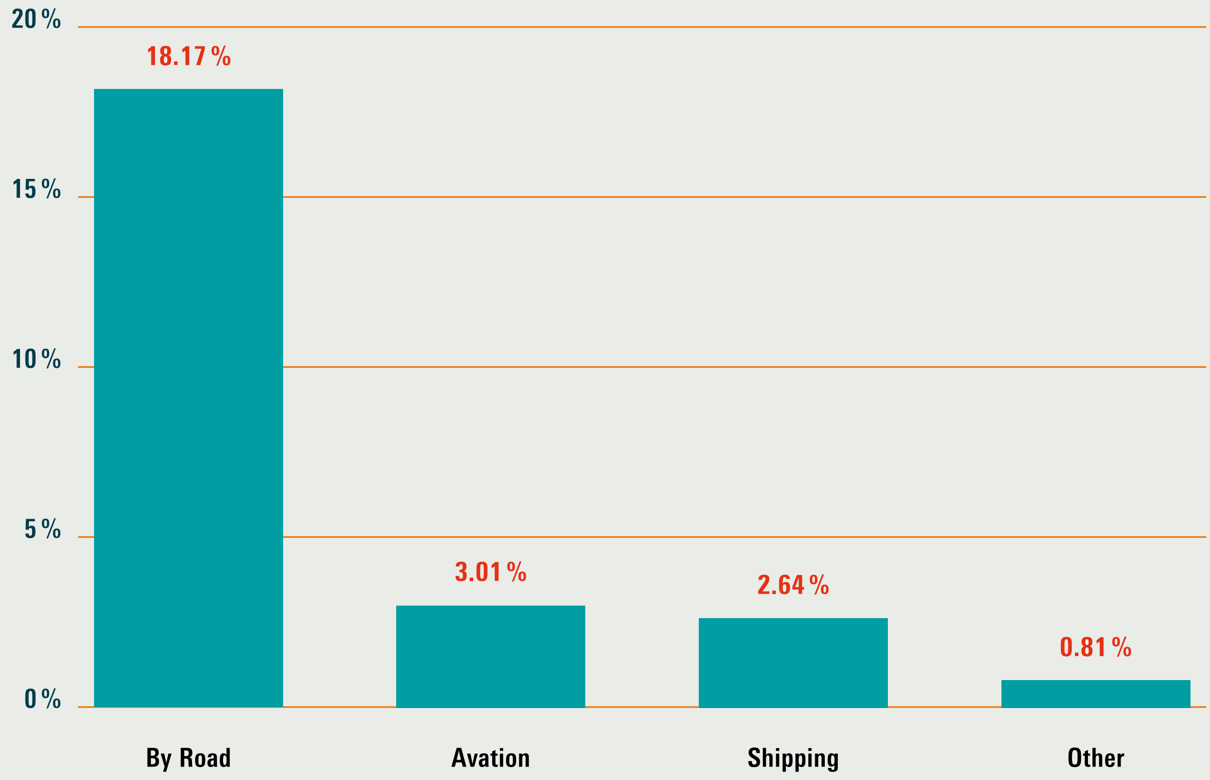
Though a car emitted 5.1 percent less carbon on average in 2019 than in 1995 as a result of technological improvements, the total carbon emissions of car traffic on German roads increased by 5.1 percent in the same period. The reason is that there are more cars on the road (see Figure 14, next page) and more people are driving. This equates to an increase in car mileage of 20.5 percent from 1995 to 2019 (Federal Environment Agency 2022b).

The increase in heavy goods traffic is particularly striking: here, the mileage in tonne-kilometres increased from 279.7 to 486 billion between 1995 and 2020, a rise of around 74 percent. Despite more efficient and environmentally friendly technology, absolute carbon emissions from road freight transport rose from 39.3 to 45.9 million tonnes, or by 17 percent (ibid.).

Against this background, countries around the world are promoting new registrations of fully electric cars and commercial vehicles (see chapter 5). In Germany, the federal government aims to raise the number of electric cars on Germany's roads to 15 million by 2030. This would be a third of the current stock, with plug-in hybrids that are still being counted as "electric cars" in most statistics being explicitly excluded. Serious predictions, such as those of the International Energy Agency, assume that the global stock of BEVs in terms of cars and light commercial vehicles will grow to about one billion by 2040 (IEA 2021d).

How climate-friendly electric cars actually are is a complex question. Questions centre around the carbon footprint of a vehicle over its entire life cycle, i.e. primarily from production and use. In addition to that, the demand for raw materials and the scrapping of electric cars pose the ecological problems that are discussed below.

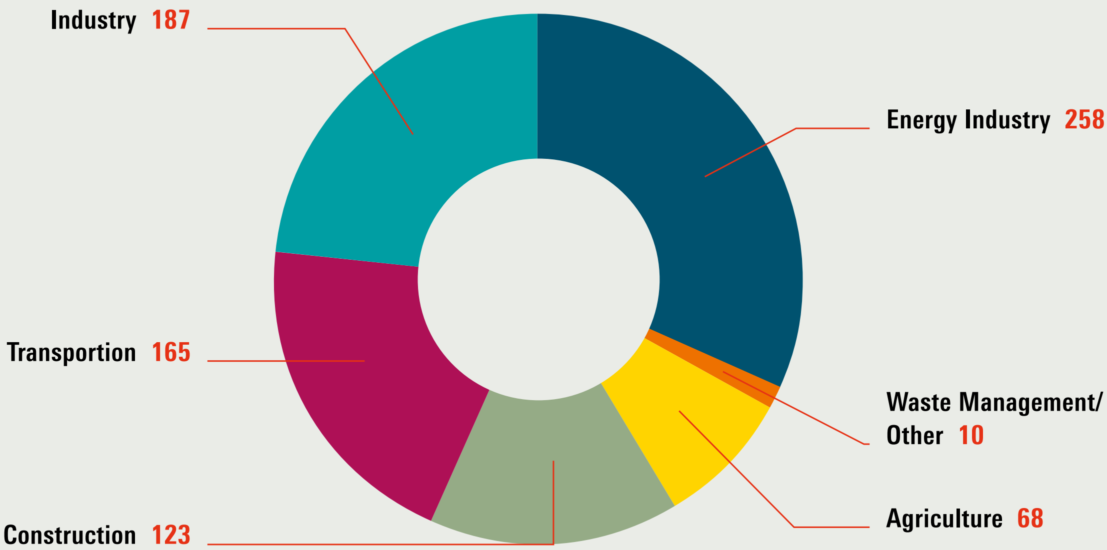
Figure 12: **Share of Transport Modes in Global Carbon Emissions in 2018**




Source: OICA 2022

Figure 13: **German Greenhouse Gas Emissions by Sector in 2019**

In million metric tonnes of carbon dioxide equivalents (MMTCDE)




Source: German Environment Agency (UBA) 2021a

Figure 14: **German vehicle population (1991 and 2021)**

| | Cars (million) | Lorries (million) |
|---|---|---|
| **1991** | 36.8 | 1,8 |
| **2021** | 48.5 | 3.8 |

Source: German Federal Environment Agency 2022c

## 4.1 ELECTRIC MOTOR: UNBEATABLE ENERGY EFFICIENCY

Battery-electric cars are powered by DC motors. This means that in contrast to the internal combustion engine, a linear movement does not have to be converted into a rotary movement by a sophisticated system involving the pistons and crankshaft – the electric motor generates a rotary movement directly. Heat loss is low, and efficiency is significantly higher. According to calculations by TÜV Nord, the efficiency is around 64 to 70 percent. In comparison, a modern diesel engine achieves up to 45 percent, while a petrol engine only achieves 20 percent (TÜV Nord 2022).

Even compared to other alternative non-fossil drivetrain systems, the energy efficiency of the electric motor is unbeatable. Taking into account the losses in the generation of electricity or fuel, scientific journalist Harald Lesch arrives at the comparative values shown in Figure 15.

## 4.2 GREENHOUSE GAS EMISSIONS DURING PRODUCTION

The production of the lithium-ion battery of an electric vehicle is particularly energy-intensive. Conservative estimates see an electricity demand of 100 kilowatt hours per kilowatt hour of storage capacity. VW already consider a reduction in consumption to 50 kilowatt hours as feasible "assuming a high production capacity utilization with serial production running smoothly" (German Bundestag 2020a). Against the background of the electricity generation mix that is currently available, this is the reason why electric cars cause more carbon emissions during

**Figure 15: Energy Efficiency of Alternative Drivetrains**

| | |
|---|---|
| BEV | 73 % |
| Fuel cell using $H_2$ | 22 % |
| Synthetic fuel ("power to fuel") | 13 % |

Source: Lesch 2022

production than comparable vehicles with combustion engines. As such, electric cars are already rolling off the production line with a larger ecological footprint.

### A wide range for emission calculations

The emission values stated in the available literature on emissions contain a wide calculation range and are the subject of fierce discussion. A study published by the IVL Swedish Environmental Research Institute in 2017 concluded that battery production releases an average of 150 to 200 kilogrammes of carbon per kilowatt hour of charging capacity (Romare/Dahllöf 2017). Two years later, the IVL published an updated version of the study (Emilsson/Dahllöf 2019), in which the authors concluded that average carbon emissions per kilowatt hour of battery capacity would be between 61 and 106 kilogrammes. How have average emissions been practically halved in just two years? One could assume that there were fundamental calculation errors in the first version or that there have been considerable technological leaps in the meantime. In fact, the reason for the substantial reduction is that the authors did not consider 50 percent but nearly 100 percent of the electricity to be generated by carbon-free means as a basis for the recalculation, "which is not yet common, but will probably be so in the future" (ibid: 5).

As the example of the Swedish study and its revision makes it clear, the issue of carbon emissions in battery production is a politically hotly contested field. Therefore, caution is advised even when dealing with supposedly hard facts, even if they are scientifically justified. There are also too many uncertain variables involved that researchers have to make choices about and their choices are always affected by political preferences or political pressure. Aside from the question of the carbon balance of the electricity used, there are further methodological difficulties in the calculations which are not always easy to respond to as there are of course also carbon emissions involved in the production of renewable energy plants. For example, an overall very e-car-friendly study conducted by Eindhoven University of Technology notes that emissions are "difficult to determine" "because factories consider such data to be commercially sensitive" (Hoekstra/Steinbuch 2020). For its part, the study assumes 40 to 100 kilogrammes of carbon emissions per kilowatt hour and states that 75 kilogrammes per kilowatt hour is a realistic average value. James Frith of the think tank BloombergNEF arrives at the figure of 20 to 80 kilogrammes per kilowatt hour in 2019 (ibid: 9). In view of the constantly growing number of new studies, the examples given here certainly do not represent the entire range of emission estimates. A 2018 study by the International Council on Clean Transportation comes to the sober conclusion: "Recent estimates of battery manufacturing emissions, however, vary by a factor of 10, indicating the need for additional research in this area" (ICCT 2018: 11).

Even if the greenhouse gas emissions generated during battery production cannot be precisely quantified, it is undisputed that the production of electric vehicles will release significantly more emissions in the foreseeable future than the production of comparable vehicles with internal combustion engines, solely because of the production of batteries.

A 2020 publication by the Fraunhofer Institute for Systems and Innovation Research ISI in Karlsruhe states:

> ***"Compared to conventional cars, the production of e-cars is significantly more energy-intensive due to the production processes for the battery. Depending on the energy source, the level of energy efficiency in production, and battery size, greenhouse gas emissions are between 70 and 130 percent higher than is the case in the production of petrol or diesel vehicles.***
>
> *(Fraunhofer ISI 2020: 10 f).*

▶

## 4.3 GREENHOUSE GAS EMISSIONS DURING USE

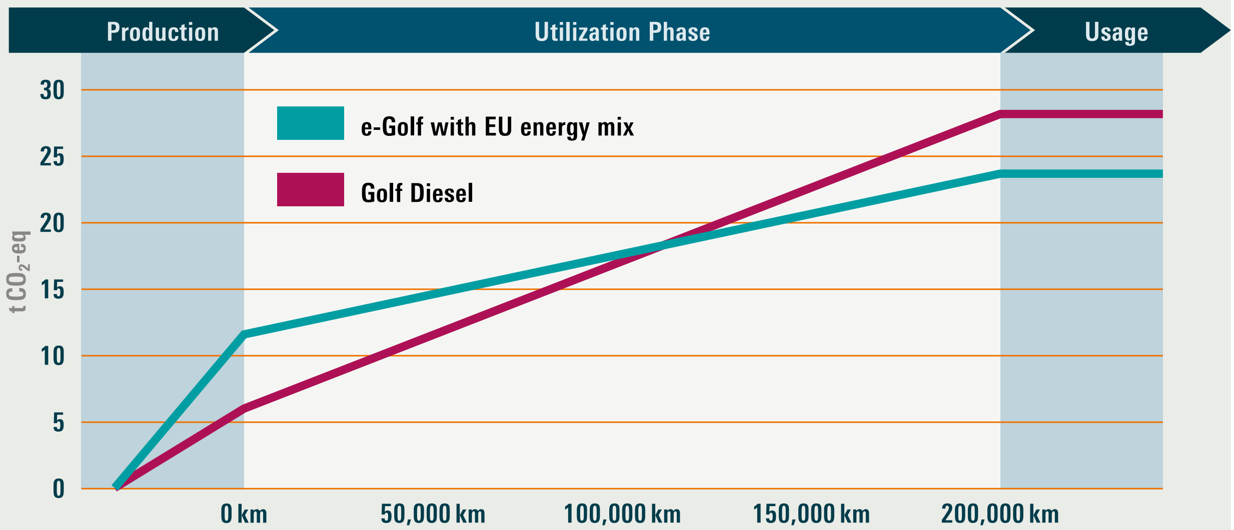
Can the larger carbon footprint that an electric vehicle rolls off the assembly line with be offset by lower greenhouse gas (GHG) emissions during use? The question has long been disputed, but "yes" is now the predominant answer in the scientific literature. What is not entirely clear due to the countless variables that are hard to determine is after how many kilometres electric vehicles "break even". To date, different studies have come to very different conclusions. While the Eindhoven study (Hoekstra/Steinbuch 2020) assumes that this point is reached at or below 30,000 kilometres for common types of cars, a study conducted by Allgemeiner Deutscher Automobil-Club (ADAC), Germany's largest automobile association, considers 50,000 to 100,000 kilometres to be a more realistic figure (Rudschies 2020). In a 2019 study, Volkswagen concludes that the VW eGolf achieves a better carbon balance than a comparable Golf diesel at 125,000 kilometres — based on the current EU electricity mix (VW 2019) (see figure 16).

Leßmann und Steinkraus (2019) put out three different scenarios based on a number of variable parameters including electricity mix, vehicle size, and service life, and conclude that in an optimistic scenario climate neutrality is achieved after 29,000 kilometres, in an average scenario after 50,000 kilometres, and in a pessimistic scenario after around 140,000 kilometres. As (Köncke 2022: 164) plausibly concludes, the range shows "that every statement can essentially be proven by an appropriate choice of parameters". Some older studies even come to the conclusion that the greenhouse gas benefit of electric cars is only marginal or that there may be no benefit at all over the life cycle (Ensslen et al. 2017), though such pessimistic assessments have become increasingly rare in recent years. More and more studies now assume a clear benefit to the climate for fully electric vehicles based on an average life cycle, even considering the current electricity mix (see Figure 17). With a continued increase in the share of non-fossil energy sources, the balance would be further improved in the future.

### Massively increased power consumption

Overall, a mass distribution of electric cars will lead to significantly greater electricity demands. Various literature quotes figures of between two and three terawatt hours per year for every million BEVs (Witsch/Tyborski 2021; Lesch 2022). If the German government's target of 15 million electric cars is reached by 2030, this would mean a demand increase of 45 terawatt hours, i.e. about eight to ten percent of current electricity production. Experts consider such a figure ambitious but technically feasible. At the same time, and in the course of this development, a debate has arisen on whether to postpone shutting down the nuclear power plants that are still on the grid. This discussion began before Russia's war in Ukraine and independently of it (Dudenhöffer 2021). It can be generally assumed that electromobility will become a driver for the expansion of nuclear power use worldwide. While the share of renewable energies in electricity generation is growing, it is still far below the 50 percent that the Swedish study of 2017 bases its figures on in the most important producing countries.

**Figure 16: Carbon Footprint of the e-Golf versus Golf Diesel**




e-Golf: Energy consumption, kWh/100 km: combined 14.1 with 17-inch wheels – 13.2 16-inch; $CO_2$ emissions combined, g/km: 0; efficiency class: A+

Source: VW 2019

**Figure 17: Share of Renewable Energies in Electricity Production by Country in 2020**

| | |
|---|---|
| EU | 39 % |
| China | 28 % |
| India | 23 % |
| USA | 20 % |
| Russia | 20 % |
| Japan | 20 % |

Source: Enerdata 2022

## 4.4 ECOLOGICAL AND SOCIAL PROBLEMS CAUSED BY THE GROWING DEMAND FOR RESOURCES

Electric cars can contribute to a reduction in the consumption of fossil fuels — though whether and to what extent depends on a number of different parameters, particularly the electricity mix used. A study by the Öko-Institut in Freiburg assumes, for example, that the annual crude oil demand for cars in Germany will fall by 56 percent by 2035 when compared to 2020, if the share of electric cars in new domestic registrations has risen to 100 percent by then (Dolega et al. 2021: 11). The IEA considers a reduction in daily global diesel and petrol consumption of between 2.5 and 4.2 million barrels a day to be possible by 2030 due to the expansion of the global electric car fleet (IEA 2020). Based on IEA data, the think tank BloombergNEF considers a saving of 14.5 million barrels a day to be possible by 2040, which would mean a reduction of around 27 percent (BloombergNEF 2019). For comparison: current global daily consumption is 53.9 million barrels (IEA 2021c). Figure 18 shows the savings potential for fossil fuels based on these forecasts.

The potential savings in fossil fuels as a result of the favourable GHG balance and the high energy efficiency of electric cars is, however, offset by a greater demand for resources, especially mineral raw materials. The raw materials used in the production of various types of batteries that are currently common and will continue to be in the foreseeable future include cobalt, aluminium, iron, copper, manganese, lithium, nickel, titanium, silicon, and graphite (adelphi et al. 2022) (see Figure 19, next page). As a rule of thumb, an electric car requires about six times the amount of metallic/mineral raw materials when compared to a vehicle with a combustion engine (IEA 2022a; IEA 2021b).

According to a study conducted by the Öko-Institut, global cobalt demand is expected to rise to 800,000 tonnes a year by 2050, while lithium consumption could be 1.1 million tonnes in 2050 (Dolega et al. 2021). The IEA estimates that a scenario based on the Paris Agreement climate targets would cause a 40 percent rise in demand for copper, a 60 to 70 percent rise in demand for nickel, and an almost 90 percent rise in demand for lithium over the next two decades.

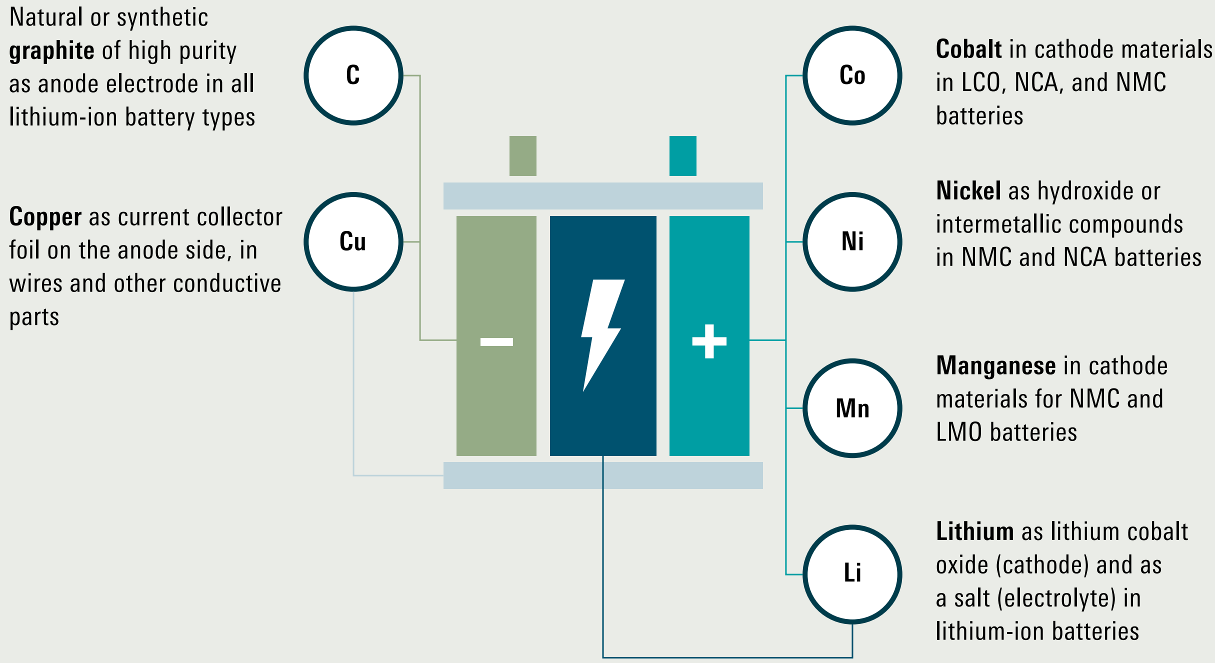
**Figure 18: Forecast Decline in Demand for Diesel and Petrol Due to E-mobility — Optimistic Scenario**

| 2021 | 2030 | 2040 |
|---|---|---|
| 53.9 mb/d | 49.7 mb/d | 39.4 mb/d |
| 100 % | 92.2 % | 73.1 % |

global daily barrel consumption by million (mb/d)

Source: own calculations IEA 2020 IEA 2021c; BloombergNEF 2019

Figure 19: **Selected Raw Materials Used in Traction Batteries for E-vehicles**




Source: adelphi et al. 2022: 69

Overall, the demand for mineral raw materials could quadruple by 2040 in a sustainable energy scenario, with by far the largest share of the increase in demand arising from electric vehicles, batteries, and the expansion of the grid (IEA 2021b).

The reserves — the deposits that can be mined with current technical possibilities — and the resources beyond that which include the total of known deposits both mineable and unmineable will not reach their limit in the short and medium term. The United States Geological Survey (USGS) puts global lithium reserves at about 21 million tonnes and cobalt reserves at about 7.1 million tonnes. The known resources are significantly higher with 86 million tonnes for lithium, 25 million tonnes for cobalt on the ground, and another 120 million tonnes of cobalt on the ocean floor (US Geological Survey 2021). Figure 20 shows the reserves and resources of three selected strategic raw materials for electric vehicles in relation to their current production volume.

There is, however, a considerable discrepancy between reserves and actual production capacities. An analysis by the major Swiss bank UBS comes to the conclusion that converting the current global vehicle

Figure 20: **Global Production Volumes, Reserves, and Resources of Selected Raw Materials in 2020**

| Raw material | Global output (million tonnes) | Reserves (million tonnes) | Ressourcens (million tonnes) |
|---|---|---|---|
| Cobalt | 0.14 | 7.1 | 25 (mainland)<br>120 (oceanic) |
| Graphite | 1.1 | 320 | 800 |
| Lithium | 0.082 | 21 | 86 |

Source: U.S. Geological Survey 2021

fleet to electric would require an increase in **global production of cobalt by 1,928 percent, of lithium by 2,898 percent, and of rare earths by 655 percent** (Belkaïd 2022). German industry and its associated think tanks and media are also already feeling nervous: "Even if all projects that are currently planned and under construction are implemented on schedule and we assume a medium growth in demand, we will not have sufficient lithium to meet global demand in 2030" quotes German newspaper *Handelsblatt*, citing a recent study by the Federal Institute for Geosciences and Natural Resources (BGR) (Witsch et al. 2022).

Regardless of the imponderables of these scenarios and their technical feasibility, the rapid growth in demand undoubtedly goes hand in hand with a number of critical environmental and social problems. With lithium extraction, the huge water consumption is a serious environmental problem, particularly since a large part of the extraction takes place in regions, like the South American lithium triangle Chile, Bolivia, and Argentina, that already struggle with water scarcity (see chapter 4.5). Ecologically, underground mining in Australian lithium mines is less critical. Nevertheless, all forecasts see the rising demand triggering a run on all accessible resources.

Cobalt mining is also problematic from an ecological point of view since it can lead to the acidification of drinking water resources. A United Nations report names acid mine drainage as one of the world's most serious environmental hazards (UNEP 2010). Cobalt is mainly mined in the Democratic Republic of Congo, where safety standards are low. In addition, around 20 percent of Congolese cobalt is mined in unregulated small-scale artisanal mines, which is associated not only with ecological but also social problems — from child labour to completely inadequate occupational health and safety standards (Mau 2019; adelphi et al. 2022).

Cobalt mining can also be associated with extreme land consumption, pollutant emissions, especially of heavy metals into the air, drinking water, and soil, and the release of radioactive uranium. Energy-intensive cobalt refining — around 60 percent of global cobalt is refined in China — is also responsible for significant greenhouse gas emissions (adelphi et al. 2022).

An analysis by the Stockholm International Peace Research Institute (SIPRI) comes to the general conclusion that the energy transition may also have undesirable effects, such as a rise in the number of land conflicts and (neo-colonial) exploitation of critical raw materials, the deterioration of inter-state relations, and the intensification of existing conflicts (SIPRI 2020). A further risk factor is that the raw materials that are important for electromobility are distributed much more unevenly around the globe than the fossil fuels oil and gas (see Figure 21, next page). Social disputes related to planned lithium mining projects are now also taking place in European countries like Spain and Serbia (Rajković 2022; Reuters 2022b).

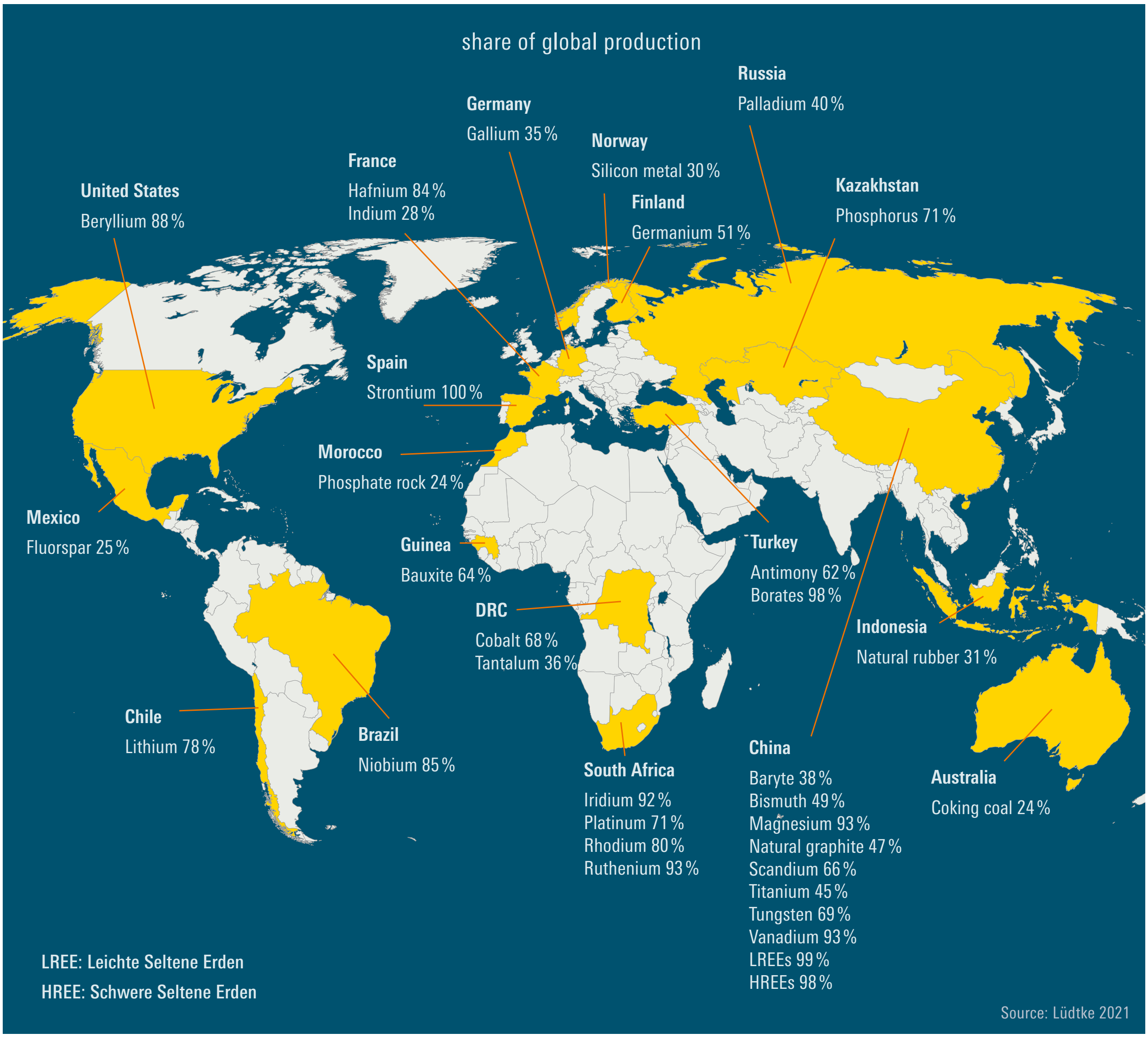
In the foreseeable expansion of battery production capacities in European countries with a high proportion of coal-fired power, like Poland at 74 percent, the associated negative environmental impacts or risks such as high level of greenhouse gas emissions and pollutants, land consumption for coal extraction, and lowering of the groundwater table have to be taken into account (adelphi et al. 2022).

In addition, it is becoming apparent that geopolitical conflicts over access to resources could intensify as competition for global raw materials intensifies. An example of this is the overthrowing of left-wing Bolivian president Evo Morales in 2019 which was described by some observers as a "lithium coup" (Business & Human Rights Resource Centre 2022). It is not clear to what extent external interference played a role in the forced resignation of Morales or the violent protests, but Elon Musk certainly caused an international sensation when he tweeted "We'll coup whoever we want!" following the coup (Telesur 2020). While this can be dismissed as the ramblings of an eccentric, nobody now disputes the growing risk of geopolitical tensions surrounding critical technology metals. An analysis by the European Council on Foreign Relations (ECFR) from late 2021 concludes that the shift away from fossil fuels will lead to major upheavals in international politics and growing rivalry between the major powers, the USA and China, but also to tensions in the transatlantic relationship (Guix 2021).

#### Can the raw material situation be alleviated through higher levels of recycling?

At the end of the battery life cycle, environmental risks arise mainly when waste batteries are not recycled correctly. The materials used in batteries are sometimes toxic, corrosive, hazardous to water and health, and also highly flammable and combustible, "particularly if they are stored and disposed of in improper waste streams (e.g. landfill) and leak, burn, or otherwise enter the environment" (adelphi et al. 2022: 81). High-voltage batteries are life-threatening if handled improperly and, according to the UBA "pose significant fire risks, e.g. when transported by ship, on scrap yards in Africa" (Buchert et al. 2022). When it comes to recycling lithium-ion batteries, there is, however, still a huge gap between what is theoretically possible and what is actually happening in practice. "Due to the relatively new fields of application for lithium-ion batteries and their long service life combined with their second-life potential, only a very small proportion of used lithium-ion batteries have thus far been included in the return flow […]. The German Federal Government is not currently planning to

Figure 21: **Deposits of Critical Raw Materials for Electromobility**




introduce collection and recycling requirements for lithium-ion batteries at a national level" is an answer given by the Federal Government to a question posed by the political party AfD (German Bundestag 2020b). The new EU Battery Directive expected for late 2022/ early 2023 will not change this. It does, however, regulate the manufacturers' obligation to take back drivetrain batteries. But what happens if the manufacturer no longer exists at the end of the presumably long and not yet foreseeable life cycle of such a battery? "Then we will have a problem", suggests battery expert Falk Petrikowski of the UBA (Interview Petrikowski). Unlike lead-acid batteries that are still valuable and relatively easy to recycle at the end of their service life, recycling lithium-ion batteries is technically very complex and will incur losses for the business sector for the foreseeable future. The reason is simple: **compared to the types of batteries that have been commonly used to date, lithium-ion batteries contain very small quantities of a large number of substances.** When it comes to recovering the contents of the battery, it is precisely this that has a frustrating effect, as the number of specific recycling processes in particular has to be increased.

Whether the recycling capacities that will be needed in the future will grow in line with the market is currently the subject of discussion. A recent study by the Fraunhofer Institute for Systems and Innovation Research and the German Engineering Federation (VDMA) shows that the volume of lithium-ion batteries and components to be recycled in Europe could be around 150 to 300 kilotonnes a year in 2030 and around 600 to 2,500 kilotonnes a year in 2040. Currently, yearly European recycling capacities in kilotonnes range around the low double-digits and would therefore have to be scaled up significantly. The study puts the necessary investments at around EUR 6.6 billion by 2040 (Neef et al. 2021: 2).

## 4.5 THE ELEPHANT IN THE ROOM: A DIFFERENT TRANSPORT SYSTEM IS NEEDED

If the global car population continues to grow at the same pace as over the last two decades, there will be around 2.35 billion cars in the world in 2040. This calculation comes from a simple extrapolation of the Federal Environment Agency data illustrated in Figure 22.

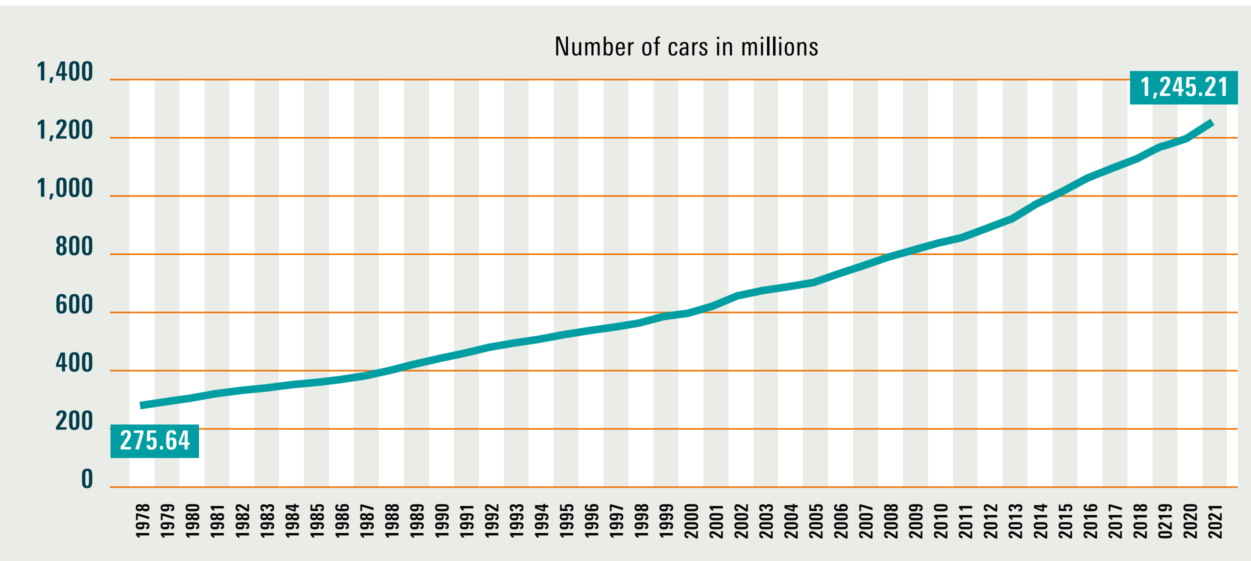
A number of studies come to similar conclusions. For example, a study prepared by Prognos on behalf of Shell assumes that "the global car fleet will grow to almost 2.5 billion by 2050 alone" (Shell Deutschland/ Prognos 2014). A study by IMF Deputy Division Chief Marcos Chamon published in the journal *Economic Policy* concluded in as early as 2008 that "the number of cars will increase by 2.3 billion between 2005 and 2050, of which 1.9 billion will be in emerging and developing countries" (Chamon et al. 2008: 244). In conclusion, this would mean that despite a rapid "market ramp-up" for electric cars, there will still be just as many vehicles on the road with combustion engines as there are today in two decades' time. Despite all the euphoria surrounding the electric car, we must not forget that in much of the world there are no plans to ban internal combustion engines in the foreseeable future, nor is there even a rudimentary infrastructure to allow for the wider use of electric cars (see Figure 23, next page). This also includes regions of the world where the motorization rate (car density per 1,000 inhabitants) is already high or growing rapidly (see Figure 24, next page).

In actuality, as of 2022, no one can predict precisely how many vehicles with combustion engines will be built worldwide in the coming years and decades, let alone how long they will be used for. A Greenpeace study published in November 2022 provides relatively detailed insight into current plans of major manufacturers. It concludes that automobile companies currently plan to produce 645 to 778 million cars and light commercial vehicles with diesel or petrol engines by 2040. The calculations show that the volume far exceeds the 1.5-degree target set out in the Paris Agreement and, at best, the study considers half of the planned production volume to be justifiable (Teske et al. 2022).

In other words: even if the more optimistic scenarios regarding the conquest of the market by e-cars materialize, in 20 years, we will still have more or less the same GHG emissions from combustion engines worldwide — emissions from the production and operation of a billion electric cars and the additional use of resources would be added. Even if the production and operational emissions per electric vehicle should generally decrease thanks to more efficient technologies and a "greener" electricity mix, it is obvious that the outlined scenario would not lead to a reduction but rather to a rise in GHG emissions from car transport.

Electrification of the drivetrain alone is not an effective climate policy measure while in the context of an update of the car-centred transport model. The advantages of the electric car, its high energy efficiency and favourable GHG life cycle balance, can only be truly effective if overall car stocks are reduced and the vehicles have a long lifetime and achieve high overall mileages. This would require there to be a massive shift away from the individual-private car ownership

**Figure 22: Development of the Global Car Population from 1978–2021**




Source: German Association of the Automotive Industry (VDA), facts and figures, yearly reports

Figure 23: **Countries with Planned Bans on New Registrations of Petrol and Diesel Vehicles**

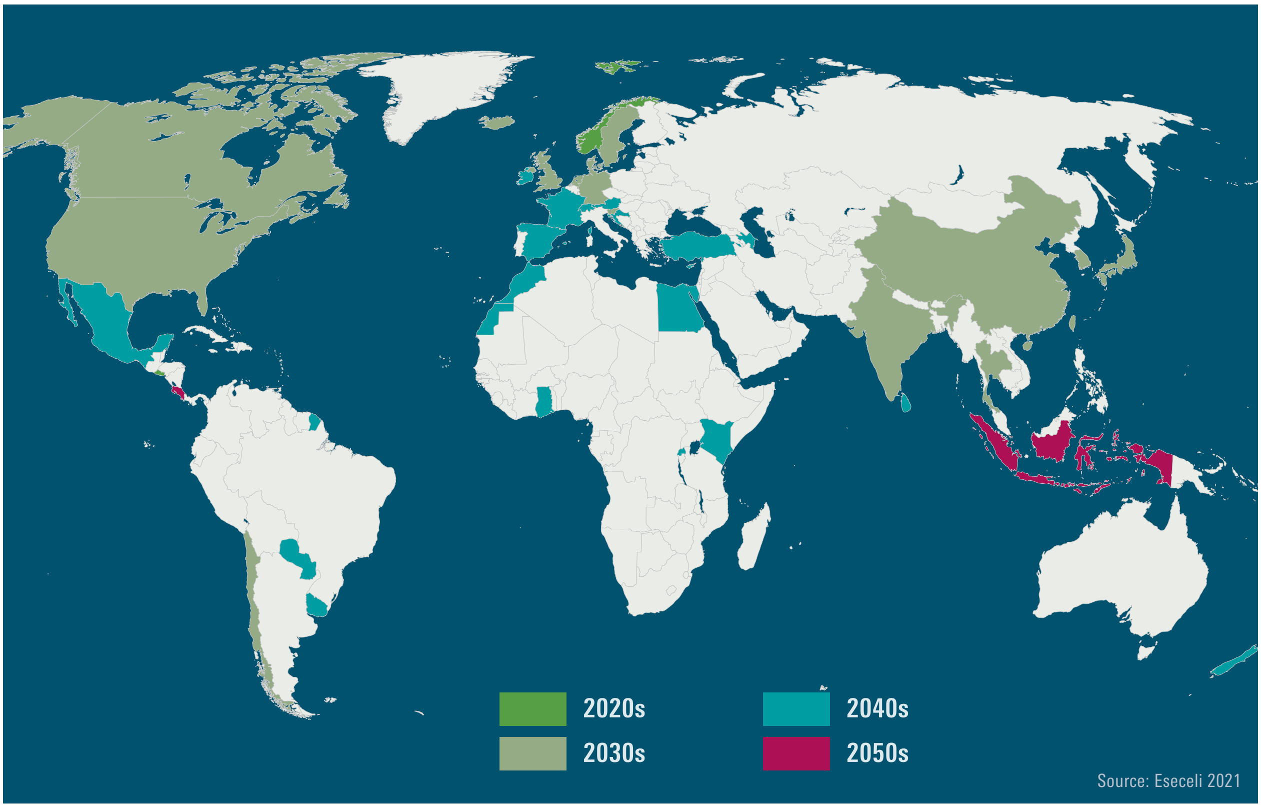
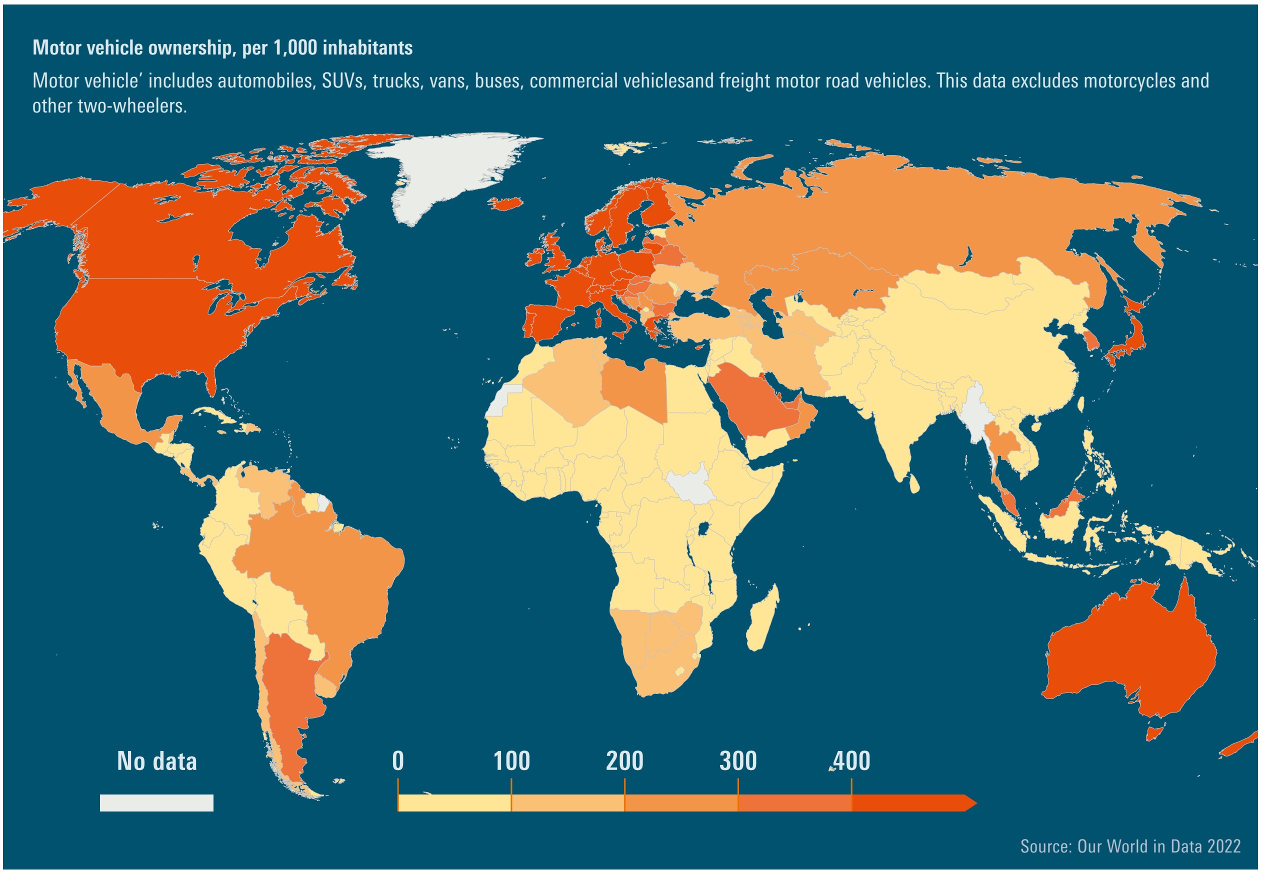



Figure 24: **Motorization Rate 2014**



model towards much greater sharing within a few years, which would only be conceivable if public transport systems were massively expanded, also in rural and suburban areas. The guiding principle would have to be an integrated mobility system, in which an emissions-free regular bus and train service forms the backbone of transport infrastructure and the gaps in sparsely populated areas are filled by an electric call-a-bus service, shuttles, taxis, and car-sharing fleets that are understood to be part of a public service. Obviously, none of this is in the interests of a private capitalist automobile industry (cf. Wolf 2019).

Thus far, however, very nearly all developed capitalist states in the Global North are already more or less failing to put this important task on the agenda in an at least somewhat acceptable manner. To have a global effect, however, such a model would also have to be seen as a desirable goal in the emerging economies of Brazil, India, and China – something we are currently still far from achieving.

# 5 INDUSTRIAL AND TRANSPORT POLICY. MEASURES AND GOVERNMENT PROGRAMMES AT A GLANCE

## 5.1 CHINA: FROM A COUNTRY OF BICYCLES TO THE WORLD'S MOST IMPORTANT ELECTRIC CAR MARKET OR THE POWER OF NUMBERS

### 5.1.1 Profile of the Region

In 1986, bicycles still ruled in China and 63 percent of Beijing residents indicated that they regularly used a bicycle while only five percent drove a car. In 2000, bicycles were still almost twice as important as cars in Beijing, with a 40 percent share of use (Geinitz 2012). But times are changing: today, with a population of 1.4 billion and more than 21 million cars produced and sold in the country, China is not only the world's largest car market but also the leading global market for electromobility (Statista 2022b, 2022c). With more than three million fully electric cars, nearly one in every two e-cars sold worldwide in 2021 was sold in China (Sattler 2022a). In 2022, the electric share of all cars sold is expected to be 23 percent (Daum 2022). In Shanghai alone — a metropolis with a population of 25 million — there are more than 103,000 electric charging stations, more than three times as many as in the whole of Germany.

As Boy Lüthje, who researches at the Institute for Public Policy at the South China University of Technology stated in an interview with the authors:

> *“E-mobility is developing ten times faster in China than anywhere else in the world. Moreover, China has the raw materials and the whole production base to produce batteries.*

And for Hua Wang, professor at Emylaon Business School and co-author of a book on the Chinese car company Geely, there is no doubt that: “China aspires to be the global leader for smart cars” (Wang et al. 2022). Jim Farley, the President and CEO of Ford suggests that the “industry's centre of gravity is moving to China” (Menzel 2022).

### 5.1.2 Industrial and Funding Policy on Electromobility

China's pathway from being a country of bicycles to the global lead market for electromobility has been a long one. A major factor was certainly the efforts of China's transport and environmental policy to get to grips with the significant problem of poor air quality in the country's major cities that came into effect in the mid-2000s. But this only partially explain the development. The industrial policy decision that was taken earlier in China than in practically all other countries globally to define electromobility and related value-added components as future technologies and to provide massive state support for them was significant. This included policy decisions on everything from production to the raw materials for the batteries. Electromobility served as an opportunity to compensate for the technological shortfalls when compared to the major international OEMs and to take a leading role in the global automotive market (Köncke 2022; Zenglein et al. 2019).

**Fighting smog with e-cars**

Roads packed with cars and a backdrop of skyscrapers obscured beyond recognition by smog. For years, such images were typical of Chinese metropolises with populations in the millions. The ever-growing number of cars is estimated to have a roughly 20–30 percent share in responsibility for the miserable air quality (Ostmann 2016). In order to at least somewhat tackle the problem, party and state leadership has launched several multi-billion dollar programmes to deal with air pollution over the last 15 years. In addition to numerous closures of particularly polluting factories, the measures taken included rigid driving and registration restrictions

(Levin 2015). The smog avoidance programme included the active subsidization and promotion of electric mobility, with measures ranging from the free provision of number plates when purchasing an electric car — in urban areas, owners of cars with combustion engines frequently have to wait years to get their car registered — to generous subsidies for the purchase of vehicles with electric drivetrains. Finally, all car manufacturers and importers are obliged to meet certain e-quotas in their sales and production (Wolf 2019).

**Active industrial policy**

This is only the micro perspective, however, and experts like Boy Lüthje and Hua Wang attribute the boom in Chinese electric cars primarily to a fundamental change of strategy in the Chinese industrial policy of the early 2010s. This can be seen in the 13th Five-Year Plan for economic growth for 2016–20 that postulated a shift from an export-oriented market to an innovation-driven, sustainable, and more domestic market (Schüller 2021). The "Made in China 2025" (MIC 2025) action plan specifically targets the development of the automotive industry. The programme, that is said to be inspired by the German Industry 4.0 programme (CSIS 2015) is likely the world's most ambitious and comprehensive project for the development of smart manufacturing. In addition to goals such as "robotization" and factory automation, MIC 2025 focuses on the development of industrial strength in areas considered strategically important, such as electric drivetrain technologies, sourcing of the raw materials required for this, and their industrial processing, as well as the integration of the e-car into a digitized infrastructure (Schüller 2021; Zenglein/Holzmann 2019). Further measures include the quota system mentioned above that requires all companies that wish to sell or produce cars in China to meet targets for fixed proportions of purely electric motors or plug-in hybrids. In 2020, the rate rose from 10 to 12 percent (Lüthje 2019b). The starting point for this new industrial policy is a change in focus when it comes to state support. For a long time, in an effort to catch up technologically with countries like the USA, Japan, or Germany, China relied on large state-owned automobile manufacturers (SOEs). To access the Chinese market, the big international car companies have to cooperate with the SOEs and produce their product in joint venture factories (see Figure 25, next page). Over the past 20 years, this is a system that has proven to be extremely stable and, above all, profitable for China. Nevertheless, a crucial goal was missed:

> ***"Chinese car companies were making their money by selling other manufacturers' cars, but they have not been able to develop into a successful brand since they lack product innovations.*** *(Interview Lüthje)*

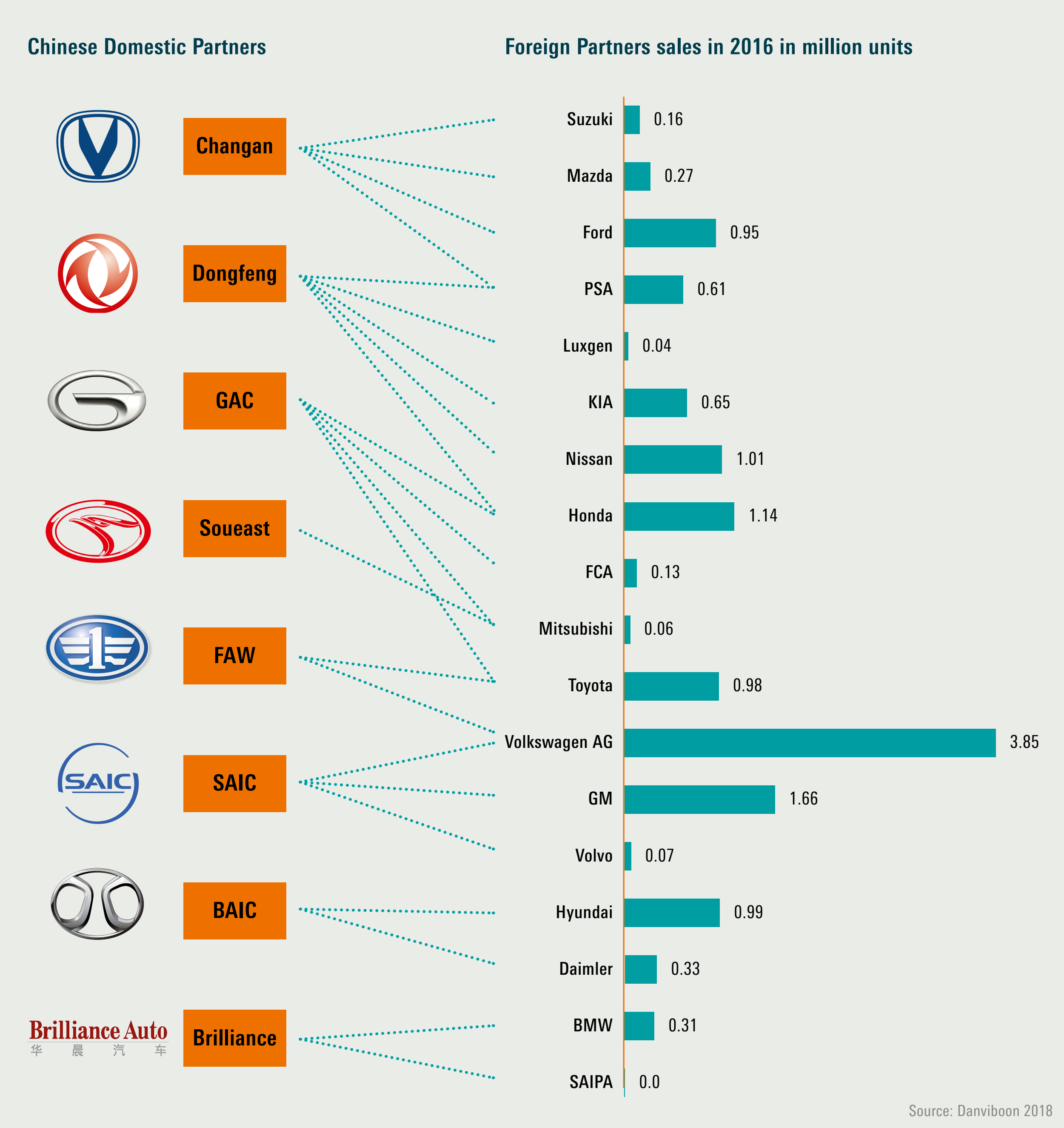
Now there has been a U-turn in China's industrial policy. It is no longer the SOEs that are expected to come up with product innovations but instead, the private or mixed-ownership companies (Lüthje 2019a). The results of the policy are particularly evident in the NEV sector, where many private sector companies that did not exist until recently have been able to successfully position themselves. These include conglomerates like BYD or Geeley, but also a number of start-ups like NIO, Li Autos, or Xianopeng. These are often financed by Chinese tech giants or venture capital and focus mainly on the premium or luxury sector that promises high returns. But, attracted by the high returns, other players are also entering the market, among them, companies like Foxconn, which has become well-known as a contract manufacturer for electronics companies such as Dell or Apple. Within a matter of a few years, it has become a "key player" (Lüthje) in the Chinese automotive industry and recently presented its own electric car platform. Foxconn also maintains numerous cooperations with Chinese OEMs and develops smart cockpit solutions for Stellantis (Pertschy 2021).

Lüthje suggests there has been a "significant change in the power structure of the Chinese automotive industry" (Interview Lüthje) which has put ever greater pressure on many international car companies that the Chinese market has become hugely important for in recent years. Chinese market leader VW, for example, has had a market share of 14 to 15 percent in recent years. In the NEV segment, the Wolfsburg-based company is not even among the top 10 despite launching several models in the VW ID electric series (Heide 2022). As reported by the trade portal Automobil Industrie, the Chinese start-up NIO sold more e-cars in China in March 2022 than Audi, BMW, and Mercedes-Benz combined (Borg 2022a).

### 5.1.3 Trade Unions and Other Social Actors

Trade unions in China are certainly not the kind of free trade unions that we imagine in the West. Nevertheless, it would certainly lack understanding to imagine them entirely as mouthpieces of party and state leadership. With the rapidly growing working class in China, there is an obvious strategic need for the international trade union movement to engage more intensively with struggles and organizations in the country. As yet, however, very little is clear and as the IndustriALL Global Union points out: "As far as we can tell, China is a black box". Cooperation or even a simple exchange with the Chinese state trade unions is practically non-existent. Lüthje points out that the already weak trade unions are struggling further in the growing NEV sector. For one thing, the MIC 2025 action plan, unlike similar industrial policy initiatives,

Figure 25: **Joint Venture Links Between Chinese and International Car Producers and their Car Sales**




Source: Danviboon 2018

does not include social, labour, urban, or environmental policies as is usually the case:

> *Most conspicuously, the Ministry of Labour and Social Security, the Ministry of Education, the All-China Federation of Trade Unions, and other mass organizations, as well as the experts associated with them, are essentially absent from the drafting and implementation of the programme.*
>
> *(Lüthje 2019b)*

Furthermore, unlike with the SOEs, the state trade unions hardly play any role at all in the new players' factories and unionized joint ventures are also experiencing conflicts as they switch to producing electric cars. This can be seen in the Volkswagen joint venture FAW-Volkswagen in Changchun. In 2017, the changes that took place there led to a massive labour dispute with agency workers who were demanding the same pay for their work as permanent employees: "The ever greater pressure on core workers may be exacerbated by the fact that most foreign car manufacturers have established new joint ventures or cooperation agreements with smaller Chinese car manufacturers to produce NEVs, as is the case with the joint venture between Volkswagen and JAC" (Lüthje 2019a: 18).

## 5.2 EUROPE: EU CLIMATE POLICY, GERMAN AUTOMOTIVE INDUSTRY, EASTERN EUROPEAN INTEGRATED PERIPHERY

At the centre of the current transformation dynamics of the European automotive industry are the German transnational manufacturers VW, Daimler, and BMW. The importance of the automotive industry for employment and industrial added value is — perhaps with the exception of Japan (see chapter 5.4) — not as great in any of the large capitalist economies in Europe or globally as it is in Germany. As such, it is unsurprising that the double transformation is a topic of considerable discussion in Germany.

The German car industry had attempted to meet the EU emissions standards by technologically improving the diesel engine, but the technology came up against objective limits. Illegal manipulations of engine control and exhaust gas purification made it possible to comply with the specifications but only during the actual test. The "diesel scandal" that was made public in 2015 following an investigation by the US Environmental Protection Agency, primarily revolved around VW, but it later turned out that Daimler, BMW, and other manufacturers and suppliers were also involved. The result: the diesel strategy had failed on a grand scale.

The tightening of European emissions directives and the prospect of rising sales in China have led OEMs to radically shift their course over the past few years and almost completely rely on BEVs for their profit. In this context, the European automotive industry is looking to maintain its position as the second most important production region in the world and, in particular, not to be marginalized in the strategic growth market that is China. With this in mind, the EU Commission has adopted and implemented a series of political regulations and support strategies, including the creation of European battery factories to reduce the current dependence of European manufacturers on Asian suppliers.

Nevertheless, the challenges remain: on the one hand, we have the unresolved question of whether the traditional OEMs are even capable of catching up with the technological lead that Tesla and the new Chinese manufacturers have already created. On the other hand, the key question for employees is whether and what quality of jobs can be secured. In addition to the technology-related job losses, especially in the drivetrain sector, we are seeing many indications that the transformation will further exacerbate the trend that has existed for decades of moving production and employment to Eastern Europe, also spreading it to EU-neighbouring states such as Serbia and Ukraine, at least in so far as it is still possible for Ukraine following the Russian war.

### 5.2.1 Profile of the Region

Around 15.8 million cars were produced in the EU in 2019. Together with the rest of Europe, the EU is the second most important production region for cars after Asia. The automotive and automotive supply industry employ around 3.5 million people. According to industry estimates, a total of around 12 million direct and indirect jobs are linked to the automotive value chain (ACEA 2022a, 2022b). By far the largest player is Germany. This applies both to the number of cars produced (Kords 2021a) and to the number of people working in the industry (assembly and suppliers), which is currently around 919,002 — more than three times as many as in France which has around 238,666 (ACEA 2022a, 2022b) (see Figure 26, next page). However, employment figures differ depending on methodology. According to the German Federal Statistical Office, 786,109 people were employed in the automotive industry in 2021, around a third of them with suppliers and external service providers. The number of jobs directly dependent on the sector is certainly significantly higher, at around 1.6 to 2.2 million once upstream and downstream value-added sectors are taken into account (Blöcker 2022: 7).

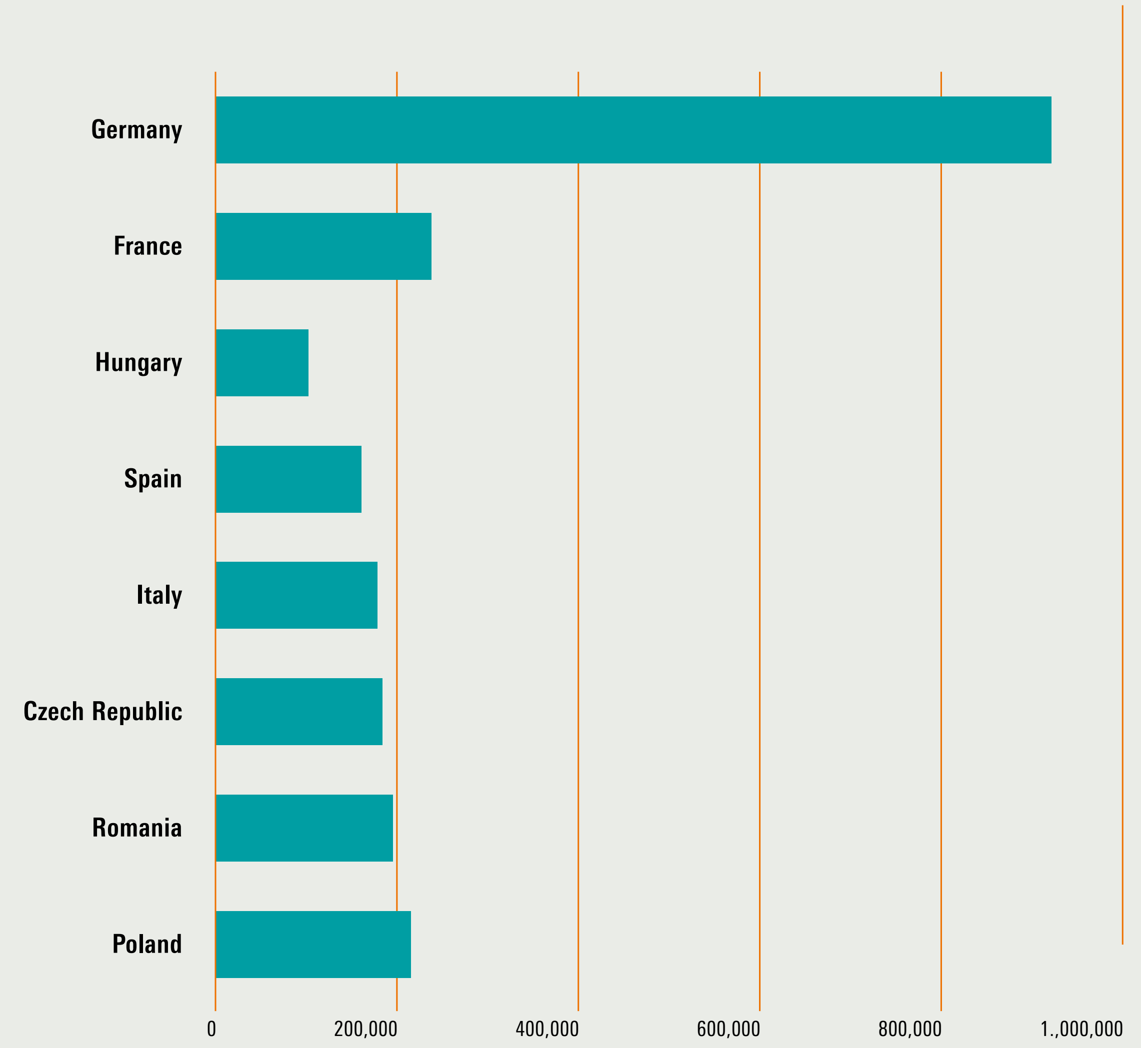
With a global turnover of around EUR 440 billion and a share of around five percent of the total gross value chain, the automotive industry is Germany's largest industrial sector. Its significance for Germany's economic strength, employment, and innovative capacity can hardly be overstated. At almost 20 percent, its share of the industrial value chain is "higher than in other countries with significant automobile production such as South Korea, Japan, the USA, or Italy" (Köncke 2022: 124) and is about four times as high as in France or Italy.

In a recent groundbreaking study, Antje Blöcker highlights four characteristics seen in the German automotive industry:

**(1)** A **"drifting apart of domestic and foreign production"** that has been clearly evident for at least the last decade (Blöcker 2022: 7). As of now, more than twice as many vehicles are being produced at the German OEMs' foreign locations (eleven million) than at domestic locations (4.7 million) (ibid.) (see Figure 27, page 41).

**(2)** A **hierarchical and pyramidal structure of relationships between OEMs and suppliers**: at the top are

Figure 26: **Automotive Jobs in Various EU Countries in 2021**




Source: [ACEA 2022b]

the German end manufacturers Audi, BMW, Daimler, Porsche, and VW, as well as the US based Ford Group and Opel, a subsidiary of the Stellantis Group (PSA, Fiat Chrysler from 2021). Closely linked to them are the most important system suppliers of the first tier "Tier 1" — large technology experts such as Bosch, Continental, ZF, and Mahle. These are followed by other second, third, fourth-tier suppliers. The pyramid is based on industry-related services, simple just-in-time assembly and producers of mass components and parts. Within this structure, that has been perfected since the turn of the millennium, the OEMs set the tone. They and can put pressure on suppliers in tenders by pushing the prices which this tends to be passed on to the supplier's employees. The further "downstream" you go in the pyramid structure, the worse the pressure. This outsourcing of even highly specialized components and development services, that has increased over the years, has led to a loss of innovative capacity among OEMs. It is now the suppliers that have taken up the role of "innovation drivers" however, it is a division of roles that is now being re-negotiated under the auspices of the double transformation (Schwarz-Kocher/Stieler 2019: 48).

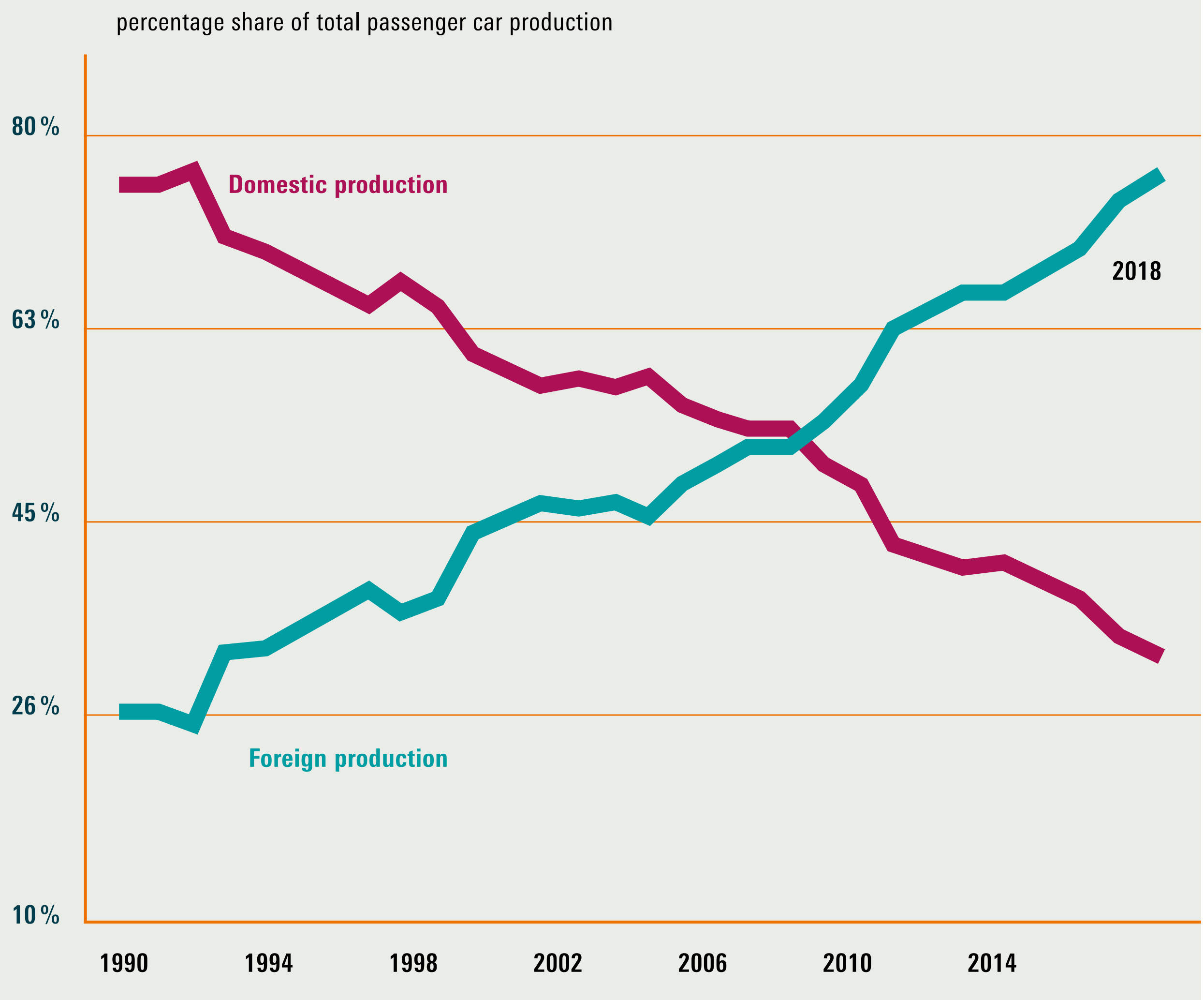
**(3)** The strong **dependence among German manufacturers on the premium sector** with its high-priced, large, heavy, and technology-intensive (diesel) vehicles, whose sales are highly dependent on institutional customers. Blöcker rightly emphasizes that this results in a path dependency: "More than 75 percent of diesel vehicle sales have mostly hinged on institutional buyers, with the technology relying on government and company car fleets" (Blöcker 2022: 7). The diesel share of new registrations has fallen sharply in recent years, though.

**(4)** There is also the **high spatial concentration of automotive clusters** in the federal states of Bavaria, Baden-Württemberg, and Lower Saxony, where the corporate headquarters of BMW, Audi, Daimler, Porsche, and Volkswagen are located, and in Saxony with plants belonging to VW, Porsche, BMW, and Daimler (or rather their battery subsidiary Accumotive). In the future, the Berlin-Brandenburg region is also likely to gain in importance with Tesla setting up its new factory near Berlin and other battery manufacturers moving to the area (Blöcker 2022).

A decisive characteristic of the German automotive industry is its global character. Yet the image often portrayed of Germany as an "export world champion" is misleading as by far the largest share of German cars is not only sold abroad but is also produced there. Or, more precisely: value creation by German car manufacturers has been predominantly taking place abroad for about a decade and a half, with the "tipping point" possibly being the 2008/09 financial crisis (see Figure 27).

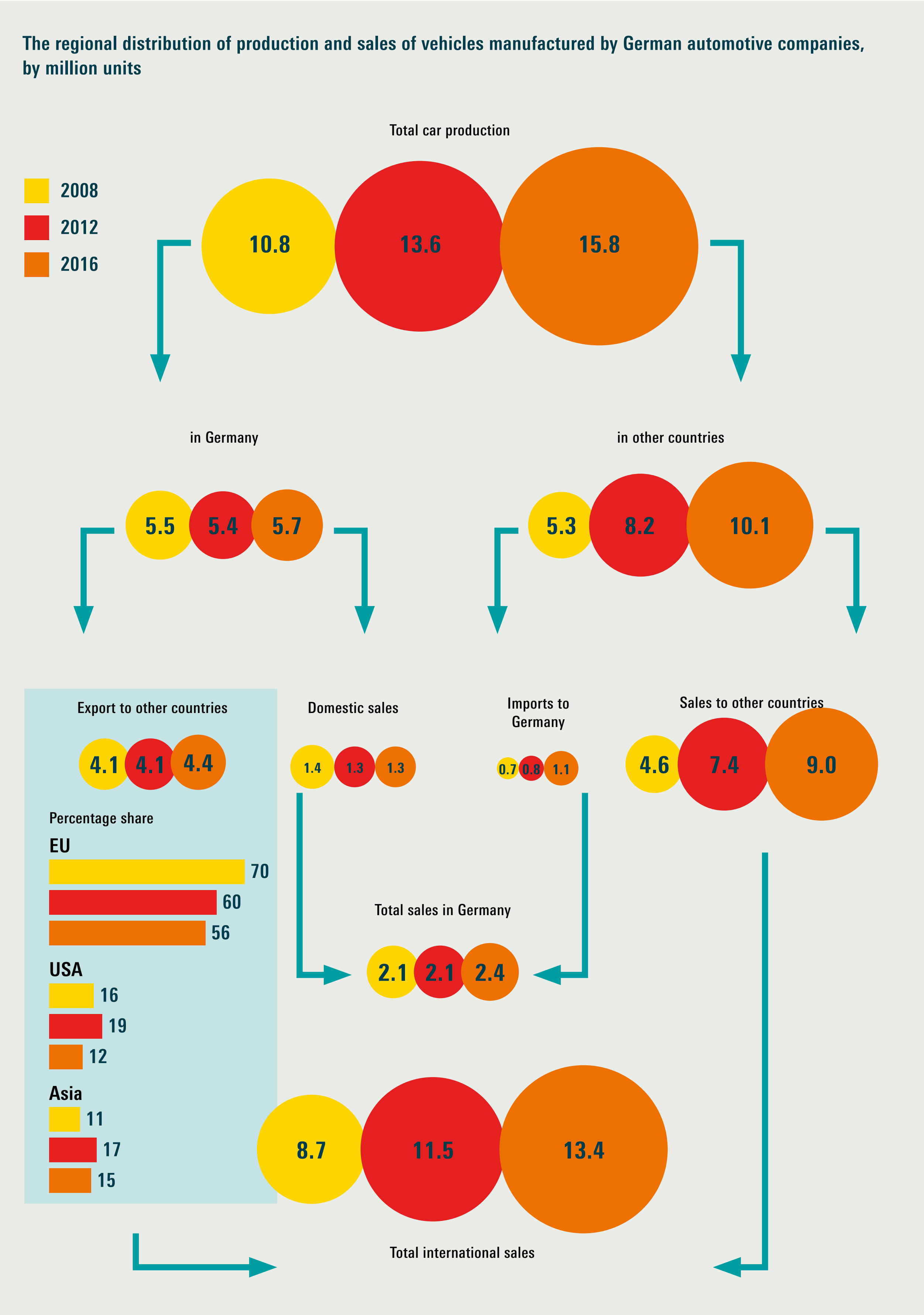
In addition to the development of production facilities in the USA and China, driven by a "local for local" concept, the region of Central and Eastern Europe is of particular importance for the German automotive industry because of its geographical proximity to the main factories. Since the 1990s and increasingly since the turn of the millennium, "best cost countries" such as Poland, the Czech Republic, Hungary, and Romania have developed into important production locations for Western European — and in particular German — end manufacturers, and their suppliers and have become part of transnational production networks.

Figure 27: **Domestic and Foreign Production of German OEMs**




Source: Köncke 2022:130

Figure 28: **Foreign Dependence of the German Automotive Industry**

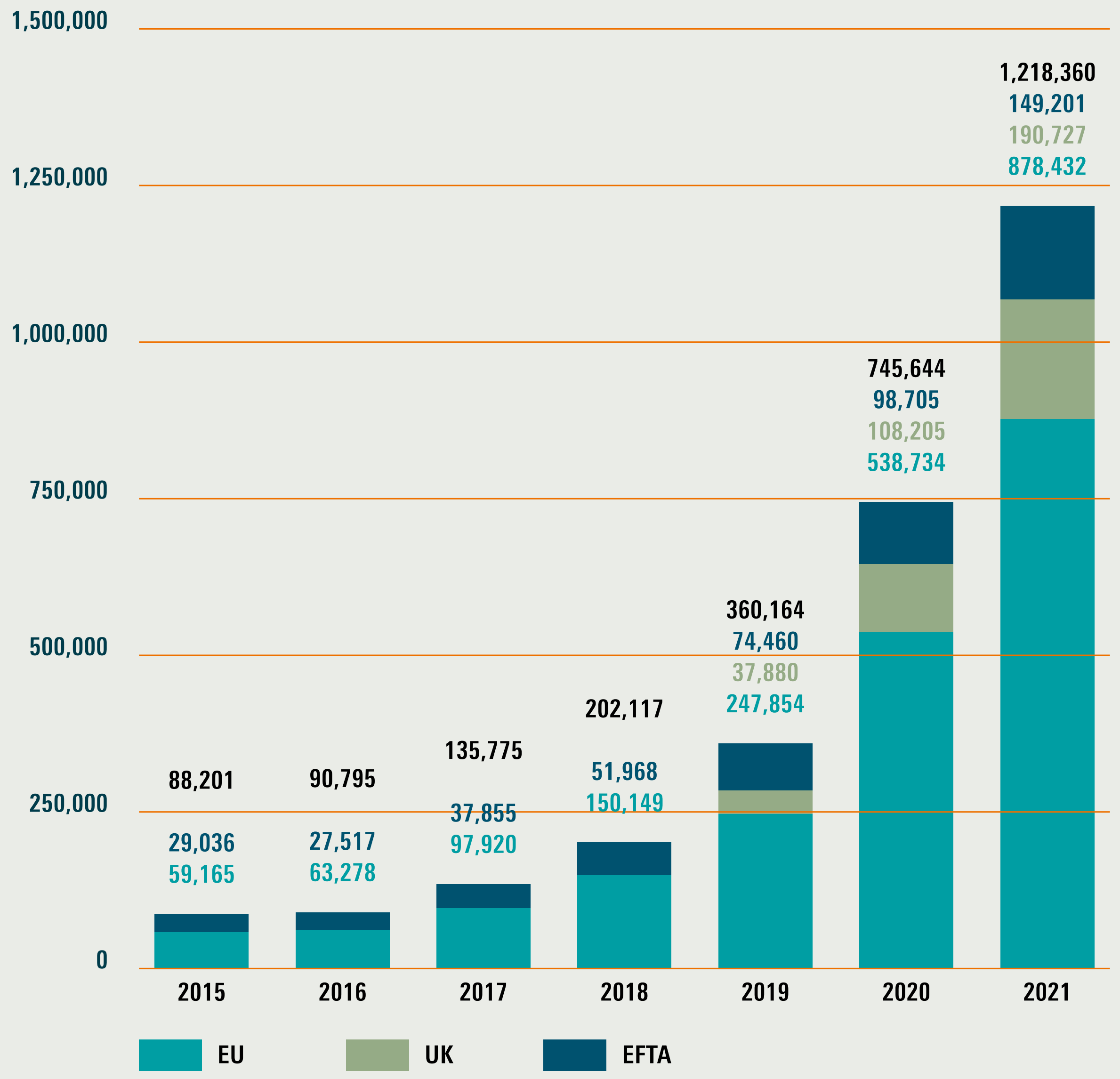



Source: Bormann et al. 2018:8

### Europe: saturated market for combustion engines, but growing share of electric vehicles

In total, around 11.7 million cars were registered in Europe (EU, European Free Trade Association, and United Kingdom) in 2021. This is a share of around 17 percent of global new registrations or 70.6 million (Statista 2022c), but the European market is largely saturated. Therefore, as an innovative product linked to the lifestyle needs of an affluent and "eco-conscious" middle class, e-vehicles are also an opportunity for manufacturers to create the "next wave of capitalist consumer goods to follow the diesel era" (Köncke 2022: 159). The share of e-vehicles in European new registrations was around ten percent or 1.2 million in 2021. In total, there were around 337 million cars on Europe's roads in 2021. Of these, around one per cent are BEVs, 3.2 million. However, their share among new vehicles is growing exponentially.

Figure 29: Number of Newly Registered BEVs in Europe from 2015–2021




Source: Statista 2022d

### 5.2.2 Industrial and Funding Policy on Electromobility

Building on the Paris Agreement of 2015, it is the European Commission's carbon emissions targets that are a key driver for the European automotive industry's change of course in favour of electric propulsion. The average carbon emissions of a manufacturer's newly registered cars and light commercial vehicles are not allowed to exceed a legally set limit per kilometre driven. While the EU set the figure at 130 grammes of $CO_2$ in 2015, it was reduced to 95 grammes in 2021. A binding interim target with a reduction target of 15 percent has been set for 2025. From 2030, average fleet emissions may only be 59.4 grammes of $CO_2$ per kilometre (Ofallinger/Harloff 2017).

The car manufacturers themselves are responsible for calculating their fleet's emissions. So-called super credits were negotiated for electric cars that allow the sale of an electric car to disproportionately reduce the total fleet consumption. Electric cars are counted twice, as are plug-in hybrids that emit below 50 grammes of $CO_2$ per kilometre (EU Parliament 2014).

The model has been the subject of criticism for years because it allows the German OEMs in particular, with their high market shares in the premium sector, to continue pushing oversized 4x4s onto the market thanks to the super credits they earn for their electric cars. There is also criticism that the $CO_2$ fleet assessment mechanism does not take the electricity consumption, weight, and performance of electric cars into account meaning:

> ***"an electric SUV weighing over two tonnes like the Volkswagen ID.4 makes it possible for VW to continue selling combustion SUVs like the Tiguan.*** *(Blöcker 2022: 8)*

In addition, the European Union and individual European governments are promoting the purchase of electric vehicles, the setting up of charging stations, and research and development into electric vehicles and the supporting infrastructure. The most important European initiative is the European Battery Alliance project involving twelve EU member states. The Important Projects of Common European Interest (IPCEI) promotes the development of a European battery cell production that is to be supported with subsidies amounting to EUR 2.9 billion (European Commission 2021). The most recent political decision has been the agreement of EU environment ministers in June 2022 to no longer allow new cars with combustion engines in the European Union from 2035. A final regulation still needs to be negotiated with the EU Parliament, but it is considered a certainty (dpa 2022).

### 5.2.3 Corporate Strategies

All OEMs have now responded to the challenges with their very own strategies. These include forming alliances, in part with other OEMs, but also with IT companies or mobility service providers. These alliances are less about acquisitions or mergers and more about "pooling resources and funding, spreading risk, and building specific expertise to accelerate product launches and achieve rapid cost reductions" (Köncke 2022: 172).

In terms of drivetrain technology, VW, BMW, and Daimler are each pursuing their own plans for the successive electrification of their model ranges and are investing large sums in developing battery cell technology and establishing their own production capacities (see chapter 6.1). Figure 30 provides an overview of the important German OEMs' transformation strategies. VW is leading the way and aims to become the market leader in BEVs by 2025. By 2026, a quarter of all cars sold by the group will be electric. VW plans to invest EUR 89 billion in electromobility and digitization, which is about 56 percent of total EUR 159 billion investments (VW 2021b).

### 5.2.4 Central and Eastern Europe: Integrated Periphery as a Boom Region

Once the Iron Curtain had fallen, Central and Eastern Europe become important locations for German automotive companies to set up shop, both as end manufacturers and suppliers. The main reason for this is labour costs that – according to figures published by the German Association of the Automotive Industry – were far below those in Germany and still are, despite catching up gradually: while a worker in Germany costs almost 56 euros per hour including taxes and other employer contributions, in the Czech Republic the cost is 17 euros, in Slovakia 15 euros, and in Romania only nine euros (VDA 2021).

According to calculations by economic geographer Petr Pavlinek, since 1991 the main part of production in the European car industry has shifted from Germany and Western Europe, excluding Spain and Portugal), to the "integrated periphery" which includes Central and Eastern Europe, Spain, Portugal, Turkey, and Morocco as well as the "unintegrated periphery" of Russia and Ukraine (Pavlinek 2022) (see Figure 31).

According to Pavlinek, the creation of new jobs in the European automotive industry is mainly driven by transnational corporations in the core automotive countries, especially Germany and France, although any new jobs that are being created are almost exclusively located in the Central and Eastern European periphery, as Figure 32 (page 46) shows.

Figure 30: **E-strategies of Important German OEMs**

| Audi | Volkswagen | Daimler | BMW |
|---|---|---|---|
| From 2026, only new **BEV models** (no further development of combustion models) | By 2030, **BEV share** of VW brand sales 70 percent (at least 50 percent of the Group) | **BEV share** of all Daimler sales 50 percent by 2025, from 2025, only development of BEV models | By 2030, 50 percent **BEV share** of BMW production/ sales |
| End of **combustion engine** production 2035<br>Local production of internal combustion engines for markets such as China and South America | Exit from business with **combustion-engine vehicles** in Europe between 2033 and 2035. No exit timeframe for other regions | 2030 phase-out of **combustion engine production** in the EU; but possible local production in other countries | BMW rejects fixed date for phasing out **combustion technology** |
| | **Development** of own BEV system with six **battery factories** in Europe, in cooperation with Northvolt and Gotion, among others | Own **battery production** and cooperation with Stellantis and Total in **battery production** | Aim to **develop own batteries** |
| | | Opening of a competence centre for research and **development of batteries** and battery cells in Stuttgart-Untertürkheim announced for 2023 | As per 2022 announcement, competence centre for **battery cell production** to be opened |
| | By 2040, the entire VW car fleet is to be **carbon-neutral** | At the 2021 World Climate Summit in Glasgow, Daimler committed to producing only zero-emission new vehicles from 2040<br><br>Entire fleet to be **carbon-neutral** by 2040 | |

Sources: Lechowski/Krzywdzinski 2022; Lang et al. 2022; Reimann 2021; Wehner 2022; Mercedes-Benz Group 2022

Figure 31: **Production Share Shift in the European Automotive Industry from the Core Countries to the Periphery**

| | Core automotive countries<br><br>(Western Europe without Spain and Portugal) | Integrated and unintegrated periphery<br><br>(Spain, Portugal, Central and Eastern European EU states, Turkey, Morocco, Russia, Ukraine) |
|---|---|---|
| 1991 | 74 % | 26 % |
| 2020 | 54% | 46 % |

Source: Pavlinek 2022

**Figure 32: Job Development in Different European Regions from 2005–2016**

| Job creation vs. job losses | |
|---|---|
| Western Europe | - 254,317 |
| Central and Eastern Europe | + 237,935 |
| Net job losses in the EU plus Norway | - 16,382 |

Source: Pavlinek 2022

As stated by the companies themselves, the main motivators are lower labour and energy costs, but also lower corporate taxation. As Pavlinek learnt during a series of interviews with European automotive managers: "Job creation is being driven by the transnational corporations in the core countries, but those jobs are almost exclusively in Eastern Europe" (Pavlinek 2022).

Transnational companies are also essentially responsible for the reduction in job numbers, although in this case it affects the core countries: "German and French companies are basically destroying jobs in their home economies" (Pavlinek 2022):

*84 percent of the job losses with German car companies were in Germany.*
*88 percent of the job losses with French car companies were in France.*

According to Pavlinek, the electrification of the drivetrain will not "fundamentally change the existing geographical structure of the European automotive industry", but instead "reinforce existing trends". However, overall "we are likely to see a slower introduction of mass production of electric vehicles than in Western Europe" (ibid.).

### "Slave labour" in the EU's "non-integrated periphery"

The "third-tier countries" belonging to the "non-integrated periphery", such as Ukraine or Serbia, feature much less in the Western European media than the production sites in the Central and Eastern European EU states. The importance of Ukraine, for example, for the labour-intensive production of cable harnesses only became clear to a wider public in Germany when, following the Russian invasion, there were supply bottlenecks affecting production in Germany from the end of February 2022. According to an industry analysis, in early 2022, around seven percent of all wiring systems for the EU automotive industry were manufactured in Ukraine (Gaupp 2022). One can generally say that the non-integrated periphery is so interesting for the industry precisely because it is located outside the EU and therefore subject to less stringent regulatory standards relating to labour and the environment. In this context, Eastern Europe expert Tibor Meszmann refers to the example of Chinese tyre manufacturer Linglong in Serbia, one of the 20 largest producers in the industry globally, that supplies Volkswagen, among others:

> *"It is worth noting that this is a kind of production that is being increasingly restricted in China for ecological reasons. China is pursuing a similar protectionist policy on environmental issues as the EU, with the dirtiest sectors of industry being moved out of the country. Production has not yet started in Serbia but there have already been huge protests against the company. Linglong hit the headlines because the subcontractor building the factory was employing Asian migrant workers who did not have work permits. The migrant workers, mostly from Vietnam, had come on tourist visas. Local NGOs documented the migrant workers' living conditions and argued that there was enough evidence of labour exploitation and violations of human dignity that the work amounted to forced labour.*
>
> (Interview Meszmann)

### 5.2.5 Trade Unions and Other Social Actors

In Germany in particular, "the sector also acts as a stronghold for wage earners to organize their movement" and "is regarded as setting the standard in which industrial labour relations are shaped" (Köncke 2022: 119). To a lesser but still relevant extent, this also applies to countries such as France, Italy, and Spain.

IG Metall expects tens of thousands of jobs in the metal and electrical industry to disappear over the next few years. Their 2020 employee survey revealed that more than half of the companies have announced plans to cut jobs, particularly in the automotive industry. In this sector alone, the union estimates that 50,000 jobs are threatened in the short term and that a further 180,000 jobs are at risk (IG Metall 2020b). To prevent mass dismissals on such a scale, the union has developed a concept based on the "ecological, social, and democratic transformation" of industrial society (here and following IG Metall 2020a) and centred around qualification, decarbonization, expansion of renewable energies, electromobility, expansion of local public transport, and rail transport. Companies are to invest in carbon-neutral technologies and the state is called upon to provide the infrastructure that permits a climate-friendly economy. Citizens would be unable to avoid changing many of their consumption and lifestyle habits. As stated by IG Metall, the change would, however, "only meet with acceptance if the interests of the employees are taken into account".

Electromobility is seen as the pivotal development in the transport transition, with the electricity to operate them coming from renewable energy sources. The state should promote and advance the nationwide expansion of the charging infrastructure for e-mobility. According to IG Metall, "modern diesel and petrol cars are indispensable as a bridging technology" in such a scenario. According to the union, other types of propulsion are more likely to play a role in the commercial vehicle sector in the medium and long term, in particular with fuel cells or combustion engines using synthetic fuels generated by electricity from renewable energies.

IG Metall considers a carbon tax for fossil fuels to only be workable as "part of a whole bundle of climate protection measures". It can only provide an incentive for more climate-friendly economic activity and living "if there are alternatives that allow such a way of life". Without such alternatives, the measure would only lead to rising living costs for people who have limited choices, and therefore dwindling acceptance of climate-protection measures. IG Metall rejects driving bans for cars as long as there are no alternative offers for affected commuters. In this context, IG Metall explicitly calls for "a massive expansion of the rail network and public transport as well as the charging infrastructure for electromobility". At the same time, "massive investments in additional trains and carriages" are needed. Metropolitan areas need the supply of underground trains and trams to be expanded. A well-developed public transport system is the prerequisite for making transport more climate friendly. Especially in rural areas, where many commuters currently have no choice but to travel by car. For commuter traffic, IG Metall is calling for shuttle concepts that would connect large companies and city centres to transport hubs.

Further to the threatened jobs, especially in the field of conventional drivetrain technologies, IG Metall also perceives the ecological transformation as causing positive employment effects, as in the railway industry, in the wind industry, and in battery production. It is prerequisite that companies "pursue sustainable business models and qualify their employees accordingly". At the same time, the state has to promote further training and offer employees security if they lose their jobs. Ecology and social security should not be played off against each other: "If climate protection translates into job losses, it will not succeed".

In practice, however, IG Metall's attitude towards the strategies pursued by the automotive industry in recent years has been fundamentally positive. According to Blöcker, IG Metall's position on electromobility has changed over time: "Initial scepticism was followed by an open commitment to the car manufacturers' e-strategy". (Blöcker 2022: 29) Blöcker summarizes IG Metall's current position in the form of these "eight facts and demands":

> " ***(1) All major importing countries for cars from Germany switch to e-cars. (2) The ranges are sufficient and the batteries are improved. (3) Battery performance increases, raw material and energy prices decrease. (4) There is enough electricity for everyone. (5) BEV cars cause fewer GHG emissions. (6) A socially just expansion of e-mobility is possible. (7) Synthetic fuels and hydrogen only make sense for commercial vehicles and shipbuilding. (8) The mobility revolution happens. It is not the climate movement and EU limits that are to blame for the end of the internal combustion car, but the environmental pollution caused by the constant growth in car traffic.*** *(Blöcker 2022: 29)*

The increasingly important production networks of the integrated periphery in Central and Eastern Europe also play a strategic role for IG Metall both explicitly from a trade-union-policy perspective and in view of the erosion of labour rights and protections. IG Metall cites Hungary as an example as it has developed into a "testing ground for the German car industry" in recent years (IG Metall 2016). In this context, it is less about technical and more about operational innovations: on-call work, pay systems that lack transparency, flexible and excessive working hours such as twelve-hour shifts, things that are either not legally permitted in Germany or would be difficult to enforce. At the same time, the transnationalization of production has a feedback effect on the German parent plants due to "benchmarking" between the global production sites: "The workforces of the individual locations become […] competitors for work packages" (Köncke 2022: 132).

From a trade union perspective, the fact that trade unions and collective bargaining coverage are weak is not something that simply happened. As Luc Triangle, General Secretary of IndustriALL European Trade Union stated in an interview: "In the wake of the 2008 financial crisis, good structures that had previously developed were destroyed, by the troika and the EU Commission, and deliberately so". At least now, trade unions are trying to counteract it. For example, IG Metall and the Hungarian Metalworkers' Federation VASAS have opened joint offices in Györ and Kecskemét. The international services union UNI Global Union runs its Central European Organizing Centre (COZZ) from Warsaw, and with the support of Scandinavian trade unionists, Lithuania and Estonia set up the Baltic Organising Academy in 2012. As yet, however, all these approaches are only affecting a small area. There is no real shift in the balance of power in favour of the trade unions in Central and Eastern Europe.

According to those on the ground and experts close to the trade unions, Eastern European trade unions in particular lack the resources to be able to shift the balance of power: Meszman states that all "unions are struggling with a lack of capacity, even for the day-to-day running of their usual operations. […] The number of paid experts and paid representatives of the trade unions is shrinking year-on-year" (Interview Meszman). Marika Varga, who works in IG Metall's Transnational Partnership Initiative and the Hungarian metalworkers' trade union VASAS considers the fragmentation of the Hungarian trade union landscape into a multitude of federations and company trade unions to be a structural problem:

> ***"There are six umbrella organizations, three of which in the private sector. Many companies have more than one company union, while others have no organization at all. Another big problem is that many company unions are not affiliated to any federation and only handle their own operational issues. They advertise with very low membership fees and are not interested in financing "apparatus" in Budapest that would coordinate trade union collective bargaining and company policy or take on an advisory role with company committees that are simply not managing on their own.***
>
> *(Interview Varga)*

All in all, it will remain a key strategic task of the international and especially the Western European automobile industry trade unions to support and advance the organization of trade union movements at Eastern European production sites. Approaches such as IG Metall's Transnational Partnership Initiative and VASAS, COZZ, or the Baltic Organising Academy are steps in the right direction but they will not be enough to decisively and sustainably change the huge imbalance of power in favour of dependent employees.

Especially in the field of lithium-ion battery production, we are seeing new starting points for trade union work emerge and as Lüthje points out: "The strategic links in the chain are the new battery factories in Eastern Europe" (Interview Lüthje). Unlike Asian battery manufacturers, Eastern European production sites are within the reach of the European metalworkers' unions and therefore, at least in principle, accessible to trade union organization. Whether such efforts will actually receive adequate resources and strategic planning, or be successful, are questions that currently remain unanswered.

## 5.3 NORTH AMERICA: THE US STRATEGY IN THE RACE FOR WORLD MARKET LEADERSHIP IN ELECTRIC MOBILITY

> ***"They [e-cars] are a vision of the future that is now beginning to happen, a future of the automobile industry that is electric — battery electric, plug-in, hybrid electric, fuel cell electric. It's electric and there's no turning back. The question is whether we'll lead or fall behind in the race for the future.***
>
> *(Joe Biden, President of the USA, 5 August 2021)*

> *"The UAW [United Auto Workers] is not focused on hard deadlines or percentages, but instead on protecting wages and benefits that are the heart and soul of the American middle class.*
> *(Ray Curry, UAW President, 5 August 2021, both cited in The White House 2021)*

For the Biden administration, electric mobility is a "Battle Royale" in terms of the technological competition between the USA and China. That is at least what Kristin Dziczek of the US Center for Automotive Research says. So, is it about beating China and being the number one manufacturing country? It is a perspective that may seem surprising: with the exception of Tesla and a few other start-ups such as Rivian, the major US manufacturers were even slower to adopt e-drivetrains than the Germans. In fact, 2020 saw only twelve BEV models produced in the US (Dziczek 2022). But a lot has happened since then, especially thanks to huge investments in charging infrastructure and tax benefits. The fact is that the US government under Joe Biden is determined to massively support the conversion of the US automotive industry to producing competitive electric cars and it is trying to secure the support of the trade unions. Unions quite rightly fear that labour standards and trade union enforcement power could be undermined in the race to becoming world leaders in the production of electric cars. In view of their own weakness that has built up over decades, they are therefore calling for protectionist measures and a subsidy policy that favours the purchase of "union-made" electric cars. It is a stance, however, that the US climate movement views sceptically, since it would slow down the pace of electrification and emissions reduction in the transport sector (ibid.).

### 5.3.1 Profile of the Region

Historically, the USA is the motherland of the modern automotive industry and currently the world's second largest sales market. Although the automobile was invented in Germany, it was in the USA that industrial mass production of cars began. Henry Ford introduced assembly line production in 1913. The resulting fall in price made his Model T or "Tin Lizzy" the first automobile that the masses could afford to buy. In 1929, 90 percent of all cars built worldwide came from the USA. The Great Depression ushered in a process of radical consolidation and following WWII, the US automotive industry was dominated by three major companies: General Motors, Ford, and Chrysler, all based right on the border with Canada in Detroit. Starting in the 1970s, the "Big Three" came under ever more pressure because of the oil crisis and international competition. In 2008, General Motors and Chrysler were forced to file for insolvency and required massive amounts of state aid to be saved. Chrysler later merged with Fiat, and FiatChrysler merged with PSA in 2021, forming the multinational Stellantis Group.

The US automotive industry has, since 1965, been closely tied to that of its neighbour Canada. The cornerstone of these ties was the 1965 "Auto Pact" (APTA) that lifted tariffs between the two countries. The agreement led to lower prices and higher production rates in Canada, particularly in southern Ontario, in the immediate vicinity of Detroit.

The second manufacturing nation that is closely intertwined with the US is Mexico. This relationship was fully established by the time that the North American Free Trade Agreement (NAFTA) came into effect in 1994 when the US market became closely linked to Mexico. What makes Mexico particularly interesting for car manufacturers is its combination of low wage levels, qualified skilled workers, and its proximity to the US market: "By manufacturing in Mexico, car manufacturers can count on a highly skilled, low-cost workforce that is technically trained to execute a variety of processes. The average hourly wage of an assembly line worker on a fully equipped line in Baja California is $ 2.60 per hour". These are the advantages as stated unabashedly in an advert designed to point out the advantages of its Mexico produced by a management consultancy specializing in Mexico (Co-Production International 2022). Such conditions attract investment in production capacity and are a trend that is continuing as part of the current transformation.

### 5.3.2 Industrial and Funding Policy on Electromobility

The Trump administration held a rather hostile view of e-mobility and made several, albeit unsuccessful, attempts to eliminate tax benefits for the purchase of electric cars that had been introduced under Obama. A 180-degree turnaround came with the Biden administration. On 5 August 2021, in the presence of representatives of the major car manufacturers — General Motors, Ford, Stellantis, and the United Auto Workers (UAW) — the President unveiled his administration's plans for up to 50 percent of cars sold in the US to be "emissions-free vehicles" by 2030. While the target is non-binding it is shared by the car companies (Reuters Media 2021).

To achieve these goals, the US government wants to invest USD 7.5 billion to expand charging infrastructure. The plan is to set up half a million charging stations nationwide. The funding is part of an Infrastructure Investment and Jobs Act passed by Biden in November 2021, that also provides USD 550 billion in investment in roads and bridges (DeFazio 2021). The law is part of

### Mexico — an 'integrated periphery'

With a production volume of 3.1 million vehicles in 2021, Mexico is the second-largest car-producing nation in the Americas after the US and ranks 7th globally, just behind Germany. Mexico is the world's fourth largest car exporter. More than half of the vehicles produced there are exported to the USA and Canada. The country's supplier industry is highly developed technologically and it also has research and development locations (International Trade Administration 2022). According to Timothy Sturgeon, who researches the automotive industry at the Massachusetts Institute of Technology (MIT), this makes Mexico part of the "integrated periphery" of the global automotive industry. Sturgeon's view is that Mexican prospects in the current transformation are significantly better than those of the geographically more remote markets in Argentina, Brazil, or South Africa (Pavlinek 2022; Sturgeon 2021).

Mexico's President Andrés Manuel López Obrador made headlines in early 2022 when he announced his intention to set up a state-owned company to extract lithium: "We do not want to be an area of conflict between foreign powers. Neither Russia nor China nor the United States will benefit from the mineral, but Mexico will" (Knobloch 2022). Mexico has large lithium deposits, of which only a fraction have been developed. The intention is to protect the metal as a strategic raw material for national development in the Mexican constitution.

Canada: here, the automotive industry is made up mainly of assembly plants belonging to US and Japanese manufacturers, and a diverse supply industry, mainly in Ontario. The region is closely linked to US manufacturers around Detroit. Magna International, one of the world's most important automotive suppliers, is headquartered in Canada. Canada was ranked 15th among producing nations in 2021, with 1.1 million cars produced, of which about two thirds were commercial vehicles.

the comprehensive Build Back Better Plan, a total public investment programme worth USD 1.75 trillion, of which parts are currently being blocked by Republicans and some Democrats in the Senate. Provisions included a USD 7,500 subsidy for the purchase of BEVs and plug-in hybrids and an additional USD 4,500 for electric vehicles built in domestic and unionized factories (Yarmuth 2021). In the USA, both of these preconditions are highly politically and legally controversial. The objective is also shared by the UAW. Experts are, however, rather sceptical considering the chances of getting the political backing to implement these plans.

### 5.3.3 Corporate Strategies

The pioneer in the development and production of electric cars is **Tesla**, a company founded in California in 2003. Tesla became the first car manufacturer to exclusively produce electric vehicles in large series and in as early as 2004 Venture capitalists bought in on a large scale. The Tesla Roadster model, that was built from 2008 to 2012, was the world's first electric production vehicle with a lithium-ion battery. Tesla has since produced a total of more than 1.3 million battery-electric cars. The company went public in 2010, managing to be in the black for the first time in 2020. Tesla sold more than 930,000 electric vehicles in 2021 (Deutsche Welle 2022), making it the world's largest manufacturer of electric cars, ahead of BYD and Volkswagen. By the end of 2020, Tesla said it had more than 99,000 employees worldwide, of which an estimated two-thirds were in the US. That Tesla largely forgoes state subsidies is a myth that company founder Elon Musk puts a lot of energy into cultivating. According to 2015 research by the *Los Angeles Times*, his companies Tesla Motors, SpaceX, and Solar City had received USD 4.9 billion in subsidies, including a USD 1.3 billion grant from the state of Nevada for a battery factory near Reno (Hirsch 2015).

The Big Three and the foreign manufacturers that are based in North America are also pursuing their own electric strategies in the region. **General Motors** (GM) is accelerating its shift towards electric mobility with plans to launch 30 all-electric models worldwide by 2025. As such, the group has plans to invest USD 27 billion, EUR 22.75 billion, in electric and automated vehicles. By the end of 2025, GM aims to have production capacity for more than one million electric vehicles in North America, including in Spring Hill, Tennessee, Ingersoll in Canada, and Ramos Arizpe in Mexico. In cooperation with LG Energy Solution, GM is operating the **Ultium Cells** joint venture to produce battery cells, including in Lansing, where there are plans to create 1,700 jobs (electrive.net 2021a). In 2021, GM began converting its plant in Ramos Arizpe, Mexico, to produce electric cars. It was the production site for the Chevrolet Blazer and Equinox combustion models, but they were to be discontinued by May 2022. GM plans to invest USD one billion on adapting the factory to the manufacture of electric vehicles. Initially, it will produce battery packs and electric motors, and entire cars from 2023 (electrive.net 2022b).

**Ford**, the second-largest US car manufacturer, has announced its intention to switch 40 percent of its car production to BEVs by 2030, for which it plans to invest USD 30 billion over the next four years, five billion as early as 2022. By 2026, Ford aims to sell more than two million e-vehicles annually worldwide, amounting to about one-third of all global Ford car sales (Sattler 2022b).

**Stellantis** plans to launch several electric 4x4s in the US over the next few years, among them the Dodge and Jeep brands. By 2030, the Group aims to achieve 40 percent of its sales in the USA with "low emission vehicles" (electrive.net 2021d).

**Volkswagen** has ambitious plans for the US. VW plans to launch more than 25 new electric car models in the US by 2030. From autumn 2022, the ID.4, that has thus far only been manufactured in Zwickau, Germany, is due to roll off the production line in Chattanooga, Tennessee. In the 2030s, Volkswagen wants to move entirely away from vehicles with internal combustion engines in the USA. VW plans to convert its plants in Mexico, the assembly plant in Puebla and the engine plant in Silao, to e-mobility as early as the mid-2020s. In addition, VW wants to push ahead with the establishment of a battery cell production facility in the USA. Part of these plans is to establish a new test and development laboratory for battery cells that is set to begin operations in Chattanooga in mid-2022 (electrive.net 2022a).

### 5.3.4 Trade Unions and Other Social Actors

At its all-time high in 2019, the automotive industry in the US was employing more than a million workers. By 2021, the number had dropped to 916,200. In Canada, 125,000 people are employed mainly in vehicle assembly and parts and components manufacturing. In Mexico, more than one million people work in the automotive sector.

The most important union in the North American automotive region is the UAW, with strongholds in the assembly plants of the Big Three. UAW is not yet represented at Tesla and, according to experts, has little chance of getting a foot in the door in the foreseeable future. A combination of factors has weakened the UAW in recent years:

- → parts of the production process have been relocated and outsourced to states with laws that make it difficult for unions to organize, especially in the Southern Automotive Corridor,
- → corruption scandals and resulting internal organizational squabbles,
- → the emergence of a union-busting industry,
- → tightening of labour laws that had already been anti-union before, especially at state level,
- → the rise of new non-union and anti-union players in the industry, such as electric car manufacturer Tesla.

#### Trade unions in the USA – how do they work?

In Germany and many other countries, workers join a union individually. This is not usually the case in the USA. If a company does not voluntarily recognize a union, workers in a workplace or "bargaining unit" have to prove by majority vote before the National Labor Relations Board (NLRB) that they want a union. If a company does not have 50 percent plus one vote support for the union, that workplace will have no collective bargaining powers, and that also means no health insurance, no pension insurance, and no representation of interests. If the election to recognize the union is successful, the employer has to negotiate with the union. Ideally, the end result is a collective agreement.

So-called right-to-work laws in more than half of all US states, especially in the South, make it difficult for unions to organize. The label "right to work" means that no worker is obliged to join or pay dues to a trade union. In the context of the US where there is no Works Constitution Act and trade unions occupy a much weaker position within the institutional system than in Germany and Europe, this dramatically curbs their rights. With right-to-work laws and a billion-dollar anti-union lobby, the barrier to union representation in the US is higher today than in any other country in the Global North. The level of organization has dropped from almost 30 percent to 11 percent. The figure for the private sector is below seven percent nationwide (US Bureau of Labor Statistics 2022).

Currently, 53 percent of the cars sold in the USA are also produced in the country, Kristin Dziczek estimates that at most "half of them are from unionized factories" (Dziczek 2022). Especially in the South, there is hardly any union organization. German manufacturer Volkswagen also successfully resisted unionization with the help of union-busting firms (Silvia 2018; Boewe 2019).

Today, the UAW seems to be the only US union to have the resources to develop its own strategy and research on the issue of e-mobility and transformation. Although it is fundamentally open to the shift in orientation towards electric drivetrains, it fears, not without reason, that the move will come at the expense of employees. According to calculations by its research department, on the quantitative side, significant numbers of jobs in the traditional drivetrain sector are threatened. The UAW Research Department, in line with estimates by the major manufacturers, expects the production of electric cars to require on average about 30 percent fewer working hours compared to internal combustion vehicles. As a result, the union expects job cuts, especially in the drivetrain sector. To soften the blow of this development, the union proposes state support for qualification and modernization measures, that should be linked to minimum standards in terms of working conditions and the protection of trade union rights:

> ***"Employers have to commit to retooling plants and retraining workers to maintain employment levels and enable American workers to produce vehicles that use advanced technologies. Policymakers should support reinvestment in these workers and plants, and such support should be conditional on employers maintaining employment levels, job quality standards, and freedom of association.***
>
> *(UAW Research Department 2020: 13)*

While, according to experts, the shift towards the electric drivetrain will create new jobs, these will be in areas and companies without trade union organization. In the USA, that simply means that workers can only enjoy social benefits such as health insurance and pensions if management grants them these as voluntary benefits. For example, a company like Tesla, that still enjoys a comfortable financial position thanks to its high market capitalization on the financial markets, is currently still successfully keeping the majority of its employees from unionizing by offering them stock options. As Stephen Silvia, professor in the Department of Economics at American University, Washington DC explains:

> ***"Typical of Tesla is that they give their employees stock options. So far, it has been very effective in making people feel that they themselves are part of the ownership of the company.***
>
> *(Interview Silvia)*

As such, Tesla is following a corporate strategy that is particularly widespread in the southern states:

> ***"The South's political and economic elite has really learned how to effectively fight unions. And then there are even these law firms that take action against trade unions. They are also very good at it. Over the past 40 or 50 years, they have learned some special techniques. They say, for example, that workers in these car factories can get low-cost leased cars as part of their benefits. So, they get a really good deal on a car and lease it at a very low price. They can replace it every three years and get a new car. And then when unions negotiate and do organizing drives, management says: "Well, if you want to negotiate a contract, everything will be on the table". And, of course, the union cannot guarantee that the lease will still be available in a future collective agreement. It is this kind of thing they develop to fight the unions that makes it extremely difficult.***
>
> *(Interview Silvia)*

The result is that in these companies, "there is a group, maybe ten to maximum 20 percent, who are interested in a union, and then another 20 percent who might be sympathetic to the idea. But it is hard to get beyond those numbers. The workers who are most likely to be interested are the ones who carry out maintenance and repairs. The higher skilled people in the factory who repair the machines on their own tend to be the stronghold when it comes to union organization" (Interview Silvia).

Carsten Hübner, long-time director of the union-affiliated Transatlantic Labor Institute in Spring Hill, Tennessee, also considers the structural division within the US automotive workforce into highly skilled service technicians and unskilled production workers as a relevant hurdle for union organizing:

**Automotive workers' unions in North America**

In addition to the UAW, important trade unions in the automotive industry in North America are the Canadian Unifor and the Mexican SINTTIA.

Unifor was formed in 2013 as a merger of the Canadian Auto Workers (CAW) and Communications, Energy and Paperworkers unions. It has around 300,000 members. According to Ian Greer, it considers electromobility "as not only to a threat, but also an opportunity":

> *I think Unifor lacks the kind of resources that IG Metall has, but it still has a coherent message: electromobility is also a potentially good thing that may allow us to improve the quality of our jobs and possibly bring new investment to threatened production sites, and therefore preserve some of our core jobs and creating something new.*
>
> (Interview Greer)

In Mexico, where state-controlled corporatist federations dominated the field for decades, the independent SINTTIA achieved a breakthrough at the GM plant in Silao in early 2022. Here 6,500 workers elected union representation for the first time under free conditions (Hermann/Schwab 2022). It remains to be seen whether the union will also succeed in gaining a foothold at the GM plant that is being converted to produce e-cars in Ramos Arizpe.

> *In the US, skilled workers only make up about ten to fifteen percent of a production workforce and they are primarily employed in maintenance and repair. The rest of the production workforce is unskilled or otherwise qualified, as well as temporary and contract workers. This, and other factors, ensure a high degree of diversity within the group. So, how can one create commonality and, where necessary, unity of action?*
>
> (Interview Hübner)

All in all, the UAW's opportunities to create its own strategic accents in the process of moving towards e-mobility are not outstanding, Ian Greer, professor at the University of Ithaca, New York, also points out:

> *There is […] a really important difference between the views held by IG Metall and those held by UAW. IG Metall is developing concepts. It makes a huge effort to frame the issue and encourage politicians, workers, and people who are relevant to it to see issues the way it does. And so, its "transformation discourse" is part of the union's conscious strategy. The UAW is in no position to do this. Rather, it responds to developments.*
>
> (Interview Greer)

Overall, the UAW seems to rely more on political support from the US federal government than on its own offensive role as a social actor. Just how problematic this approach is becomes evident in the discussion about additional subsidies for electric cars made by unionized factories. It is not only that the scheme envisaged in the original draft for the Build Back Better Plan has little chance of being put into action, but their protectionist "Made in America" approach also threatens to undermine cross-border solidarity between unionized workers in the Detroit-Windsor auto cluster, for example, as expert Ian Greer points out:

> *The UAW wanted these subsidies to only be available for cars built by US union members, but not for those built in Canada by Unifor members. It was a big problem, not just for Unifor, but also for UAW members who supply the assembly plants in Canada, such as Buffalo in the state of New York that supplies plants in Ontario. Both Democratic Party representatives and unionists on the ground were quite shocked by this decision that came out of Detroit [UAW headquarters] to exclude Canadian union members from the subsidies.*
>
> (Interview Greer)

Currently, as of autumn 2022, only three battery-electric models are being produced in a unionized plant in the USA: the Chevrolet Bolt EV, its slightly longer version Chevrolet Bolt EUV, and Ford's F-150 Lightning e-pick-up. Both of the Chevrolet models are being made at GM's assembly plant in Orion, Michigan, while the Ford Lightning is being made at the Dearborn plant near Detroit. Ford's Mustang Mach-E is being produced in Mexico. Volkswagens ID.4 is currently still being imported and comes from the unionized VW plant in Zwickau. While it is set to be built in Tennessee from 2023, the factory will probably not have union organization (Green Car Reports 2022).

Can we expect any promising organizing efforts in the field of BEV production in the foreseeable future? Experts are rather sceptical. As yet, Silvia sees trade union approaches as offering hope for a new class organization less in the UAW and the other unions in the manufacturing sector, but rather in the service sector and the linking of collective bargaining demands with a broader "social movement unionism":

> *"The most innovative organizing in the United States in recent years has been in the service sector rather than in manufacturing. I would say there have been very few innovations in the industry. [...] The innovations have taken place in the service sector. With the "Fight for 15" and a series of projects known as "Bargaining for the common good". In other words, the union is not only trying to achieve something for its members but is campaigning for a minimum wage that would benefit all workers.*
>
> (Interview Silvia)

In the context of broader progressive social movements and at least partially changed societal values, he argues that new spaces have also opened up organizing in the workplace:

> *"You might conclude that the current developments do not look very promising. But one thing I am seeing hope in is broader organizing and the social movements we are seeing. I think the women's movement against Trump and the Black Lives Matter movement have injected some energy into organizing, especially among the younger generation. We have seen progress here, something has changed. Perhaps not to the extent we would all like. But I think when police officers who kill black people are being convicted in the United States nowadays, it's a huge social change. So, it has been shown that mass mobilization sometimes works and changes society.*
>
> (Interview Silvia)

As an example, Silvia points to the organizing of the grassroots union Amazon Labor Union, that managed to achieve union representation in a US Amazon logistics centre for the first time in April 2022, and to experiences at the Starbucks coffee shop chain:

> *"We are seeing people like Chris Smalls trying to organize his own union for Amazon workers in Staten Island, we are seeing what Black Lives Matter has done. It is not far-fetched to think that I can do it in the context of my own workplace too. So, it is important to make that connection. And then there are some of these companies, especially in the tech sector, whose CEOs say they are progressive, that they support LGBTQ rights, climate action, etc. That puts the companies in a position where workers can say: "Well, you say you are progressive, but what about workers' rights? What does it look like in the workplace here and now?"*
>
> (Interview Silvia)

### Social Movement Unionism

Social Movement Unionism is a strategic approach in the trade union movement. It seeks to link workplace organizing around issues like wages and working conditions with broader political struggles for human rights, social justice, and democracy. According to Moody the "union as a movement" relies on the "strength of the many", is "militant" and "conflict-oriented", rejects concessionary policies, is oriented towards building union power at the workplace and cooperates with different groups from the wage-earner class as well as other unions, neighbourhood groups, or social movements (Moody 1997).

Nonetheless, whether and within what kind of time frame approaches like that of the Amazon Labour Union will see themselves replicated in the US automotive industry cannot yet be estimated.

## 5.4 THE JAPANESE PARADOX

### 5.4.1 Profile of the Region

A look at the transformation in Japan reveals another paradox. O-n the one hand, Japanese governments took concrete measures to promote ecological alternatives to the internal combustion engine much earlier than those of other automobile nations. Holger Bungsche, professor at Kwansei Gakuin University in the city of Nishinomiya, points out that there have been serious attempts by government to provide support for a number of forms of electric vehicles since the 1970s, but the results have fallen far short of expectations. That only changed in 2009: "In the wake of the Lehman crisis, the government found a way and achieved the turnaround mainly by offering tax breaks" (Bungsche 2022). In fact, the market share of electric vehicles, commonly known as Next Generation Vehicles in Japan, has risen to about 40 percent, of which the majority are hybrid and plug-in hybrid vehicles (GTAI 2022). However, despite the pace of hybridization, the country has been slow to convert to purely electric motors. In 2021, only 21,000 BEVs were sold in Japan (ibid.), while the figure was 356,000 in Germany.

Japan is the world's third-largest car manufacturing market and is home not only to the world's largest car company, Toyota, but also to some of the world's most successful Tier 1 suppliers, such as Denso and AISIN. Similar to Germany, the automotive industry is one of the most important, if not the most important, employment sector in the country. Depending on how the figures are calculated, up to 5.5 million people, i.e. nine percent of all employees work in the automotive industry (Fraunhofer IAO/e-mobil 2018).

The well-being of the Japanese automotive industry is dependent on exports to a greater extent than Germany. The domestic market has been stagnant for a long time and has even seen sales declining over the last two years. In 2019, 36 percent of all cars built worldwide came from Japanese factories (Puls/Fritsch 2020). With a share of almost 50 percent, North America is by far the most important export market, followed by Europe and Asia (Kords 2021b).

### 5.4.2 Industrial and Funding Policy on Electromobility

If the Japanese transformation discussion were to be summed up in one word, it would be "pragmatic". At least that is what Martin Pohl, former technical officer at IG BAU, associate professor at the University of Tsukuba, Counsellor at the German Embassy in Tokyo, and head of Matrix Transformation at IG BCE since mid-2022, suggests:

> ***"Unlike in Germany, the debate in Japan is very rational and less excited. It is evident not just in the aforementioned government initiatives to promote Next Generation Vehicles, but also in the Japanese government's plans to become a carbon-neutral society. It envisages no more cars with pure combustion engines being registered by 2035 and emitting no more carbon by 2050.***
> *(Interview Pohl)*

In its concrete economic policy, Japan remains true to its tradition and is focusing on promoting Japanese industry, which it steers in the desired direction primarily by providing financial incentives. Among the many programmes are long-term technological concepts like the social vision of "Society 5.0" with the aim of achieving global leadership in the fourth industrial revolution (Pohl 2021), numerous concrete measures to achieve the 2035 and 2050 goals, such as the two trillion yen (JPY) – equivalent to roughly EUR 15 billion – Green Innovation Fund, for the promotion of competitive and carbon-reducing technologies, and a reform of corporate taxation, that improves the situation of companies that invest in decarbonization (Bungsche 2022). In 2021, the Japanese government allocated JPY 37.5 billion or around EUR 290 million to promote electric mobility. Of this, JPY 25 billion – EUR 193 million – were intended in purchase subsidies for BEVs, plug-in hybrids, and fuel cell vehicles, JPY 6.5 billion or EUR 50 million euros for more charging stations, and JPY six billion or EUR 46.5 million for new hydrogen fuel stations (electrive.net 2021b). Japan intends to expand the charging infrastructure to 150,000 charging points by 2030.

A number of contradictions are, however, already becoming apparent in this plan. At the end of the 2020 fiscal year, Japan had 2.3 charging points per 10,000 inhabitants. According to a report in the *Japan Times*, however, these are hardly used because electric cars are not very widespread.

### 5.4.3 Corporate Strategies

While VW was still working on programming its software for diesel vehicles that allowed them to cheat in emissions tests, Toyota was already focusing on the electrification of the drivetrain with hybrid cars in 1997. As such, Japan's most important OEMs have for some years been among the few manufacturers to comply with European emissions regulations and emit less than 95 grammes of CO2 per kilometre. The Group was also an early adopter of the digital mobility services that Toyota successfully offers in Southeast Asia, for example (Kölling 2019). This was apparently also one reason why Toyota refused to jump on the bandwagon of pure electric mobility for a very long time.

Despite their late entry into the market for purely electric cars, experts like Pohl and Bungsche do not expect the world's largest car manufacturer to face serious problems. The reason for this is the huge effort going into the electrification of the drivetrain and the EUR 31 billion that is set to be invested in electromobility by 2030, with 30 new BEV models planned by the end of the decade (dpa 2021b). It is interesting to note that Toyota remains "open to technology" and continues to research hybrid drivetrains and fuel cells as an energy source (Kölling 2019). In addition, Toyota is well positioned in all the globally significant markets. In 2021, the company even took General Motors' spot as market leader in the USA for the first time (tagesschau 2022).

Other manufacturers are likely to have more issues. Competitors like Honda and Nissan have been struggling for years. While the latter was able to save itself after a near-bankruptcy in 1999 by entering into a partnership with Renault, which Mitsubishi also joined in 2016 (Wikipedia 2021), Toyota has swallowed up several former competitors like Subaru, Daihatsu, and Suzuki or tied them to itself through partnerships. They also have also a partnership with Mazda (Welter 2019). And, in addition, the future is likely to be difficult for Honda, the only remaining independent Japanese manufacturer apart from Toyota. Honda focusses essentially on two wholesale markets: China and the US. Given the current trade tensions, it is likely to prove very difficult to serve both markets. At the same time, new manufacturers are entering the market: technology giant Sony unveiled its second prototype of an e-car at the Consumer Electronics Show (CES) in Las Vegas in early 2022 and also intends to venture into the mobility business (Fritz 2022).

> *"Unlike in Germany, concerns about impending job losses resulting from the transformation seem to be limited in Japan, and this is due, among other things, to the specific labour law and demographic situation in Japan.*

Pohl points to the high level of protection against dismissal that at least the core workforce, about 60 percent of the workforce, in the large companies de facto enjoy. For many employees, the upcoming restructuring does not appear to threaten their existence. Another factor is the significant ageing of Japanese society. Between 2000 and 2018, the number of people of working age decreased by about eleven million (Pohl 2021). Japan is facing labour shortages in virtually all sectors of the economy: "Nobody is worried about mass unemployment here" (Interview Pohl).

In addition, the relationship structure between Japanese OEMs and the supplier industry is very different to what we see in Germany. Instead of the pyramid-like system in Germany, where OEMs dictate prices and put orders out to tender, the Japanese model is characterized by multiple personnel and financial links between OEMs and suppliers at all levels. OEMs also involve "their" suppliers in long-term planning and as Pohl suggests: "They see themselves rather as a kind of Japan plc; there may be fierce competition, but you would never drive a competitor out of the market". Accordingly, the transformation is also understood as a joint project that also has to be tackled together (Interview Pohl).

### 5.4.4 Trade Unions and Other Social Actors

That does not mean the Japanese automotive industry will get through the transformation without any issues. The major threats include (1) the lack of skilled workers, especially in the IT sector, and (2) the weakness or widespread absence of trade unions, both in industrial and social transformation discourse.

Pohl sees the biggest challenge for the Japanese automotive industry as Japanese society's lack of a welcoming culture for foreign workers which effects technological developments in the country itself and above all, in Japan's ageing labour market where companies are barely able to find the IT specialists they need to innovate. And foreign IT specialists, the likes of which are flocking en masse to Berlin, Tel Aviv, or Seattle, venture extremely rarely to Tokyo. Instead, large Japanese corporations are developing their IT and digitization research in the USA or Singapore. In addition, communication between employees in Japan, who are accustomed to the Japanese work culture, and tech people abroad is extremely difficult due to divergent life-world experiences: Japanese workers, for example, are usually permanently employed for life, many have practically no knowledge of English and hardly any experience working with people who are not Japanese. Recruiting and retaining the necessary skilled workers is therefore a bottleneck in the Japanese industry's digital transformation.

**Trade union solidarity with the industry?**

> *“The second danger is the weakness of the trade unions. In the Japanese transformation debate, they are practically non-existent as a possible corrective voice. Their degree of organization has been steadily decreasing since the 1960s — especially in those areas where precarious employment conditions are spreading more and more.*

This is also true for the automotive industry, where, for example, temporary work is steadily growing in relation to the historically predominant permanent workforce (Daimon 2012). Currently, the degree of organization in Japan is around 16 percent, which is similar to the level in Germany. It should, however, be noted that closed shops are widespread in many sectors of the Japanese economy, which stabilizes the degree of organization without the union having to make any efforts of its own. Another important and essential feature of the Japanese trade unions, especially in the context of the dangers of transformation for workers, is their lack of a socio-political programme. They are also not involved in the various government-industrial policy programmes that as Pohl states: “has to do with their special structure”. De facto, Japanese trade unions are primarily enterprise unions. The central guideline dictating their actions is the economic success of their company. Against this background, it is not surprising that, for example, the union of Toyota’s permanent workers has few interests in common with the union of workers in Toyota’s own temporary workers’ company. There may be umbrella organizations that are organized both at a sectoral level and across sectors but they are not legal entities and have little weight of their own. As Pohl states: “A large part of their work is about voting, while their own positions are hardly represented”. A critical view of the respective transformation strategies of these companies is also not to be expected — on the contrary: IndustriALL Global Union reports that it received unhappy calls from Japanese trade unionists pushing to lobby against the COP-26 initiative in which some 30 states, cities, and car manufacturers pledged to switch completely to zero-emission cars by 2040 (Deutsche Welle 2021b)[2].

The largest confederation by far is the Confederation of Japanese Trade Unions (Rengō) with more than six million members. Founded in 1989, following the merger of three trade union confederations, its unifying political idea over the past few decades was the goal of ending the long-term government of the Liberal Democratic Party (LDP). Rengō regularly supported candidates of the opposing Democratic Party in parliamentary elections. Recently the federation has made a political U-turn and entered into an alliance with the very same LDP. The Toyota car workers’ union played a key role in this shift. It justified its change of course as a means of “ending the confrontation between workers and management in order to jointly address the challenges facing the company, such as the need to achieve carbon neutrality”, as reported by the popular Japanese daily *The Asahi Shimbun*, that commented: “Rengō should ask itself whether it will be able to serve workers’ interests if it befriends the LDP, with its close ties to employers’ organizations” (The Asahi Shimbun 2022). This development indicates that a relevant part of the Japanese trade union movement has decided to seek a strategic alliance with the companies during the transformation rather than to represent the interests of the workers independently.

## 5.5 SOUTH AMERICA: STUCK BETWEEN RELOCATION ANXIETY AND LITHIUM INTOXICATION

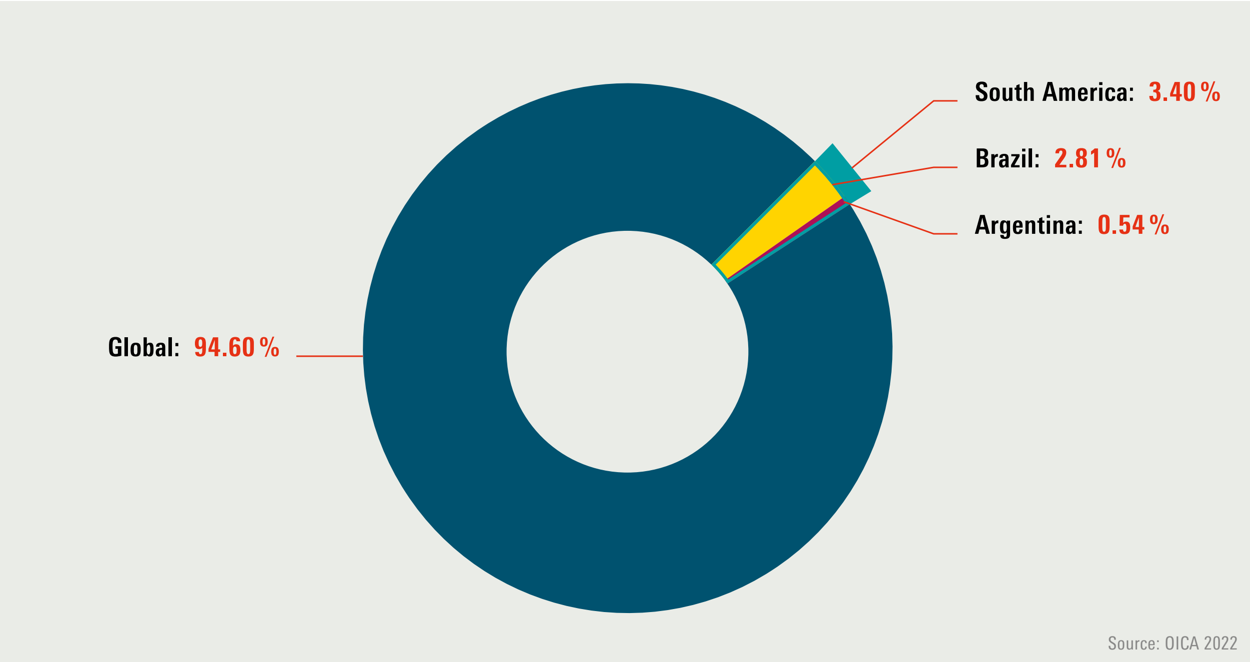
South America is perhaps the region where the dangers of the double transformation and the hopes associated with it are closest. On the one hand, there is concern in the two most important producing countries, Brazil and Argentina, that decarbonization could significantly exacerbate the crisis in the automotive industry that has been ongoing for several years. The decision by Ford to withdraw from Brazil after more than 100 years, which became public in early 2022, is seen by the trade unionists who were interviewed as a sign of the direction in which the industry is heading. On the other hand, countries such as Argentina, Chile, and Bolivia have huge lithium deposits, which is — at least at present — the most important raw material in the transition to electromobility. This is fuelling hopes for an independent industrialization project that will end the region’s centuries-old dependence on foreign countries.

### 5.5.1 Profile of the Region

As a production location, South America is not a blank canvas, but rather a grey area in the value chains of the global automotive industry. With a share of 3.12 percent of total automobile production in 2020, the region is fairly marginal, as Figure 33 (next page) shows (OICA 2022).

2 These companies include Daimler, Volvo, BYD from China, Jaguar Land Rover, a unit of India’s Tata Motors, and US car manufacturers Ford and General Motors (Deutsche Welle 2021b).

Figure 33: **South America, Brazil, and Argentina's Share of Global Car Production in 2021**




The two most important producing countries by far are Brazil and Argentina. At 180,000, Argentina has a modest number of employees working in the automotive industry — out of a workforce of around 21 million (Destatis 2022b) — however, as Argentinean trade unionist Cristian Alejandro Valerio emphasizes "due to the above-average wages in the sector, its importance for the entire domestic economy is immense" (Interview Valerio). For Brazil, the industry is even more important, with half a million workers directly dependent on the automotive industry (Sturgeon 2021) and as many as 1.3 million indirectly dependent on it (Gelowicz 2018) — with about 103 million people in the workforce in total (Destatis 2022a).

In fact, there is hardly a popular international OEM or supplier that is not represented in one of the two countries. VW, for example, has been producing in Argentina for 40 years and currently has two plants in Brazil, where the group has been active for 60 years and has become the largest exporter in the country's history. A few years ago, VW opened its own development centre in Brazil. Toyota manufactures at one site in Argentina and three in Brazil. Fiat currently has the largest vehicle production site in South America, in Belo Horizonte (Gelowicz 2018).

### 5.5.2 Industrial and Funding Policy for Electromobility: A "Death by a Thousand Cuts"?

Nevertheless, academic observers and trade union activists both see significant risk that the region will be thrown under the bus of the double transformation. For example, Timothy Sturgeon, who has been researching global value chains at the Massachusetts Institute of Technology (MIT) for more than 20 years, speaks of a "death by a thousand cuts" in the region. The reason for this, he explains, is the small share that Brazil or Argentina have in the global production of OEMs and suppliers (see Figure 33). With the exception of Fiat and Renault, the figure is at or below just four percent for Brazil (Sturgeon 2021). In view of the immense cost of transformation, OEMs in particular want to manufacture as efficiently as possible and that requires high production numbers. The trade unionists that were interviewed, such as Marino Vani from the Latin America and the Caribbean Office of the IndustriALL Global Union, share a similar view:

> *"Unfortunately, the situation is looking pretty bleak. We fear that the electric cars of the future will not be produced in Brazil or Argentina, but instead imported to South America from Mexico. We may of course continue to produce internal combustion vehicles for a few more years but after that we could lose the automotive industry, which is a very important sector for us, entirely.* (Interview Vani)

He sees this fear confirmed by Ford's historic decision announced at the beginning of 2022: after more than 100 years of operations in Brazil, the US company announced its plans to cease production there and to close the remaining three plants, meaning job losses for several thousand employees. (dpa 2021a)

As Vani explains, there are two reasons for the automotive industry's potentially declining interest in the region: one is the severe economic crisis that the region has been experiencing for several years. Most recently, fewer than 1.7 million cars were sold in Brazil, which is just half as many as in the peak years of 2012 and 2013. Back then, Brazil was still the industry's fourth largest market, ahead of Germany even (Gelowicz 2018). Due to the high import tariffs that were imposed by the left-wing government led by Lula da Silva and Dilma Rousseff (2002 to 2016), companies like Daimler, BMW, and Audi decided to build new plants exclusively for the huge domestic market. But contrary to expectations, growth came to a halt and Brazil entered an economic crisis that lasted for years (Manager Magazin 2020). There is no active industrial policy in place. This is especially true of Brazil, the region's economic powerhouse and the Bolsonaro government that was voted out of office in October 2022. As Vani explains:

> ***"The Bolsonaro government works on the principle that the market is always right. As such, the government is making no political effort to actively promote electrification in the country. But without active industrial policies, workers are solely at the mercy of the decisions of the big car companies.***
> *(Interview Vani)*

A positive exception is the progressive government of Aníbal Fernández in Argentina, that was elected in 2019. In late 2021and early 2022, for example, the government enacted the "Law for the Promotion of Sustainable Mobility", that, among other things, provides for measures to promote environmentally friendly mobility technologies (Página 2022). Argentinean trade unionist Cristian Alejandro Valerio considers this an important development because trade unions are now involved in legislation for the first time in a long time:

> ***"From our point of view, this is a big step in the right direction. In addition, the government has set up a tripartite body in which industrial and transport-policy decisions are made with the participation of trade unions.*** *(Interview Valerio)*

In fact, there are now some companies in Argentina producing e-cars in small numbers, around 500 (infobae 2021). But Valerio warns against attributing more importance to these initiatives than they merit an in view of the constant issues with the dollar and the difficult economic situation, he thinks it will be difficult to seriously compete with the big players.

### 5.5.3 High on Lithium: Opportunity for Industrialization or "New Ecological Colonialism"?

Nevertheless, the high hopes associated with the double transformation in South America are not just fuelled by progressive governments like those in Bolivia, Argentina, Chile since March 2022, and Brazil from 2023, but also by social movements and trade unions. It is the presence of lithium, a raw material that is vital for electromobility, that is responsible. The so-called lithium triangle, an area in the border region between Argentina, Bolivia, and Chile, is currently said to hold about 58 percent of the world's lithium reserves, with Bolivia's Salar de Uyuni holding the world's largest single deposit of 21 million tonnes (Vogt 2022b). The raw material is likely to become even more important in the future: over the next 35 years, according to one of many estimates, demand could increase fivefold (Schmitt 2021).

Chile and to a lesser extent Argentina have been relying on intensive lithium mining, primarily mined by private mining companies, for decades. Bolivia is different. For some years now, there have been dreams of extracting the huge deposits as part of a national industrialization project and as stated by Bolivian head of state Luis Acre in April 2021 at a symposium on lithium: "We will use our raw materials as a sovereign nation and for the benefit of Bolivians". The government wants to be able to meet around 40 percent of global demand by 2030 (ntv 2021).

Their intentions are obvious: for centuries, the countries in the region were locked in the role of exporters of raw materials. Now the huge lithium reserves are to be used as a way of breaking out of this role and building their own lithium-processing industry or at least organizing the mining operations themselves — without large international corporations appropriating the profits.

Similar plans are now also being discussed in Argentina and Chile, where progressive governments have recently taken the helm. This is also thanks to movements like Chile por el Litio, a strong alliance made up of Indigenous groups, scientists, and trade unions. In recent years, they have succeeded in starting a broad discussion about the role of raw materials in Chile's political and economic development. Most recently, Gabriel Boric's government that took office in early 2022 announced that it would be setting up a state-owned lithium company. Its aim is to guarantee

### Environmental risks of lithium mining

In the extraction of lithium you can distinguish between "conventional" and "unconventional" methods, with conventional referring to mining from mineral rocks and sedimentary deposits and unconventional referring to brine extraction mining, as is the case with the brine pools in the South American lithium triangle. In unconventional extraction, the lithium-containing salty brine is pumped upwards from cavities in the underground rock, pushing the huge brine deposits into shallow basins, where it is combined with huge amounts of fresh water and left to evaporate in the sun over a 12–24-month process. The remaining minerals are separated from each other by chemical treatment in processing plants and processed into lithium carbonate. One of the major issues is the immense water consumption of this process, not least because most of the mining regions have extremely low rainfall and already suffer from water shortages. It takes about two million litres of water to extract one tonne of lithium. In addition, drilling in the salt pans and pumping the brine to the surface can result in brine mixing with fresh water, which salinates the existing groundwater (Vogt 2022a; suednordfunk iz3w 2022; Dorn 2021).

"clean Environmental risks associated with lithium mining" (Borbolla 2022). The announcement in and of itself is a novelty since Chile has thus far relied entirely on private companies to mine its lithium. Shortly before leaving office, the conservative government under Penera had even awarded licences for the exploitation of 80,000 tonnes of lithium each to the Chinese car manufacturer BYD and a Chilean mining company. Several courts have since declared this decision invalid, not least thanks to the commitment of the organization Chile por el Litio, (Reuters 2022a; Diario Constitucional 2022).

Nevertheless, the idea of a national industrialization project based on resource extraction is far from uncontroversial. There is strong criticism, especially from the indigenous areas where many of the brine pools are located, and also from the ecology movement. The viewpoint of Bolivian human rights activist Vivian Lagrava Flores on the Bolivian government's attempts to industrialize Salar de Uyuni serves as an example here: "The brine pool is a unique ecosystem. The government fails to recognize it as such in terms of its scope. The region already lacks water for agriculture and animals" (suednordfunk iz3w 2022).

In fact, the Bolivian project of industrializing lithium mining faces major issues: after more than ten years, the government has had to scale down the demands quite considerably. As yet, Bolivia has no significant lithium production, only pilot projects that are not making much progress, and despite investments of USD one billion (suednordfunk iz3w 2022), the "Made in Bolivia" battery has not been produced yet either. In the meantime, Bolivia is holding the middle ground and relying on a joint venture between the state-owned extraction company YLB and the German company ACI Systems Alemania from Rottweil in Baden-Württemberg. That, however, is also meeting with fierce resistance in the affected region. Indigenous groups are holding large rallies to protest against the development and are criticizing the lack of transparency from government and business. They fear negative impacts on the regions water supply and criticize the lack of revenue this extraction will produce for the region (ibid.).

Bolivian economist Carlos Arze even believes that the huge global increase in demand for lithium could actually increase the dependence of the exporting countries and speaks of a new "eco-colonialism" (ibid.).

Chilean trade unionist Horacio Fuentes also sees these problems but warns against categorically taking a stand for or against lithium extraction. What is decisive, he explains, is whether a left-wing government will succeed in reconciling the interests of the different interest groups in a socially just and democratic way:

> ***"It is about whether we involve the people and the affected communities in essential decisions. With Chile por el Litio, we have been very successful so far. Here, we have organized a series of joint demonstrations involving both trade unions and Indigenous organizations.*** *(Interview Fuentes)*

# 6 CHANGES IN THE VALUE CHAINS

## 6.1 THE DRIVETRAIN BATTERY: DISRUPTIVE KEY TECHNOLOGY AND CENTRAL CHALLENGES FOR UNION ORGANIZING

The drivetrain battery is the central key component of the electric car. While conventional motor vehicles also have rechargeable batteries that are indispensable, primarily for the starting process, it takes a lot more energy to operate an electric car: today's drivetrain batteries store about 100 times as much electricity as a conventional starter battery, which means that they are not simply larger starter batteries, but a fundamentally new component.

Technically, different types of electricity storage systems are suitable for use in electric vehicles. For about a decade now, lithium-ion batteries, like those used in mobile phones, have primarily been used as drivetrain batteries. Lithium-ion batteries come in different variants with different properties. They have gained acceptance because they currently offer the greatest range at comparatively low cost.

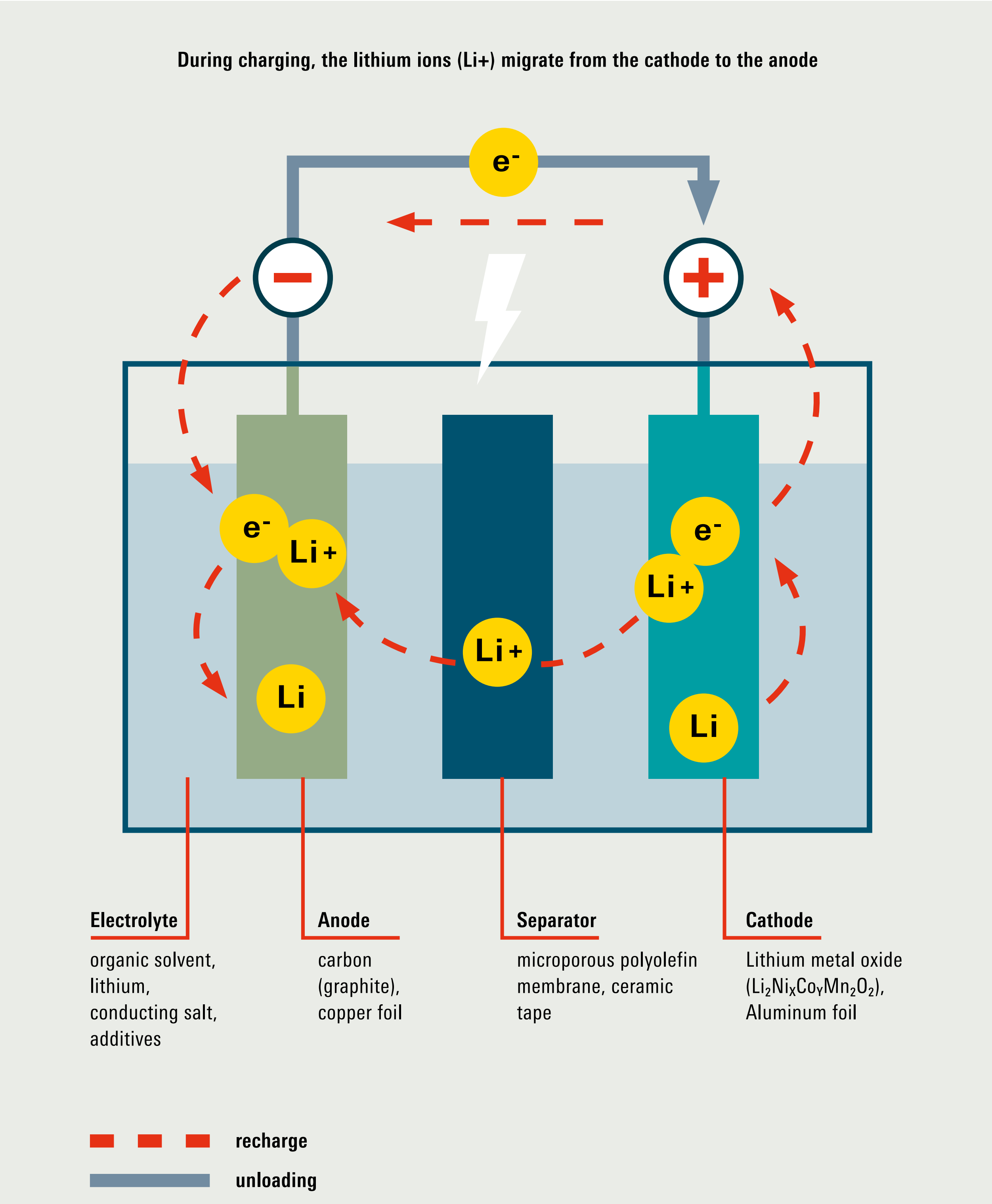
Figure 34 (next page) shows the build of lithium-ion batteries. They consist of: an anode, a negative pole, usually made of graphite; a cathode composed of various combinations of metal oxides, usually the metals lithium, nickel, manganese, and cobalt in different variations; and an electrolyte liquid containing the salt lithium hexafluorophosphate. The current most advanced lithium-ion batteries offer the highest energy densities compared to other battery types. The quality of batteries is determined by their energy density measured in kilowatt hours, i.e. the amount of energy that can be stored per unit of weight.

### What will the battery of tomorrow look like?

The development of **sodium-ion batteries**, which could make battery production independent of the critical raw material lithium, and **solid-state batteries** are currently considered promising. The latter are said to be able to achieve a longer driving range and enable faster charging.

Research is also being conducted on lithium-sulphur, zinc-air, and aluminium-ion batteries, as well as completely new types of storage such as intelligent membranes or graphene-based supercapacitors. In essence, the industry is hoping for shorter recharging times, higher operational reliability, a reduction in dependence on raw materials, and longer battery life cycles.

Figure 34: **Main Components of a Lithium-Cobalt Battery**

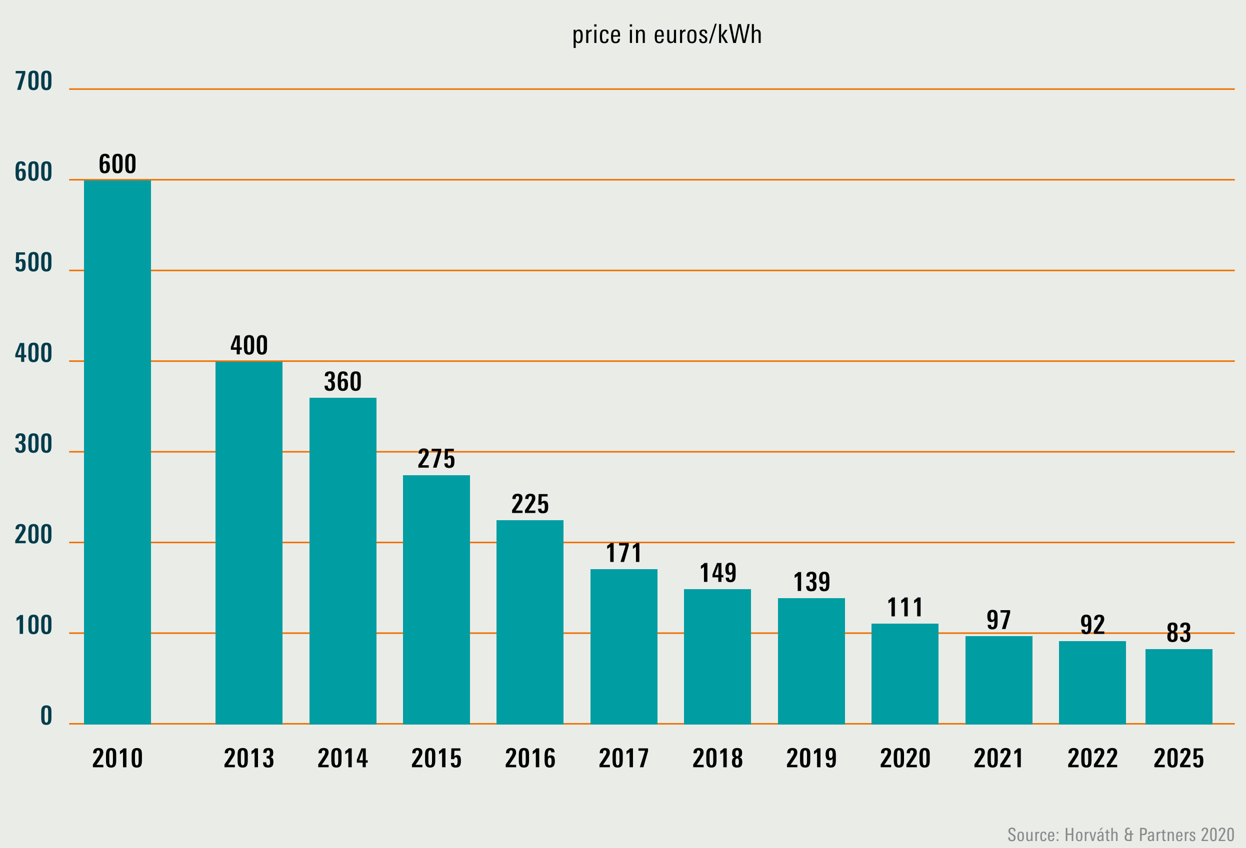



Source: ADAC 2020

**Falling manufacturing costs**

As Figure 35 shows, the manufacturing costs for lithium-ion batteries have fallen by 97 percent over the past three decades, with the price drop of around 80 percent mainly taking place in the last decade. The reasons lie in improved processes and scaling up due to mass production. It has only been because of this sharp decline in costs that the large-scale mass production of electric cars is possible at all. Nevertheless, the drivetrain battery is still the most expensive

**Figure 35: Price Development for Lithium-ion Batteries Worldwide from 2010–2019 and Forecast for 2025, in euros/kWh**




Source: Horváth & Partners 2020

component in an electric car, with a share of value creation that is currently around 30 to 40 percent (Bauer et al. 2019).

### 6.1.1 Disruptive Key Technology

Unlike the central components of conventional cars, the batteries for electric cars are not manufactured by traditional car manufacturers themselves. And so far, even large automotive suppliers have remained uninvolved. The completely new vehicle battery component is supplied mainly by specialized producers in the **electronics industry** and in particular, by companies that themselves have decades of experience in the production of lithium-ion batteries for mobile phones, for example. Unlike the traditional automotive and supplier industry, they can rely on their established relationships with the relevant raw material and semi-finished product suppliers.

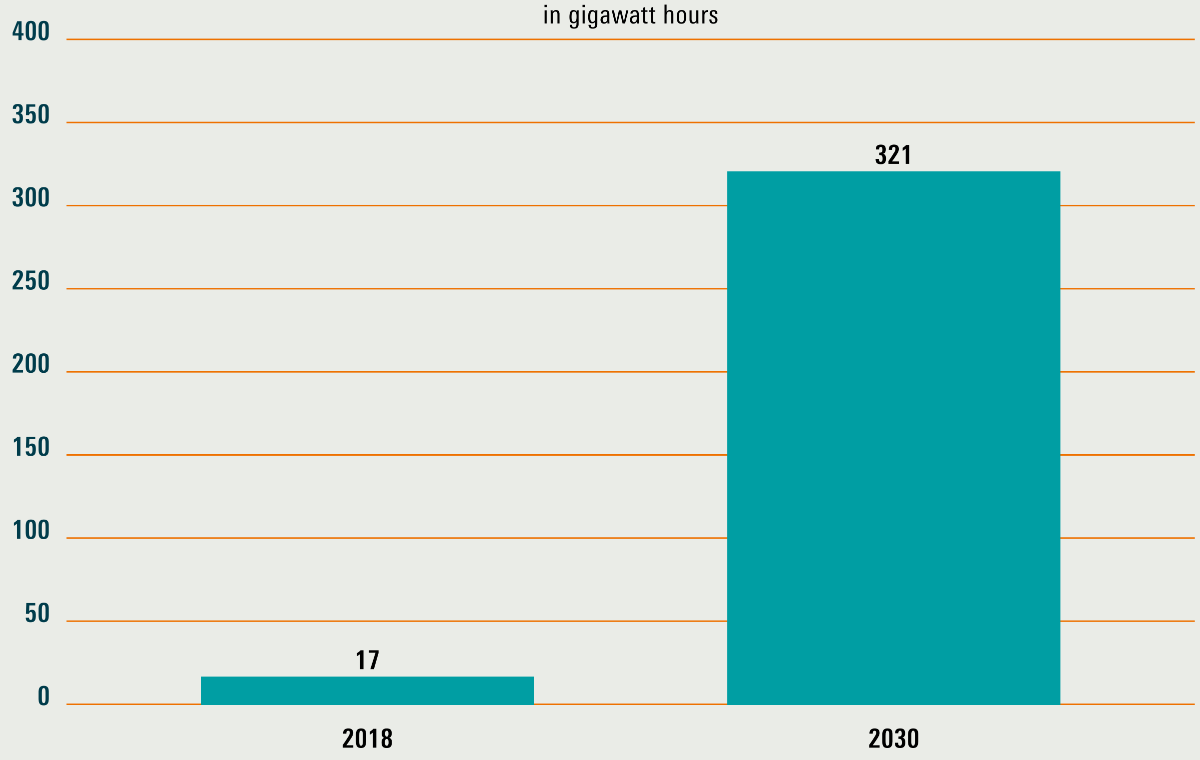
This makes the drivetrain battery a disruptive technology in two respects: it is enabling a fundamental change in drivetrain technology, while also being a driver of the constructive destruction of the previous industrial structure of the automotive sector. If scientists like Lüthje are to be believed, the drivetrain battery as a key component has a **pilot function** in the **implementation of a modular production model** in the automotive industry. What does this mean?

> *"I see the automotive industry developing towards a production structure such as we have become acquainted with in mobile phone production or the electronics industry: it is not the manufacturers of end products who dominate the value chain, but the suppliers of the components. The OEMs are becoming followers.* (Interview Lüthje)

According to Lüthje, we are already seeing battery producers taking up a key role in the restructuring of global production networks: "The main players in hardware components are in the battery production sector — Chinese companies like CATL or BYD" (Interview Lüthje, see also Lüthje 2006, 2019a, 2019b).

And their heyday is soon to come since **the global demand for drivetrain batteries** has grown rapidly in recent years and continues to grow (see Figure 36, next page). The Fraunhofer Institute for Systems and Innovation Research ISI expects the demand for

Figure 36: **Global Annual Energy Requirements of E-car Batteries in 2018 and Forecast for 2030**




Source: Statista 2022a

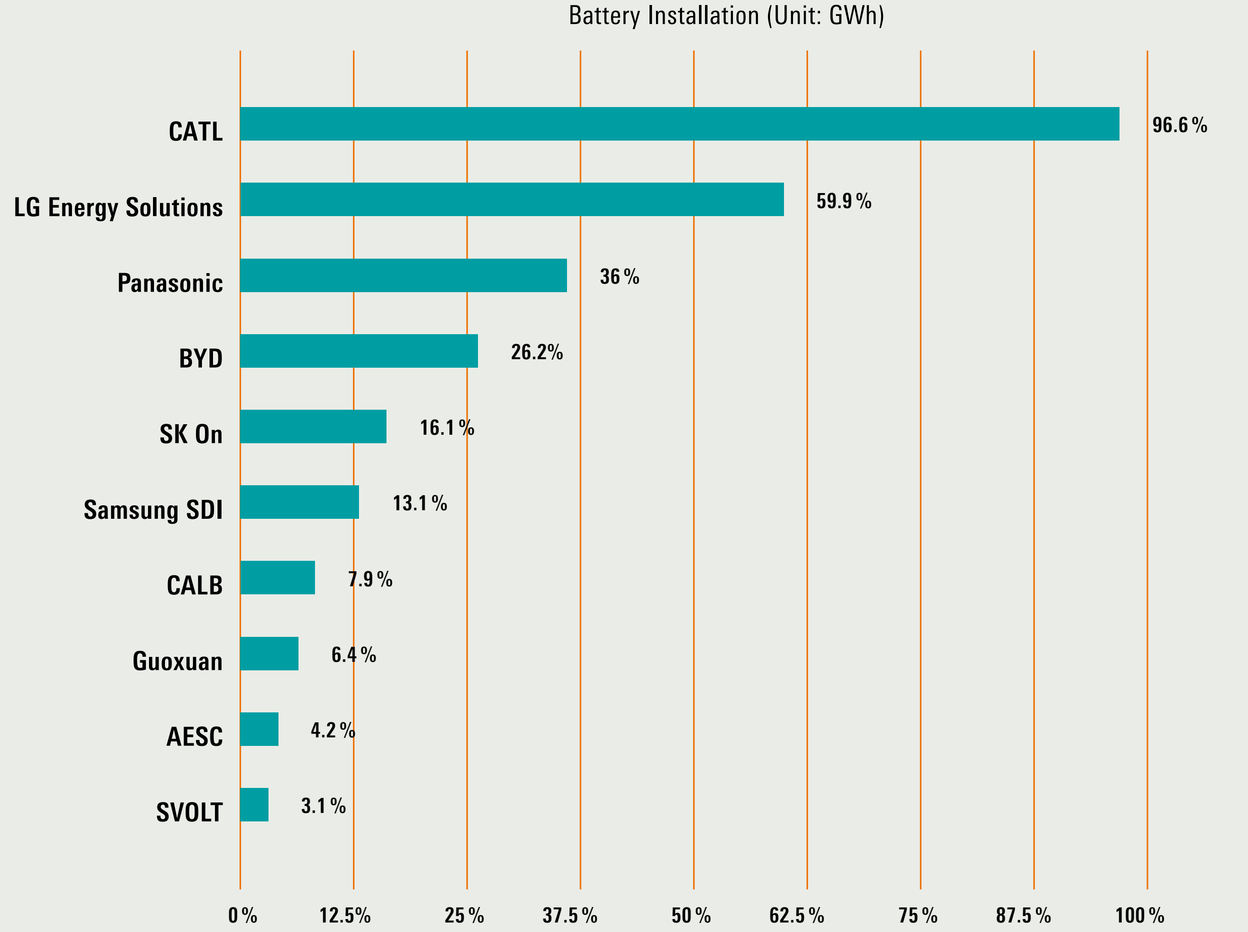
lithium-ion cells for electromobility alone to rise 20–40-fold by 2030 (Diermann 2020).

### 6.1.2 Big Players are Based in Asia

**Chinese, South Korean, and Japanese companies** have thus far dominated the global market, with Chinese firms gaining considerable influence within the market in recent years (Bork 2022b). At six percent in 2020, the European battery manufacturers' share of the global market is astonishingly small (Schulte 2021). This is mainly due to the technological leadership of Asian manufacturers which has developed over decades. Apparently, many Western car manufacturers and suppliers thought the ship had already sailed. An example in this context is the 2018 decision by Bosch to both withdraw from research on battery cells and to forego producing batteries in Germany. The reason: in view of the established Asian competition and their cost advantages, as newcomers, the Stuttgart-based company did not expect to stand a chance (Buchenau 2018).

The up-and-coming Chinese OEMs, such as **BYD**, are quite different. While BYD "only" ranked 4th among global battery producers by sales figures in 2021 and is still barely known as a brand to a wider audience in Europe, BYD is currently the global leader in NEV sales, i.e. electric cars and hybrid vehicles. In sales of purely electric cars, BYD is currently, in mid-2022, just behind Tesla (Bork 2022c). The group is also a vertically integrated electronics company that, in addition to batteries for its own vehicles, also produces storage systems for solar and wind power plants, and for public transport systems, and is involved in "smart city" technologies in a number of ways. Most importantly, BYD, like many other Chinese battery companies, is looking to control large parts of the battery production value chain (Lüthje 2022). The company already has stakes in some Chinese lithium producers and there have been increasing recent reports of the acquisition of lithium mines in Latin America (see chapter 5.5.3) and Africa (Gusbeth et al. 2021). Figure 37 provides an overview of the world's largest battery manufacturers.

Figure 37: **Top 10 Battery Manufacturers for Electric Cars Worldwide in 2021**




Source: SNE Research, nach batterienews.com

## Side note: why is Asia the leader in battery production?

The lithium-ion batteries that are now being used as the drivetrain batteries for electric cars are not technologically revolutionary themselves. Building on basic research at universities from the 1970s, Japanese electronics companies, in particular Toshiba and Panasonic, were already working on using them in the industry in the 1980s. Sony launched the first commercial lithium-ion battery in 1991 which was used to power the Hi8 video camera CCD-TR1. Since then, lithium-ion batteries have been powering portable devices with high energy requirements for which the nickel-cadmium or nickel-metal hydride batteries that had been commonly used until then were too heavy or too large. They can be found in digital cameras, camcorders, notebooks, hand-held consoles, torches, mobile phones, and tablets. The last decade has seen them find a new field of application in electromobility where there used as energy storage units for e-bikes, electric wheelchairs, hybrid vehicles, and finally electric cars.

> *“As you can see, the production know-how for lithium-ion batteries has been maturing in the East Asian electronics industry for three decades because mass production of batteries is already taking place in Japan, South Korea, and China. There are at least 25 large battery factories in the greater Pearl River Delta region of China alone.*
>
> *(Interview Lüthje)*

## Spotlight: Tesla's strategic partnership with Panasonic

"At this stage, a strategic partnership was agreed with Panasonic, that saw the company investing USD 30 million in Tesla. Beyond this investment, Tesla has "co-innovated" with Panasonic to develop a next-generation battery. To equip the Model S, an agreement was reached with Panasonic in October 2011 to supply the battery cells for 80,000 lithium-ion batteries over the following four years. In 2019, Tesla also quietly acquired Canadian battery cell maker Hibar Systems and US memory and transmission technology ultracapacitors maker Maxwell Technologies for USD 218 million, which gave Tesla the skills to make battery cells itself" (Boes/Ziegler 2021: 31 f).

### 6.1.3 Expansion, Partnership, Technology Transfer, Catching Up With Developments: Where Does Europe Stand?

Brussels has also noticed this dependence, particularly in regard to China. Therefore, the European Union has been promoting domestic drivetrain battery production for several years as part of its industrial policy to become strategically less dependent on Asian technology leaders in the medium to long term. The EU Battery Alliance (EBA) was therefore launched in 2017. The initiative includes 14 EU Member States, the European Investment Bank, and 500 companies and academic institutions working together to build a European battery industry. The goal is to produce battery cells for seven to eight million electric cars per year by 2025 (EBA 2022). Figure 38 gives an overview of the battery production currently happening and planned in Europe.

There are cooperations occurring both with Asian battery producers, that are using it as a means of also building up production capacities in Europe and the USA, and with European and North American chemical and battery producers that are trying to catch up technologically to the market leaders in the Far East.

Being the most important in Europe, the **German automotive industry** in particular has revised its previous direction and would now like to take a pioneering role in battery cell production in the medium to long term, both economically and technologically. The goal by 2030, is that 30 percent of the batteries needed globally are to come from Germany or Europe (Schulte 2021).

Will Europe remain a battery no-man's land or will it succeed in building industrial value creation here too? Industry, works councils, and trade unions such as IG Metall certainly see a significant future for battery production for electric cars in Europe (see Figure 38).

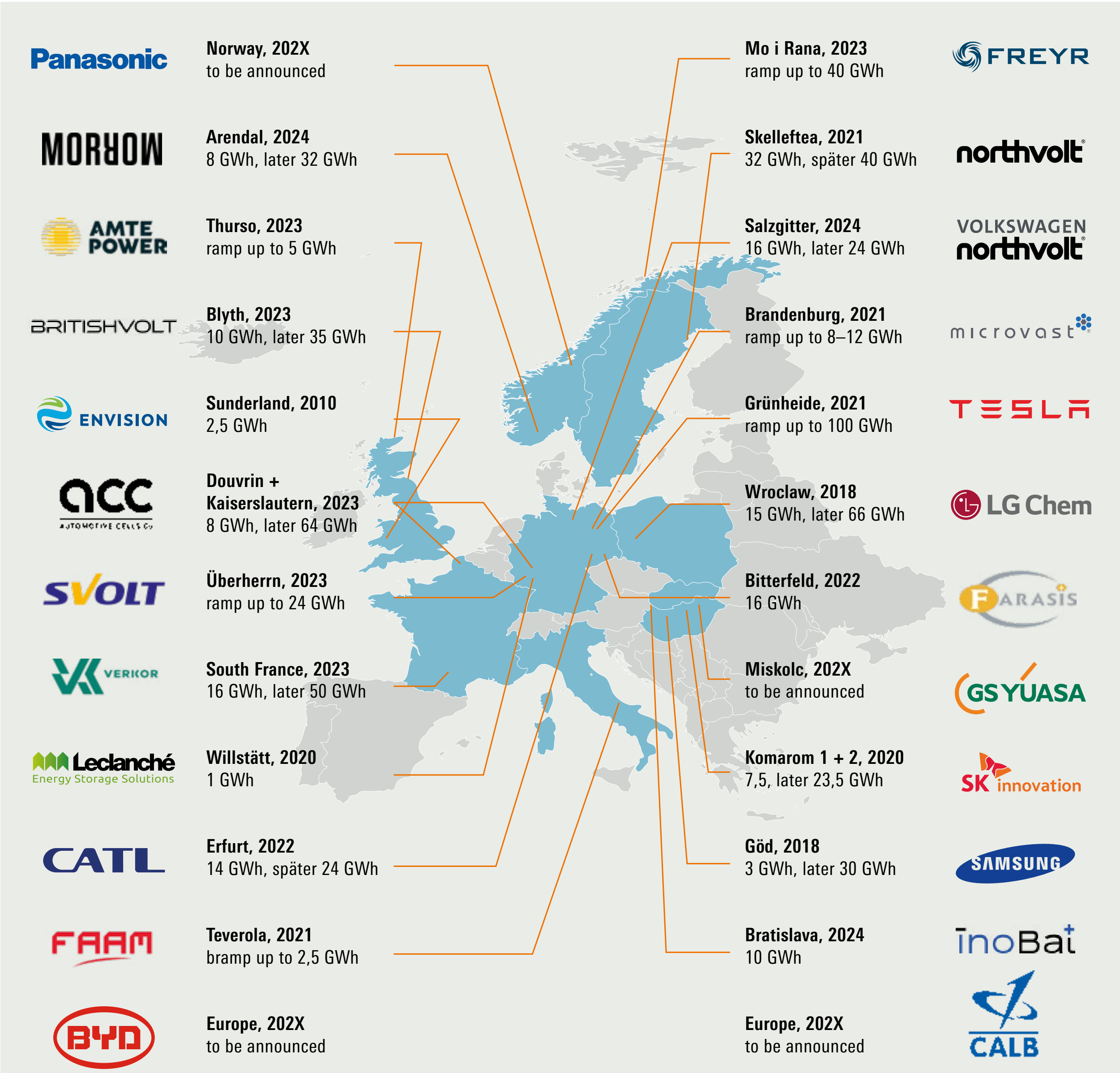
**Volkswagen** has plans to build six battery factories in Europe in cooperation with the Swedish company **Northvolt**. By 2030, up to 80 percent of all VW electric vehicles will be fitted with their own batteries. VW is also looking to set up a joint venture for battery production with system supplier Bosch (T3n Magazin 2022). VW subsidiary **Porsche** is planning to build a battery cell factory in Tübingen, Baden-Württemberg, in cooperation with German company Customcells. **Mercedes-Benz** wants to build eight battery factories, four of them in Europe, one in the USA, and three in Asia. **BMW** is already producing batteries for electric cars at three locations in Germany. Technologically, BMW intends to press ahead with the development of solid-state batteries and, according to Frank Weber, Member of the Board of Management for Development, to "by the end of the decade […] develop a solid-state battery suitable for automotive use in serial production" (quoted in Fasse 2021). In the future, **Tesla** also intends to spend around EUR five billion on building a factory for battery cell production in addition to its car plant in Grünheide in the next few years. German battery manufacturer **Varta** also wants to venture into the production of batteries for electric vehicles.

#### Technological backlog written in stone?

Whether European and US manufacturers will be able to catch up with their Asian competitors remains questionable. Battery production requires very specific manufacturing know-how that differs significantly from the core competencies of the traditional automotive industry and large suppliers: traction batteries are not mechanical objects like a piston engine or gearbox but essentially a vessel in which electrochemical reactions take place. Production knowledge from the traditional automotive industry or even from the traditional IT industry is of very little help here. The main problem in battery manufacturing is to make the mass production process of battery cells technically stable enough to avoid failures. This is because a drivetrain battery, unlike a conventional starter battery, does not have three, six, or twelve cells, but hundreds or even thousands.

If even just one of them fails to work, it can lead to accelerated wear and within a short timeframe, total failure. The traditional European and US battery producers, whether traditional companies like Varta and Saft or start-ups like Northvolt, are not able to draw on decades of experience in the mass production of lithium-ion batteries like Asian consumer electronics manufacturers can.

**Figure 38: Battery Factories Planned or Under Construction in Europe**




Source: Zenn 2021

## 6.2 THE SOFTWARE: NOT BECOMING JUST ANOTHER PROVIDER ON THE GOOGLE PLATFORM?

### 6.2.1 Escaping Dependence

> *"Tech or death"*
>
> *(Ex-VW CEO Herbert Diess, quoted in. Hubik/Tyborski 2022)*

In the course of the digitization of automobiles, as one of the two main concerns of the double transformation, the software that is built into the product takes on a totally new meaning, both in terms of the expectations of today's customers and as a factor for future value creation. Software development has thus far definitely not been one of the core competencies of traditional car manufacturers, though and as Herbert Diess is quoted as saying in German newspaper *Handelsblatt*: "We used to deliver the programmes to our suppliers and not intervene at all after that. They then ran for ten or fifteen years" (Murphy et al. 2022). The VW CEO, who was replaced by Oliver Blume in August 2022, has clearly realized that this model is no longer sustainable: to survive in the current market, the software must be continuously adapted. You need "constant updates, just like with a smartphone" (ibid.).

Diess concludes that we have to do it ourselves: "Today, software is simply part of the product. It cannot be delegated" (ibid.). It is a path that the works council representatives that were interviewed also support:

> ***"We have to be careful that we do not just become some kind of provider on the Google platform, where we only provide the cars and others make the money from the digital services […]. VW needs to develop a digital ecosystem around the cars and create digital opportunities. Cars will become a high-end computer on wheels. They will be like smartphones. Smartphones are the benchmark.*** *(Interview VW works council 1)*

One measure VW took to keep pace with this development was to establish its own software subsidiary, Car.Software.Org (CSO) in 2019. The company was renamed Cariad in March 2021. As per its own figures, it currently employs more than 5,000 people who are working on the development of a uniform software platform for all of the group's car brands as well as on an automotive cloud, on which it is cooperating with Microsoft. The official goal is to increase their own share of software from currently ten to 60 percent (Cariad 2022). The two German premium manufacturers, Mercedes-Benz and BMW are taking similar, albeit not quite as ambitious steps with their recently founded software subsidiaries Mbition and BMW Car IT.

Boes and Ziegler describe this strategy as setting the course for the development of "strategic building blocks such as operating systems for cars, that, just like with smartphones, can foreseeably be used under licence" (Boes/Ziegler 2021: 20). Of course, it is also about earning money through permanent "on-air-updates". Diess's successor, Blume, has recently moved away from the 60 percent target and apparently wants to rely more on the support of German suppliers such as Bosch and Continental (Tyborski 2022).

VW, at least among German manufacturers, is the company that is investing by far the most resources in this area. Whether VW will follow this path consistently, however, remains to be seen. According to media reports, Cariad is significantly lagging behind in developing its own operating system (Hubik et al. 2022).

Boes and Ziegler come to the following conclusion:

> ***"Even if it is by no means a foregone conclusion whether the VW Group will succeed in developing the VW-OS operating system and selling it as a competitive standard product beyond the Group, this decision provides the basis for a successful transformation into a technology company. In other words: Whatever being a technology company will end up meaning for the VW Group — without a new software competence, it is inconceivable that the company will succeed in achieving this strategic goal.***
>
> *(Boes/Ziegler 2021: 97)*

So, for various reasons, not just German OEMs are moving to set up their own software subsidiaries. In view of the growing importance of software, no company wants to be dependent on the external know-how of the big tech companies. For premium brands like Mercedes, standing out from what the mass manufacturers are offering also plays a role. While others can use a navigation system with Google Maps relatively easily, Daimler or Porsche customers would certainly not accept it: regardless of whether the technology is more advanced or just rebranded, they demand something "better".

In addition, users of the "free provider apps" like Google Maps, Waze, Magic Earth, or HereWeGo usually have to agree to disclose their data, something the kind of clientele that buys premium brands is unwilling to do (Martin 2022).

There is, however, also resistance within companies to the "doing-instead-of-buying" approach, especially from the purchasing departments that have become very powerful in recent years. They fear for their existence when there is too much inhousing and are resisting, as is inherent in any bureaucratic structure (interview VW works council 2; interview software subsidiary OEM).

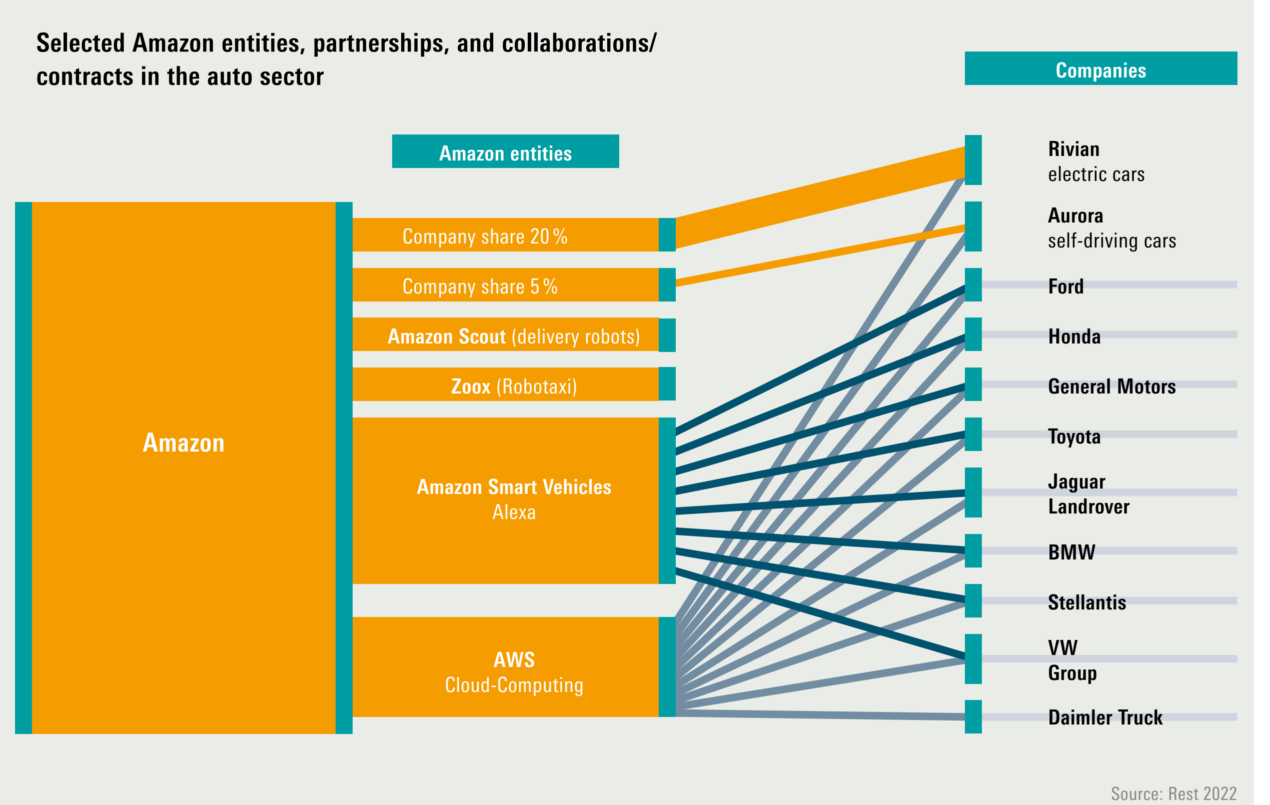
Other manufacturers, that are more firmly anchored in the mass market and possibly financially less strong, are taking more of a division-of-labour approach. They are largely avoiding the need to develop their own elaborate operating system and instead are relying on cooperations with big tech, such as with the Volvo subsidiary Polestar, whose Polestar 2 model is "the first car to run Android Automotive as its operating system for the multimedia subsystem" (Boes/Ziegler 2021). The mass-motorization-focused Stellantis group is focusing on a collaboration with Internet giant Amazon (Hubik/Tyborski 2022). It remains to be seen which strategy will ultimately be more successful, but it is a fact that the importance of IT companies in the automotive industry will increase. Figure 39 shows the extent to which a company like Amazon is already networked with the industry.

On the one hand, Amazon also holds shares, e.g. 20 percent in the e-car start-up Rivian, from whom Amazon has already ordered 100,000 electric delivery vehicles. On the other hand, corporate units are working directly on innovations for the production of cars. Amazon Scout is developing delivery robots and Zoox, a Silicon Valley start-up bought in 2020, is building robotaxis. Finally, Amazon works for virtually all the major OEMs through subsidiaries, AWS provides architecture for over-the-air updates and technology that allows vehicle data to be collected in real time. Amazon Smart Vehicles is marketing much more than an infotainment system with a variant of the Alexa voice assistant specially designed to be used in cars. Amazon's voice software could soon be used to handle a wide range of services such as navigation, temperature or light control, shopping, and payment services.

### 6.2.2 Trade Union Perspectives: Obstacles and Opportunities

For the trade union strategy, the new position that software development has assumed in the automotive industry is certainly of huge strategic importance:

Figure 39: **Amazon's Connections to the Car Industry**




Source: Rest 2022

> ***The crucial thing is actually to organize this huge army of IT people. That is what I consider crucial. Especially Volkswagen and Tesla are proving to be very self-sufficient in that respect. They are basically saying it is now our new core competency. We will hire the people ourselves, whatever the cost. The people are not cheap, but of course there is also training going on etc. From a trade union point of view, it is of central importance to get in there.*** *(Interview Leutert)*

For the trade unions, reaching out to and organizing employee groups in the IT sector is far from familiar ground, similar to the case for to the automotive OEMs, software development is not one of their traditional core competencies. There is a whole range of socio-cultural hurdles that need to be overcome here, as a programmer from a software company of a large German OEM who was interviewed points out:

> ***Works council work is the opposite of what programmers like doing. You have to talk to people, to human resources, deal with legal stuff. But I really appreciate working alone.*** *(Interview software subsidiary OEM)*

In addition, companies are currently courting computer scientists, which frequently allows them to negotiate good working conditions on an individual basis. Nevertheless, this relatively privileged and highly qualified group of workers is also reacting to social injustices and is feeling at least latently threatened by the growing competition, that sometimes even exists within the corporations themselves: "One employee [located in the city where OEM is headquartered] costs as much as two in Berlin or six in India" (Interview with OEM software subsidiary). In this respect, there are certainly opportunities for trade union organization in the field of software development. This could be seen, for example, in the works council election at the Mercedes software subsidiary MBition in Berlin, that took place in the spring of 2022 with the support of IG Metall.

## 6.3 SEMICONDUCTORS

### 6.3.1 Growing Demand

With the double transformation, the importance of electronic components in vehicles is growing both in terms of quality and quantity. It is changing the role of semiconductor manufacturers within the value chains: their specific importance is growing, with end manufacturers becoming increasingly dependent on chip producers.

Why is there a growing demand for electronic components? There are two main reasons for this. **Digitization** is turning cars more and more into what Patrick Morgan, Vice President Automotive at Analog Devices – one of the world's largest semiconductor manufacturers – calls "data centres on wheels connected to the cloud" (cited in Vollmer 2021: 3). The more driver assistance systems, control units, navigation, and entertainment technology are installed in modern cars, the more semiconductor elements they need, processors, memory chips and displays, to name but a few. This trend has been emerging for years, completely independent of the question of what kind of engine powers the cars.

However, the **electrification of the drivetrain** is greatly **increasing** the automotive industry's need for semiconductor components. This is because the electric motors are controlled by complex power electronics. Sophisticated battery management systems require real computing power and control hardware. According to Morgan, an industry insider, the shift by car manufacturers towards electric cars will increase demand in this sector by 35 to 40 percent a year. A McKinsey study assumes a growth in global semiconductor production of six to eight percent a year by 2030, with the main share of demand expected from the automotive industry (Pillau 2022).

According to a study conducted by Sylvia Stieler and Benjamin Frieske, electrification alone increases the value shares for semiconductor components against the background of electrified drivetrain components "from approximately EUR 330 to approximately EUR 690 in material value for plug-in hybrids or purely battery-electric vehicles" (Frieske/Stieler 2021: 7). According to the authors, this does not include the now greater demand created by automated and/or autonomous driving functions.

German newspaper Handelsblatt provides slightly different figures, but they reflect a similar trend: according to the newspaper, car manufacturers bought semiconductors to the value of USD 490 on average for a car with a petrol or diesel engine in 2021, while an electric vehicle required parts worth USD 950 (Hofer 2022).

The costs for electronics in premium vehicles are significantly higher. Here, according to calculations by the Roland Berger consultancy, high-end manufacturers today install semiconductor components worth around EUR 2,500 in an upper-class combustion-engine model, while for a premium car with semi-autonomous driving functions, the agency forecasts costs of EUR 5,900 for the year 2025 (Frieske et al. 2022: 7) (see Figure 40).

**Figure 40: The Need for Semiconductor Elements in a Premium Vehicle**

| Combustion engine (2020) | Electric vehicle (forecast 2025) |
| --- | --- |
| approx. EUR 2,500* | approx. EUR 5,900* |
| *pure material value | |

Source: Frieske/Stieler 2021: 7

We already got a taste of the increasing demand for semiconductor components during the so-called **semiconductor crisis of 2020/21**. After the automotive market totally collapsed during the COVID-19 pandemic in the first half of 2020, a global supply shortage of key electronic components made itself felt in the autumn of 2020, when the demand for cars recovered surprisingly quickly. This was partly for short-term and pandemic-related reasons: automobile manufacturers had cancelled orders with semiconductor manufacturers in response to their production being curtailed in the spring. Due to the demand for PC technology, notebooks, communication, and consumer electronics rose sharply during the pandemic, chip manufacturers set new priorities. Car manufacturers had a worse hand in the competition than the electronics sector: for smartphones we are talking about more than a billion devices a year, whereas car manufacturers only build tens of millions of vehicles and therefore only account for five to ten percent of global chip numbers. Added to this were other pandemic-related hurdles like disrupted supply chains due to lockdowns, closed freight ports, short-term disruptions such as factory fires at the site of the Japanese chip manufacturers AKM and Renesas, and an Arctic winter storm in North America, that led to the collapse of power supplies in Texas and to production restrictions lasting several weeks at plants of important electronics suppliers to the automotive industry such as NXP, Samsung, and Infineon (Frieske/Stieler 2021: 3).

The obvious connection with the pandemic, however, in part obscured the view of the deeper structural causes of the semiconductor crisis, i.e. that demand is higher than supply, even without a pandemic. The automotive industry, compared to other buyers like communications, IT, and consumer electronics, has thus far had only a very small share of the market. Stieler and Frieske point out that their share of global sales in 2020 was only about eleven percent, while IT and data technology bought about 65 percent of the chips produced (ibid.). Figure 41 (next page) shows the leading manufacturers of semiconductors globally.

It is interesting to note, however, that companies like Samsung thus far hardly play a role in the automotive business. As Figure 42 (next page) shows, the automotive industry is only a relevant customer for a relatively small number of producers.

The largest autochip manufacturer is Infineon with a market share of 13 percent, ahead of NXP from Eindhoven at just under eleven per cent. They are followed by Renesas from Japan, Texas Instruments, and STMicroelectronics (Frieske/Stieler 2021).

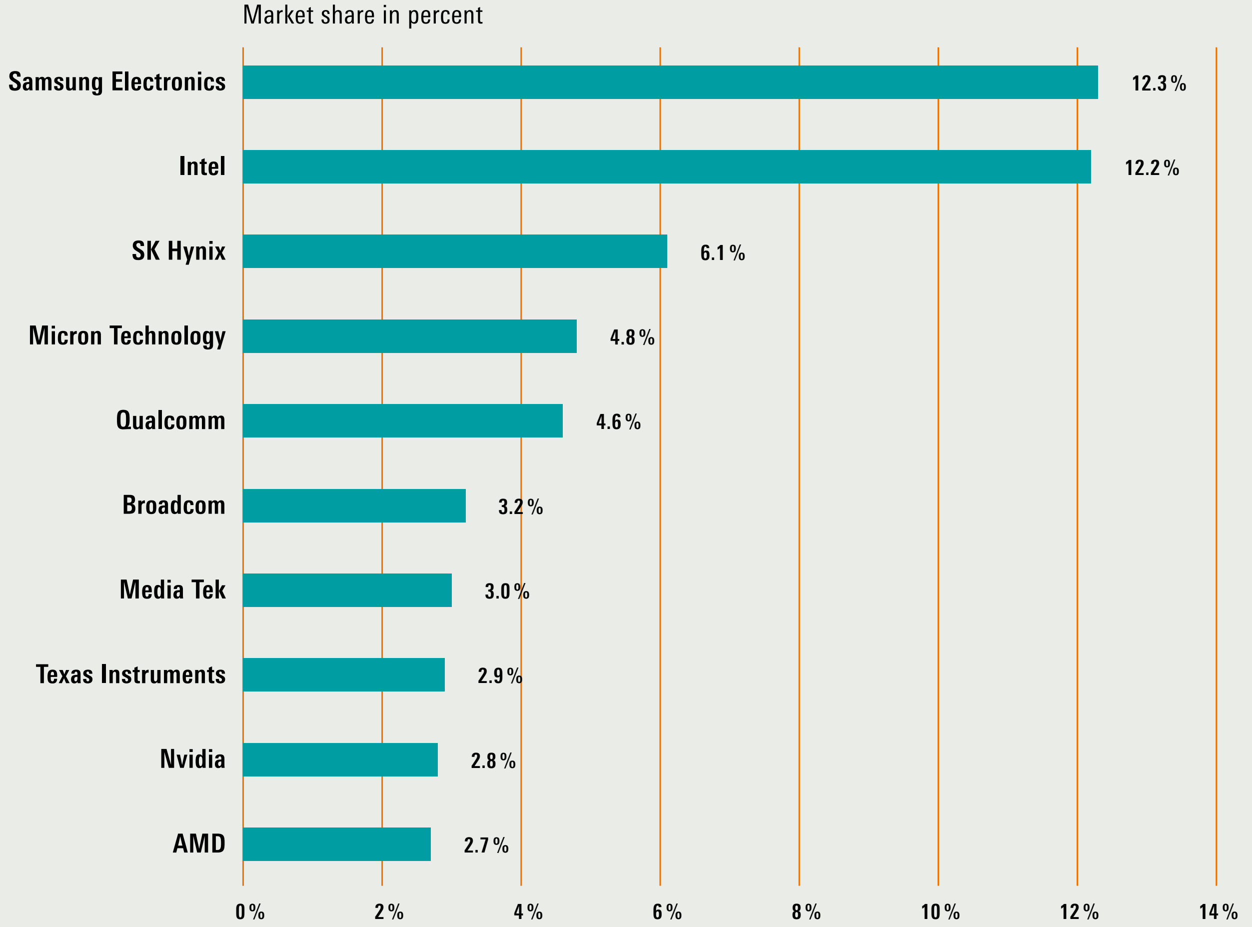
The relative insignificance of the car industry for the largest chip manufacturers is, however, likely to change quite significantly over the coming years. This is already evident in the trade press that has recently been reporting regularly on new or upcoming collaborations between the major OEMs and companies such as Intel, Nvidia, and Qualcomm: they have become highly sought-after cooperation partners because they develop and produce powerful processors that are essential for the central computers of future electrified and digitized cars. More memory chips are also needed from manufacturers including Samsung, SK Hynix, and Micron.

### 6.3.2 Company Strategies and Perspectives

In view of the growing demand, the companies that manufacture electronic parts for the automotive industry may well continue to grow. As reported by *Handelsblatt*, since 2021/22, manufacturers such as Infineon have had their order books completely full for two years, with orders worth more than EUR 31 billion. As Infineon CEO Reinhard Ploss stated: “The supply bottlenecks are far from over, and the situation is not expected to calm down until 2023” (Hofer 2022). This continues to cause production cutbacks at plants like VW, where a large part of the night shifts at the main plant in Wolfsburg were already cut in 2022.

Semiconductor manufacturers are responding to the growing sales market by investing to expand production capacities. But things like that do not happen overnight and according to Stieler and Frieske (2021: 7), the construction phase for a semiconductor factory is about three years and requires

Figure 41: **Leading Manufacturers of Semiconductors, by Global Revenues in 2021**




Source: Statista 2022f

Figure 42: **Significance of the Automotive Industry for Important Semiconductor Manufacturers Worldwide**

| Manufacturer | Automotive industry share of turnover in percent |
|---|---|
| AMD/ATI | 1 % |
| TSMC | 3 % |
| Qualcomm | 4 % |
| Nvidia | 6 % |
| Texas Instruments | 20 % |
| Infineon | 42 % |
| NXP | 44 % |
| Renesas | 48 % |

Source: Frieske/Stieler 2021

an investment of up to EUR 20 billion. In particular, European semiconductor manufacturers like Infineon and STMicroelectronics, for whom the automotive industry plays a greater role than for most Asian producers, want to expand their capacities.

### 6.3.3 New Industrial Policy Strategies: More Independence

Due to the strategic significance of semiconductor production, the topic has now also been taken up as part of industrial policy initiatives in the EU, the USA, China, and South Korea. Germany and France are planning a European semiconductor alliance to strengthen investments and reduce dependencies on overseas markets. The **EU** wants to support the industry with an "Important Project of Common European Interest" (IPCEI) and mobilize public and private investments of EUR 43 billion for this purpose by 2030 (European Commission 2022). The goal is to increase the share of European manufacturers in global production from the current ten percent to 20 percent by 2030 (Frieske/Stieler 2021: 8).

The **USA** also wants to make their semiconductor demand less dependent on other world regions, especially Asia, and is promoting the expansion of the domestic semiconductor industry with EUR 45 billion over the next five years (ibid.). **China**, for its part, plans to achieve 70 percent self-sufficiency in semiconductor chips by 2025 as part of its current five-year plan and has launched an investment fund worth EUR 25 billion for this purpose. It is worth noting, however, that EUR 125 billion have already been invested in the industry over the last ten years. **South Korea** has released government grants of EUR 730 million for the development of chips in the AI field by 2029, as well as another programme worth EUR 14.5 billion for the development of "next generation chips" (ibid.).

### 6.3.4 Employment Building and Union Successes

The growth of the industry, especially in Europe, offers strategic perspectives for the unionization of workers. This applies not only the actual semiconductor producers, but also the manufacturers of specialist machines and production equipment. This is exemplified by the companies Carl Zeiss SMT in Oberkochen, TDK-Micronas in Freiburg, and Robert Bosch GmbH in Reutlingen in the Baden-Württemberg automotive cluster.

We can expect that expanding the capacities of European semiconductor producers to be associated with a corresponding growth in employment, which will take place in an economic environment, in which trade unions hold a relatively strong position

#### Union successes at Zeiss SMT Oberkochen

ZEISS Semiconductor Manufacturing Technology (SMT) in Oberkochen, Baden-Württemberg, is a strategically important growth company for IG Metall. The company produces special optical tools for semiconductor production, laser lithography, and is at the forefront of technology globally and therefore, part of the key industries of digitization. SMT achieved a record turnover of EUR 2.3 billion in 2021, an increase of 26 percent in one year once adjusted for inflation. The number of employees in the SMT division grew to more than 5,200 worldwide in 2021, a growth of approximately 20 percent. According to the annual report, "the Semiconductor Manufacturing Technology division recorded the largest increase in personnel to date" (Zeiss Gruppe 2021: 34). The company's main site is Oberkochen currently has around 3,500 employees. Between 80 and 100 new employees were hired there every month in 2021. The degree of organization in IG Metall was, in early to mid-2022, in the moderate double-digit percentage range and is struggling to keep pace with the rapid increase in employee numbers. A large part, about one third, of the employees work in research and development. These are highly paid professionals for whom there is great demand in the labour market and who are not spontaneously inclined to organize. More than half of employees have been working from home for weeks or, in some cases, months. The works council and union shop stewards have also been communicating almost exclusively via video conference for a long time, using MS Teams and Zoom.

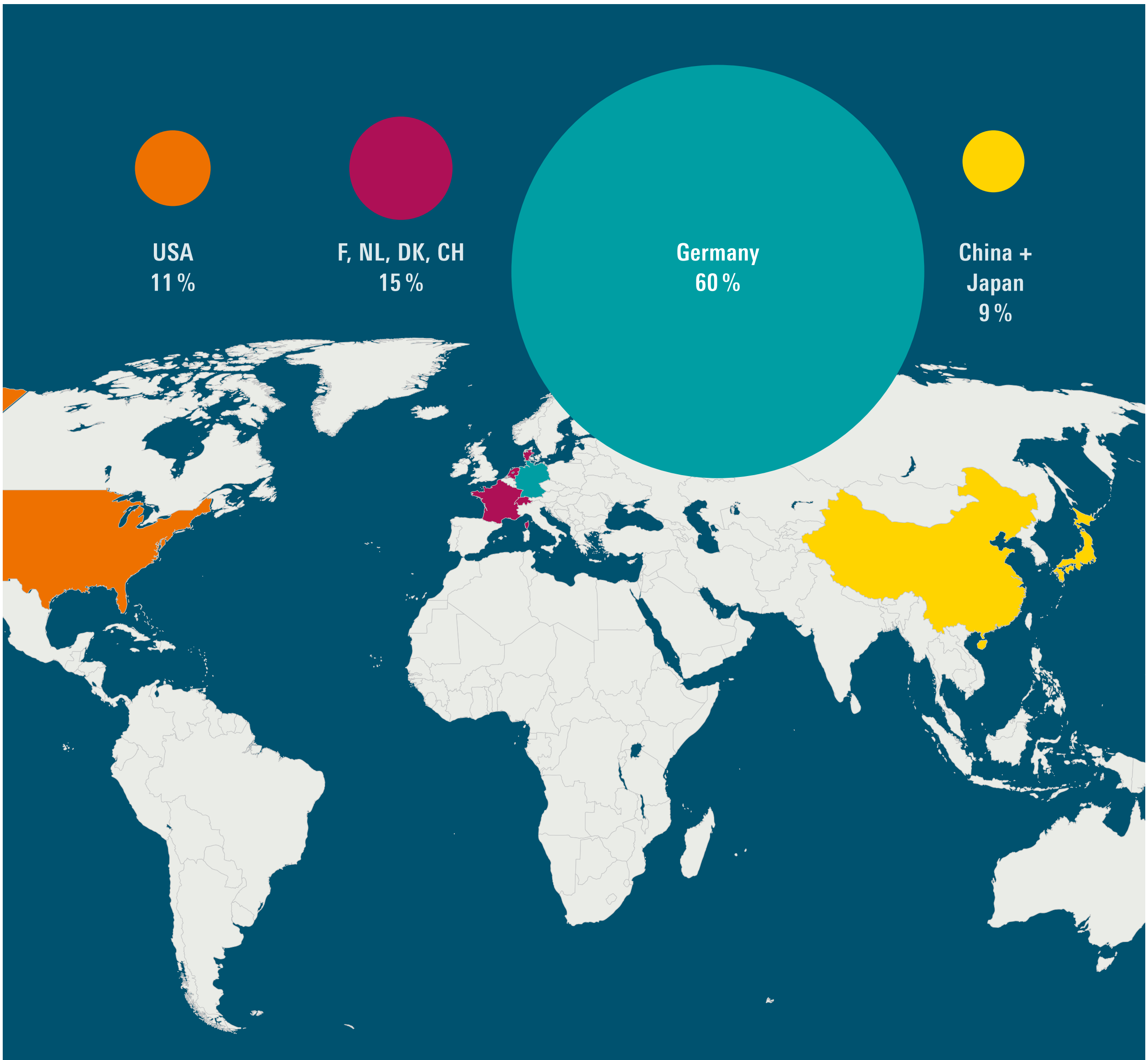
The local IG Metall Aalen has made Zeiss SMT a focus of its work and is trying to strengthen its position within the company by using a targeted approach to contacting workers, an organizing campaign, and pooled resources. The first successes could be seen in the works council elections on 1 March 2022: the IG Metall workers in the company won 24 of the 31 seats on the new committee.

when compared to Asia or the USA. Proactive, campaign-based, and participation-oriented work, as IG Metall in particular has been promoting in battery cell production for several years in the Baden-Württemberg automotive region, is a promising approach to expanding trade union assertiveness and compensating for strategic losses in the traditional core areas of automotive production.

## 6.4 CASE STUDY VW GOLF 8 VS. ID.3: A COMPARISON AT MODEL LEVEL

How does the replacement of the combustion engine-based drivetrain by the electric drivetrain affect the value chains in concrete terms? Is the move of traditional OEMs towards electromobility an opportunity to bring more value creation back into their own companies, or at least to bring them closer? Scientists from the IMU Institute in Stuttgart and the DLR Institute of Vehicle Concepts have investigated this question in a comprehensive study, using the example of a comparison between the two VW models Golf 8 and ID.3 (Frieske et al. 2022). Specifically, they compared the value chains of the two models' components: "combustion engine", "battery system", and "drivetrain as a whole". The findings of the study are clear, underlines IMU scientist Sylvia Stieler:

**Figure 43: Component Network/Value-Added Flows for the VW Golf 8 Combustion Engine**



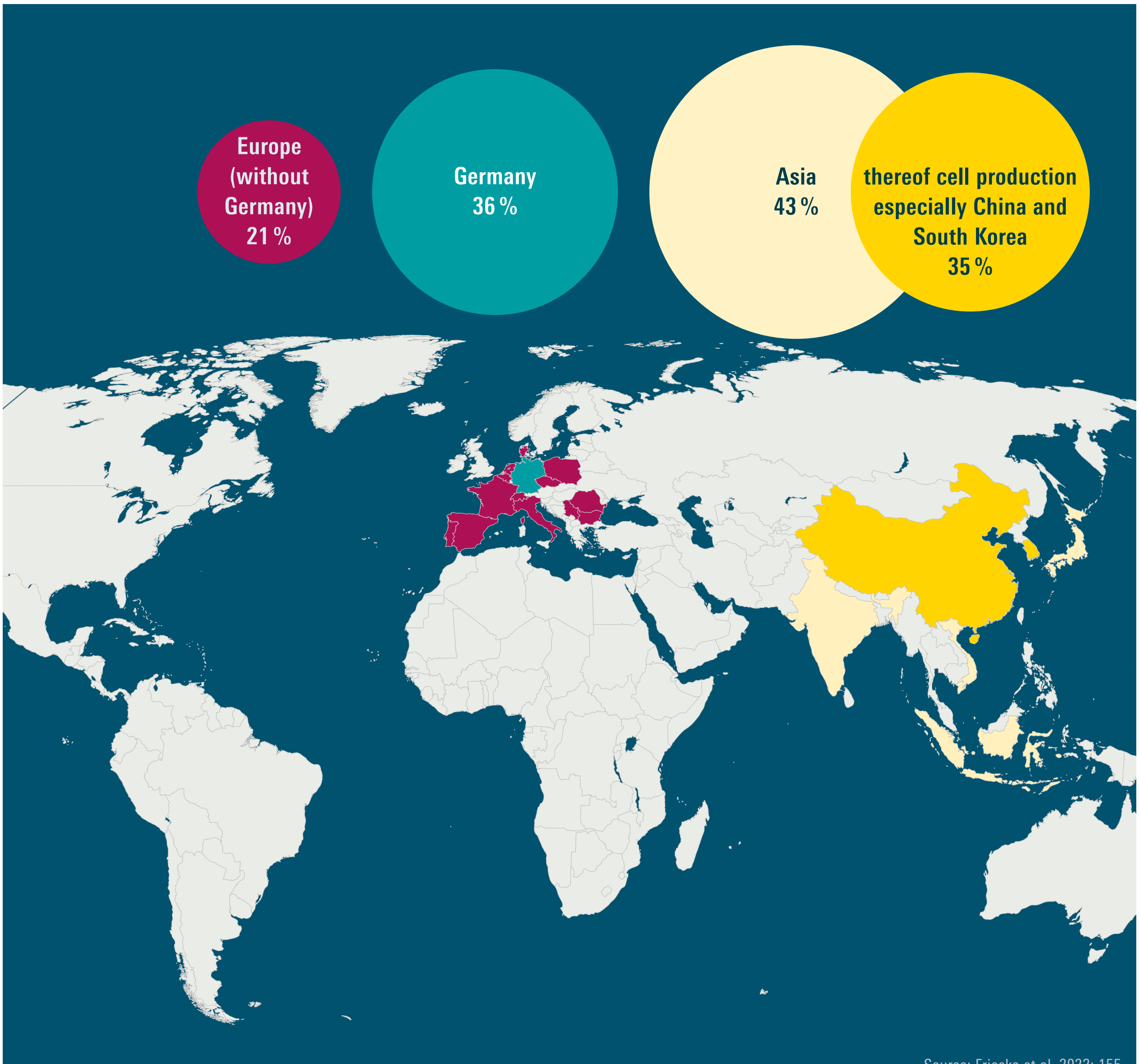

Source: Frieske et al. 2022: 154

> *“There is an extreme shift in value creation away from Germany, away from Europe and towards Asia. This has mainly to do with the batteries and the battery cells, that are currently predominantly coming from Asia.*
> *(Interview Stieler)*

Figure 43 shows the production network for the Golf 8's combustion engine. The authors identified a total of 80 components “from camshafts and crankshafts to cylinders, pistons, piston rods, valves, housings, seals, sensors, and control units” (Frieske et al. 2022: 155) that can be clearly assigned to specific manufacturers and production sites. Their conclusion: the supplier network for the Golf 8 engine is “strongly oriented towards German production sites and suppliers” and a “total of 48 of the 80 components (60 percent) come from suppliers and production sites in Germany, another twelve components from other EU countries (France, the Netherlands, Denmark, Switzerland; 15 percent), nine parts (eleven percent) from the USA, and seven from Asia (China, Japan; nine percent). Four components come from other regions of the world, especially India (five percent)” (ibid.: 153).

In contrast, the production network of the battery system for the VW ID.3 (see Figure 44) has “a completely different structure” (ibid.: 153). Of the total of 14 clearly identified and assigned components — battery cells, housing, cooling, wiring, and sensors — only 36 percent come from Germany, another 21 percent from other

**Figure 44: Component Network/Value-Added Flows for the VW ID.3 Battery System**




Source: Frieske et al. 2022: 155

Figure 45: **Value Creation Structure and Localization in the "Drivetrain" Component Network**

| Model | Platform | Proportion of German components | Proportion of EU components | Proportion of Asian components | Value-added proportion of drivetrain for OEM | Value-added proportion of drivetrain for suppliers |
|---|---|---|---|---|---|---|
| VW Golf 8 | MQB | 60.0 % | 75.5 % | 12.9 % | 20,8 % | 79.2 % |
| VW ID.3 | MEB | 27.3 % ↘ | 39.4 % ↘ | 32.7 % ↑ | 30.9 % ↗ | 69.1 % ↘ |

Value creation structure and localization in the "powertrain as a whole" component network of the VW Golf 8 and ID.3 models in comparison

Source: Frieske et al. 2022: 155

European countries, and 43 percent from Asia. Key suppliers are the cell producers CATL, LG, Samsung SDI, and SKI with production sites in China and South Korea, which, according to the study, have a value-added share of 35 percent of the total drivetrain (ibid.: 154).

Since it is hardly possible to directly compare systems as functionally different as the combustion engine and the battery, it is instructive that the authors have extended their analysis to the "drivetrain as a whole" (see Figure 45). This shows that around 60 percent of the identified parts and components for the Golf 8 are sourced in Germany, a further 16 percent in other EU countries, 13 percent in Asia, and eight percent in the USA.

In the ID.3, on the other hand, a third of components come from Asia, 33 percent, while the share of German production sites is only 27 percent. Another nine percent of the components are sourced in other EU countries.

Remarkable, since it is in some ways at odds with this finding, is the fact that for the electric ID.3, the OEM's own production share is about ten percent higher (see Figure 45), which the authors attribute to "a higher degree of vertical integration in component production, specifically of the Volkswagen in-house production of the electric motor and gearbox" (ibid.: 156). As they themselves note, however, the figures are not clear as a considerable part of the value chain cannot be clearly attributed, eight percent for the Golf 8 and eleven percent for the ID.3, and should probably to be attributed to the suppliers.

Nevertheless, what must be considered is that the findings of the shifts in the value creation networks are only a snapshot, and the authors also emphasize this:

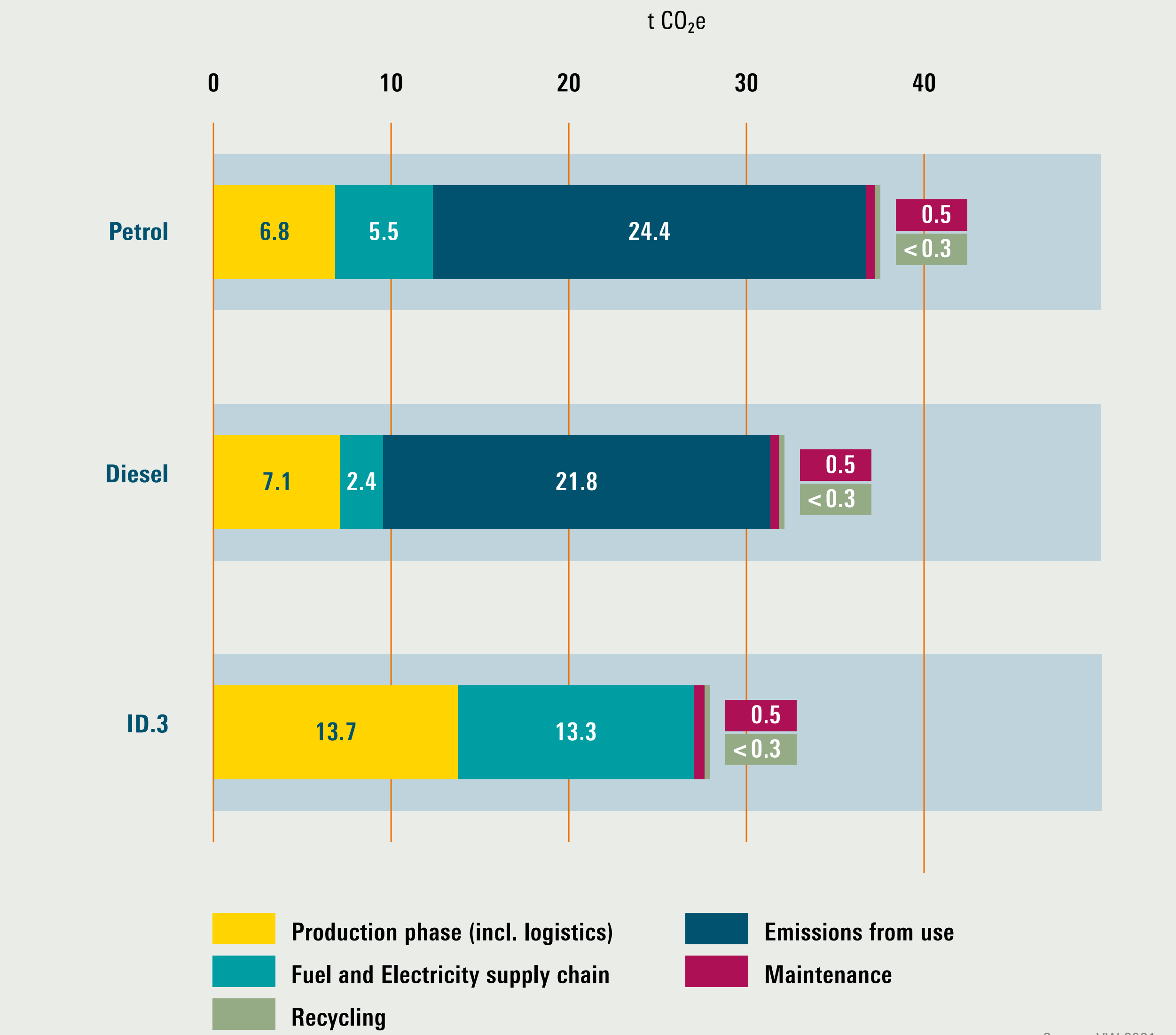
> *"We strongly suspect that at least some German OEMs will take steps or are already taking steps to increase their vertical integration and thus also be able to shape the value chain itself more strongly.*
> *(Interview Frieske)*

In short: whether the shifts diagnosed in this study will last in the long term depends on whether European manufacturers manage to catch up with their Asian competitors. But even if they do, as the authors point out, German and European manufacturers would still be "extremely dependent on strategic raw materials, many of which continue to come from China" (Interview Frieske).

The study does not look into the social, trade union, and ecological differences in the two value chain models that were compared. These are areas where further research is needed. With regard to GHG emissions in production, there is a balance sheet prepared by VW itself, according to which the production-related carbon footprint of the ID.3 is about twice as large as that of a Golf 8 with a petrol or diesel engine (see Figure 46).

What is significantly more complex and difficult to assess are the consequences for the organizing power of trade unions along the production chains. In principle, it can be assumed that a shift of value-added shares from the EU to Asia of the magnitudes identified is likely to weaken trade union power resources, at least in the short and medium term. Georg Leutert of IndustriALL Global Union, outlines the situation as follows:

Figure 46: **Comparing Aspects of the Carbon Footprint of Current VW Vehicles in the Compact Class**




Source: VW 2021a

*“We are currently running a pilot project on batteries and are working with two companies to look at their entire supply chain: What about workers’ rights? We hope to be able to use it to shed some light on the Chinese black hole. After all, the value creation along the supply chains is 60–70-percent Chinese. [...] For us as a global union, the main problem is that the [Chinese companies] are essentially not involved in the whole issue of due diligence [due diligence/transparency], human rights, etc. And that makes it extremely difficult for us when we say to “our” companies in the West: come on, we have to do something about this. And all they do is bring up the issue of the competitive disadvantage: “The Chinese don’t need to do any of that and therefore they don’t need to raise the funds.” It is a huge problem for us.* (Interview Leutert)

# 7 CONCLUDING REMARKS

1. **The double transformation (Bendel/Haipeter 2022a; 2022b) of the automotive industry with its core elements of electric drivetrain and digitization has taken on a dynamic in the years between the "diesel scandal" of 2015 and the COVID-19 crisis of 2020 that has made it the dominant development trend of the global automotive industry.** The interplay between Chinese industrial policy, financial-market-driven investment decisions, and a need to justify actions in terms of climate policies was decisive in setting this course (Dörre 2021). As irreversible as the process has become, it remains open-ended. The double transformation is an attempt at the reform of the automotive industry and its business model as it collides with climate and urban planning limits "from the inside out". Whether this attempt will lead to a successful modernization of the global capitalist lead industry remains to be seen. It is already clear, however, that it cannot lead to an absolute reduction in greenhouse gas emissions or savings of natural resources for decades to come, at least until the middle of the century, and that it does not represent a way to achieve a socio-ecological turnaround in transport.

2. **The double transformation is a global process of unequal and combined developments.** Today, the process has encompassed all major automotive companies and continues the trend of international division of labour along different socio-economic, ecological, and regulatory standards in transnational production networks that has been ongoing since the 1990s. Nevertheless, the dynamics and characteristics of this division of labour are manifested in very different ways in different regions of the world as well as production and product markets. While the market share of electric vehicles is growing rapidly in China, Western Europe, and, to a lesser extent, the USA, India, and Japan, and new registrations of cars running on combustion engines should no longer be possible in a few years to decades, as things currently stand in large parts of the world — South America, the Russian Federation, the Near and Middle East, Africa, and Australia — the combustion engine will remain the predominant drivetrain variant for cars and commercial vehicles in the long term.

3. **Despite all cyclical and structural crises, the global automobile population has grown since the end of WWII and has been growing exponentially since at least the 1970s: doubling roughly every 20 years. The E-strategy of the major car manufacturers is not interrupting or decelerating this dynamic, but simply continuing it with a different drivetrain technology.** Even such serious historical caesuras as the collapse of the Soviet Union and its Eastern European allies, the global financial and economic crisis of 2008/09, and the COVID-19 pandemic of 2020/21 have not fundamentally changed the long-term expansion of the global car population. The economic rise of emerging countries, especially the BRICS nations, will raise motorization rates in other regions of the world. This dynamic is toxic for the global climate and the development of urban and suburban living spaces in particular.

4. **Electric vehicles have clear advantages over vehicles running on petrol or diesel engines but they cannot be a central element of a socio-ecological transport transition.** The energy efficiency of electric cars is significantly higher and their greenhouse gas balance over their lifecycle is undoubtedly better if they are powered by electricity from renewable sources. This applies not only

in comparison to vehicles powered by fossil fuels, but also in relation to other alternative drivetrains such as fuel cells or combustion engines using synthetic fuels. These benefits of electric cars can, however, only unfold their potential if the overall stock of cars is reduced, if the vehicles have a long service life, and if they achieve high mileages. But this would require a far-reaching departure from the individual private car model, more shared use sharing or pooling systems, and a massive expansion of public transport systems, also in rural and suburban areas.

5. **Starting points for a left-wing, social, and ecological intervention are both struggles for the preservation of jobs and social standards within the companies that are threatened by transformation, for trade union organization, and for better working conditions for workers in the new enterprises and value chains, as well as the struggles for climate justice and human-centred transport systems in liveable cities.** A left-wing transformation strategy must be oriented towards what connects the content and the strategic interlocking of these struggles. It is necessary to link trade union defensive struggles in the "fossil" car industry, "organizing drives" at Tesla and the new battery manufacturers with local, regional, and national initiatives for a turnaround in transport systems. The guiding principle in terms of strategy should be an integrated socio-ecological mobility system with climate-neutral regular bus and train services as its foundation, an intelligent gap closure using electric call-a-bus services, shuttles, and taxis in suburban and rural areas, and with widely available car-sharing fleets for individual needs. At its core, such a mobility system must be organized as part of public services rather than a private capitalist business model. And it needs to also be able to appear attractive as a model for emerging countries and the Global South.

6. **For the industrial trade unions, the double transformation is an essential, perhaps even the core area of their organizational power. To remain a serious political player in the automotive industry of the 21st century, they will have to organize workers along the new strategic value chains.** Specifically, the battery complex, from lithium/cobalt mining to refinery processes, cell production, and battery manufacturing to final assembly, and the digital value chain meaning semiconductor producers, their equipment, and raw material suppliers, software developers, internet infrastructure companies, the platform economy, and Big Data.

   The global federation of industrial unions, IndustriALL Global Union, has recognized this challenge, but is still in the early stages of tackling it. As Kan Matsuzaki, Assistant General Secretary at IndustriALL, states outlining the objective of addressing battery production from raw material extraction to final assembly as a new strategic area of union organizing: "We are trying to use our organizing power with the car manufacturers to strengthen workers' rights along the entire battery supply chain". Valter Sanches, former General Secretary of IndustriALL, puts it clearly: "We are trying to engage the lithium and cobalt miners in Congo or Chile, Argentina, and Bolivia with the manufacturers and the OEMs that use these batteries as part of a common trade union strategy" (Interview Sanches). Glen Mpufane, IndustriALL director for the mining sector, even speaks of the strategic goal of a "global picket line" along the entire value chain: "A global picket line, across all sectors: it could start with one company, maybe a refinery, somewhere in the world [...]. Then you connect that to the workers who use the products from that factory, you go down the supply chain and you create cross-sector solidarity. That way, we have the opportunity to create not just global network solidarity within a single sector, but across sectors, in multiple sectors, and multinationally" (Interview Mpufane).

   The same strategic task arises for trade unions in relation to companies in the digital value chain: "The crucial issue today is organising the huge army of IT people" states IndustriALL Director for the Automotive Sector Georg Leutert, outlining the challenge.

7. **If trade unions want to successfully shape the transformation in the interest of the employees and set effective impulses for a socio-ecological transport turnaround, they have to focus simultaneously on building countervailing power within companies as well as in society.** Carsten Hübner, a long-time union consultant and former director of the Transatlantic Labor Institute in Spring Hill, Tennessee, puts it this way: "If a trade union wants to be sustainably successful in a differentiated landscape of companies and locations and also able to tap into new workforces, it needs to not only have professional organizing concepts, but also strong foundations locally, in society, politics,

sport, and everyday culture" (Interview Hübner). Trade unions in the automotive industry can and should also carefully study new kinds of organizing experiences in the service sector, gig economy, and Amazon, and critically evaluate them to find inspiration in their approaches to organizing.

8. **The corporate "orders of justification" and legitimation ideologies that are currently determining the double transformation focus on climate protection and saving the planet, and are generally associated with a "progressive" attitude. Even if this is ultimately marketing, workers and political activists can "turn" this narrative around and use it strategically in the interests of workers and socio-ecological intervention**. US trade union researcher Stephen Silvia points to organizing disputes at the world's largest café chain, Starbucks, as an example:

> *When Starbucks tried to stop the organizing drives, they sent people in who could say: "I am a member of Greenpeace, I am a member of Amnesty International". And then the employees said: "Good, then you understand why we are trying to organize?" So, there are these efforts by some American companies to look cool and progressive and be at the forefront of the social progress movement. Well, in part you can turn that against them and say: "Well, that's great. If you stand up for civil rights, for gay rights, and for the environment, then you should also stand up for workers' rights". It is a strategy that I think will be used more and more. I think it can be very effective.* (Interview Silvia)

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# ANNEX

## TABLE OF ACRONYMS

| | |
|---|---|
| **ACC** | Adaptive Cruise Control |
| **BEV** | Battery Electric Vehicle |
| **BRICS countries** | Brazil, Russia, India, China, and South Africa |
| **CEO** | Chief Executive Officer |
| **$CO_2$** | carbon dioxide |
| **EFTA** | European Free Trade Association |
| **IEA** | International Energy Agency |
| **LGBTQ** | lesbian, gay, bisexual, transsexual, queer |
| **NAFTA** | North American Free Trade Agreement |
| **NEV** | New Energy Vehicle – used particularly in China to describe electric vehicles |
| **OEM** | Original Equipment Manufacturer |
| **ÖPNV** | öffentlicher Personennahverkehr – public transport |
| **PHEV** | Plug-in-Hybrid Electric Vehicle |
| **SOE** | State-Owned Enterprises |
| **SUV** | Sport Utility Vehicle |
| **GHG** | greenhouse gas |
| **UAW** | United Auto Workers – largest union of automotive workers in the USA |

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## IMPRINT

**Publisher:**
Rosa-Luxemburg-Stiftung
Chemin de Balexert 7–9
1219 Châtelaine
Switzerland

**www.rosalux-geneva.org**
**info@rosalux-geneva.org**

September 2023

**Editorial responsibility:**
Jan Leidecker //// Liable in accordance with German press laws:
Jan Leidecker

ISBN 978-2-8399-3945-4

**Authors:**
Jörn Boewe/Johannes Schulten, Journalistenbüro work in progress
**Editing:** TEXT-ARBEIT, Berlin
**Typesetting and design:** Dirk Braunheim
**Printing:** Media Service GmbH Druck und Kommunikation

This publication was produced with the financial support of the German Federal Ministry for Economic Cooperation and Development (BMZ). This publication is the sole responsibility of the publisher. The positions expressed herein do not reflect the views of the funding agency. The publication is distributed free of charge and may not be used for electoral campaigning purposes.
A German version of this study was published in March 2023 under the ISBN 978-2-8399-3840-2.