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Import-export regulations for electric vehicles: A comparative analysis between the EU and China

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前言

近几年来，一种新的型汽车在全球道路上变得越来越普及，那就是电动汽车（EVs）。与传统的内燃机汽车（ICE）不同，这种汽车靠电池而不是汽油运行，因此噪音大大降低，减少了噪声污染。更重要的是，电动汽车正在成为汽车行业未来的基石，因为各国都通过实施生态友好型政策和承诺遵守国际环境协定，将环境可持续性放在首位。向电动汽车过渡对于减少二氧化碳排放尤为重要，而二氧化碳是气候变化的主要因素之一，而气候变化主要是由交通部门造成的。

中国目前在全球电动汽车市场中处于领先地位，销售量超过了所有其他国家的总和。紧随中国之后，欧盟（EU）与美国是全球第二大和第三大电动汽车市场，而世界其他地区的市场份额相对较小。随着全球各国政府将推广电动汽车作为可持续发展目标的一部分，预计电动汽车的生产将持续增长。然而，由于电动汽车相对于传统汽油车和柴油车的成本较高，使其难以被广大消费者所接受，因此广泛采用电动汽车仍具有挑战性。

中国通过大规模生产，降低了制造成本，成功地缓解了这一经济承受能力障碍，实现了大规模应用。这种具有竞争力的成本优势不仅加快了国内电动汽车的普及，还吸引了特斯拉、宝马等西方汽车制造商在中国设立生产基地。通过利用较低的生产成本，这些公司在中国制造电动汽车，并随后将其出口到包括欧洲在内的其他市场。

本论文研究了中国与欧盟之间电动汽车进出口的监管框架。在欧洲方面，分析侧重于进口法规，而在中国方面，研究则探讨国家出口标准。这两个地区之间的经济相互依赖显而易见，因为欧洲企业受益于中国具有成本效益的生产，而中国汽车制造商则寻求扩大在欧洲市场的影响力。

通过对欧洲和中国监管框架的全面分析，本研究为希望进入欧洲市场的中国制造商提供指导，同时也为在中国生产电动汽车并出口到欧洲的西方企业提供参考。其目标是提供电动汽车贸易相关监管要求的见解，重点介绍合规方面的主要考虑因素以及成功融入市场的必要步骤。

本论文通过广泛的研究，并利用意大利语、英语和中文的多种来源进行撰写。主要资料来源包括欧洲和中国主要机构的官方文件。在欧洲方面，通过欧盟委员会、欧洲理事会等机构的官方出版物研究了监管框架和政策。在中国方面，信息来源包括商务部、

生态环境部、财政部、国家税务总局以及工业和信息化部等政府机构。欧洲法规通过欧盟官方立法数据库获取，而中国国家标准则来自国家标准公开系统。

除了官方来源外，还参考了多种次要资料，以提供更广泛的背景信息和更深入的见解，助力电动汽车行业发展的研究。这些资料包括学术论文、行业报告和学术文章，为本研究奠定了理论和实证基础。此外，知名在线期刊的文章提供了额外视角，以及统计数据和图表分析，从而促进对市场趋势和监管影响的更全面研究。

本论文围绕两个核心分析领域展开：一是规范从中国进口电动汽车（EV）进入欧盟的监管框架，二是规范电动汽车出口至欧洲的中国国家标准。

第一章全面概述了全球电动汽车市场。首先探讨电动汽车的历史起源、不同类型的电动汽车以及其基本运行原理。随后，讨论转向传统内燃机汽车带来的环境挑战，并分析向电动出行转型如何促进环境可持续性。接着，本章对全球电动汽车的分布情况进行分析，评估各地区的采用率及阻碍其广泛普及的因素。最后，本章对市场趋势进行评估，探讨电动汽车行业是否具备长期增长潜力，还是当前的扩张仅是暂时的增长浪潮。

第二章深入探讨本论文的第一个重点：欧盟电动汽车进口的监管框架。首先评估欧盟的气候目标、政策举措及相关立法措施，这些措施旨在促进可持续发展并减少碳排放。随后，分析中国制造的电动汽车在欧盟市场的渗透情况，识别主要行业参与者及其竞争定位。最后，本章对欧盟针对从中国进口电动汽车的具体法规进行深入研究。

第三章将重点转向中国电动汽车出口的国家标准，探讨中国如何通过战略举措成为全球电动汽车生产的领导者。本章首先概述中国政府推动国内电动汽车产业增长的政策和补贴措施。与上一章相对应，本章还分析中国在应对环境挑战方面的策略，以及为减少汽车生产和使用对生态的影响而实施的监管措施。最后，本章对中国出口电动汽车至欧盟的关键法规进行分析，阐述其适用范围及重要性。

第四章，也是最后一章，对欧盟和中国的监管框架进行对比分析，重点探讨其相似之处、差异以及对全球贸易的广泛影响。本章评估监管差异如何影响制造商、贸易关系和国际电动汽车市场，同时还考虑潜在的监管协调与合作领域。

INDEX

前言 1

INDEX 3

INDEX OF FIGURES 5

INTRODUCTION 6

CHAPTER 1: GLOBAL PRODUCTION AND DISTRIBUTION OF ELECTRIC VEHICLES 9

1.1 Historical Background 9

1.2 Types and Functioning of EVS 10

1.3 Environment Problems 11

1.4 Distribution of EVs 16
1.4.1 Challenges of EVs' Growth 16
1.4.2 Hofstede's six dimensions of national culture 18

1.5 Electric Vehicles Global Market 19
1.5.1 Electric car sales 20
1.5.2 How is and will 2024 go? 25
1.5.3 Electric cars' second-hand market 29
1.5.4 Outlook for electric mobility 33

CHAPTER 2: DISTRIBUTION IN EUROPE AND RELATED REGULATIONS 36

2.1 Environment Regulations 36
2.1.1 Sustainable Development Goals 36
2.1.2 Paris Agreement 38
2.1.3 European Green Deal 40

2.2 Distribution in Europe of China's Electric Vehicles 44

2.3 European Regulations Regarding Imports from China 48
2.3.1 Regulation (EU) 2019/631 51
2.3.2 Regulation (EU) 2018/858 53
2.3.3 Regulation (EU) 2019/2144 55
2.3.4 Regulation (EU) 2023/1542 57
2.3.5 Regulation (EU) 2023/956 59

CHAPTER 3: DISTRIBUTION IN CHINA AND RELATED REGULATIONS 61

3.1 China's Electric Vehicle Market 61
3.1.1 Dual Credit Policy 62

3.2 China's Environmental Regulations 69
3.2.1 China National ETS 71

3.3 Chinese Regulations Regarding Exports of Electric Vehicles 72
3.3.1 GB 7258-2017 74

3.3.2 GB 19578-2021 ..... *75*
3.3.3 GB 18384-2020 ..... *77*
3.3.4 GB/T 36276-2023 ..... *78*

CHAPTER 4: EUROPEAN REGULATIONS VS CHINA'S NATIONAL STANDARDS 80

4.1 CO_2 Emission Limits 81

4.2 Type Approval and Market Surveillance 82

4.3 Safety of Onboard Systems 83

4.4 Battery Sustainability 85

CONCLUSIONS 88

BIBLIOGRAPHY 91

Primary sources 91
Regulations *91*
National standards *92*
Official definitions, classifications and database *93*

Secondary sources 94

Sitography 100

INDEX OF FIGURES

Figure 1 Evolution of CO_2 emissions in the EU by sector (1990-2019) (EEA 2022) 12
Figure 2 Transport emissions in the EU (EEA, 2022) 14
Figure 3 Survey results of disinterest in EVs from the public (Noel et al. 2019) 17
Figure 4 Global electric car stock trends, 2010-2023 (IEA, 2024) 20
Figure 5 Electric car registrations and sales share, 2015-2023 (IEA, 2024) 23
Figure 6 Electric car sales in selected countries and regions, 2015-2023 (IEA, 2024) 24
Figure 7 Quarterly electric car sales, 2021-2024 (IEA, 2024) 26
Figure 8 Electric car sales, 2010-2024 (IEA, 2024) 28
Figure 9: Second-hand market size for electric and conventional cars 2021-2023 (IEA, 2024) 30
Figure 10: Electric vehicle sales by region and scenario, 2030 and 2035 (IEA, 2024) 34
Figure 11: 17 Sustainable Development Goals (SDGs) (United Nations website) 37
Figure 12: Top five concerns for respondents to buy an EV (EY, 2023) 41
Figure 13: BEV sales share in Europe (ACEA, 2024 and T&E, 2024c) 45
Figure 14: Share of the BEV market imported from China (T&E and Dataforce, 2024) 47
Figure 15 The management framework of Dual-Credit Policy (Yang et al., 2022) 64
Figure 16 Development of NEV Passenger Vehicles 2016-2022 (MIIT, 2023) 67
Figure 17 China's New Energy Vehicles (NEVs) from 2013 to 2022 (Gary, Zhao and Bao, 2024) 68

INTRODUCTION

In recent years, a new type of vehicle has become increasingly prevalent on roads worldwide, that is electric vehicles (EVs). Unlike traditional internal combustion engine (ICE) vehicles, these cars operate on batteries rather than gasoline, making them significantly quieter and reducing noise pollution. More importantly, electric cars are emerging as a cornerstone of the automotive industry's future, as nations prioritize environmental sustainability by implementing eco-friendly policies and committing to international environmental agreements. The transition to EVs is particularly critical in reducing CO_2 emissions, a key contributor to climate change, which is primarily driven by the transportation sector.

China currently leads the global EV market, with sales surpassing those of all other countries combined. Following China, the European Union (EU) and the United States rank as the next largest EV markets, while the rest of the world accounts for a comparatively smaller share. As governments worldwide promote the adoption of electric vehicles as part of their sustainability goals, it is anticipated that EV production will continue to expand. However, widespread adoption remains challenging due to the high cost of EVs relative to conventional petrol and diesel cars, making them less accessible to a broad consumer base.

China has successfully mitigated this affordability barrier, achieving mass adoption through large-scale production, which has driven down manufacturing costs. This competitive cost advantage has not only accelerated domestic EV adoption but has also attracted Western automotive manufacturers, such as Tesla and BMW, to establish production facilities in China. By leveraging lower production costs, these companies manufacture EVs in China and subsequently export them to other markets, including Europe.

This thesis examines the regulatory frameworks governing the import and export of electric vehicles between China and the European Union. On the European side, the analysis focuses on import regulations, while on the Chinese side, the study explores national export standards. The economic interdependence between these two regions is evident, as European companies benefit from China's cost-effective production, while Chinese automakers seek to expand their presence in the European market.

By providing a comprehensive analysis of both European and Chinese regulatory frameworks, this research serves as a guide for Chinese manufacturers looking to enter the European

market, as well as for Western companies producing EVs in China and exporting them to Europe. It aims to offer insights into the regulatory requirements governing the trade of electric vehicles, highlighting key compliance considerations and the necessary steps for successful market integration.

This thesis was developed through extensive research utilizing a diverse range of sources in Italian, English, and Chinese. The primary sources included official documents from key European and Chinese institutions. On the European side, regulatory frameworks and policies were examined through official publications from entities such as the European Commission and the European Council. On the Chinese side, information was gathered from government bodies including the Ministry of Commerce, the Ministry of Ecology and Environment, the Ministry of Finance, the State Taxation Administration, and the Ministry of Industry and Information Technology. European regulations were accessed through the European Union's official legislative database, while Chinese national standards were obtained from China's national standards disclosure system.

In addition to official sources, a variety of secondary materials were consulted to provide broader context and deeper insights into the development of the electric vehicle sector. These included academic papers, industry reports, and scholarly articles that contributed to the theoretical and empirical foundation of this research. Furthermore, articles from reputable online journals provided additional perspectives, as well as statistical data and graphical analyses, which facilitated a more comprehensive examination of market trends and regulatory impacts within the electric vehicle industry.

This thesis is structured around two core areas of analysis: the regulatory framework governing the import of electric vehicles (EVs) into the European Union from China and the corresponding Chinese national standards governing the export of EVs to Europe.

The first chapter provides a comprehensive overview of the global electric vehicle market. It begins with an exploration of the historical origins of electric vehicles, the various types of EVs, and the fundamental principles of their operation. The discussion then shifts to the environmental challenges posed by traditional internal combustion engine vehicles and examines how the transition to electric mobility can contribute to environmental sustainability. This is followed by an analysis of the global distribution of EVs, assessing regional adoption

rates and the obstacles hindering widespread deployment. The chapter concludes with an evaluation of market trends, examining whether the electric vehicle sector is poised for long-term growth or if its current expansion represents a temporary surge.

The second chapter delves into the first focal point of the thesis: the European regulatory framework for EV imports. It begins with an assessment of the European Union's climate objectives, policy initiatives, and legislative measures aimed at promoting sustainability and reducing carbon emissions. The discussion then turns to the market penetration of Chinese-manufactured EVs within the European Union, identifying key industry players and their competitive positioning. The chapter concludes with an in-depth examination of the specific European regulations that govern the importation of electric vehicles from China.

The third chapter shifts the focus to China's national standards on EV exports, exploring the strategic initiatives that have positioned China as the global leader in electric vehicle production. It provides an overview of the Chinese government's policies and subsidies that have accelerated the growth of the domestic EV industry. In parallel with the previous chapter, this section also addresses China's approach to environmental challenges and the regulatory measures implemented to mitigate the ecological impact of vehicle production and usage. The chapter concludes with an analysis of the key Chinese regulations governing the export of electric vehicles to the European Union, outlining their scope and significance.

The fourth and final chapter presents a comparative analysis of the European and Chinese regulatory frameworks, highlighting their similarities, differences, and the broader implications for global trade. This section evaluates how regulatory divergences impact manufacturers, trade relations, and the international electric vehicle market, while also considering potential areas for regulatory harmonization and cooperation.

CHAPTER 1: GLOBAL PRODUCTION AND DISTRIBUTION OF ELECTRIC VEHICLES

1.1 Historical Background

If someone were to ask, "When was the first electric vehicle created?", many might assume the answer lies sometime after the 2000s. Surprisingly, however, the inception of the first genuine electric car dates back to 1888. This pioneering vehicle, known as the "Flocken Elektrowagen", was the brainchild of German inventor and entrepreneur Andreas Flocken. The vehicle achieved a maximum speed of 16 km/h, and despite the technological limitations of the era that restricted its range, it laid essential groundwork for future advancements in electric mobility (V2C, 2024).

Before the rise of the internal combustion engine, electric cars enjoyed significant popularity and held numerous speed records. In the early 1900s, electric vehicles were sold more frequently than their gasoline counterparts, particularly among the elite class. Their simple, clean and quiet operation made them especially appealing as vehicles suitable for women (Nuvoli, 2017).

However, the success of electric cars waned during the Second Industrial Revolution, coinciding with the discovery of new oilfields. Improvements in the performance and reliability of petrol-powered cars soon eclipsed electric vehicles, leading to their decline in market dominance (Nuvoli, 2017).

In recent decades, growing environmental awareness and oil crises of 1973 and 1979 in the Middle East reignited interest in electric vehicles. Major automotive manufacturers invested in research and development of electric prototypes, though these early efforts struggled to compete with the well-established combustion engine cars. The primary obstacle was the insufficient energy storage capacity of batteries (Nuvoli, 2017).

The 1990s saw the emergence of the first modern electric vehicles, such as General Motors' EV1 and Honda's EV Plus. These vehicles offered greater range than their predecessors but continued to face challenges related to cost and the availability of charging infrastructure (V2C, 2024).

It wasn't until the 2010s that electric cars began to gain significant popularity. Major automotive manufacturers intensified their research and development efforts to overcome the known limitations of electric vehicles, such as speed, range, recharging time and the availability of infrastructure like charging stations, thereby enabling them to compete more effectively with traditional fossil-fuel vehicles (V2C, 2024).

Governmental efforts and incentive policies have also played a pivotal role in the transition to electric vehicles. Many countries have implemented decarbonization plans and set ambitious targets for reducing greenhouse gas emissions, further accelerating the adoption of electric vehicles (V2C, 2024).

The evolution of electric vehicles from their early models to the present day underscores the remarkable progress in technology and the growing importance of environmental sustainability. While challenges such as battery cost persist, electric vehicles undeniably play a crucial role in the transition towards a more sustainable future.

1.2 Types and Functioning of EVS

How does an electric vehicle (EV) actually work, and what sets it apart from a conventional car?

As the name suggests, an electric vehicle operates using electricity as its primary energy source. Unlike conventional cars, which rely on fossil fuels such as petrol or diesel, EVs are powered by an electric motor. This motor draws energy from a controller, which adjusts the power output based on the driver's input on the accelerator pedal. The energy used by electric vehicles is stored in rechargeable batteries, making them distinct from their fossil fuel-powered counterparts (Ghizzardi, 2018).

There are currently four main types of electric vehicles available on the market, each differing in how the on-board electricity is generated and/or recharged, as well as how the internal electric motor interacts with any combustion engine:

- Battery Electric Vehicle (BEV): BEVs are powered exclusively by an electric motor and must be regularly recharged from an external charging station;

- Hybrid Electric Vehicle (HEV): HEVs combine a conventional internal combustion engine with an electric motor. In these vehicles, the electric motor's electricity is generated by the combustion engine itself.
- Plug-in Hybrid Electric Vehicle (PHEV): Similar to HEVs, PHEVs feature both a combustion engine and an electric motor. However, unlike HEVs, the electric motor in PHEVs is powered by an external source, much like BEVs.
- Fuel Cell Electric Vehicle (FCEV): FCEVs are fully electric, like BEVs, but instead of drawing power from batteries, they generate electricity through hydrogen fuel cells. This process involves combining hydrogen with oxygen to produce electricity, which then powers the electric motor (Ghizzardi, 2018).

Each of these types represents a different approach to integrating electric power into automotive design, reflecting the diverse strategies being employed to reduce dependence on fossil fuels and lower greenhouse gas emissions in the transportation sector (Ghizzardi, 2018).

1.3 Environment Problems

The growing awareness of people regarding the environment sustainability prompted people to be more conscientious in their purchasing decisions. More and more people would think carefully before making a purchase. They would wonder themselves if the product is tested on animals, if it’s eco-friendly or where is it from. While this shift in consumer behaviour may seem trivial to some, it reflects a broader realization that Earth is our only home, and the degradation of this planet could potentially lead to the extinction of humanity.

Recognizing the urgency of these concerns, governments worldwide are enacting policies aimed at guiding consumers toward more sustainable practices. For instance, the European Environment Agency reports that the transport sector is responsible of about one quarter of the CO_2 emission in Europe in 2019, 71,7% of which is produced by road transport (European Parliament, 2023/03/22).

In response, the European Union has set an ambitious goal to reduce greenhouse gas emissions from transport by 90% by 2050 compared to 1990 levels. This objective is a key component of the EU's broader efforts to lower CO_2 emissions and achieve climate neutrality by 2050, as outlined in the European Green Deal roadmap (European Parliament, 2023/03/22).

Figure 1 Evolution of CO_2 emissions in the EU by sector (1990-2019) (EEA 2022)

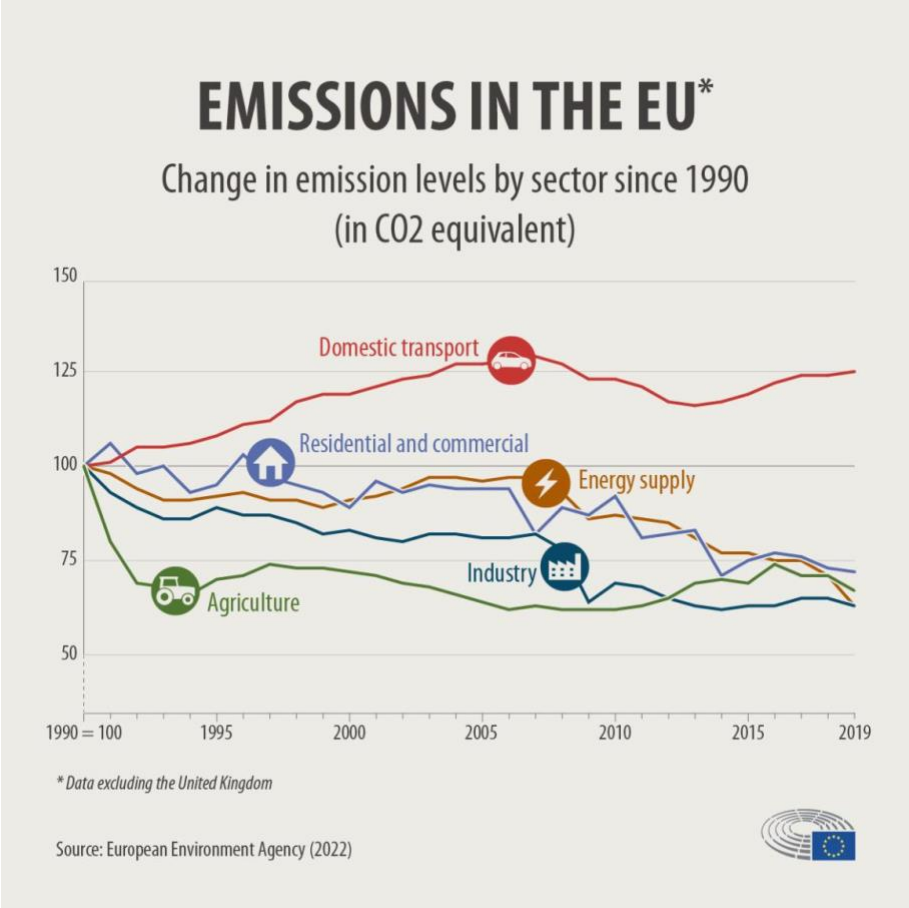


Figure 1 illustrates the changes in CO_2-equivalent emission levels across various sectors from 1990 to 2019, excluding data from the United Kingdom. The five key sectors analyzed, each represented by a distinct line on the graph, are as follows:

- Domestic transport;
- Residential and commercial;
- Energy supply;
- Industry;
- Agriculture.

The red line corresponds to domestic transport, which exhibits a consistent upward trajectory until the mid-2000s. This is followed by a modest decline, leading to stabilization from approximately 2013 onwards. Notably, this sector consistently maintains a high level of CO_2 emissions, remaining above 100 throughout the period and peaking in the mid-2000s. The sustained emission levels in this sector may be attributed to the continued reliance on fossil fuels, particularly oil for automobiles, and a reluctance among the population to adopt more

environmentally friendly alternatives, potentially due to factors such as cost and lack of awareness.

The purple line represents the residential and commercial sector, which demonstrates a fluctuating pattern, followed by a decline in more recent years.

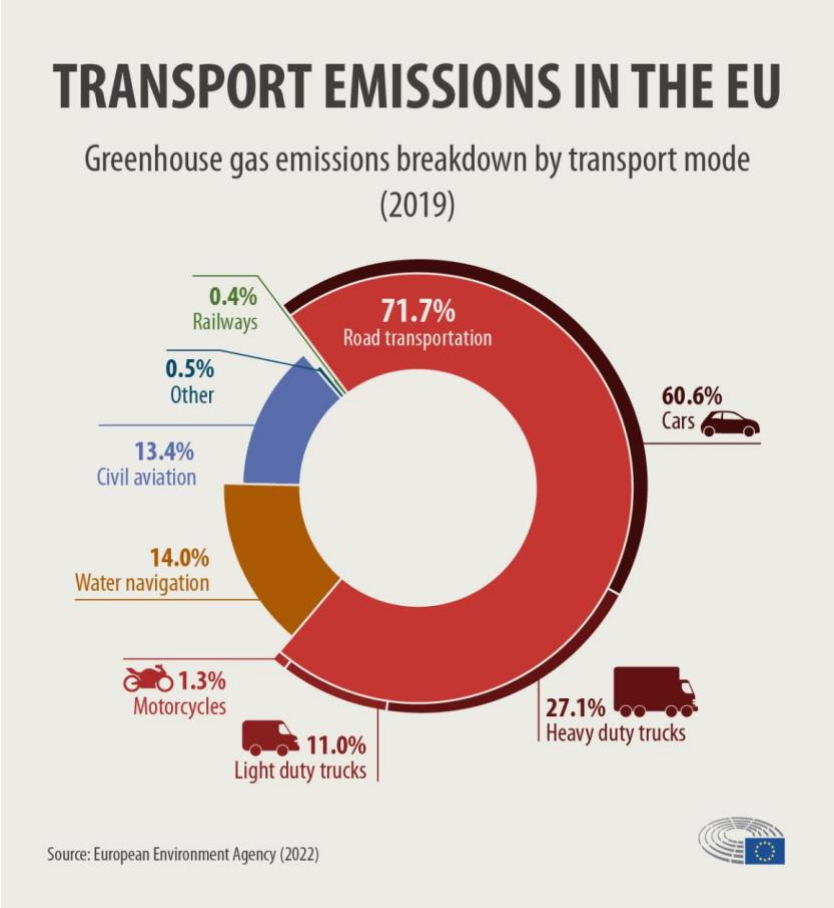
The brown line indicates the energy supply sector. This sector remains relatively stable until around 2008, after which it begins a gradual decline. This trend likely reflects the success of the European Union's sustainable energy policies, which have encouraged the adoption of cleaner energy sources, such as wind, solar and hydroelectric power.

The blue line represents the industry sector, which has shown a nearly continuous decline in emissions. This downward trend underscores the effectiveness of EU policies aimed at reducing greenhouse gas emissions in the industrial sector.

The green line corresponds to the agriculture sector, which experienced an initial decline after the 1990s, followed by fluctuations while generally maintaining a steady level of emissions. The initial reduction in emissions may be linked to advancements in agricultural practices, improved land management, and the adoption of technologies designed to reduce methane and other greenhouse gases.

Overall, the graph highlights the positive impact of EU policies on CO_2 emissions, particularly in the energy supply and industry sectors. However, domestic transport remains a critical area where further efforts are required. It is the only sector where greenhouse gas emissions have increased over the past three decades, rising by 33.5% between 1990 and 2019. Projections indicate that transport emissions will decrease by only 22% by 2050, falling short of current reduction targets (European Parliament, 2023/03/22).

Figure 2 Transport emissions in the EU (EEA, 2022)



The pie chart in Figure 2 presents the distribution of greenhouse gas emissions by transport mode within the European Union in 2019. The chart is divided into five categories:

- Road transportation;
- Water navigation;
- Civil aviation;
- Railways;
- Other modes.

The most significant portion, accounting for 71.7% of emissions, is road transportation. This category is further broken down into four sub-sections: cars (60.6%), heavy-duty trucks (27.1%), light-duty trucks (11.0%) and motorcycles (1.3%). The predominance of road transport, particularly cars, underscores the urgent need for policies aimed at reducing greenhouse gas emissions in this sector. Governments should consider implementing stronger incentives for purchasing electric vehicles and expanding public transportation networks.

Water navigation contributes 14.0% to transport emissions. While this is less than road transportation, it still represents a substantial impact. To address this, there is a pressing need to adopt cleaner maritime technologies, such as low-sulfur fuels, improved shipping logistics and advancements in electric or hydrogen-powered vessels.

Civil aviation accounts for 13.4% of transport emissions, a figure comparable to that of water navigation. This highlights the environmental impact of air travel, which is increasingly concerning due to the growth in flight numbers and air traffic. Governments should encourage alternative modes of travel for short distances, perhaps by reducing the cost of such options and eliminating short-haul flights. Additionally, promoting more fuel-efficient aircraft and the development of sustainable aviation fuels are critical strategies.

Railways contribute only 0.4% of transport emissions, the smallest share on the chart. This low figure suggests that rail transport is a highly sustainable alternative to both road and air transport. Thus, governments should prioritize the expansion and improvement of rail infrastructure to further reduce overall transport emissions.

Other transport modes constitute 0.5% of emissions. This category likely includes less conventional forms of transportation.

This chart clearly demonstrates that the majority of greenhouse gas emissions stem from road transportation, with cars being the primary contributors. This finding highlights the necessity for more targeted policies in this area. In addition to promoting electric vehicles and public transportation, alternative methods such as cycling, walking and car-sharing should be encouraged. Car-sharing platforms, such as BlaBlaCar, which “connects drivers and passengers traveling in the same direction, offer a practical solution” (BlaBlaCar website). Companies can also adopt similar initiatives; for example, Mérieux NutriSciences in Italy has developed an app for employees to carpool with colleagues from the same city.[1]

The relatively minor contribution of railways to emissions suggests significant potential for promoting rail transport as a more sustainable option.

Given the European Union's ambitious goal to reduce transport emissions by 90% by 2050 under the European Green Deal, this chart highlights the sectors where efforts should be

[1] Mérieux NutriSciences is a multinational company that offers practical testing, auditing, consulting, training, and research solutions to meet the needs of manufacturers, food processors, caterers and retailers.

concentrated. Reducing emissions from road vehicles and enhancing the sustainability of air and water transport are particularly critical to achieving these targets.

1.4 Distribution of EVs

1.4.1 Challenges of EVs' Growth

The current state of the environment is highly concerning, particularly when considering other detrimental factors such as water wastage, pollution and biodiversity loss. Despite increasing awareness and concern for environmental issues, the continued high emissions of greenhouse gases from internal combustion engines (ICEs) persist. The reasons for this are multifaceted and vary by country. A study has even linked the development of electric vehicles (EVs), particularly Battery Electric Vehicles (BEVs), to Hofstede's six dimensions of national culture, highlighting cultural influences on the adoption of EV technology.

According to research published in the *Journal of Mechanical Engineering Research and Developments (JMERD)*, four primary challenges impede the widespread adoption of electric vehicles:

- Economic;
- Technological;
- Social;
- Environmental (Faizal et al. 2019).

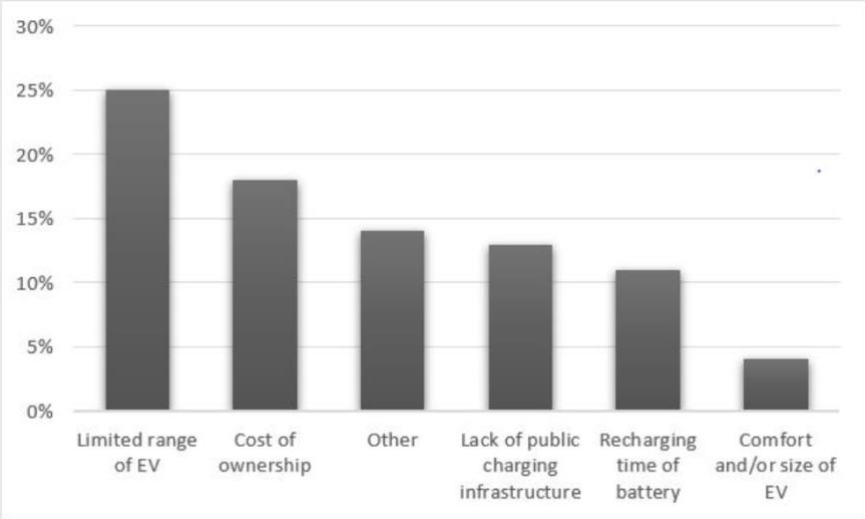
The economic aspect is crucial for the growth of EVs. Research indicates that a mere 1% reduction in EV prices could result in a 4% increase in sales, underscoring the significant impact of cost on consumer adoption. The high price of EVs is largely driven by the cost of batteries, which remains a major barrier to mass production. Additionally, the cost of charging is influenced by the source of energy. Although renewable energy sources like wind, solar and hydropower offer a sustainable alternative, the technology required to harness these resources is costly, affecting the overall price of EVs (Faizal et al. 2019).

From a technological perspective, battery performance and the availability of charging infrastructure are key concerns. A major issue for EV drivers is "range anxiety", in other words the fear that a vehicle's battery will not provide sufficient range to reach a destination, especially on longer journeys. This anxiety could be mitigated by enhancing battery capacity

and expanding the network of public charging stations. However, improving battery capacity increases costs due to the high price and limited availability of raw materials. Furthermore, the lack of standardization in charging systems and plug types presents additional challenges, necessitating a unified standard for EV charging infrastructure (Faizal et al. 2019).

Social factors also play a role, particularly in relation to range anxiety. Even when driving ranges are adequate, some individuals experience irrational anxiety about the vehicle's range, deterring them from purchasing EVs. As indicated by the survey in Figure 3, the limited range of EVs remains the most significant barrier to their adoption (Faizal et al. 2019).

Figure 3 Survey results of disinterest in EVs from the public (Noel et al. 2019)



While electric vehicles (EVs) do not emit greenhouse gases during operation, making them more environmentally friendly than internal combustion engine (ICE) vehicles in that regard, their production and battery disposal processes still produce CO_2 emissions. However, these emissions can be reduced by using alternative energies and eco-friendly manufacturing technology (Faizal et al., 2019). According to Franzò and Nasca, despite these production-related emissions, the overall life cycle of an electric vehicle has still significantly lower greenhouse gas emissions compared to that of a vehicle powered by an internal combustion engine (Franzò and Nasca, 2021).

The intervention of the government can play a crucial role in the growth of the EV market. It's sufficient to look at China, which has the largest EV market globally, has implemented policies that encourage EV purchases. Governments worldwide could adopt similar measures, such as

reducing taxes on EVs, funding research and development of EV technologies, and increasing the number of public charging stations (Faizal et al., 2019).

1.4.2 Hofstede's six dimensions of national culture

As previously mentioned, a study has established a correlation between Hofstede's six dimensions of national culture and the adoption of electric vehicles (EVs). According to Hofstede, cultural differences across the world can be understood through six dimensions:

- Power distance;
- Uncertainty avoidance;
- Individualism vs. Collectivism;
- Masculinity vs. Femininity;
- Long-Term vs. Short-Term Orientation;
- Indulgence vs. Restraint;

This study suggests that the acceptance and growth of electric vehicles are closely linked to a country's cultural characteristics as defined by these dimensions. Therefore, understanding the cultural context of a country is crucial, not only for promoting EVs but also for executing successful international marketing campaigns. Misalignment with local cultural values can have severe repercussions, as exemplified by the backlash against Dolce & Gabbana's 2018 advertising campaign in China. Similarly, for the promotion of EVs, it is essential to consider cultural factors, as perceptions and acceptance of electric vehicles vary significantly between countries (Novotny et al., 2022).

The research proposes six hypotheses related to these cultural dimensions:

1. Power distance: countries with higher power distance tend to have lower EV adoption rates;
2. Uncertainty avoidance: countries with greater uncertainty avoidance are less likely to adopt EVs;
3. Individualism vs. Collectivism: more individualistic cultures tend to have lower EV adoption rates;
4. Masculinity vs. Femininity: countries with more masculine cultures are less inclined to adopt EVs;

5. Long-Term vs. Short-Term Orientation: cultures with a long-term orientation are more likely to embrace EVs;
6. Indulgence vs. Restraint: countries with more indulgent cultures have higher rates of EV adoption (Novotny et al., 2022).

In summary, countries characterized by egalitarianism, risk tolerance, collectivism, femininity (which emphasizes collaboration and cooperation), long-term orientation (with a focus on future planning) and indulgence (which values the free satisfaction of desires) are more likely to adopt electric vehicles. Given these cultural differences, companies should tailor their communication strategies accordingly. For instance, in cultures that value masculinity, marketing campaigns should highlight the power, speed and luxury aspects of electric vehicles. Conversely, in cultures with a stronger orientation towards femininity, the emphasis should be on practicality and functionality (Novotny et al., 2022).

1.5 Electric Vehicles Global Market

Up to now, it has been analyzed the history of electric vehicles (EVs), the different types of electric cars and the environment problems concerning the use of internal combustion engine (ICE) cars, including the need for more countries to promote the adoption of electric vehicles to decrease the emission of greenhouse gases. Additionally, a broad overview of the distribution of EVs was given, as well as possible obstacles and how culture factors can influence their distribution.

Now it's time to examine the current state of the global electric vehicle market. Which are the main markets? Is it true that more and more people are starting to purchase an EV? If so, will this growth continue for a very long time? Or it's only a temporary trend that will blur once the interest of EVs vanish, bringing consumers to retrace in their steps towards internal combustion engine cars? Will history repeat itself?

The global market analysis of electric vehicles in the following parts will be mainly based on the data provided by the International Energy Agency (IEA)[2], which gives in-depth analyses into every energy sectors. Fundamental is then their collaboration with the Electric Vehicles

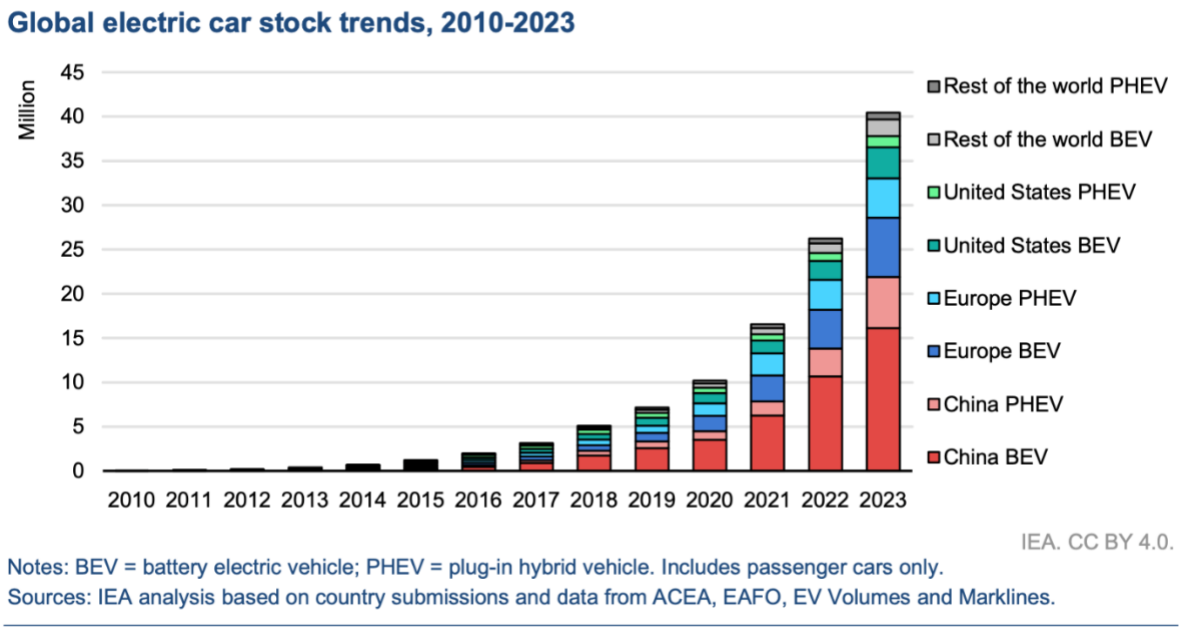
[2] IEA is an autonomous intergovernmental organization that provides policy recommendations, analysis and data on the global energy sector.

Initiative (EVI) produces every year a report that analyzes global development in electric mobility.

1.5.1 Electric car sales

The data that will be analyzed in this section will confirm the growing increase in electric car sales, underling a significant upward trend. The analysis will show that the main markets driving this growth are China, Europe and the United States, with China taking up almost half of the global market share.

Figure 4 Global electric car stock trends, 2010-2023 (IEA, 2024)



The histogram in Figure 4, produced by the International Energy Agency (IEA), illustrates the global trends in electric car stock from 2010 to 2023. The x-axis represents the timeline from 2010 to 2023, while the y-axis shows the number of cars sold in millions. The histogram primarily focuses on Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) sales worldwide, with particular emphasis on the three major markets: China, Europe and the United States. China is depicted in red, Europe in blue, the United States in green and the rest of the world in grey.

The data reveals a consistent annual growth in electric vehicle sales, with a notable acceleration after 2020. While sales showed steady increases until 2019, the post-2020 period witnessed a significant surge, peaking between 2022 and 2023, with an increase of

approximately 14 million units. This trend indicates a growing consumer shift toward electric vehicles, suggesting that government policies and incentives are gradually taking effect.

China emerges as the largest market for electric vehicles, with its market share, depicted in red (BEV) and pink (PHEV), dominating global sales. By 2017, China had already surpassed other markets, and by 2023, its share of over 20 million units accounted for nearly half of the global total of over 40 million units. BEV sales in China have shown remarkable growth, establishing the country as a global leader in this sector. Notably, PHEV sales also saw significant growth between 2022 and 2023, nearly doubling during this period. The robust growth in electric vehicle sales in China is particularly noteworthy, especially considering that 2023 marked the first year in which "China's New Energy Vehicle (NEV)[3] industry ran without support from national subsidies for EV purchases, which have facilitated the expansion of the market for more than a decade" (IEA, 2024). This milestone indicates that China's EV industry has matured to the point where consumer interest remains strong even in the absence of government subsidies. Although some support measures, such as tax exemptions, remain in place, this continued growth underscores that "the automotive industry is seen as one of the key drivers of economic growth" (IEA, 2024). Furthermore, 2023 was a pivotal year for China in another significant way. According to the Japan Automobile Manufacturers Association (JAMA), China surpassed Japan as the largest auto exporter in the world: "JAMA's figures revealed that Japan shipped 4.42 million vehicles in 2023, while China exported 4.91 million, as reported by the China Association of Automobile Manufacturers" (IEA, 2024). This further highlights the critical importance of 2023 for China's automotive and electric vehicle industries.

Europe has also experienced a remarkable surge in EV sales, largely driven by the European Union's stringent emissions regulations and incentives for electric vehicle purchases. In this region, BEV (blue) sales have consistently outpaced those of PHEV (light blue), although the difference was not particularly pronounced until 2022. It was in 2023 that BEV sales significantly outstripped PHEV sales, doubling the latter's figures. The year 2023 was especially significant for Europe as "Germany, for example, became the third country after China and the United States to record half a million new battery electric car registrations in a single year, with 18% of car sales being battery electric (and another 6% plug-in hybrid)". Germany achieved

[3] "In the Chinese context, the term New Energy Vehicles (NEVs) includes BEVs, PHEVs and FCEVs" (IEA, 2024).

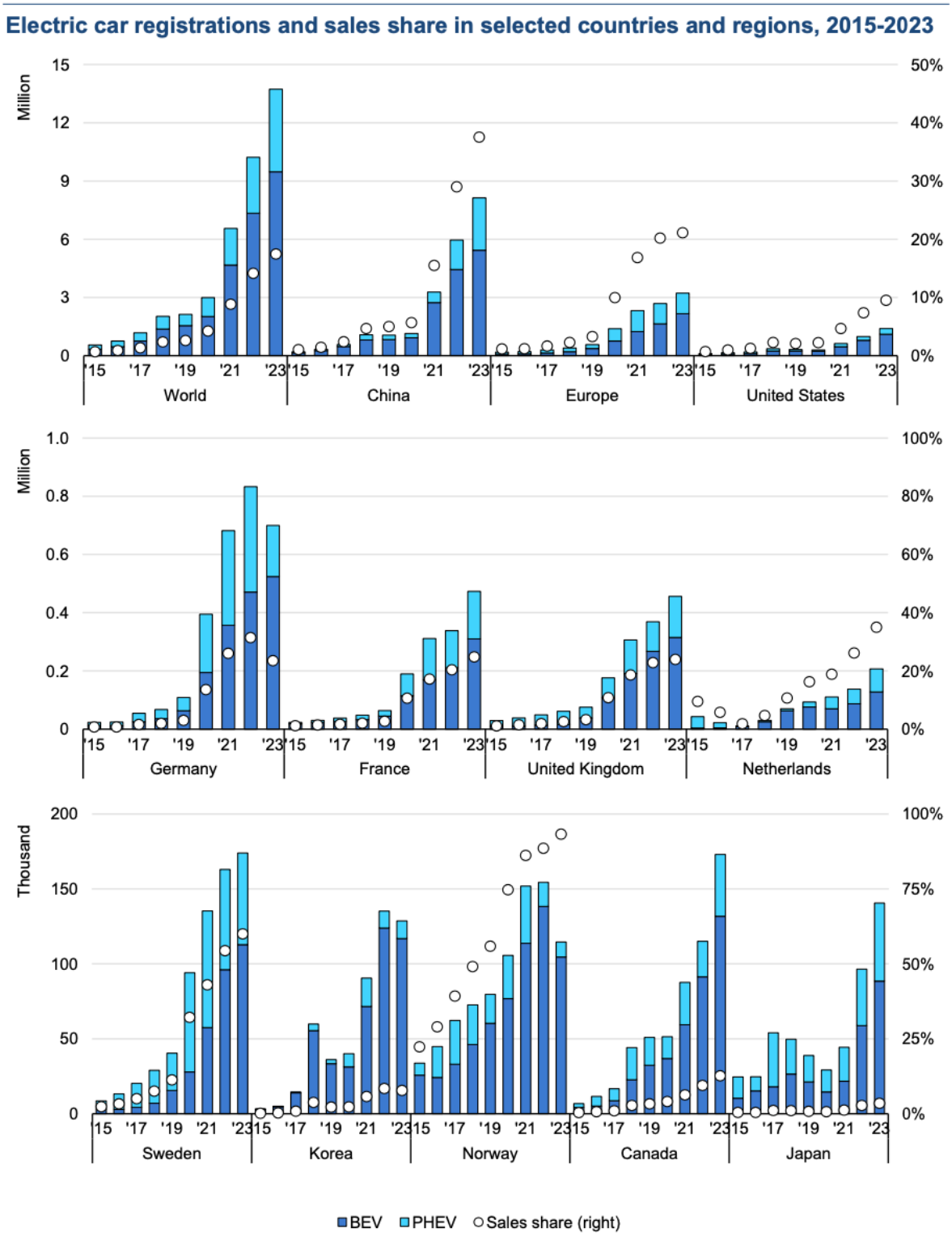
this milestone despite “the phase-out of several purchase subsidies in Germany", which had initially slowed overall EV sales growth. Nevertheless, sales across the rest of Europe have continued to rise. In fact, “around 25% of all cars sold in France and the United Kingdom were electric, 30% in the Netherlands, and 60% in Sweden. In Norway, sales shares increased slightly despite the overall market contracting, and its sales share remains the highest in Europe, at almost 95%” (IEA, 2024).

The growth of electric vehicle (EV) sales in the United States has been consistently strong, with a notable increase in 2023. While BEV (deep green) sales continue to surpass those of PHEV (light green), the growth in the U.S. market is more evenly distributed compared to that of China and Europe. The U.S. government's implementation of the Clean Vehicle Tax Credit has played a significant role in encouraging EV purchases. The revised version of this credit in 2023 made more popular EV models, such as the Tesla Model Y, eligible for the incentive, contributing to the rise in sales. Although the 2024 version of the tax credits will reduce the number of eligible models, it is unlikely to slow down growth, as leasing business models will also qualify for the tax credits in both 2023 and 2024 (IEA, 2024).

The "Rest of the World" category has also demonstrated a steady increase in electric vehicle (EV) sales over the years (see Figure 5 and Figure 6). Sales of BEVs (light grey) continue to surpass those of PHEVs (dark grey). However, this segment remains relatively small compared to the markets in China, Europe and the United States, despite encompassing all other countries globally. Noteworthy markets within this category include India, Thailand, Vietnam, Malaysia and various Latin American countries such as Brazil, Mexico, Colombia, and Costa Rica. Across these regions, EV sales have risen, largely driven by government incentives, subsidies and tax benefits. The expansion of charging infrastructure has further supported this growth. In Thailand and Latin America, Chinese automakers, particularly BYD,[4] have played a significant role in boosting EV adoption. In India, local manufacturers like Tata and Mahindra dominate the market.[5]

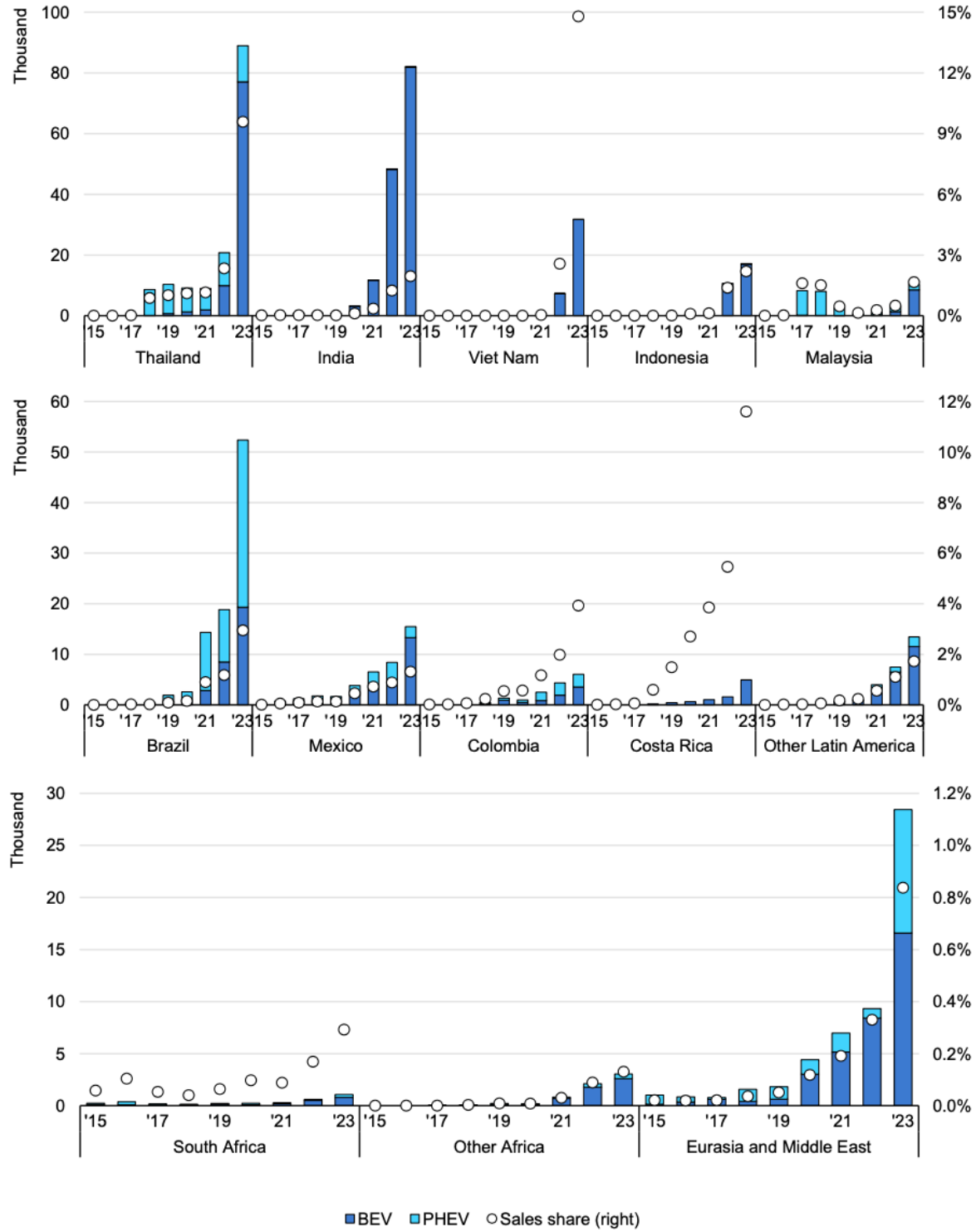
[4] BYD is a Chinese carmaker company based in Shenzhen, Guangdong.
[5] Tata is the most important Indian carmaker company, based in Mumbai.
Mahindra is an Indian carmaker company based in Mumbai.

Figure 5 Electric car registrations and sales share, 2015-2023 (IEA, 2024)



Notes: BEV = battery electric vehicle; PHEV = plug-in hybrid vehicle.
Sources: IEA analysis based on country submissions and data from ACEA, EAFO, EV Volumes and Marklines.

Figure 6 Electric car sales in selected countries and regions, 2015-2023 (IEA, 2024)



Notes: BEV = battery electric vehicle; PHEV = plug-in hybrid electric vehicle. For regional groupings, see Annex C.

Sources: IEA analysis based on country submissions and data from ACEA, EAFO, EV Volumes, Marklines, Asomove, MDAE, and Andemos.

Vietnam's VinFast holds a monopoly and is actively expanding into international markets,[6] including North America. Several countries aim to enhance their EV manufacturing capabilities, either through domestic companies or by attracting foreign investment, as seen in Thailand and Brazil, particularly from Chinese manufacturers. The least developed regions in terms of EV adoption are Africa, Eurasia and the Middle East, which collectively account for "less than 1% of total car sales". Nevertheless, countries like Uzbekistan and Jordan have shown some growth due to partnerships with Chinese automakers and favorable import duties (IEA, 2024).

In conclusion, the outlook for the electric vehicle (EV) industry is highly optimistic, with significant growth observed in 2023. China continues to take the lead in this industry and may be the one to pull all the other countries in that direction. It is evident that government support plays a crucial role in the growth of the EV sector; without such support, the global increase in EV adoption would likely be much slower. The chart passes down a powerful message: in almost over a decade, the automotive industry has experienced a tremendous growth, rising from zero EV sales in 2010 to over 40 million in 2023. As technological innovations continue to progress, the expansion of the electric vehicle market, particularly for BEVs, is expected to accelerate further. This growth will contribute significantly to reducing greenhouse gas emissions and decreasing dependence on fossil fuels.

1.5.2 How is and will 2024 go?

The previous section's analysis was focused on only data up until the first quarter of 2024. This section will analyse projections for the rest of 2024. It’s mostly a forecast based on the performance trends observed in previous years' quarters.

The histogram in Figure 7 illustrates the quarterly trend in electric car sales from the first quarter of 2021 to the first quarter of 2024. The x-axis represents the timeline of years, while the y-axis shows the number of electric vehicles (EVs) sold in millions.

The data focuses on four key markets: China, Europe, United States, and the rest of the world.

[6] VinFast is a Vietnamese carmaker company based in Hanoi.

Figure 7 Quarterly electric car sales, 2021-2024 (IEA, 2024)

Source: IEA analysis based on data from on EV Volumes, China Passenger Car Association and the European Automobile Manufacturers' Association.

A consistent pattern emerges across each year: sales progressively increase from the first quarter to the fourth, reaching a peak, followed by a decline at the beginning of the new year. Notably, despite the dip at the start of each year, sales in each quarter are higher than the corresponding quarter in the previous year. This cyclical pattern may be attributed to year-end incentives and promotions. Government tax incentives or subsidies for electric vehicles often expire at the end of the year, prompting consumers to take advantage of them before they lapse, which in turn drives a surge in sales. Additionally, automakers and dealers may offer promotions to clear out inventory, further boosting year-end sales. The subsequent decline in the first quarter of each year may be due to the holiday season, during which consumers are less likely to make significant purchases such as cars.

Despite these fluctuations, the overall trend from the first quarter of 2021 to the first quarter of 2024 shows a substantial increase of approximately 2 million units. The peak was reached in the fourth quarter of 2023, with around 4.3 million units sold. Given the observed pattern, it is reasonable to anticipate that sales in the fourth quarter of 2024 could surpass previous records.

The most notable section of the histogram is the red bars, representing China, which consistently dominates the global electric vehicle market. China's share regularly exceeds 50% of total quarterly sales. "In March, NEV sales in China surpassed a share of 40% in overall car

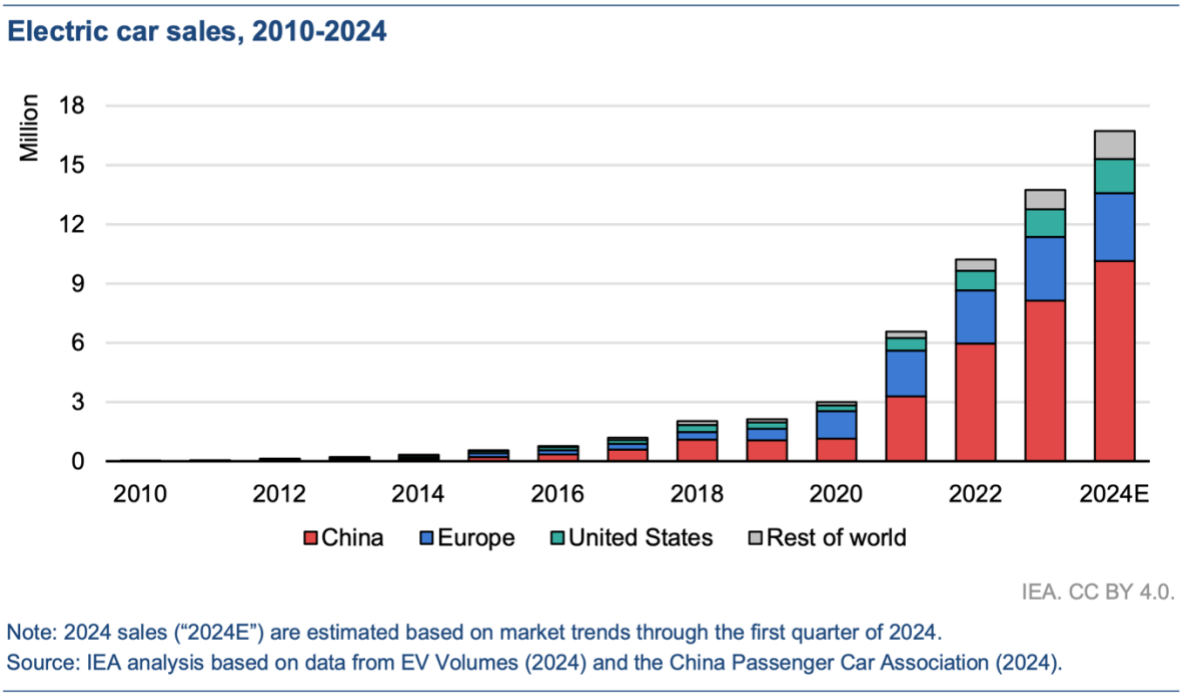
sales for the first time, according to retail sales reported by the China Passenger Car Association". Interestingly, the sales of plug-in hybrid electric vehicles (PHEVs) are growing faster than those of battery electric vehicles (BEVs). "Plug-in hybrid electric car sales in the first quarter increased by around 75% year-on-year in China, compared to just 15% for battery electric car sales" (IEA, 2024).

The blue bars represent Europe, which holds the position as the second-largest market for electric cars. European EV sales have steadily increased, with a marked acceleration in recent years. The leading European markets include France, Germany, Italy and the United Kingdom. In France and the United Kingdom, sales in the first quarter rose by approximately 15% compared to the same period the previous year. However, Germany presents a more challenging scenario, as "battery electric car subsidies ended in 2023, sales of electric cars fell by almost 5% in the first quarter of 2024, mainly as a result of a 20% year-on-year decrease in March". Similarly, in Italy, the outlook is less optimistic, with "sales of electric cars in the first three months of 2024 more than 20% lower than over the same period in 2023, with the majority of the decrease taking place in the PHEV segment". In both Germany and the United Kingdom, PHEV sales outpaced those of BEVs (IEA, 2024).

The green bars denote the United States, where EV sales have also grown, though not as rapidly as in China and Europe. As with other regions, the growth of PHEV sales in the United States is outpacing that of BEVs.

Finally, the grey bars represent the "Rest of the world". This category also shows steady growth, indicating that the adoption of electric vehicles is spreading even in developing regions. "In January and February, electric car sales almost quadrupled in Brazil and increased more than sevenfold in Vietnam (see Figure 8). In India, sales increased more than 50% in the first quarter of 2024" (IEA, 2024).

Figure 8 Electric car sales, 2010-2024 (IEA, 2024)



Note: 2024 sales ("2024E") are estimated based on market trends through the first quarter of 2024.
Source: IEA analysis based on data from EV Volumes (2024) and the China Passenger Car Association (2024).

Based on this analysis, it can be estimated how the rest of 2024 may go. According to the IEA, "electric car sales could reach around 17 million in 2024", which represents a growth of over 20% compared to 2023. This growth shows that the electric vehicle (EV) market is maturing as time passes, with electric cars potentially accounting for more than one-fifth of total car sales by the end of the year (IEA, 2024).

It is estimated that the majority of the increase is driven by China, which is expected to see an increase of nearly 25%, reaching around 10 million units sold. This would account for 45% of China's total car sales. In the United States, a 20% increase is anticipated, translating to nearly half a million additional EVs sold, or roughly one in nine cars sold being electric. In contrast, Europe's growth is expected to be more modest, with an increase of less than 10%, with electric cars representing 25% of total sales.

In the rest of the world, it is expected that electric car sales will surpass 1 million units, marking a 40% increase from 2023. This growth is likely to be influenced by the expansion of domestic and Chinese carmakers in Southeast Asia, with these emerging markets potentially representing around 5% of total global car sales in 2024. Such trends could mean that global mass adoption of electric vehicles is very likely to happen.

However, several challenges could halt this optimistic outlook for 2024. These include high interest rates, economic uncertainty, restrictions under the IRA on US electric car tax incentives, and China's tightening of technical requirements for EVs to qualify for purchase tax exemptions. Despite these obstacles, the possibility of faster-than-expected market expansions could accelerate global EV sales beyond current projections.

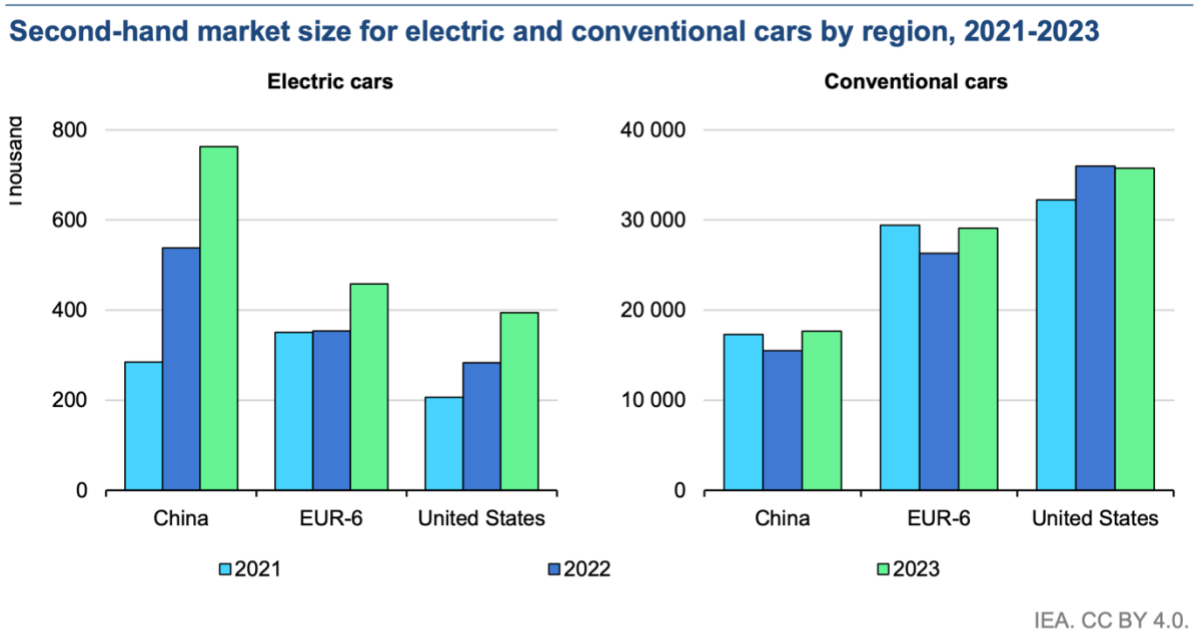
In conclusion, the trend of increasing electric car sales remains strong, with China as the major player. The consistent sales patterns observed in recent years suggest that 2024 is likely to follow suit, despite all the difficulties it may face. It's also possible that there would be new records for EV sales. The example of Germany highlights the importance of government intervention in driving EV adoption. Therefore, until the market is fully developed and stable, continued government support will be essential to sustain and accelerate the growth of electric vehicle sales.

1.5.3 Electric cars' second-hand market

One effective strategy to make the electric vehicle (EV) sector more accessible to more people is through the development of the second-hand market. Indeed, the second-hand market is one of the solution for the economic problem associated with electric vehicles. If taken into account that electric cars are generally more expensive than internal combustion engine (ICE) cars, not everybody can afford a brand-new, full-priced EV. Many people are discouraged by this financial barrier, often leading potential buyers to opt for the more affordable ICE vehicles. Even among those who are not scared off by the higher costs of electric vehicles, a significant portion would still prefer to purchase a second-hand vehicle due to its lower price point.

In fact, "it is estimated that eight out of ten EU citizens buy their car second-hand, and this share is even higher – around 90% – among low- and middle-income groups. Similarly, in the United States, about seven out of ten vehicles sold are second-hand, and only 17% of lower-income households buy a new car". These statistics show the crucial role that the second-hand market plays in vehicle ownership, particularly among low- and middle-income groups. Therefore, to further accelerate the adoption and growth of electric vehicles, it is essential to foster the development of the second-hand market for electric cars (IEA, 2024).

Figure 9: Second-hand market size for electric and conventional cars 2021-2023 (IEA, 2024)



Notes: In this figure, EUR-6 refers to France, Germany, Italy, Spain, the Netherlands and the United Kingdom.

Sources: IEA analysis based on data from Recurrent on US electric cars, Cox Automotive on the US total car market, Autovista on the total car market in France, Germany, Italy, Spain and the United Kingdom, BOVAG for the total and electric cars in the Netherlands, SMMT on electric cars in the United Kingdom, CADA on the total and electric car markets in China, and using the assumption that 1% of the used car market is electric for France, Germany, Italy and Spain following findings of the ICCT.

As shown in the charts in Figure 9, the second-hand electric vehicle (EV) market is already quite developed in China, EUR-6 and the United States. Figure 9 compares the sales of second-hand electric cars with those of conventional cars, analyzing data over three years, from 2021 to 2023. For Europe, only six countries are considered: France, Germany, Italy, Spain, the Netherlands and the United Kingdom. These countries were chosen more likely due to their market size, since they are among the largest and most influential automotive markets in Europe.

The first chart focuses on electric vehicles. It is evident that China has the leading role even in the second-hand market, maybe a reflection of its more mature EV market compared to other countries. Despite China's dominance, growth is observed in every market represented in the chart.

China, represented by the light blue bar, shows significant increases over the three years: from nearly 300,000 units sold in 2021, to more than 500,000 in 2022, and almost 800,000 in 2023. This rapid growth of the second-hand market in China reflects the country's strong emphasis on the EV sector. The mass-market penetration of electric cars in China has led to lower prices,

which, in turn, has reduced the cost of second-hand electric vehicles. China's example demonstrates that as the EV market matures, it is possible to decrease prices for both new and used electric cars.

EUR-6 countries, represented by the dark blue bar, also show growth, with the most significant increase occurring in 2023, where sales reached over 400,000 units. Sales in 2021 and 2022 remained relatively stable, around 300,000 units each year.

In the United States, represented by the green bar, there is a gradual increase in sales: from approximately 200,000 units in 2021, to nearly 300,000 in 2022, and close to 400,000 in 2023. The growth in the United States is more gradual, it consistently increases by about 100,000 units annually.

The growth of second-hand electric car sales in EUR-6 countries and the United States is smaller compared to China, especially in 2023, where sales in China nearly double those in EUR-6 and the United States.

The second chart highlights sales of conventional cars in these three markets, revealing that the second-hand market for conventional cars is much larger than that for electric cars. In this case, the situation is reversed: the United States has the largest market, while China has the smallest. However, it is very reasonable if we take into account the relative development of the EV market.

In China (light blue bar), sales of second-hand conventional cars show a decrease in 2022 and a rebound in 2023, with overall numbers remaining around 16 million units annually. EUR-6 countries (dark blue bar) show a similar pattern, though with much higher numbers, ranging between 28 million and nearly 30 million units sold.

As noted, the United States (green bar) leads the second-hand conventional car market. It shows an increase in 2022 and a slight decrease in 2023, with overall sales hovering around 35 million units.

The slower growth of second-hand electric cars in EUR-6 countries and the United States correlates with the dominance of second-hand conventional cars. This indicates that electric cars are still not so developed in these regions, highlighting the need for more policies in favour of electrification.

In conclusion, these two charts present a clear picture: the second-hand conventional car market remains dominant, particularly in EUR-6 countries and the United States. However, the situation is gradually improving, as the second-hand market for electric cars is growing. China still plays an important role and may help the other countries move toward electrification.

Notably, it is expected that used electric cars will play an increasing role in international trade, with China potentially exporting its vehicles to other countries. This trend could also extend to Europe and the United States. For China, the government granted the right to 27 cities and provinces to export second-hand cars as early as 2019. “In 2022, China exported almost 70,000 used vehicles, a significant increase from 2021, when fewer than 20,000 vehicles were exported. About 70% of these were NEVs, of which over 45% were exported to the Middle East”. Similar growth is observed in Europe, where “in both 2021 and 2022, the market size grew by 70% year-on-year, reaching almost 120,000 electric cars in 2022” (IEA, 2024).

It is also important to recognize the significant role that leasing companies can play in the expansion of the electric vehicle (EV) market. Leasing companies have the potential to significantly accelerate the adoption of electric vehicles (EVs) by driving shifts in consumer behavior and expanding the second-hand market. In the context of car leasing, these companies provide customers with vehicles for a specified period in exchange for a monthly payment, with the option to return or purchase the car at the end of the lease term.

“The leasing sector currently has more than 50% market share of new car purchases, and this is forecasted to increase to 70% by 2030”. This underscores the crucial role leasing companies play in the automotive industry, particularly within the second-hand market. “Private owners tend to keep their vehicles for around ten years. Assuming a 3–4-year ownership period, every year an estimated 4.6 million cars enter the used car market coming from the leasing segment”. By rapidly increasing the availability of electric cars in the market, leasing companies could play a pivotal role in the widespread adoption of EVs (IEA, 2024).

Despite this potential, major leasing companies have been slow to incorporate electric vehicles into their fleets. This slow uptake is hindering the electrification of the second-hand market, particularly in the EU, where leasing is key to providing affordable used battery electric vehicles (BEVs) to citizens. Should leasing companies decide to lead the charge towards sustainability, an additional 18 million used BEVs could enter the second-hand market by 2035, with 8 million

of these being affordable for low- and middle-income households, i.e., costing less than €10,000 (IEA, 2024).

By offering consumers a lower-risk opportunity to experience EVs without the long-term commitment of ownership, leasing companies can make EVs more accessible, especially to those hesitant about the new technology. Furthermore, by collaborating with automakers and governments to develop innovative programs that incentivize electric vehicle leasing, such as lower monthly payments or packages that include access to charging networks, leasing companies could further ease the transition to electric mobility.

In the long term, leasing companies could contribute to the circular economy by ensuring that electric vehicles are well-maintained during their lease periods, thereby extending their lifespan and enhancing their value in the second-hand market. This increased availability of affordable used EVs could significantly boost market penetration, especially among lower-income households, and ultimately contribute to global efforts to reduce greenhouse gas emissions and combat climate change.

1.5.4 Outlook for electric mobility

In the concluding section of this chapter, a comprehensive overview of the future of electric mobility up to 2035 will be presented. This overview is developed using a scenario-based approach that incorporates recent market trends, policy drivers, and technological developments. The analysis yields three distinct scenarios:

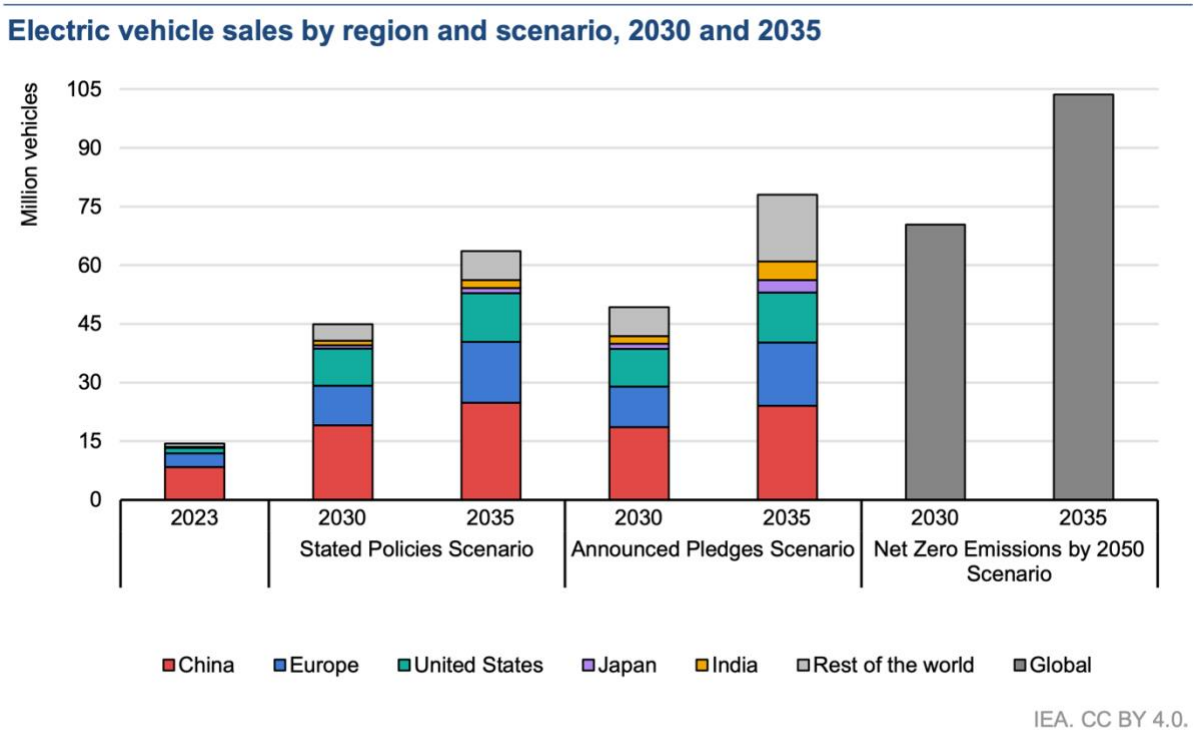
- Stated Policies Scenario (STEPS);
- Announced Pledges Scenario (APS);
- Net Zero Emissions by 2050 Scenario (NZE Scenario).

The STEPS scenario is a projection that integrates "current EV-related policies, regulations, and investments, as well as market trends based on the expected impacts of technology developments, announced deployments, and plans from industry stakeholders".

The APS scenario closely mirrors STEPS but "assumes that all announced ambitions and targets made by governments around the world are met in full and on time".

The NZE Scenario "is a normative scenario that shows a pathway for the global energy sector to achieve net zero CO_2 emissions by 2050, with advanced economies reaching net zero emissions ahead of others" (IEA, 2024).

Figure 10: Electric vehicle sales by region and scenario, 2030 and 2035 (IEA, 2024)



Note: Regional EV sales projections can be explored in the interactive Global EV Data Explorer.

This histogram in Figure 10 presents projections of electric car sales by region and scenario for the years 2030 and 2035. The regions analyzed include China, Europe, the United States, Japan, India and the rest of the world. The x-axis represents the years, with 2023 included for comparison, while the y-axis displays the number of cars sold in millions.

The projections for 2030 and 2035 are categorized into three scenarios: STEPS, APS and NZE. Across all scenarios, a significant increase in sales is evident.

The STEPS scenario represents the most conservative estimate, projecting sales to rise by nearly 31 million units over seven years, reaching 45 million in 2030 and over 60 million in 2035, an almost fourfold increase from 2023 to 2035.

The APS scenario anticipates higher sales, with nearly 50 million units in 2030 and over 75 million by 2035. In this scenario, sales are expected to quintuple by 2035.

The NZE Scenario is the most optimistic, predicting sales to surpass 70 million in 2030 and exceed 100 million by 2035, almost seven times higher than in 2023.

Notably, in all scenarios, China remains the dominant market, followed by Europe, the United States, the rest of the world, India and Japan. Although China, Europe and the United States lead in market size, the growth in India and Japan is also significant. The "rest of the world" category shows substantial progress, indicating successful electric vehicle development in other markets.

In conclusion, all three scenarios demonstrate robust growth in electric vehicle sales, suggesting that government policies and incentives are effectively driving interest in electric vehicles, thereby contributing to environmental benefits and reducing greenhouse gas emissions.

CHAPTER 2: DISTRIBUTION IN EUROPE AND RELATED REGULATIONS

2.1 Environment Regulations

2.1.1 Sustainable Development Goals

Before addressing the situation in Europe, it is also essential to first examine the global regulatory landscape concerning environmental standards. Given that the member states of the European Union (EU) are also part of the United Nations (UN), it is inevitable that the regulatory frameworks of these two institutions are somewhat aligned.

In its pursuit of a safer and more sustainable world, the United Nations introduced the 2030 Agenda for Sustainable Development, a global action plan adopted by all UN member states in 2015. This agenda outlines 17 Sustainable Development Goals (SDGs), which aim to address critical global challenges with the cooperation of all member countries. These goals are based on the Millennium Development Goals (MDGs) of 2000, which included only 8 targets. According to the United Nations, the 2030 Agenda seeks to improve the quality of life for both people and the planet, striving towards inclusive prosperity. The 17 SDGs are as follows:

1. End poverty;
2. End hunger;
3. Ensure good health and well-being;
4. Ensure quality education;
5. Achieve gender equality;
6. Ensure access to clean water and sanitation;
7. Ensure access to affordable and clean energy;
8. Promote decent work and economic growth;
9. Support industry, innovation, and infrastructure;
10. Reduce inequality within and among countries;
11. Build sustainable cities and communities;
12. Ensure sustainable consumption and production patterns;
13. Take climate actions;
14. Conserve and sustainably use the life below water;
15. Protect, restore, and promote sustainable use of terrestrial ecosystems;

16. Promote peaceful and inclusive societies, provide access to justice, and build effective, accountable institutions;
17. Strengthen the means of implementation and revitalize the global partnership for sustainable development (United Nations website).

Figure 11: 17 Sustainable Development Goals (SDGs) (United Nations website)

The shift towards electric vehicles (EVs) falls under Goal 11 (see Figure 11), which calls for promoting sustainable transportation as part of the effort to create safe, inclusive, and resilient cities. Reducing air pollution generated by internal combustion engine vehicles is crucial in this context and electric or hybrid vehicles are seen as key tools in this transition (United Nations website). Beyond their contribution to global warming, CO_2 emissions from vehicles pose serious health risks at high concentrations (above 15,000 ppm), leading to respiratory issues (Enectiva, 2017).

The global recognition of the need for sustainable transportation is not new. The first major acknowledgement came at the United Nations Earth Summit in 1992, where it was noted that transportation would be a critical factor in the world's economic growth. Over the years, attention to sustainable transport has increased, with growing recognition that "sustainable

transport achieves better integration of the economy while respecting the environment, improving social equity, health, the resilience of cities, urban-rural linkages and productivity of rural areas". Notably, nearly a quarter of all energy-related global greenhouse gas emissions come from the transport sector, with projections suggesting that these emissions will continue to grow in the coming years (United Nations website).

To counter this, global institutions emphasize the need for regulations and policies that promote sustainable transport, including incentives for the adoption of electric vehicles, as a means of reducing greenhouse gas emissions and mitigating climate change impacts.

2.1.2 Paris Agreement

An essential international climate agreement is the Paris Agreement, adopted on 12th December 2015, and entered into force on 4th November 2016. Signed by 196 countries, the agreement's primary objective is to limit global warming to below 2°C above pre-industrial levels, with an aspirational target of limiting the temperature increase to 1.5°C. This threshold was established by the United Nations Intergovernmental Panel on Climate Change (IPCC), which highlighted that exceeding it could lead to severe climate impacts such as more frequent droughts, heatwaves, and extreme rainfall events.

The Paris Agreement is structured around a five-year cycle of progressively ambitious climate actions by the signatory countries. Under this framework, countries are required to submit their Nationally Determined Contributions (NDCs) every five years, each successive plan reflecting a higher level of ambition than the previous one.

The Paris Agreement entered into force with Decision 1/CP.21, which includes several key components:

- Long-term temperature goal (Article 2), the agreement aims to limit the increase in global temperature to well below 2°C, ideally to 1.5°C, compared to pre-industrial levels;
- Global peak and neutrality (Article 4), the ultimate goal is to achieve a balance between anthropogenic emissions (from sectors such as industry) and the Earth's capacity to absorb these gases, through natural processes such as those provided by forests and oceans, by the second half of the century;

- Mitigation (Article 4), countries are required to submit NDCs outlining their emissions reduction targets. Developed countries are expected to lead with clear national emission reduction goals while developing countries are encouraged to enhance their efforts over time;
- Sinks and reservoirs (Article 5), parties are encouraged to maintain and enhance greenhouse gas sinks and reservoirs, such as forests, to absorb carbon from the atmosphere;
- Voluntary cooperation (Article 6), the agreement allows for both market-based and non-market-based approaches to emission reduction. These approaches must adhere to principles of transparency, environmental integrity, and clear accounting, facilitating emissions reductions and promoting sustainable development;
- Adaptation (Article 7), all countries must develop and regularly update plans to increase resilience, reduce climate risks, and adapt to the impacts of climate change;
- Loss and damage (Article 8), the agreement highlights the importance of reducing risks related to climate change impacts, promoting cooperation among countries to improve understanding and support, through mechanisms such as the Warsaw International Mechanism;
- Financial, technological, and capacity-building support (Articles 9, 10, and 11), developed countries are tasked with providing financial resources, technology transfer, and capacity-building support to help developing countries pursue sustainable and climate-resilient development;
- Public awareness and participation (Article 12), the agreement stresses the importance of strengthening climate change education, public participation, and access to information;
- Transparency (Article 13), a robust system is established for monitoring and reporting countries' progress in implementing their climate actions and supporting each other, tailored to their different national capabilities;
- Global stocktake (Article 14), a global inventory will be conducted every five years, starting in 2023, to assess collective progress toward meeting the climate goals;

- Implementation and compliance (Article 15), the establishment of a system to ensure that countries are held accountable for their commitments, based on clear and transparent criteria;
- Role of non-state actors, the agreement recognises the pivotal role of civil society, businesses, cities, and local communities in addressing climate change. These actors are invited to intensify their efforts and share their progress through the Non-State Actor Zone for Climate Action platform (European Council, 2024/11/15).

The European Union and all its member states have ratified the Paris Agreement, committing themselves to its goals. This commitment is further reflected in the EU's Green Deal strategy, which aims to make Europe the first climate-neutral continent by 2050 (European Council website).

2.1.3 European Green Deal

Having analysed the global environmental regulations, we can now narrow the focus to Europe, specifically the European Union (EU). In recent years, the EU has intensified its commitment to sustainability, largely under the leadership of the von der Leyen Commission, named after its president, Ursula von der Leyen. Re-elected by the European Parliament on 18th July 2024, the von der Leyen Commission will serve until 2029. One of their central promises has been to lead Europe on a more environmentally sustainable path, which culminated in the creation of the European Green Deal (EGD). The EGD's overarching goal is to achieve net-zero greenhouse gas emissions by 2050, positioning Europe as the world's first climate-neutral continent.

The European Union has increasingly recognized the urgent need for sustainability. It is clear that we have only one planet and its resources must be cherished and protected. Global warming is intensifying and, as highlighted by the European Commission, "one million of the eight million species on the planet are at risk of being lost", while the environment continues to suffer from pollution and degradation (European Commission website). If decisive action is not taken, humanity's resource consumption will quickly outpace the planet's capacity to sustain it. The concept of Earth Overshoot Day, which in 2024 occurred on 1st August, illustrates this predicament. From that day onward, humanity began consuming more resources than the

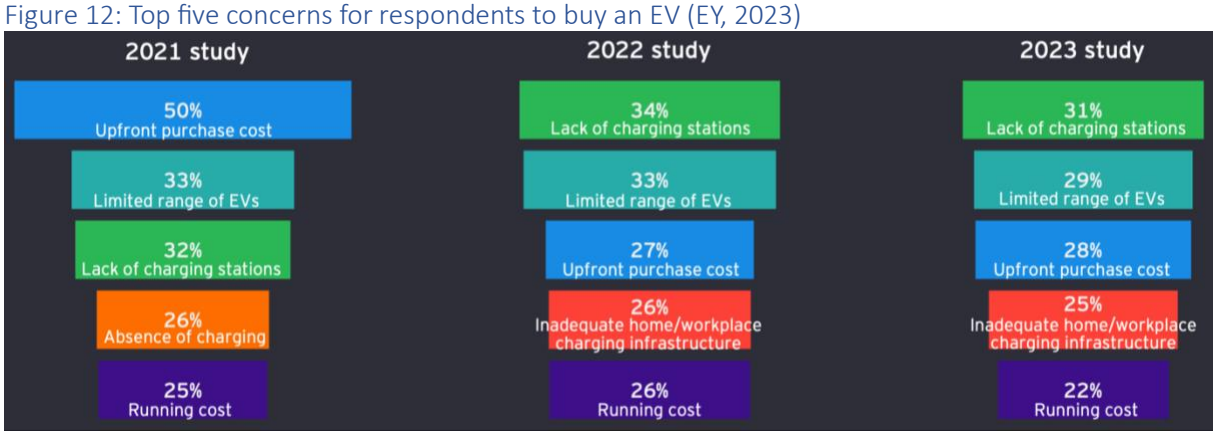
Earth can regenerate within a year. If current consumption patterns persist, by 2050, humanity could be using twice the resources that Earth can produce annually (Essere Animali, 2023).

Given these alarming trends, the EU has enacted policies to transform Europe "into a fair and prosperous society, with a modern, resource-efficient, and competitive economy" (European Commission website). These efforts are not only aimed at economic transformation but also at protecting the environment, as well as the health and well-being of European citizens.

A cornerstone of the EU's efforts to implement the European Green Deal is the European Climate Law, which enshrines the Green Deal's targets into legally binding commitments. Published in the Official Journal on 9th July 2021, and entering into force on 29th July 2021, the law establishes a legal framework for achieving climate neutrality by 2050.

Among the key pieces of legislation tied to this law is the "Fit for 55" package, introduced in July 2021. "This initiative aims to reduce net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels" (European Council website). One of the central strategies for achieving this is to invest in clean transportation, which includes promoting more sustainable transport options, such as electric vehicles (EVs). In line with this, new regulations mandate that by 2035, all newly registered vehicles in the EU must be zero-emission. Additionally, the legislation requires the construction of new recharging points and hydrogen refuelling stations along European motorways (European Commission, 2023). This infrastructure development is intended to alleviate drivers' "range anxiety", as the availability of charging stations is critical to encouraging more widespread adoption of electric cars, thereby driving up EV sales (see Figure 12).

Figure 12: Top five concerns for respondents to buy an EV (EY, 2023)



According to the 2023 EY Mobility Consumer Index (MCI), which surveyed 15,000 respondents, the primary barrier to electric vehicle (EV) adoption remains the lack of charging infrastructure, cited by 31% of participants. This concern was followed by the limited range of EVs (29%), high upfront purchase costs (28%), inadequate home or workplace charging options (25%), and running costs (22%) (EY, 2023).

The survey data highlights a shift in concerns from 2021 to 2022. While government subsidies have successfully mitigated the upfront purchase cost for EVs, the issue of charging infrastructure has risen in prominence, despite no significant improvement in availability. Although the ranking of other concerns, such as range and running costs, remained relatively stable, the shift from "lack of charging stations" to "inadequate home/workplace charging infrastructure" suggests that while there has been an increase in the number of charging points, these advancements have not yet sufficiently addressed consumers' need for convenient charging at home or work.

In conclusion, government policies have made significant strides in reducing the economic barrier to EV adoption, nearly halving the number of respondents concerned about upfront costs. This has made electric vehicles more accessible and affordable to a broader audience. However, the charging network remains a critical challenge. The slow development of sufficient and convenient charging infrastructure has become the primary obstacle to the widespread adoption of electric vehicles and this issue will need to be addressed if EV adoption is to continue growing.

In relation to the European Green Deal, Commission President Ursula von der Leyen remarked:

> The European Green Deal is delivering the change we need to reduce CO_2 emissions. It does so while keeping the interests of our citizens in mind and providing opportunities for our European industry. The legislation to reduce our greenhouse gas emissions by at least 55% by 2030 is now in place, and I am very happy that we are even on track to overshoot this ambition. This is an important sign to Europe and to our global partners that the green transition is possible, that Europe is delivering on its promises (European Commission website).

From President Ursula von der Leyen's speech, it is evident that she holds an optimistic perspective on the European Green Deal. She expresses confidence that Europe will not only meet the established targets but may even surpass them, achieving more than initially anticipated. In addition to reducing greenhouse gas emissions, the Green Deal is poised to benefit European citizens by fostering economic growth and enhancing social welfare. Ultimately, Europe can position itself as a global leader in the green transition, serving as a model for other nations to follow in their pursuit of sustainability.

The "Fit for 55" package also includes the Alternative Fuels Infrastructure Regulation (AFIR), formerly known as Regulation (EU) 2023/1804, which repeals Directive 2014/94/EU. This regulation has been in effect since 13th April 2024. One of the key objectives of AFIR is to establish a minimum infrastructure for charging and refuelling alternative fuel vehicles across all EU member states. This aims to address the current inadequacy in charging networks that hinder the growth of the electric vehicle (EV) market (European Commission, 2023/10/09).

The European Union recognizes that the present lack of sufficient charging infrastructure is a major barrier for consumers considering the purchase of EVs. While efforts have already been made to reduce the upfront purchase cost of electric vehicles, the expansion of charging networks is now a priority in order to alleviate drivers' "range anxiety". This anxiety, stemming from concerns about the availability of charging points, has been a significant obstacle to EV adoption.

The EU's strategy aims to progressively eliminate barriers to the widespread adoption of electric vehicles. Although it may take time to fully address all concerns, the expansion of charging infrastructure is expected to significantly reduce these obstacles. Eventually, as these challenges diminish, EV sales are projected to surpass those of internal combustion engine vehicles.

In reference to the new regulation, Andreas Carlson, the Swedish Minister for Infrastructure and Housing, emphasized its importance by stating:

> The agreement will send a clear signal to citizens and other stakeholders that user-friendly recharging infrastructure and refuelling stations for alternative fuels, such as hydrogen,

> will be installed throughout the EU. This means that more public recharging capacity will be available on the streets in urban areas as well as along the motorways. Citizens will no longer have a reason to feel anxious about finding charging and refuelling stations for their electric or fuel-cell car (European Council, 2023/03/28).

In his speech, Minister Andreas Carlson seeks to reassure citizens that the expansion of recharging infrastructure across the European Union will significantly alleviate consumer concerns about "range anxiety". He emphasizes that an increasing number of recharging stations will be constructed in both urban areas and along motorways, ensuring greater accessibility for both short- and long-distance driving. Additionally, Carlson's remarks serve as a call to stakeholders, encouraging further investment in alternative fuel technologies to support the ongoing transition to more sustainable transportation solutions.

2.2 Distribution in Europe of China's Electric Vehicles

The first chapter examined the global distribution of electric vehicles, setting the foundation for an analysis of the European electric vehicle market.

The European Union currently ranks as the world's second-largest EV market, following China and preceding the United States. Over recent years, the market in Europe has shown considerable growth, with registrations increasing from 745,000 in 2020 to over 2 million in 2023. (Elettrico Magazine, 2024) Although sales continued to rise in 2024, analysis by T&E indicates that growth was restricted by Germany's abrupt termination of EV purchase subsidies, leading to "a 16.4% decrease in BEV sales in Germany in the first half of 2024" (T&E, 2024a).

Figure 13 shows the market share of electric vehicles (EVs) from 2019 to 2026. The data from 2019 to the second quarter of 2024 (depicted by the blue line) represents historical trends, while the data from the third quarter of 2024 onwards (orange line) reflects projections based on Transport & Environment's (T&E) modelling of carmakers' compliance with CO_2 regulations.

On the x-axis, the years are divided into four quarters, while the y-axis shows the market share in percentage terms. The chart presents four distinct phases: two periods of stagnation and two of growth, which alternate over time.

Figure 13: BEV sales share in Europe (ACEA, 2024 and T&E, 2024c)

Overall, the trend shows a consistent increase in EV market share, punctuated by significant growth at specific points followed by sharp but temporary declines. Notably, these declines occur during the fourth quarter of each year and the first quarter of the following year. This cyclical pattern mirrors the sales trends analysed in the previous chapter, which covered quarterly EV sales from the first quarter of 2021 to the first quarter of 2024. The fluctuations are likely due to factors such as government incentives, promotions, and the holiday season, and this trend is expected to continue into 2025 and 2026.

The first stagnation period occurred in 2019, with no significant rise in market share, which remained around 2%, indicating limited EV adoption across Europe at that time.

From 2020 to 2021, the market experienced its first growth phase, with a marked increase in EV market share, reaching 6% in 2020 and 10% in 2021. This surge coincided with the implementation of the European Green Deal, which likely stimulated the market as governments across Europe introduced subsidies and tax incentives to encourage the purchase of EVs.

The second stagnation phase, lasting from 2022 to the third quarter of 2023, was the longest period of stagnation observed. Although the market share increased during this period, the growth rate slowed, with market shares rising modestly to 13% in 2022 and 15% in 2023. This slowdown may be attributed to external factors such as economic uncertainties in the aftermath of the COVID-19 pandemic or the ongoing limitations in charging infrastructure.

By 2024, the market share remained consistent with 2023 levels, reflecting the stagnation seen in recent quarters.

The second growth phase is projected to begin in 2025. The projections estimate that market share will rise dramatically, reaching 24% in 2025 and 27% by 2026. This growth is expected to align with the European Union's new CO_2 emissions regulations under the "Fit for 55" package.

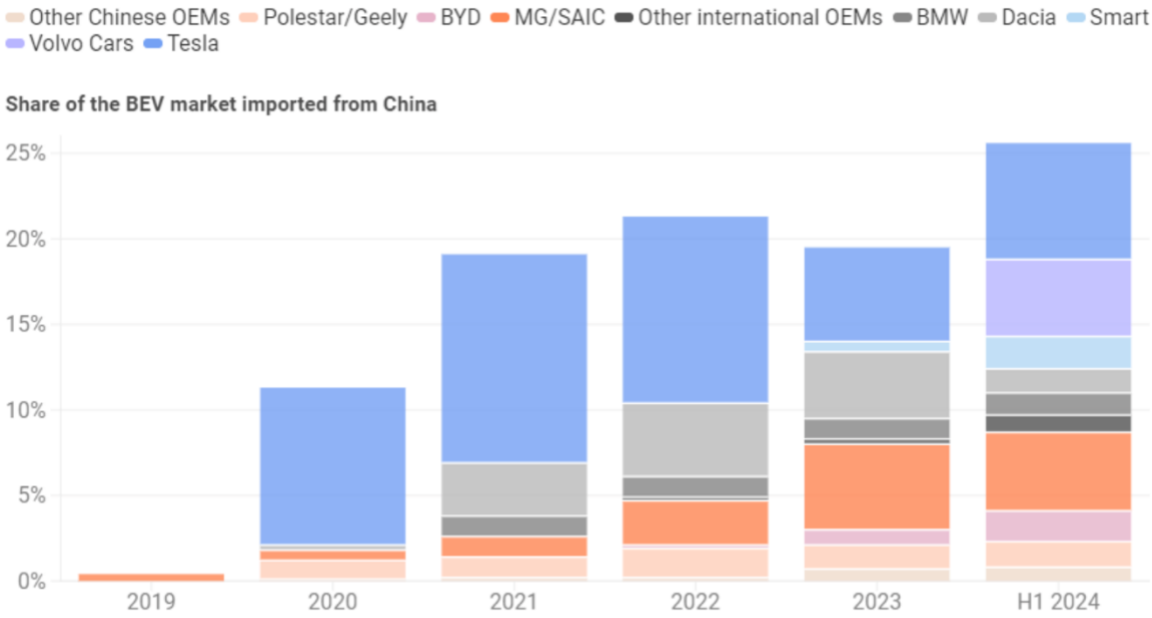
As the European Union sets more stringent CO_2 targets, automakers will be required to comply with these new regulations. Given their crucial role in producing and pricing vehicles, automakers are key players in this transition. Historically, many automakers have prioritized profits from internal combustion engine (ICE) cars, contributing to periods of stagnation. However, the European Union's regulatory intervention is expected to accelerate the production of mass-market, affordable EVs, prompting a shift away from ICE vehicles (T&E, 2024c).

A portion of the market share represented in the chart consists of electric vehicles manufactured in China and then imported into the European Union. This is expected for Chinese companies, which are headquartered and produce within their own country. However, Chinese exports to Europe are not only limited to domestic companies. Several Western manufacturers also produce vehicles in China, exploiting the advanced EV market and lower production costs available there.

In 2023, nearly one-fifth (19.5%) of electric vehicles sold in Europe were manufactured in China, and T&E projections indicate that this share could reach a quarter (25%) by 2024 (T&E, 2024b).

Figure 14 illustrates the share of electric vehicles (EVs) imported from China into the European Union between 2019 and the first half of 2024. The data includes not only Chinese companies, such as BYD and MG/SAIC, but also Western companies like BMW, Volvo Cars, and Tesla, that have opted to manufacture vehicles, or portions thereof, in China. Additionally, Original Equipment Manufacturers (OEMs), firms that produce components or parts for other companies, are represented in this analysis (Investopedia, 2024).

Figure 14: Share of the BEV market imported from China (T&E and Dataforce, 2024)



Source: T&E analysis of EEA (2019 and 2020) and Dataforce data (from 2021). Scope: Passenger cars in the EU imported from China.

Overall, the trend reveals a steady increase in market share for China-made EVs in Europe, with a temporary dip in 2023. However, shares surged again in 2024, surpassing 2022 levels.

Between 2019 and 2020, there was an extraordinary increase: MG/SAIC initially held a modest 0.4% market share, which escalated to 11.4% by 2020. Tesla accounted for most of this surge, capturing 9.2% of the market, while other manufacturers, including Chinese OEMs, Polestar/Geely and Dacia, entered the market. This marked the beginning of Western companies capitalizing on China's advanced EV market for cost-effective production. Notably, the year saw increased involvement from European manufacturers, such as Dacia, followed by BMW in 2021, and later Smart and Volvo Cars in 2023 and 2024, respectively. This highlights the attractive production cost advantage offered by China, prompting even European firms to shift some manufacturing there to remain competitive in the EU market.

In 2021, EV imports from China nearly doubled to reach a 19.1% market share, with Tesla still dominating at 12.2%. BMW entered with 1.2%, joining MG/SAIC and a strengthening presence from Dacia, which climbed to 3.1%.

Growth continued in 2022, albeit modestly, with the entry of BYD and other international OEMs. MG/SAIC nearly doubled its share, reaching 2.6%, although Tesla began to show signs of decline, slowly losing its dominant market position.

The year 2023 marked an overall decline in market share, potentially reflecting hesitation among importers amid the European Union's investigation into Chinese EV imports. Tesla's share dropped to 5.5%, though it retained the lead, closely followed by MG/SAIC, which reached 5% and continued its upward trajectory. Smart also entered the market this year.

By 2024, imports of China-made EVs peaked at 24.9%. This surge was bolstered by the entry of Volvo Cars, capturing 4.5% of the market. While MG/SAIC and Dacia experienced slight declines, other companies saw notable gains, particularly BYD, other international OEMs, and Smart.

In conclusion, the increasing market share of China-manufactured EVs in Europe highlights a growing reliance on China's cost-effective production, albeit one that may face disruption with the EU's imposition of countervailing duties on Chinese imports. This dependency also underscores the maturity of China's EV sector relative to Europe's, suggesting potential vulnerabilities in the European market's ability to compete with China's established EV manufacturing ecosystem.

2.3 European Regulations Regarding Imports from China

As it turns out, China has emerged as the largest exporter of electric vehicles, primarily due to its competitive manufacturing costs. But how are these vehicles being imported into the European market? What specific regulatory frameworks govern the import of electric cars into the European Union? The final section of this chapter will focus on examining the various measures and regulations that oversee the importation of electric vehicles produced in China, whether manufactured by Chinese companies or Western companies with production facilities in China.

When importing goods into a country, it is crucial to navigate the various bureaucratic, legal, and regulatory aspects of the process. Import regulations encompass not only the laws of the destination country but also those of the country of origin. Goods must meet both national and international requirements, making the import process potentially lengthy and complex.

In the context of Europe, it is important to distinguish between member states of the European Union (EU) and non-member states. The EU's member countries form a single market, one of

the EU's most significant achievements since its creation in 1993. This single market allows for the free movement of goods, services, capital, and people, greatly facilitating trade within the EU and enhancing mobility for citizens and companies (European Council, 2024). Furthermore, the EU operates as a Customs Union, meaning that goods traded between member states are not subject to customs duties or tariffs.

For non-member states wishing to import goods into the EU, imports are subject to a common external customs tariff, which varies depending on the type of product. Being part of the Customs Union means that once customs duties have been paid and the goods have passed the necessary compliance checks to ensure they meet EU standards, they can circulate freely across all member states without additional checks or controls (European Commission website). This streamlined system supports trade by reducing barriers once goods enter the EU market.

In this thesis, the product under consideration is electric vehicles and the country of origin is China. The companies involved in importing into the European Union (EU) may include Chinese manufacturers, such as MG, or Western companies, like Tesla, which produce vehicles in China to take advantage of lower production costs.

As previously mentioned, goods imported from non-EU member states are subject to a unified tariff known as the Common Customs Tariff (CCT). Although this tariff is uniform for all products, the rates may vary depending on the product and its country of origin. According to the European Commission, "the rates depend on the economic sensitivity of products" (European Commission website).

Each product imported into the EU is classified using a system known as the Combined Nomenclature (CN), which is a harmonized coding system applied across all EU member states. This system is based on the Harmonised System developed by the World Customs Organisation (WCO). It follows a hierarchical structure consisting of:

- Section;
- Chapter (2 digits);
- Headings (4 digits);
- Sub-headings (6 digits).

The EU's Combined Nomenclature expands on this structure, incorporating additional subdivisions and legal notes tailored to the specific needs of the EU (European Commission website).

Electric vehicles fall under Section XVII, titled "Vehicles, aircraft, vessels, and associated transport equipment", Chapter 87, which covers "Vehicles other than railway or tramway rolling stock, and parts and accessories thereof", Heading 03, which includes "Motor cars and other motor vehicles principally designed for the transport of persons (other than those of heading 8702), including station wagons and racing cars", and Sub-heading 80, which refers to "Other vehicles, with only electric motor for propulsion". As such, the HS Code for electric vehicles is 8703.80. The European version of the Combined Nomenclature adds two additional digits, specifically 10, for new battery electric vehicles, resulting in the CN code 8703.80.10 for electric vehicles in the EU (European Commission website).

The CN code can be used in the TARIC database (the Integrated Tariff of the European Union), which contains all measures related to EU customs tariffs, and commercial and agricultural legislation. By entering the CN code and specifying the origin/destination of the product, users can search for the tariffs applied to the import of electric vehicles from China (European Commission website).

According to EU regulations, electric cars imported from non-EU countries, including China, are subject to a 10% import tariff. However, in the case of imports from China, there is an ongoing debate regarding the imposition of provisional countervailing duties. These duties, governed by World Trade Organization (WTO) rules, are designed to offset the adverse effects of subsidies that give foreign producers an unfair advantage over domestic manufacturers. They are typically imposed after investigations confirm that subsidies are causing harm to domestic industries (European Commission website).

In the case of China, such an investigation was announced by European Commission President Ursula von der Leyen on 13th September 2023, in response to the growing influx of low-cost electric vehicles from China, which posed a threat to European electric vehicle manufacturers that struggled to compete with the cheaper Chinese alternatives.

On 4th July, 2024, provisional duties were introduced for Chinese electric car companies, with different rates applied depending on the company. For instance, duties potentially applicable to three major Chinese companies include:

- BYD: 17.4%;
- Geely: 19.9%;
- SAIC: 37.6%.

Other companies that were not directly sampled but cooperated in the investigation will be subject to duties of 20.8%, while non-cooperating companies will face a 37.6% duty. Notably, Tesla, a U.S.-based company with production facilities in China, has applied for an individualized duty rate. Other companies may also apply for individualized rates, which will be evaluated on a case-by-case basis (European Commission, 2024/07/04).

As of 4th October 2024, the European Commission has secured the necessary support to impose definitive countervailing duties on electric cars imported from China. Despite this, negotiations between the EU and China continue in an effort to reach an alternative resolution that adequately addresses the concerns raised (European Commission, 2024/10/04).

Beyond tariffs, the European Union has established additional regulatory measures that manufacturers must consider when importing vehicles into the EU market. These measures include type approval requirements, adherence to safety standards, battery composition restrictions, end-of-life recycling mandates, and the implementation of the Carbon Border Adjustment Mechanism (CBAM). Each of these standards plays a critical role in ensuring that imported vehicles align with the EU's stringent environmental and safety objectives.

2.3.1 Regulation (EU) 2019/631

The first regulation under analysis is Regulation (EU) 2019/631 of the European Parliament and of the Council of 17th April 2019, which establishes CO_2 emission performance standards for new passenger cars and light commercial vehicles. This regulation aligns with the objectives of the Paris Agreement, aiming to support the European Union in meeting its greenhouse gas emission reduction targets for 2030 and beyond.

The scope of the regulation encompasses all new vehicles in categories M1 (passenger cars) and N1 (light commercial vehicles) registered for the first time within the EU. However, it excludes special-purpose vehicles. The regulation's primary objective is to achieve a progressive reduction in annual EU fleet-wide average CO_2 emissions from new vehicles, with the following targets:

- A 15% reduction for the period 2025–2029;
- A 55% reduction for new passenger cars and 50% for new vans for the period 2030–2034;
- A 100% reduction starting from 1st January 2035.

Member States are required to record and report data on newly registered vehicles, including their specific CO_2 emissions and the total number of vehicles sold. Real-world emissions data, collected via onboard monitoring devices, must also be compared with laboratory test values to ensure consistency.

Each year, the European Commission issues an implementing act establishing the average CO_2 emissions and specific targets for each manufacturer to assess their compliance. Manufacturers or importers exceeding their CO_2 emission limits are subject to financial penalties, calculated at €95 per gram of CO_2/km above the limit for each registered vehicle.

To incentivize the adoption of zero- and low-emission vehicles (ZLEVs), a ZLEV incentive mechanism is in place from 1st January 2025 to 31st December 2029. Under Article 5, manufacturers earn "super-credits" for vehicles with emissions below 50 g/km. Manufacturers exceeding specific ZLEV benchmarks (25% for cars and 17% for vans) receive more favourable CO_2 emission targets.

Additionally, Article 1(6-7) introduces mandatory benchmarks for ZLEV registrations:

- From 2025, at least 15% of new vehicle registrations must be low-emission vehicles;
- By 2030, this target increases to 35% for cars and 30% for light commercial vehicles.

Article 10 outlines derogations for small-scale manufacturers or those with limited production volumes (up to 10,000 cars or 22,000 light commercial vehicles annually). These manufacturers are granted adjusted targets to account for their lower production capacities.

The regulation also provides incentives for innovative technologies through "eco-innovation" credits. These credits reward emission reductions achieved through innovative solutions, capped at 7 g CO_2/km per manufacturer. However, this cap will decrease starting in 2025, and the credits will be phased out entirely by 2035. Article 11 governs the use of these credits, ensuring that they encourage genuine advancements in emissions reduction.

The Commission is tasked with developing a methodology by 2025 to assess and report the life-cycle CO_2 emissions of cars and vans sold in the EU. From 1st June 2026, manufacturers may begin reporting these emissions using the common EU methodology, fostering greater transparency and accountability in evaluating environmental impacts.

To ensure ongoing progress, the European Commission must submit reports to the European Parliament and the Council by 31st December 2025, and biennially thereafter. These reports will evaluate the transition to zero-emission road mobility and assess the need for additional measures, including financial instruments, to ensure a just transition. The first report will specifically analyse the financial challenges within the automotive sector, focusing on small and medium-sized enterprises and regions disproportionately affected by the shift, and may include recommendations for targeted financial support.

By 2026, the Commission will review the regulation's effectiveness and impact, presenting its findings to the European Parliament and Council, potentially accompanied by proposals for further action (European Union 631, 2019).

2.3.2 Regulation (EU) 2018/858

Regulation (EU) 2018/858 of the European Parliament and of the Council of 30th May 2018 concerns the approval and market surveillance of motor vehicles, their trailers, systems, components, and separate technical units intended for such vehicles. The regulation ensures that vehicles and trailers conform to EU requirements for safety and environmental protection.

The regulation defines its applicability to:

- Category M, motor vehicles with at least four wheels used for the transport of passengers;
- Category N, motor vehicles with at least four wheels intended for goods transportation;
- Category O, trailers.

Its primary objective is to establish a harmonized framework for vehicle approval and inspection across EU member states. A uniform system for issuing conformity certificates for vehicles before their market entry is implemented, requiring manufacturers to secure an EU type-approval certificate that ensures compliance with safety, environmental, and health standards.

Type-approval certificates are issued by independent and competent type-approval authorities. Member states are responsible for overseeing these authorities and associated technical services. Ongoing market surveillance is mandated to ensure continuous compliance with EU standards. Member states must establish dedicated authorities to verify market compliance of vehicles, conduct inspections and tests, and apply corrective actions such as recalling non-compliant vehicles. The results of these audits are publicly accessible, except for confidential information, enhancing transparency and consumer confidence. The European Commission also conducts independent verifications and may impose penalties of up to EUR 30,000 per non-compliant vehicle and revoke technical service designations when non-compliance is identified.

The regulation outlines stringent safety standards that vehicles must meet for market entry (articles 9 and 10):

- Braking and Stability should be in compliance with UNECE Regulation R13H for Electronic Stability Control (ESC);
- Crash Tests, mandatory tests for passenger protection, as per UNECE Regulations R94 and R95;
- Advanced Driver Assistance Systems (ADAS), the inclusion of systems like Automatic Emergency Braking (AEB) and Lane Departure Warning (LDW);
- Adherence to UNECE Regulation R100, specifying insulation and protection requirements for electric vehicle batteries.

Environmental standards for vehicles include (article 5):

- Euro Standards, compliance with Euro 6 for passenger cars and light commercial vehicles.
- Noise Reduction, conformance with UNECE Regulation R51.

- Recycling and Recovery, adherence to Regulation 2005/64/EC, promoting designs that facilitate recycling.
- Battery Standards, compliance with Directive 2006/66/EC, governing battery disposal, recycling, and hazardous material usage.

Additional requirements address the safety of passengers and conductors. Electric and hybrid vehicles must adhere to UNECE Regulation R10, which limits exposure to electromagnetic fields. Materials in passenger compartments must comply with fire and chemical safety standards. Restrictions apply to harmful chemicals, such as volatile organic compounds (VOCs), emitted by interior materials.

Vehicles undergo comprehensive testing by authorized technical services to certify the conformity of essential systems, including brakes, engines, and batteries. Upon meeting all type-approval requirements, an EU Certificate of Conformity is issued. This certificate accompanies each vehicle entering the market, providing assurance of compliance with the regulatory framework (European Union 858, 2018).

2.3.3 Regulation (EU) 2019/2144

Regulation (EU) 2019/2144 of the European Parliament and of the Council of 27th November 2019 on type-approval requirements aims to enhance vehicle safety and the protection of vulnerable road users. It complements Regulation (EU) 2018/858 by specifying the technologies and safety features that must be included in vehicles to obtain EU-type approval. This regulation prioritizes the integration of advanced technologies to improve road safety, particularly for vulnerable road users such as pedestrians and cyclists.

The regulation establishes the EU's first comprehensive framework for automated and fully automated vehicles, promoting the global competitiveness of EU car manufacturers. In addition to addressing safety, it emphasizes environmental sustainability by introducing new technical standards to enhance efficiency and reduce environmental impact.

Article 6 outlines the mandatory advanced vehicle systems applicable across all motor vehicle categories:

- Intelligent speed assistance;
- Interfaces for fitting alcohol interlock devices (breathalysers);

- Driver drowsiness and attention warning systems;
- Advanced driver distraction warning systems;
- Emergency stop signals;
- Reversing detection systems;
- Event data recorders;
- Accurate tire pressure monitoring.

Article 7 specifies requirements for passenger cars and light commercial vehicles (categories M1 and N1):

- Advanced emergency braking systems capable of detecting motor vehicles and vulnerable road users;
- Emergency lane-keeping systems;
- Enlarged head-impact protection zones to mitigate injuries during collisions with vulnerable road users.

Article 9 details requirements for buses and trucks (categories M2, M3, N2, and N3):

- Advanced systems for detecting pedestrians and cyclists near the vehicle, providing warnings to drivers and preventing collisions;
- Designs that reduce blind spots in front of and to the side of the driver.

Article 10 addresses requirements for hydrogen-powered vehicles, considering future technological developments

Article 11 outlines the specific requirements for automated and fully automated vehicles:

- Systems that replace driver control, including signalling, steering, acceleration, and braking;
- Real-time information systems for monitoring the state of the vehicle and its surroundings;
- Driver availability monitoring systems;
- Event data recorders for automated vehicles;
- Harmonized data exchange formats, for example, to facilitate multi-brand vehicle platooning;
- Systems providing safety information to other road users.

This regulation is expected to significantly reduce accidents, injuries, and fatalities by implementing advanced safety systems. Furthermore, it fosters innovation, strengthens the EU's position as a global leader in automated vehicles, and enhances protection for vulnerable road users, reinforcing the EU's commitment to sustainable and inclusive mobility solutions (European Union 2144, 2019).

2.3.4 Regulation (EU) 2023/1542

One of the key distinctions between electric vehicles (EVs) and internal combustion engine (ICE) vehicles lies in their energy sources: EVs are powered by batteries, while ICE vehicles rely on oil. Consequently, conventional vehicles follow regulations pertaining to oil management, whereas electric vehicles adhere to distinct rules governing batteries. In the European Union, all battery types are regulated under Regulation (EU) 2023/1542 of the European Parliament and the Council, adopted on 12th July 2023, which addresses batteries and waste management.

This regulation aligns with the objectives of the European Green Deal, establishing comprehensive sustainability standards for batteries. These standards aim to ensure low-carbon production, minimize the use of hazardous substances such as mercury, cadmium, and lead, and enhance the EU's strategic autonomy by reducing reliance on imported raw materials. Additionally, the regulation promotes the efficient collection, reuse, and recycling of batteries within the EU. Incentives for low-carbon battery technologies and the development of recycling and reuse infrastructure further support the European Green Deal's overarching goals.

The regulation applies to all types of batteries, including:

- Portable batteries;
- Electric vehicle (EV) batteries;
- Industrial batteries;
- Starting, lighting, and ignition (SLI) batteries (commonly used in vehicles and machinery);
- Batteries for light means of transport (LMT), such as electric bikes, e-scooters, and e-mopeds.

The regulation specifies obligations across the entire battery life cycle, including production, use, collection, and recycling. It mandates specific recycling targets for EV batteries, with minimum recycled content requirements to be met by 18th August 2031, as follows:

- 16% for cobalt;
- 85% for lead;
- 6% for lithium;
- 6% for nickel.

Companies involved in battery production or distribution are required to identify, prevent, and mitigate social and environmental risks associated with the sourcing, processing, and trading of critical raw materials, such as lithium, cobalt, nickel, and natural graphite.

The regulation introduces rigorous performance, durability, and safety standards for batteries, including restrictions on hazardous substances and mandatory disclosure of their carbon footprint. Producers must conduct conformity assessments, often involving notified bodies, to ensure compliance. Due diligence policies are obligatory, requiring companies to address environmental and social risks throughout the supply chain.

For imported batteries, importers bear the responsibility for ensuring compliance, including the regulation of used or reconditioned batteries.

A pivotal aspect of the regulation is the emphasis on traceability, ensuring that consumers have access to detailed information about a battery's composition, performance, and recyclability. Batteries must feature clear labelling, including information about components, recycled content, and end-of-life management. Starting in 2026, these labelling requirements will be supplemented by a QR code. From 2027 for LMT, industrial, and EV batteries, a digital battery passport will be introduced, further enhancing traceability and consumer awareness.

This regulation represents a significant step toward aligning the battery sector with the EU's sustainability and circular economy goals, while simultaneously supporting the region's strategic autonomy in raw material sourcing and battery technology development (European Union 1542, 2023).

2.3.5 Regulation (EU) 2023/956

Regulation (EU) 2023/956 of the European Parliament and of the Council, adopted on 10th May 2023, establishes the Carbon Border Adjustment Mechanism (CBAM), a policy designed to mitigate the risk of carbon leakage, reduce global greenhouse gas emissions, and support the objectives of the Paris Agreement. By applying equivalent rules to imports entering the European Union (EU), it complements the EU Emissions Trading Scheme (EU ETS), extending similar emissions reduction measures to goods imported into the EU.

The regulation introduces the CBAM to address the risk of carbon leakage for specific goods with embedded greenhouse gas emissions that are imported from third countries. It ensures that such imports are subject to similar regulations as those imposed on EU-produced goods, thereby creating a level playing field between EU and non-EU producers. This mechanism also revises elements of the existing system to reflect the extent to which EU ETS allowances are allocated free of charge.

The CBAM applies to a list of imported goods outlined in Annex I, primarily from sectors with high emissions, such as:

- Steel and iron;
- Cement;
- Aluminium;
- Fertilisers;
- Electricity.

Electric vehicles (EVs) produced in third countries, such as China, may also be subject to the CBAM if their production process results in significant greenhouse gas emissions. Therefore, EVs imported into the EU from countries with high emissions in their manufacturing processes could fall under the regulation's scope.

From 2026, only entities that have been authorised as CBAM declarants, either importers or indirect customs representatives who have successfully applied to their national authorities, will be permitted to import goods covered by the regulation during the definitive period. To become an authorised declarant, applicants must submit basic information, including contact details, the nature of their economic activity, and evidence of compliance with customs and

taxation rules over the preceding five years. EU Member State national authorities are responsible for maintaining a register of authorised CBAM declarants.

Starting in 2027, CBAM declarants are required to submit an annual declaration by 31st May detailing their activities for the previous year. This declaration must include:

- The quantity of each type of import;
- The total embedded emissions in the goods;
- The number of CBAM certificates surrendered;
- Copies of verification reports.

Additionally, CBAM declarants must maintain detailed records for four years regarding the information used to calculate embedded emissions, as specified in Annex V of the regulation. They are also required to ensure that the total embedded emissions reported in their declarations are verified by an accredited verifier. To account for the carbon price paid in the country of origin, declarants may apply for a reduction in the number of CBAM certificates they must surrender.

The regulation establishes a central platform where Member States can sell CBAM certificates to authorised declarants. The European Commission is tasked with setting up and managing this platform. Transactions, including the sale, repurchase, and cancellation of CBAM certificates, are recorded and updated in the CBAM registry at the end of each working day.

Through these provisions, the CBAM seeks to support the EU's climate goals by preventing carbon leakage, incentivising cleaner production in third countries, and ensuring that imports into the EU are held to the same environmental standards as domestic products (European Union 956, 2023).

CHAPTER 3: DISTRIBUTION IN CHINA AND RELATED REGULATIONS

3.1 China's Electric Vehicle Market

From the preceding analysis, it is evident that China holds a dominant position in the global electric vehicle (EV) market. For years, the country has led this sector, and projections suggest it will maintain its supremacy over other nations in the foreseeable future. This dominance prompts a critical question: how has China managed to establish such an edge over major automotive powerhouses like Germany, Japan, and the United States, which are home to globally recognized brands such as Volkswagen, Toyota, and Ford?

According to an analysis by *MIT Technology Review*, China recognized as early as the 2000s that its domestic carmakers lacked the brand power to compete with foreign manufacturers dominating the market for traditional internal combustion and hybrid vehicles. In response, the Chinese government strategically committed to EV development, prioritizing battery-powered vehicles as the foundation of its automotive future. This vision was embedded in the country's *2001 Five-Year Plan*, where EV technology was identified as a key area of scientific research (MIT Technology Review, 2023). The Ministry of Science and Technology (MOST) launched the Electric Vehicle Key Project under the 863 Program, allocating $290 million for new energy vehicle research. By the 11th Five-Year Plan (2006–2010), funding for EV development had surged to $1.5 billion through various policy initiatives (Helveston et al., 2019). A notable contributor to this momentum was Wan Gang, a former Audi auto engineer who became China's Minister of Science and Technology in 2007, providing critical impetus to the EV sector (MIT Technology Review, 2023). These concerted efforts culminated in the 2008 Beijing Olympic Games, where nearly 600 electric car models were showcased (Xu and Su, 2016).

A significant turning point occurred during 2009–2012 with the launch of the *Ten Cities, Thousand Vehicles (TCTV) Demonstration and Deployment Program*. This initiative introduced subsidies for public fleet vehicles, such as buses and taxis, in 25 pilot cities. By 2010, these subsidies had been extended to private consumers in six cities (Xu and Su, 2016). During the subsequent 12th Five-Year Plan (2011–2015), the New Energy Vehicles (NEVs) sector was designated as one of seven *Strategic and Emerging Industries* (Howell, Lee, and Heal, 2014).

In the years that followed, incentives were expanded to all vehicle purchasers, including both public fleets and individual buyers (Ou et al., 2017). Buyers could sometimes receive subsidies covering up to 30% of an EV's cost, along with additional benefits such as tax exemptions, license plate privileges, and rebates. In 2015, the Chinese government launched the *Made in China 2025* initiative, a strategic plan to solidify the country's leadership in advanced sectors, including EVs and batteries, aiming to establish China as a global EV manufacturing leader.

This developmental trajectory underscores the critical role of the Chinese government in fostering the growth and consolidation of its EV market. Through financial subsidies, tax incentives, and policy support, the central government significantly stimulated EV adoption and production. Local governments also played a crucial role by collaborating with EV companies to customize supportive policies. For instance, BYD, a major EV manufacturer, flourished through its close relationship with Shenzhen, which became the first city worldwide to fully electrify its public bus fleet (Pinalloy, 2024).

Given these comprehensive measures, China's emergence as a global EV leader is hardly surprising. Its example highlights the transformative impact of coordinated governmental policies in driving market development. Other countries seeking to enhance their EV sectors could draw valuable lessons from China's approach, emphasizing the importance of robust policy frameworks to encourage EV adoption and innovation.

3.1.1 Dual Credit Policy

The development of the electric vehicle (EV) market in China has just been analysed, revealing how the market's rapid expansion has been largely driven by continuous state intervention. By designating the new energy automobile industry as one of the seven strategic emerging industries, the Chinese government has actively promoted and supported it through a variety of industrial policies, including fiscal subsidies, tax incentives, integration of production and research, government procurement, and other measures.

However, these initiatives alone are insufficient to ensure the industry's sustainable development. Many car manufacturers have focused on financial gains rather than a genuine commitment to sustainability. This results in enterprises exploiting state incentives for short-term benefits without dedicating themselves to the research, development, and production

of high-quality new energy vehicles. Such a focus on immediate financial returns rather than long-term innovation and sustainability risks undermining the market's future growth.

To address these issues, the Chinese government began phasing out and eventually eliminating subsidy policies by the end of 2020. Simultaneously, on 1st April 2018, the government implemented the Parallel Management Method of Average Fuel Consumption and New Energy Vehicle Integral for Passenger Vehicle Enterprises (乘用车企业平均燃料消耗量与新能源汽车积分并行管理办法 *Chéngyòngchē qǐyè píngjūn ránliào xiāohàoliáng yǔ xīn néngyuán qìchē jīfēn bìngxíng guǎnlǐ bànfǎ*), commonly referred to as the Dual-Credit Policy（"双积分"管理办法 *shuāng jīfēn guǎnlǐ bànfǎ*) (Yang et al., 2022).

In forming this policy, China took inspiration from the U.S. Corporate Average Fuel Economy (CAFE) standards and California's zero emission vehicle programme (Wu et al., 2022).

This policy establishes two distinct credit targets for passenger vehicle manufacturers:

- Corporate Average Fuel Consumption (CAFC) credit;
- New Energy Vehicle (NEV) credit.

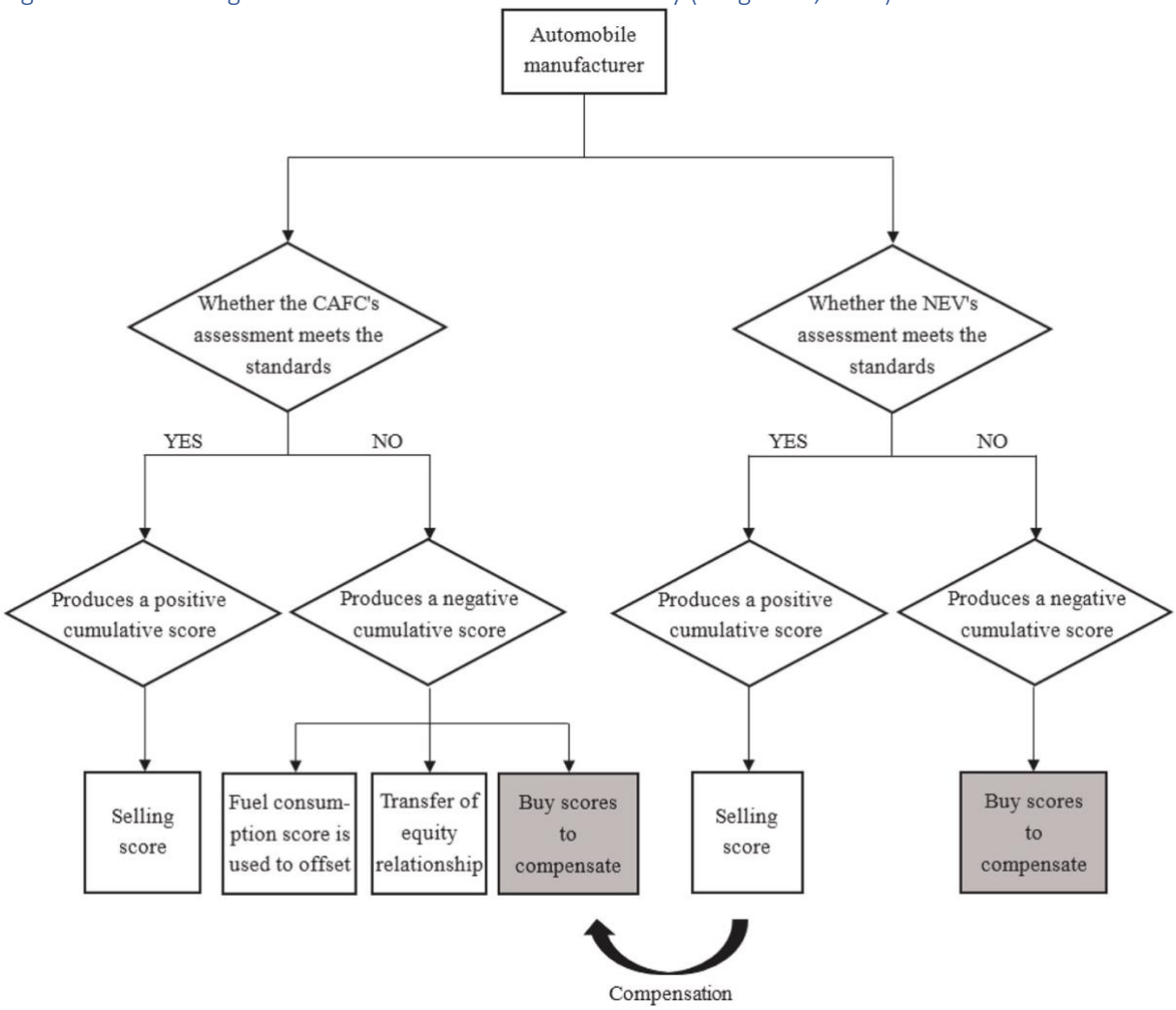
The credits are calculated independently, leading to the policy being popularly known as the "double points" policy. Under this framework, manufacturers earn positive or negative credit scores in both categories based on their production portfolio. Manufacturers with low average fuel consumption and a high proportion of NEVs achieve better credit performance. Positive credits can be transferred or traded on the Fuel Consumption and New Energy Vehicle Points Management Platform, developed by the Ministry of Industry and Information Technology (MIIT), generating additional revenue for the enterprises.

This market-based mechanism incentivizes manufacturers to invest in technologies that improve fuel efficiency and expand NEV production capacity. It also creates a financial motivation for manufacturers to develop energy-saving technologies for traditional vehicles and to scale up NEV innovation and production (Wen, 2023).

To comply with the policy, manufacturers must meet both credit targets by producing sufficient fuel-efficient and new energy vehicles or by purchasing credits from other manufacturers with surplus points. The credit trading mechanism fosters a competitive environment that rewards

innovation and collaboration, encouraging manufacturers to adopt more sustainable practices in vehicle production (Gary, Zhao and Bao, 2024).

Figure 15 The management framework of Dual-Credit Policy (Yang et al., 2022)



The diagram in Figure 15 provides a simplified representation of how the Dual-Credit Policy operates, offering a clear framework for understanding its mechanisms. As depicted, the policy exclusively targets automobile manufacturers, evaluating their performance on two distinct criteria:

- Corporate Average Fuel Consumption (CAFC), a metric that serves as a regulatory standard for passenger vehicles, including non-plug-in hybrid passenger cars, and measures their average fuel efficiency. It aims to reduce fuel consumption and greenhouse gas emissions. The CAFC assessment applies to vehicles powered by gasoline or diesel as well as new energy passenger vehicles (Central People's Government, 2013);

- New Energy Vehicles (NEV), that includes electric vehicles (EVs), fuel cell vehicles, and alternative energy vehicles (Sun et al., 2021).

The policy is structured into two separate assessments: the CAFC evaluation on the left side of the diagram and the NEV evaluation on the right. In both assessments, the key question is whether the manufacturer meets the required standards. Companies that meet or exceed these benchmarks generate positive credits, while those that fail to meet the standards accumulate negative credits.

The calculation of CAFC credits is based on the difference between an enterprise's compliance value and its actual average fuel consumption, multiplied by its production or import volume. To assess compliance, the target fuel consumption of each model produced by the manufacturer is adjusted by a predetermined coefficient. If the enterprise's actual fuel consumption is lower than the compliance value, it generates positive CAFC credits.

For NEV credits, the calculation varies depending on the type of powertrain technology. For example, in the case of pure electric passenger vehicles, the credits are primarily determined by the vehicle's electric range. Additional adjustment factors, such as battery system energy density and power consumption, are applied to the base credits to reflect the vehicle's technological performance. Generally, higher electric range, greater battery energy density, and lower power consumption result in better credit performance, aligning incentives with the advancement of innovative, energy-efficient technologies (Wen, 2023).

Companies generating positive credits can sell them to other manufacturers that fail to meet the standards and accumulate negative scores. Those with negative CAFC scores can also offset their deficits by using fuel consumption credits or transferring credits between related manufacturers.

This system is designed to incentivize the production of new energy vehicles. Manufacturers that prioritize fuel-efficient or NEV technologies can generate surplus credits, which can be sold to generate additional revenue. Conversely, companies that rely on conventional internal combustion engine vehicles and fail to meet CAFC standards face penalties in the form of negative credits, compelling them to purchase credits from compliant companies. This creates both economic rewards for innovation and financial disincentives for non-compliance,

effectively encouraging the transition towards cleaner and more sustainable vehicle production.

According to the annual report by the Equipment Industry Development Centre of the MIIT, the implementation of the "Double Points" Management Measures since 2018 has significantly impacted China's automotive industry. Over five-point transactions, the policy has facilitated a cumulative transaction value exceeding ¥25 billion.[7] This system has been instrumental in advancing energy conservation, reducing emissions, and promoting the growth of new energy vehicles (NEVs) in China (MIIT, 2023).

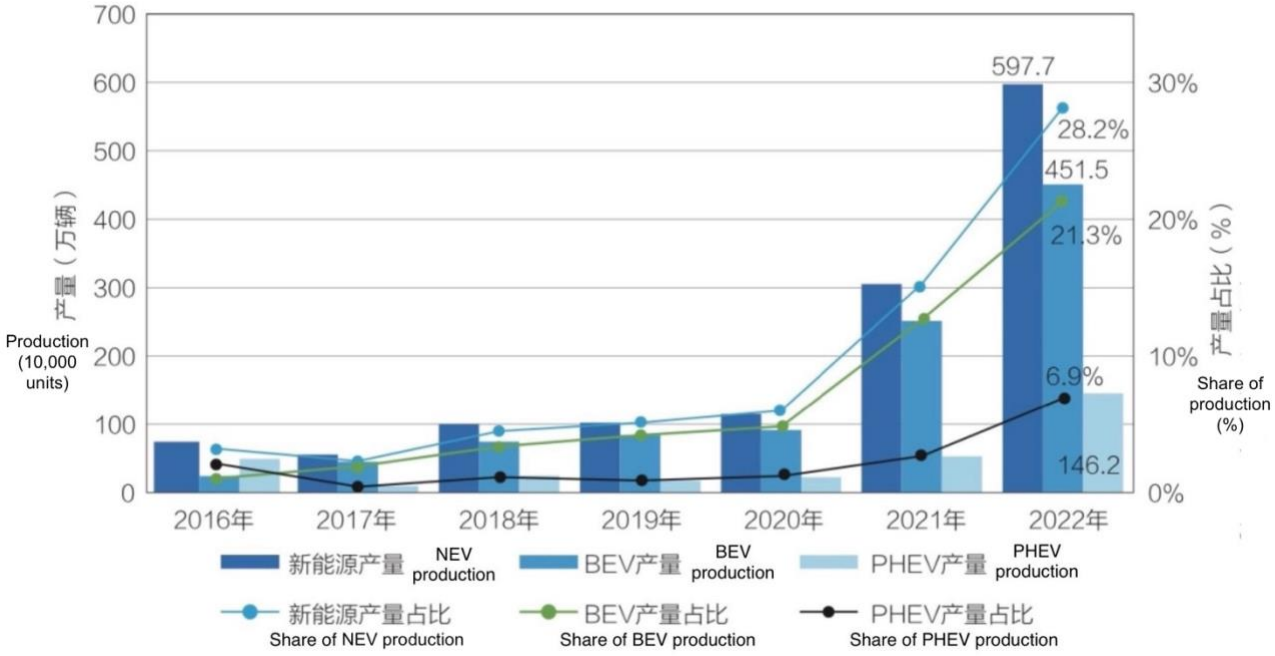
In alignment with China's overarching strategic goals of achieving carbon peak and carbon neutrality, and to enhance the effectiveness of policies promoting the high-quality development of the energy-saving and new energy automobile industries, the Dual-Credit Policy underwent a significant revision in June 2020. These updates aim to support the "double carbon" objectives and were officially implemented as of 1st August 2023.

The revised policy introduced several key changes:

- The points calculation method has been further adjusted downwards for standard models of new energy passenger cars;
- A system for pooling NEV credits was established to stabilize credit market dynamics. This mechanism allows companies to voluntarily store surplus positive NEV credits, valid for up to five years, when supply exceeds twice the demand. These stored credits can then be released when demand surpasses supply. This reform aims to address imbalances in the credit market and provides a buffer mechanism to accommodate tightening regulations on NEV credits;
- CO_2 emissions accounting of car manufacturers, increasing transparency and facilitating integration with the national carbon market. This approach supports the reduction of emissions over the entire vehicle lifecycle and prepares companies for future challenges, such as export carbon duties (Wen, 2023).

[7] ¥25 billion is almost €3,10 billion.

Figure 16 Development of NEV Passenger Vehicles 2016-2022 (MIIT, 2023)



The accompanying chart illustrates the development trends of NEV passenger vehicles in China between 2016 and 2022. The x-axis represents the timeline, while the y-axis features dual scales: the left measures production volume in units of 10,000, and the right shows the production share as a percentage.

Data is segmented into two categories: Battery Electric Vehicles (BEVs), depicted by light blue columns and a green line, and Plug-in Hybrid Electric Vehicles (PHEVs), represented by azure columns and a dark line. Total production is illustrated with dark blue columns and a blue line.

Production data reveals that BEVs consistently outpace PHEVs in volume. While both categories generally demonstrate growth over the years, 2017 stands out as an anomaly, with PHEV production experiencing a significant decline. Despite this, the overall trend for NEVs is one of steady annual growth.

A pivotal shift occurred in 2022, with production surging from over 1,000,000 units to more than 3,000,000 units, nearly tripling within a single year. This upward trajectory continued into the following year, with production reaching 5,977,000 units, representing almost double the output of the previous year. This sharp increase is also mirrored in the NEV production share line, underscoring the growing prominence of NEVs in the market.

The production trend remained relatively stable up to 2020 but exhibited exponential growth in subsequent years. This acceleration can be attributed to the adoption of the Dual-Credit Policy. The timing aligns with the Chinese government's decision to phase out direct subsidies for electric vehicles by 2020 and the concurrent introduction of the new policy framework. By incentivizing manufacturers through a system of positive and negative credits, along with the ability to trade these credits, the Dual-Credit Policy effectively motivated greater investment and innovation in NEV production.

These figures highlight the critical role of government policies in shaping the NEV market in China. While initial subsidies and incentives laid the foundation for the industry's development, the implementation of the Dual-Credit Policy served as the decisive catalyst for the sector's rapid expansion. This policy's structure not only encouraged compliance but also fostered competition and technological advancement, ultimately achieving its intended goal of accelerating the transition to sustainable mobility.

Figure 17 China's New Energy Vehicles (NEVs) from 2013 to 2022 (Gary, Zhao and Bao, 2024)

This chart illustrates the evolution of China's new energy vehicle (NEV) market from 2013 to 2022, highlighting sales volume (represented in blue bars) and year-on-year growth rate (depicted with a red line).

On the x-axis, the time period under analysis is shown, while the y-axis displays the sales volume in increments of 10,000 units on the left and the percentage of year-on-year growth on the right.

Sales volumes were relatively low in 2013 and 2014, with 18,000 and 75,000 units sold, respectively. Beginning in 2015, sales demonstrated steady growth, achieving remarkable progress over the next seven years, climbing from 331,000 units in 2015 to 1,575,000 in 2021. This upward trend can be partially attributed to government incentive policies that supported market expansion. The only notable decline occurred in 2019, likely due to the reduction of state subsidies. However, the market quickly recovered, overcoming this dip by 2020. The pivotal year was 2022, when sales reached an unprecedented peak of 6,887,000 units, nearly quadrupling from the previous year. This milestone underscores the rapid expansion of China's NEV market.

The year-on-year growth trend initially demonstrated remarkable peaks in 2014 and 2015, with growth rates of 323.8% and 342.9%, respectively. This surge likely reflects the impact of government incentives introduced during this period. However, the growth rate subsequently declined, culminating in a negative rate of -4% in 2019, coinciding with a reduction in subsidies. Despite the challenges posed by the COVID-19 pandemic, growth rebounded strongly in subsequent years, peaking again at 352.1% in 2021 before stabilising in 2022.

This data highlights the critical role of government intervention in fostering the development of the NEV market. Fluctuations in growth rates are closely aligned with changes in government policies, illustrating the importance of incentives in shaping market dynamics. Moreover, the decline in 2019 demonstrates that subsidies alone were insufficient to sustain long-term market growth. Recognizing this, the Chinese government introduced the Dual-Credit Policy, which provided the necessary impetus to consolidate the NEV market, ensuring its continued expansion and aligning it with national sustainability goals.

3.2 China's Environmental Regulations

Like the member states of the European Union, also China is part of the United Nations. As a consequence, also China adopted the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs). (United Nations China website) This act shows that also China is interested in safeguarding the planet, they have the will to do their utmost to ensure global sustainability. Moreover, the Chinese government also signed the Paris Agreement, further solidifying China's will in taking part in the fight towards a green future. (United Nations, 2015) China is also realising that climate change is a matter of utmost

importance and is striving to become an increasingly environmentally responsible country. The country's participation in these international events also makes it clear that China is also slowly alienating its national policies with international frameworks.

All these actions by China can be reflected in its 14th Five-Year Plan (2021-2025). "In short, the five-year plan's outline sets a 18% reduction target for "CO_2 intensity" and 13.5% reduction target for "energy intensity" from 2021 to 2025. For the first time, it also refers to China's longer-term climate goals within a five-year plan and introduces the idea of a "CO_2 emissions cap", though it does not go so far as to set one" (Carbon Brief, 2021).

The goals outlined in the 14th Five-Year Plan is also a consequence of what President Xi Jinping said in his speech at Climate Ambition Summit in 2020:

> China has made important contributions to adopting the Paris Agreement and has made active efforts toward implementing it. I announced in September that China would scale up its nationally determined contributions and adopt more vigorous policies and measures. We aim to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060.
>
> Today, I wish to announce some further commitments for 2030: China will lower its carbon dioxide emissions per unit of GDP by over 65 percent from the 2005 level, increase the share of non-fossil fuels in primary energy consumption to around 25 percent, increase the forest stock volume by 6 billion cubic meters from the 2005 level, and bring its total installed capacity of wind and solar power to over 1.2 billion kilowatts (Ministry of Ecology and Environment, 2020).

President Xi Jinping's speech underscores China's commitment to ambitious climate goals, including enhancing economic efficiency, investing in renewable energy, and increasing carbon absorption capacity through extensive reforestation efforts. These initiatives solidify China's role as a key participant in global climate governance and demonstrate its determination to address the climate crisis with serious intent.

China's path to achieving carbon neutrality can be outlined in a three-step strategy:

1. Achieving carbon emissions peak by 2030;

2. Rapidly reducing carbon emissions by 2045;
3. Reaching deep decarbonization levels and achieving carbon neutrality by 2060.

The “double carbon targets” are explicitly incorporated into the 14th Five-Year Plan, specifically in Chapter 3, Section 1, which addresses the nation’s vision for 2035. The plan states: “Formulate an action plan to peak carbon emissions by 2030… Strive to be carbon neutral by 2060” (CNEUND website).

3.2.1 China National ETS

To achieve its dual-carbon goals, the Chinese government has implemented various initiatives and strategic plans, including the national Emissions Trading System (ETS, 碳排放权交易体系 *tànpáifàng quán jiāoyì tǐxì*), which became operational in July 2021 (MEE, 2024).

The ETS is a market-based mechanism designed to control greenhouse gas (GHG) emissions by trading emission rights. It serves as both a policy instrument to achieve carbon peaking and neutrality goals and a tool to assign emission reduction responsibilities to enterprises while offering incentives to reduce overall societal costs of emissions mitigation (PWC website). The system reduces carbon intensity through a tradable performance standard and was initially implemented in the power generation sector, with plans for future expansion to other industries. A gradual transition is anticipated from an intensity-based trading system to an aggregate-based approach (Karplus, 2021).

As of now, the ETS encompasses 2,257 key emitters, accounting for approximately 5.1 billion tonnes of annual CO_2 emissions, which represents over 40% of China’s total CO_2 emissions. This scale makes the Chinese ETS the world’s largest carbon market in terms of greenhouse gas coverage (MEE, 2024).

The ETS operates by setting a cap or limit on CO_2 emissions for participating companies. Each enterprise is allocated allowances based on historical emissions, industry benchmarks, and other criteria. Companies must report their emissions regularly, and if they exceed their allocated cap, they are required to either reduce emissions or purchase additional allowances on the ETS market. Conversely, firms emitting less than their allowance can sell their surplus permits. This supply-and-demand-driven market mechanism determines the price of allowances, incentivising cost-effective emission reductions (Circularity website).

The launch of the national ETS in 2021 was preceded by pilot projects initiated in June 2013 in seven regions: Shanghai, Guangdong, Tianjin, Shenzhen, Beijing, Hubei, and Chongqing. These areas were selected due to their significant economic contributions, collectively accounting for 24.9% of China's GDP. The pilot focused on highly carbon-intensive sectors such as iron and steel, chemicals, power, heating, cement, and petrochemicals, which together represent 7% of national GHG emissions. Despite limited trading activity, only 1.4% of allowances were traded during the pilot period, the initiative laid the groundwork for the national ETS, with average carbon prices around RMB 30 per metric tonne, varying regionally (Zhang et al., 2025).

To strengthen the regulatory framework for carbon trading, Premier Li Qiang recently signed a State Council Decree introducing the Interim Regulations for the Management of Carbon *Emissions Trading* (碳排放权交易管理暂行条例 *Tànpáifàng quán jiāoyì guǎnlǐ zànxíng tiáolì*), effective from 1st May 2024. These regulations outline key elements such as market coverage, inclusion targets, allowance allocation, data supervision, and trading operations. This marks a significant step toward establishing a robust management system and stringent supervision mechanism for the national carbon emissions trading market (PWC website).

3.3 Chinese Regulations Regarding Exports of Electric Vehicles

In the preceding chapter, the focus was on analysing the process of importing electric vehicles into the European Union. This chapter shifts perspective to examine the process of exporting electric vehicles from China. Similar to the European Union, China imposes a comprehensive set of regulations that all electric vehicle manufacturers, whether Chinese or foreign entities operating within China, must adhere to. However, unlike the European Union, which comprises 27 member states with potentially varying requirements, China operates as a single nation, with only national regulations governing exports.

China, like the European Union, follows the Harmonized System (HS) of tariff nomenclature for classifying goods in international trade operations. China officially adopted the HS system on 1st January 1992, and on 1st August 2018, transitioned from a 10-digit to a 13-digit HS code system for its customs classification. The updated system includes:

- The first 8 digits as the Commodity HS code under the "Import and Export Tariff of the People's Republic of China";

- The 9th and 10th digits for customs supervisory purposes;
- The 11th to 13th digits for inspection and quarantine purposes.

For electric vehicles, the HS code closely aligns with the European Union's CN code, being 8703800090999 under the description "Other manned vehicles with drive motor only" (其他仅装有驱动电动机的其他载人车辆 qítā jǐn zhuāngyǒu qūdòng diàndòngjī de qítā zàirén chēliàng) (Transcustoms website).

Exporting goods, like importing, is subject to customs tariffs that depend on the type of goods being traded. In China, customs tariffs are specified in the Import and Export Tariffs of the People's Republic of China (中华人民共和国进出口税则 *Zhōnghuá rénmín gònghéguó Jìnchūkǒu shuìzé*), a comprehensive document listing duties applicable to various goods (CTS, 2024). It serves as a critical part of the *Regulations on Import and Export Tariffs* and includes tariff lines, rates, and classification rules aligned with national tariff policies and international agreements. This document provides the foundation for customs tariff calculations (Baidu E). According to this regulation, electric vehicles are exempt from export duties. In fact, they are not explicitly listed in the export goods section, indicating that no tariffs apply to this category.

The absence of tariffs for exporting electric vehicles aligns with China's broader strategic objectives. China actively promotes the development and global leadership of its electric vehicle industry as part of its green technology initiatives. By waiving export duties for electric vehicles, the government fosters competitive advantages for this sector. This policy underscores the critical role of governmental support in shaping and advancing key industries.

In addition to tariff exemptions, China offers an export tax rebate system to further incentivize foreign trade. This system allows companies to reclaim the value-added tax (VAT) paid during production, reducing the overall cost of exported goods and enhancing their international competitiveness. Over time, the government has streamlined the rebate process by reducing required documentation and enabling online submissions through platforms such as the national customs portal. Electric vehicle manufacturers benefit significantly from this mechanism, as they can recover the 13% VAT levied on their production costs. This refund system ensures that Chinese electric vehicles are priced more competitively in international markets (Zhongshan Municipal Taxation Bureau, 2022).

The State Taxation Administration provides tools to verify export tax rebate rates. By using the HS code for electric vehicles, manufacturers can confirm that the VAT refund rate matches the taxation rate of 13%, allowing them to reclaim the entire VAT amount paid. These measures collectively illustrate the extensive support provided by the Chinese government to facilitate export operations and bolster the global competitiveness of domestic manufacturers.

Chinese export regulations for electric vehicles bear similarities to the European framework, as previously analysed. For each European regulation discussed in earlier chapters, a corresponding Chinese standard exists. In China, these are referred to as National Standards (国家标准 Guójiā Biāozhǔn), which are established and publicly released by state agencies. National standards are developed to unify technical requirements across the country, with the State Council Administrative Department for Standardization responsible for drafting, approving, and publishing them. These standards take precedence over regional or industry-specific standards and form the foundation of a four-tier standardization system. Compulsory national standards are denoted as GB, while recommended standards are labelled GB/T.

Once national standards are issued, overlapping or redundant industry and local standards are abolished, ensuring uniformity. These standards play a crucial role in aligning China's export operations with global market requirements and reinforcing its position as a leading player in the electric vehicle sector (Fujian Provincial People's Government, 2023).

3.3.1 GB 7258-2017

Among China's regulations on electric vehicles, one closely resembles the EU Regulation (EU) 2018/858: the Technical Specifications for Safety of Power-Driven Vehicles Operating on Roads (机动车运行安全技术条件 *jīdòngchē yùnxíng ānquán jìshù tiáojiàn*), commonly referred to by its abbreviation, GB 7258-2017. Similar to its European counterpart, this regulation establishes technical requirements for the safety approval of vehicles.

Implemented on 1st January 2018, under the proposal of the Ministry of Public Security of the People's Republic of China, GB 7258-2017 outlines fundamental technical standards related to the operational safety of vehicles and their main components, as well as safety devices. It also includes additional provisions for specialized vehicles, such as fire trucks, ambulances, technical rescue vehicles, police vehicles, and vehicles designed for persons with disabilities.

While it applies to all motor vehicles operating on China's roads, it excludes trams and special-purpose wheeled mechanical vehicles not designed or built for road travel, which are primarily used for construction or operations within enclosed spaces (Baidu C).

As a core component of China's National Technical Safety Standards for Motor Vehicles, GB 7258-2017 serves as the fundamental technical reference for various processes, including registration inspections, inspections of vehicles in use, assessments of operational safety, and evaluations of vehicles involved in accidents. It also plays a critical role in the mandatory approval of new vehicle types, factory inspections for new vehicles, and checks on imported motor vehicles.

Article 4 mandates permanent markings on visible parts of vehicles and requires unique vehicle identification systems, such as the Vehicle Identification Number (VIN).

Article 7 specifies the installation standards for critical safety systems, including Anti-lock Braking Systems (ABS), automatic braking systems, and automatic brake gap adjustment devices.

Article 12 sets requirements for airbags, seat belts, fire protection systems in buses, and advanced driver assistance systems such as automatic braking.

Article 12.13 is specifically devoted to electric and hybrid vehicles, outlining detailed requirements for battery protection, integration with the vehicle, and the implementation of battery monitoring and management systems.

This regulation plays a vital role in ensuring road safety and aligns with China's broader objectives to standardize and enhance the safety and performance of motor vehicles, particularly in the context of the growing electric vehicle market (National Standard of the People's Republic of China, 2017).

3.3.2 GB 19578-2021

The Chinese counterpart to Regulation (EU) 2019/631 is the Fuel Consumption Limits for Passenger Cars (乘用车燃料消耗量限值 *Chéngyòngchē ránliào xiāohàoliáng xiàn zhí*), officially designated as GB 19578-2021. This regulation, approved on 20th February 2021, came into effect on 1st July 2021. It falls under the jurisdiction of the National Technical Committee

of Auto Standardisation (NTCAS), the primary technical authority for standardizing the national automobile industry, encompassing both passenger cars and motorcycles (Baidu A and Baidu D).

As indicated by its title, this regulation establishes fuel consumption limits for passenger vehicles, mirroring the objectives of its European counterpart. It outlines the requirements for type certification, fuel consumption determination, certification value recording, production consistency checks, and provisions for updates or extensions to type certification. The regulation applies to M1-category vehicles fuelled by petrol or diesel with a maximum design gross mass not exceeding 3,500 kg. It excludes vehicles exclusively powered by gaseous or alcohol-ether fuels (Baidu A).

The regulation aims to support national energy conservation and emission reduction goals, facilitate the adoption of sustainable driving technologies, and promote the growth of an environmentally responsible automotive industry. Additionally, it seeks to ensure a smooth regulatory transition for manufacturers adapting to the new standards.

Key provisions of GB 19578-2021 include detailed fuel consumption limits based on vehicle configurations, such as manual transmissions and designs with fewer than three rows of seating. Vehicles must comply with production standards defined in GB/T 19233.[8] Design modifications that do not impact fuel consumption are exempt from re-certification requirements.

From 2025, the testing methodology for fuel consumption will transition from the New European Driving Cycle (NEDC) to the Worldwide Harmonised Light Vehicles Test Cycle (WLTC), a more accurate and representative standard.[9] This change will influence the calculation of fleet-wide average fuel consumption. The regulation also updates loading methods, replacing the inertial mass system with a continuous loading system as defined in GB/T 19233-2020.

A linear classification system based on vehicle weight is introduced for calculating fuel consumption, with reference values adjusted to account for technologies like gasoline particulate filters (GPFs), turbocharged engines, and plug-in hybrid electric vehicles (PHEVs).

[8] GB/T 19233/2020: *Measurement methods of fuel consumption for light-duty vehicles*.

[9] NEDC is a test procedure that is used to measure the fuel consumption and emissions of vehicles in the European Union (EU), meanwhile WLTC is used worldwide.

The regulation is aligned with the Dual Credit Policy management system to promote sustainability in the automotive sector and contribute to China's broader carbon peaking and climate neutrality objectives (National Standard of the People's Republic of China, 2021).

3.3.3 GB 18384-2020

The full title of the regulation is Electric Vehicles Safety Requirements (电动汽车安全要求 *Diàndòngqìchē ānquán yàoqiú*), which parallels Regulation (EU) 2019/2144. Like its European counterpart, this Chinese regulation outlines safety requirements and testing methods for electric vehicles to ensure the protection of passengers, pedestrians, and infrastructure.

Implemented on 1st January 2021, under the Ministry of Industry and Information Technology of the People's Republic of China (PRC), GB 18384-2020 applies to all types of electric vehicles, including private cars, buses, and commercial vehicles. It mandates that the maximum operating voltage of the onboard drive system be classified as Class B voltage.[10] However, the standard excludes road vehicles that remain continuously connected to the power grid while in operation (Baidu B).

The regulation requires the onboard electrical system to be isolated and protected to prevent both direct and indirect contact, particularly for systems operating at voltages exceeding 60 V. To ensure operational safety, vehicles must incorporate fault detection devices capable of identifying short circuits, overvoltages, and other anomalies.

Battery systems are mandated to meet stringent safety criteria, including measures to prevent overheating and ensure resilience in the event of a fire. They must also be designed to withstand shocks, vibrations, and other mechanical stresses. Rigorous testing is required under extreme conditions, such as high temperatures, pressure variations, and humidity, to confirm their durability and safety.

The physical design of electric vehicles must ensure the protection of batteries and electrical components during collisions. Vehicles must successfully pass frontal, side, and rear impact tests while maintaining the integrity of the electrical system. Additionally, automatic

[10] Class B voltage means voltage between 60 V and 1500 V (DC) and 30 V and 1000 V (AC) (Durot Electric).

disconnection systems are required to interrupt the flow of electricity in the event of a crash, minimizing the risk of electrical hazards.

Electric vehicles and their components must meet specific waterproofing standards to ensure functionality in everyday scenarios, such as exposure to rain or vehicle washing.

Compatibility with standardised charging stations is a critical requirement to ensure both safety and interoperability. Charging systems must comply with national standards to prevent risks such as overloading and short circuits.

To address the inherent quietness of electric vehicles, they must be equipped with audible warning systems to alert pedestrians and other road users to their presence. Additionally, clear labelling and documentation are required to communicate electrical hazards and provide guidelines for safe maintenance (National Standard of the Peoples Republic of China, 2020).

3.3.4 GB/T 36276-2023

GB/T 36276-2023, officially titled Lithium-Ion Battery for Electrical Energy Storage (电力储能用锂离子电池 *Diànlì chǔ néng yòng lǐlízǐdiànchí*), was released on 28th December 2023, and is scheduled for implementation on 1st July 2024. This national standard serves as the foundational framework for conducting type tests, factory tests, and sampling tests on lithium-ion batteries, exerting significant influence on the energy storage industry.

The standard applies to lithium-ion batteries used in energy storage systems, including power grids, electric vehicles, and stationary applications. However, it does not extend to batteries designed for consumer electronic devices or portable instruments. It establishes rigorous standards to ensure the safety, reliability, and sustainability of lithium-ion batteries in energy storage applications. These requirements encompass design, electrical performance, mechanical strength, and thermal management, promoting compliance with modern standards while advancing environmental protection goals.

The standard mandates that batteries be designed to prevent short circuits, overheating, and electrical leakage. Physical protection against shocks and vibrations is required, along with resistance to temperature and humidity fluctuations. Batteries must also meet waterproof and dustproof criteria. To ensure operational safety, components must provide adequate insulation to prevent charge loss and include systems to mitigate risks such as overloads and

short circuits. The standard stipulates that batteries must endure temperatures of up to 85°C without deformation or functional degradation.

To guarantee safety and compliance, the standard prescribes a series of rigorous tests:

- Compression tests ensure that batteries can withstand external pressure without exploding or leaking electrolytes;
- Penetration tests verify resilience to puncture without causing fire or explosion;
- Overload tests evaluate battery behaviour under voltages exceeding operational limits to ensure safety under extreme conditions.

Beyond operational safety, the standard emphasizes environmental considerations, requiring batteries to comply with regulations governing material disposal and recycling.

For applications such as electric vehicles, the integration of advanced battery management systems is required. These systems must monitor and address anomalies such as overheating, short circuits, and overloads. Real-time diagnostic tools must be incorporated to provide continuous information about the battery's condition, ensuring both safety and optimal performance (National Standard of the People's Republic of China, 2023).

CHAPTER 4: European Regulations VS China's National Standards

Reviewing the development of electric vehicles (EVs) in China reveals how this industry has evolved and reached a degree of stability in recent years. The analysis in the preceding chapter provided valuable insights into how China, as a global economic powerhouse, has achieved a leading position in this sector. This success was not the result of a spontaneous phenomenon but rather a deliberate and carefully planned strategy implemented by the Chinese government. These efforts have propelled China into a dominant position in the global EV market.

China's competitive pricing has also encouraged numerous Western companies to establish manufacturing facilities within its borders. This allows these companies to produce EVs at lower costs and subsequently sell them in European and US markets at prices more competitive than those of their rivals. Given the growing attractiveness of this approach, it is conceivable that an increasing number of companies may adopt similar strategies in the future.

Understanding the regulatory frameworks in both the European Union (EU) and China is therefore crucial not only for Western firms operating in China but also for Chinese companies seeking to internationalize and expand into European markets. By analyzing the import and export regulations of the EU and China, this chapter seeks to identify and compare their legal frameworks, focusing on commonalities and divergences.

The analysis draws on five key EU regulations governing the importation of electric vehicles from China, alongside four Guojia Biaozhun (GB) standards that regulate the export of EVs from China to Europe. These regulations collectively address four primary aspects of EVs:

- CO_2 Emission Limits;
- Type Approval and Market Surveillance;
- Safety of Onboard Systems;
- Battery Sustainability.

This chapter will undertake a comparative analysis of these aspects, highlighting areas of alignment and divergence between the two regulatory systems. Additionally, it will identify the key areas of focus for automotive companies navigating these frameworks, offering valuable guidance for both Western and Chinese firms aiming to optimize their strategies within the global EV market.

4.1 CO_2 Emission Limits

The first regulations under consideration are Regulation (EU) 2019/631 and GB 19578-2021, both of which govern vehicle emissions and aim to improve energy efficiency in the automotive sector. These regulations share a common overarching objective: the reduction of CO_2 emissions generated by vehicles while promoting energy efficiency and environmental sustainability. To achieve this, both frameworks encourage the development and adoption of cleaner technologies, including electric and low-emission vehicles. Both regulatory systems also establish precise standards for CO_2 emission limits for passenger and light commercial vehicles and mandate the monitoring and reporting of vehicle emissions to ensure compliance.

Both the EU and China aim to mitigate environmental impacts through stringent regulations that incentivize manufacturers to prioritize cleaner technologies. This alignment reflects the global urgency to transition toward sustainable practices in the automotive industry.

The EU regulation adopts a pooling mechanism, allowing manufacturers to pool emissions across different fleets to meet collective targets. In contrast, the Chinese regulation employs a credit-based system, as outlined in the Dual-Credit Policy. This system assigns positive credits to manufacturers producing low- or zero-emission vehicles and negative credits for failing to meet efficiency targets. Noncompliance in Europe results in severe financial penalties for manufacturers exceeding annual emission limits, whereas in China, the credit system operates as both an incentive and a penalty mechanism.

The EU calculates CO_2 emissions using the Worldwide Harmonised Light Vehicles Test Procedure (WLTP), a globally recognized standard. In China, emissions are assessed using the China Light-Duty Vehicle Test Cycle (CLTC), which is tailored to local driving conditions and regulations. This distinction reflects the EU's emphasis on global standardization, while China's approach aligns more closely with its specific domestic requirements.

Regulation (EU) 2019/631 sets clear and progressive emission reduction targets for 2025 and 2030, ensuring a long-term roadmap for compliance. Conversely, GB 19578-2021 updates earlier Chinese regulations, focusing more on the short to medium term to align with China's national carbon neutrality goals.

For Chinese manufacturers seeking to export EVs to the EU, adherence to these differing standards is a significant challenge. They must translate their compliance with Chinese methodologies, such as the CLTC, into the EU's WLTP framework. This necessitates designing vehicles that satisfy both sets of regulations, leading to increased research, development, and production costs.

Consequently, companies that excel in innovation and adaptability gain a competitive advantage, as they can efficiently navigate these dual regulatory systems. Conversely, manufacturers that struggle to meet these complex requirements risk exclusion from highly regulated markets like the EU.

In conclusion, while both regulatory systems share the goal of fostering environmental sustainability, their distinct mechanisms, methodologies, and timelines necessitate careful strategic planning for manufacturers operating across these markets.

4.2 Type Approval and Market Surveillance

Regulation (EU) 2018/858 and GB 7258-2017 are critical legal frameworks designed to ensure the safety, conformity, and sustainability of vehicles in their respective regions. Both regulations aim to enhance road safety by establishing technical standards, ensure vehicle conformity through certification processes, and promote sustainability by encouraging practices and technologies aligned with long-term environmental goals.

Both frameworks require manufacturers to provide comprehensive technical documentation and subject vehicles to rigorous testing for approval. Oversight mechanisms for vehicles already on the market are mandated to ensure continued compliance, with collaboration among manufacturers, regulatory bodies, and relevant authorities being central to achieving these objectives.

A notable difference lies in the system of approval. Regulation (EU) 2018/858 operates on a centralized, harmonized system, where approval granted in one EU member state is valid across the entire Union. This ensures uniform standards and facilitates market access. In contrast, GB 7258-2017 focuses on the Chinese domestic market, with localized requirements tailored to specific conditions, ensuring vehicles meet the unique demands of China’s transportation environment.

On sustainability, the European regulation places significant emphasis on environmental performance, enforcing stringent emission standards such as Euro 6 and monitoring vehicles' environmental performance continuously. The Chinese regulation, while acknowledging environmental objectives, prioritizes technical safety and mechanical reliability over emissions and sustainability.

Surveillance mechanisms also differ between the two systems. The EU employs a harmonized post-market surveillance framework, enabling systematic monitoring of vehicles after market entry. China's approach relies on mandatory periodic inspections for vehicles already in use, focusing primarily on operational safety rather than emissions monitoring.

These differences pose challenges for manufacturers exporting electric vehicles from China to the EU, as they must meet the standards of both regulations. This dual compliance process increases production, testing, and administrative costs, creating barriers for market entry.

A mutual recognition agreement between the EU and China on vehicle approvals could alleviate these challenges. Such an agreement would reduce duplicative testing and certification, lower costs for manufacturers, and promote bilateral trade in vehicles. This would benefit manufacturers and foster closer cooperation between the two regions, supporting the global transition to sustainable mobility.

While Regulation (EU) 2018/858 and GB 7258-2017 share overarching goals of safety, conformity, and sustainability, their differing approaches reflect regional priorities and contexts. Manufacturers must strategically adapt their vehicles to meet the distinct requirements of both markets, ensuring compliance while balancing cost-efficiency.

4.3 Safety of Onboard Systems

Both Regulation (EU) 2019/2144 and GB 18384-2020 address vehicle safety and performance, with a particular emphasis on electric vehicles (EVs). These regulations share a common objective: establishing rigorous safety standards for EVs to ensure the secure operation of vehicles and their components. Specifically, they focus on the safety of batteries, introducing technical requirements that include high-voltage system protection, battery thermal management, and measures to prevent fire or explosion risks. To enhance safety, both

regulations also promote the use of advanced battery monitoring systems to detect and prevent failures or accidents.

On the broader spectrum of road safety, these frameworks mandate the incorporation of advanced technologies aimed at improving both active and passive safety measures in EVs. By doing so, they not only enhance the reliability and safety of electric vehicles but also contribute to the broader goal of promoting sustainable and secure mobility. This aligns with their role in fostering the transition to electric mobility as part of a more environmentally friendly transportation paradigm.

Despite their shared objectives, notable differences exist between the two regulations. Regulation (EU) 2019/2144 emphasizes general vehicle safety and mandates advanced driver assistance systems (ADAS) for all vehicles, including Intelligent Speed Assistance (ISA), automated emergency braking, and driver attention monitoring systems. In contrast, GB 18384-2020 focuses more narrowly on the technical safety of electric vehicles, particularly on the safety of batteries and high-voltage systems. Its requirements prioritize aspects such as electrical insulation, short-circuit prevention, and fire risk mitigation, reflecting a more specialized approach to electric vehicle safety.

The two regulations also diverge in their testing methodologies. Regulation (EU) 2019/2144 relies on harmonized European standards, such as those developed under the WLTP (Worldwide Harmonized Light Vehicle Test Procedure) and UNECE (United Nations Economic Commission for Europe) frameworks. In China, GB 18384-2020 adopts localized testing procedures tailored to Chinese technical standards, particularly for batteries and electrical systems. This difference in testing protocols creates additional complexity for manufacturers aiming to comply with both regulatory frameworks.

Another significant distinction lies in the treatment of environmental impact. While the European regulation includes indirect requirements aimed at minimizing environmental harm, such considerations are not explicitly addressed in GB 18384-2020. In China, environmental issues are typically managed through broader national strategies or separate regulatory mechanisms, such as the Dual Credit Policy. Conversely, the EU integrates technical vehicle regulations into a more comprehensive legislative framework that includes environmental objectives, reflecting its emphasis on cohesive policy-making. These differences are indicative

of the varying political priorities, levels of regulatory integration, and societal expectations in the two regions.

For Chinese manufacturers, exporting electric vehicles to Europe entails additional costs due to the need to meet both domestic and European standards. However, successfully navigating this dual regulatory landscape provides an opportunity for manufacturers to showcase the quality and safety of their vehicles, thereby enhancing their competitiveness and reputation in the global market. By demonstrating compliance with stringent international standards, Chinese EV manufacturers can position themselves as leaders in the evolving landscape of electric mobility.

4.4 Battery Sustainability

Regulation (EU) 2023/1542 and GB/T 36276-2023 both address one of the most critical components of electric vehicles: batteries. Both regulations aim to advance the technological development of batteries, focusing on making them safer and more efficient to accelerate the adoption of electric vehicles.

However, their commonalities are largely limited to this overarching objective, as their specific focuses diverge significantly. Regulation (EU) 2023/1542 prioritizes environmental sustainability, with an emphasis on the recyclability and traceability of batteries. In contrast, GB/T 36276-2023 concentrates more on the operational safety of batteries, with detailed provisions to prevent issues such as fires and short circuits. This distinction reflects the broader goals of the two regulatory frameworks: while the European Union is deeply concerned with managing the environmental impact of batteries throughout their lifecycle, from production to disposal, China places a greater emphasis on technical safety to build consumer trust and mitigate battery-related risks.

One particularly notable feature of Regulation (EU) 2023/1542 is its requirement for a digital battery passport. This passport must include comprehensive information on the battery's composition, origin, and recyclability, fostering transparency and accountability within the battery supply chain. In contrast, GB/T 36276-2023 does not impose standardized traceability requirements, further underscoring the divergence in regulatory priorities.

These differences present significant challenges for Chinese electric vehicle manufacturers seeking to export to the European market. Compliance with European regulations requires ensuring that batteries meet stringent traceability standards, along with sustainability requirements that mandate detailed disclosures on carbon emissions, recycling processes, and the overall ecological impact of batteries. Meeting these demands necessitates adjustments to production processes and increases manufacturing costs, as manufacturers must adhere to two sets of distinct regulatory standards.

Despite these challenges, the divergence between the two regulations also offers opportunities for innovation. Chinese manufacturers that successfully adapt their battery technologies to align with European standards can not only access the lucrative European market but also position themselves as global leaders in sustainability and safety. This alignment enhances their competitiveness and reputation, paving the way for broader international expansion and collaboration in the rapidly growing electric vehicle industry.

This comparative analysis of European and Chinese regulations on electric vehicles underscores the distinct approaches each region has adopted in addressing the challenges and opportunities within this sector. The European Union places significant emphasis on environmental sustainability, integrating it with safety and traceability standards. In contrast, China prioritizes technical and operational safety while also focusing on the economic development of its domestic market.

These regulatory differences present substantial challenges for Chinese manufacturers aiming to export to Europe. They must adapt their products to meet both regulatory frameworks, which demands considerable effort and incurs additional costs in production and innovation. Compliance with European standards, such as the WLTP emission calculation methodology and the mandatory digital passport for batteries, requires Chinese manufacturers to redesign processes and invest in advanced technologies. However, overcoming these obstacles could provide a transformative opportunity, enabling these companies to penetrate and expand within the European market, where the growing demand for electric vehicles presents significant potential for growth.

The divergence in regulatory frameworks acts as a significant non-tariff barrier, hindering the seamless trade of electric vehicles. This barrier could be addressed through bilateral agreements or mechanisms for mutual recognition between the EU and China. Such cooperation would facilitate easier market entry for Chinese manufacturers, while simultaneously accelerating the global transition to sustainable mobility.

For Chinese manufacturers, entering the European market represents a pivotal milestone. By successfully aligning their products with European standards, they demonstrate exceptional quality, innovation, and sustainability, thereby enhancing their reputation and strengthening their position in the global market. This alignment not only supports their competitiveness but also contributes to the advancement of electric vehicle adoption worldwide.

CONCLUSIONS

This thesis has sought to analyze and compare European and Chinese regulations regarding the import and export of electric vehicles (EVs) from China to Europe.

The study began with a general analysis of the EV market, tracing its origins back to the late 19th century, with Andreas Flocken in Germany pioneering the concept of electric mobility. From these historical roots, the thesis moved to a technical examination of EV classifications, such as Battery Electric Vehicles (BEVs), Hybrid Electric Vehicles (HEVs), Plug-in Hybrid Electric Vehicles (PHEVs), and Fuel Cell Electric Vehicles (FCEVs).

Environmental issues were then addressed, particularly the contribution of CO_2 and greenhouse gas emissions from various sectors, with transportation identified as the largest contributor. This underscores the urgency of transitioning to electric vehicles to mitigate climate change. However, this transition is hindered by technical challenges and cultural resistance, which require significant governmental intervention to overcome.

A global overview of the EV market revealed remarkable growth in recent years, with China leading in sales, followed by Europe, the United States, and other regions. Projections suggest this growth will continue as nations push for greener transportation policies. The expansion of the second-hand EV market is also expected to increase accessibility, further accelerating the decline of internal combustion engine (ICE) vehicles.

The second chapter delved into the EU's regulatory framework, highlighting its commitment to sustainability. All EU member states, as signatories to the UN's 2030 Agenda and the Paris Agreement, have embraced ambitious goals such as limiting global warming and achieving net-zero emissions. The European Green Deal, a cornerstone policy, aims to make Europe the first climate-neutral continent by 2050. Key initiatives under this deal include the "Fit for 55" package, which mandates that all new vehicles registered in the EU be zero-emission by 2035, and the Alternative Fuels Infrastructure Regulation (AFIR), designed to address range anxiety by expanding charging infrastructure.

The European market analysis showed steady growth in EV adoption, with Chinese manufacturers and Western brands producing in China gaining a foothold due to competitive pricing. However, this growth has raised concerns for local European manufacturers, prompting the EU to impose tariffs on EV imports from China.

European regulations governing these international transactions were analyzed, focusing on five key directives:

- Regulation (EU) 2019/631, addressing CO_2 emission standards for vehicles;
- Regulation (EU) 2018/858, concerning vehicle approval and market surveillance;
- Regulation (EU) 2019/2144, emphasizing vehicle safety and protection for vulnerable road users;
- Regulation (EU) 2023/1542, targeting battery sustainability and recycling;
- Regulation (EU) 2023/956, establishing the Carbon Border Adjustment Mechanism (CBAM) to ensure imported goods meet EU emissions standards.

The third chapter shifted focus to China, a global leader in the EV industry. The Chinese government has played a pivotal role in this sector's development through subsidies, incentives, and policies like the Dual Credit Policy, which encourages manufacturers to produce more EVs. This policy has created a credit market that rewards companies for positive performance, driving innovation and investment in the sector.

China's commitment to sustainability is reflected in its participation in international agreements like the 2030 Agenda and the Paris Agreement. Domestically, its 14th Five-Year Plan aims to reduce CO_2 and energy intensity while achieving carbon neutrality by 2060. Measures such as the national Emissions Trading System further support these goals.

China also supports its EV exports through policies like the HS code system and the absence of export tariffs. Additionally, the export tax rebate system reduces costs by refunding VAT paid during production. Key Chinese regulations analyzed include:

- GB 7258-2017, which sets safety standards for vehicles;
- GB 19578-2021, which establishes fuel consumption limits;
- GB 18384-2020, which addresses EV safety, particularly for passengers and infrastructure;
- GB/T 36276-2023, which regulates lithium-ion battery safety and testing.

The final chapter conducted a comparative analysis of European and Chinese regulations, revealing similarities in their scope but significant differences in approach. The EU prioritizes environmental sustainability alongside safety and traceability, with stringent requirements for

emissions calculations and battery digital passports. In contrast, China emphasizes technical and operational safety, with less explicit focus on sustainability.

These regulatory disparities impose significant costs on Chinese manufacturers seeking to export to Europe, as they must comply with both frameworks. However, achieving compliance enhances their global competitiveness by demonstrating quality, innovation, and sustainability.

The topic of electric vehicles remains critical for addressing climate change and advancing sustainable mobility. While China's leadership in this sector could support global markets, the influx of competitively priced Chinese EVs poses challenges for local industries, such as those in Europe. To remain competitive, other nations should adopt robust policies and incentives to foster their own EV sectors, accelerating the transition to cleaner transportation and contributing to global efforts to combat climate change.

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