POLICY BRIEF

Anders Hove
March 2025

Decoding China's Electric Vehicle Success: Lessons for Europe

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Foreword

China's rapidly-growing electric vehicle (EV) sales and exports, as well as its dominance of battery manufacturing and critical minerals, present both challenges and opportunities for advanced economies with existing automobile manufacturing industries, such as Germany. On the positive side, the scale-up of battery manufacturing has not only reduced prices through greater economies of scale and process improvements, but has also led to improved performance that can enable faster uptake of electric vehicles worldwide. However, in recent years China's EV developments have come to be seen as a threat to the industrial competitiveness of countries such as Germany, whose shift to electrification has taken more time; despite efforts by policy makers and carmakers to cultivate this emerging market.

This policy brief seeks to present an overview of the future of EV in the context of EU-China trade relations. The policy brief will outline current trends for EVs in the European and Chinese markets, implications for EU-China trade and investment, and present scenarios for how the German automotive industry and related policy could respond to the challenges presented by China's rising dominance over the EV supply chain.

Chapter 1 will briefly outline the present status, trends, and policies underlying EV market developments in the EU (especially Germany) and China. The origins of China's rapid scale-up of battery and EV manufacturing will be examined in chapter 2, including factors that may be unique to China (state planning) as opposed to those that could apply elsewhere (technology characteristics). The effectiveness of China's industrial policies and whether such policies may present an alternative to tariffs, which are currently advocated as a key solution for industrial policy in Europe and the US, will be evaluated in chapter 3. Specific EV and battery policies adopted in China include promotion and guidance of R&D and innovation, local content requirements, technology transfer, encouragement of industrial clustering, and subsidised capital costs for manufacturing investment. Chapter 4 draws lessons for how the European automobile manufacturing industry could evolve in a positive way despite the leading position enjoyed by China across multiple aspects of the EV supply chain. These lessons may include short-term strategies, such as local content requirements and promotion of technology licensing, as well as longer-term scenarios with a focus on R&D and industrial clustering.

It is an open question whether European companies can become as successful EV producers as the Chinese. However, this policy brief suggests that critical factors in China's EV success can be identified. It examines its structural underpinnings and shows that it was neither a linear, magical success story nor a monocausal planning process. Although it is not easily replicable, there are lessons to be learned for Europe.

We wish you an informative read!

Niels Hegewisch
FES Berlin

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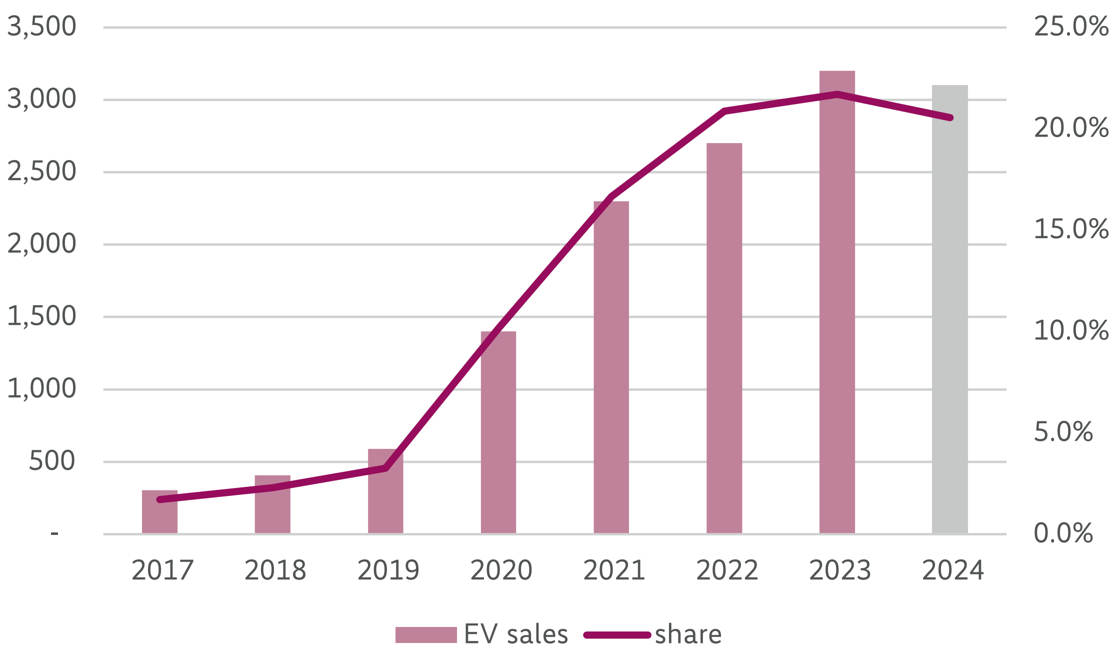
Chapter 1 – Introduction and Present Status and Trends

For over a decade, there has been a global trend towards electrification of light-duty passenger vehicles (LDVs). The worldwide EV market has exhibited impressive growth over the past ten years, and particularly since 2020, as more EV models have become available and manufacturers scaled up production across Europe, North America and Asia. It was only recently that China began to pull away from Europe and the US in terms of both vehicle adoption and technology, achieving a monthly scale of over one million New Energy Vehicles (NEV): this is a category that includes pure EVs and also plug-in hybrids, but excludes hybrids without a plug. The causes and turning points are difficult to ascertain, but China's rapid increase in EV sales clearly began in 2020 and 2021 and was set in motion by purchase subsidies and falling costs for batteries. In the meantime, EV sales in the US and Europe have also been on an upward trend; albeit at a more gradual and measured pace. This led many automobile manufacturers to call for curtailing ambitions for electrification. The number of available models and the range of EV sizes and prices have expanded everywhere, but in China even more so. Most importantly, the speed at which Chinese firms introduce new models has accelerated dramatically, outpacing what European and American players can manage.

Europe

Since 2017, annual EV sales in Europe have grown tenfold and rose to over three million units per

Figure 1. European EV Sales and Market Share, 2017 to 2024 (Thousands)
Source: EV Volumes



year. (See Figure 1). Of this figure, pure EVs account for approximately two-thirds of sales and the remainder are plug-in hybrids (PHEVs).

While this growth has been impressive, the media this year have focused on the slower growth or actual decline in EV sales. Germany experienced a notable drop in EV sales following the elimination of purchase subsidies as of 2024. In July, German EV sales were down nearly 40 percent from the same month during the previous year. EV sales have risen in other markets, such as Belgium, the Netherlands, and France, but not enough to offset the decline in Germany.[1] The EU has also introduced import duties ranging from 17 percent to 36 percent on EVs imported from China. Still, this may only have a negligible impact on Chinese EV sales based on present pricing.[2] BYD has said it plans to more than triple its market share in Europe by the end of 2025.[3]

This recent sales trend has been accompanied by concerns expressed by automobile manufacturers that consumers "do not want EVs" or that "the demand is not there".[4] Yet, EV Volumes projects that growth in European EV sales will gradually resume in the coming years as climate targets and fuel efficiency regulations tighten, new models become available, and battery prices continue to fall.

Price is proving to be a more important factor in the slower uptake of EVs than policy makers and manufacturers expected. The withdrawal of purchase subsidies in Germany is indeed a recent factor, but price has been a sticking point for EV sales more broadly. In Germany and several other markets, EVs currently on the market are still priced at a significant premium to comparable conventional options – up to 20 percent more in Germany.[5] While inflation and commodity prices partially explain the situation, analysts have noted that major automobile manufacturers in Europe and North America chose to offer larger and more expensive EVs – perhaps with the aim of replicating Tesla's early path to success. As Transport & Environment has noted, "in 2021, the average price of EVs was below Euro 30,000 and the share of large EV sales was close to 40 percent. By early 2024, the average price had increased by more than Euro 10,000 and the share of large EVs sold increased to approximately 60 percent.[6] According to the International Energy Agency, two-thirds of worldwide EV models are large cars, SUVs or trucks.[7]

Charging infrastructure poses a barrier to EV adoption in Europe, too. According to a report by the European Automobile Manufacturers' Association (ACEA), public charging has not kept pace with EV sales – EV sales grew three times faster than the number of public chargers from 2017 to 2023. Only three countries (Germany, France and the Netherlands) account for 61 percent of public chargers. Almost all public chargers are slow chargers, with merely 13.5 percent of public chargers offering speeds above 22 kW.[8] Interoperability and ease of payment have been a problem – which has only recently started to be addressed by the Alternative Fuelling Infrastructure Regulation (AFIR). Chargers are often poorly maintained, leading to errors and failed charging sessions even when the charger is 'working'. This is something I have experienced first-hand all across Europe.

Furthermore, public charging is expensive in Europe. The average so-called DC (direct current) fast charging session in the Netherlands costs Euro 0.71/kWh, whereas according to Verivox, the average German DC fast charging is Euro 0.66/kWh; this makes DC fast-charging on longer trips eight percent more expensive than diesel.[9] Pricing at fast chargers is also confusing and differs for members of different networks. One 150-kW station in Salzburg shows 66 different charging prices available from various networks, with prices ranging from Euro 0.24/kWh to Euro 0.99/kWh, not including one-time sign-up fees, which can be substantial.[10] I recently rented an EV in Italy and paid Euro 1.00/kWh for fast charging, which made it an expensive short trip. While most EV owners save money by charging at home, the high cost of public charging is a well-known deterrent to EV ownership.

China

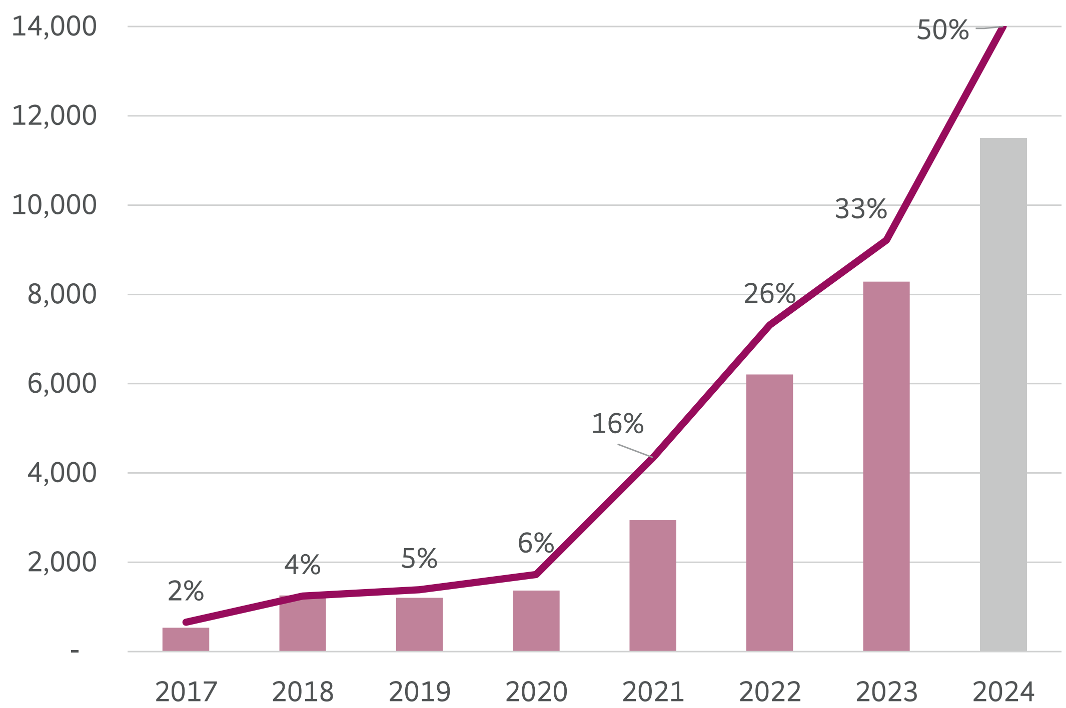
China's EV penetration stagnated at around five percent from 2018 to 2020, but then rose rapidly from 2020 to the present. In July 2024, the China Passenger Car Association (CPCA) projected that NEV sales would reach 11.5 million for the full year of 2024;[11] a roughly 45 percent share for the full year. This may be conservative, since NEV sales tend to increase towards the end of the year (see Figure 2). China looked as though it would easily achieve a significant milestone in mid-2024, as CPCA forecast that NEVs would account for well over 50 percent of passenger car sales in August.[12] According to data by the China Passenger Car Association (CPCA) NEVs have held a more than 50 percent market share in new passenger vehicles since November.[13] This is up from a full-year penetration of 36 percent in 2023.[14]

In terms of both numbers and market penetration, China has the largest EV market as well as having become a major exporter of EVs to both Europe and the developing world, especially Southeast Asia. While many of China's exports are made-in-China Tesla vehicles, domestic Chinese brands recently gained a foothold in several regions ranging from New Zealand and the Middle East to Southeast Asia and Europe.[15]

Several factors underlie the trend towards faster EV adoption in China. They can be briefly summarised as follows: (1) rapid introduction of a large number of appealing, low-priced models with longer range and better charging, (2) purchase subsidies and tax exemptions, (3) local government policies such as restrictions on new license plates for conventional vehicles, (4) lower cost of charging and wider availability of charging infrastructure, and (5) consistent

Figure 2. China Passenger NEV Annual Sales and Share of Total Passenger Vehicle Sales, 2017 to 2024 (Thousands)

Source: Anders Hove, data from China Passenger Car Association



signals from automobile manufacturers and policy makers that EVs are the future.

On the whole, the lower cost of EVs in China have been a major factor in their popularity among consumers. The IEA estimates that average Chinese domestic EV prices fell 25 percent from 2018 to 2023, and that 65 percent of EV models are cheaper than a gasoline equivalent, with prices falling further in 2024.[16] Over 50 models are available at prices below RMB 100,000 (Euro 13,000). Vehicle range, vehicle size, and battery capacity have all risen, which reflects falling battery prices and economies of scale in EV manufacturing. What is more, Chinese EVs typically feature advance onboard electronics and infotainment systems that appeal to Chinese buyers – offering an incentive to purchase an EV for the overall experience, not just economics or the environment.

Subsidies have been a factor in EV adoption in China as well as Europe and North America. In recent years, however, the central government has withdrawn many direct purchase subsidies, leaving mainly an exemption from purchase taxes. Direct subsidies to EV manufacturers are more difficult to estimate and come in the form of lower costs of capital, low or free cost for land, or access to low-cost manufacturing capacity at state-owned automobile manufacturers. Many of these subsidies are passed on to consumers in lower purchase prices.

Low charging costs and the convenience of charging are major factors driving EV adoption in China. Relative to Europe, a smaller proportion of EV buyers have access to home or work charging, which is why the cost and ease of public charging is particularly critical. As of November 2024, China had 3.5 million public chargers: half of which were DC fast chargers.[17] Recently, ultrafast chargers have been the trend, with China now having more than 400,000 chargers at a charging capacity above 120 kW – almost as many as Europe's public AC (alternating current) and DC chargers combined.[18] Payment and interoperability are scarcely an issue, seeing as WeChat and AliPay for payment are available virtually anywhere in the world – few drivers would carry credit cards, bank cards or RFID (radio-frequency identification) cards.

When driving myself in China, I estimated that it took less than 30 seconds to activate and pay for a charge on my phone after arriving at a charging network that I had never used before – a stark contrast with Europe. Charging at public chargers is now priced reasonably and the government has generally capped or 'guided' service fees for public charging to keep prices low. According to Autohome, in 2024 DC charging at State Grid charging station cost between RMB 0.4 and 0.9/kWh (Euro 0.05 to Euro 0.11/kWh) depending on the time of day, while third-party DC fast chargers range between RMB 1.2 and 1.8/kWh (Euro 0.16 to Euro 0.23/kWh).[19] On my own EV road trip from Beijing to Inner Mongolia, I estimate that I paid 77 percent less to charge than if I had used a similar gasoline vehicle; paying an average of RMB 1.35/kWh (Euro 0.18/kWh) and generally using 50 kW chargers. For this reason, even owners of PHEVs tend to say that they abide by the "charge if you can" principle rather than saving time by fuelling when on the road. A full tank costs over RMB 100, while a charge costs only a couple of dozen RMB. EV owners, too, are even willing to go out of their way to benefit from low-cost electricity at night.[20] Having said that, charging costs have been on the rise due to the charging infrastructure industry shifting from a loss-making market-share-focused scramble towards developing financially sustainable business models.[21]

Still, charging infrastructure in China is not perfect. Charging is more available on major motorway corridors and large cities and there can be long queues during major holidays. Maintenance is also an issue. Reportedly, one-fifth of public chargers were broken as of 2023.[22] During my years in China (2010 to 2022), I had several experiences with broken or non-functional EV charging stations. However, this is mitigated by the overall greater ease and availability of charging generally.

Chapter 2 – The Origins of China's Rapid Scale-Up of Battery and EV Manufacturing

There are three important elements underpinning China's rapid rise to become the global leader in EV manufacturing: (1) policy, (2) dynamic private-sector players and (3) technology characteristics. This chapter will discuss each in turn, but the three elements all contribute to one core feature of China's EV transition: speed. Consistent policy support for the EV transition has guided consumers and automobile manufacturers to rapidly make the transition without looking back – of course, with the help of subsidies, but only as one factor. The EV transition has also been led by private companies that did not exist or were scarcely known a couple decades ago: BYD, CATL, Geely, Xpeng, and others. Seeing an opportunity, the leaders of these start-ups did not focus on building an expensive halo car, such as the Tesla Model S, to fund future investments. Instead, they pursued the low-cost model, competing at cut-throat levels to drive down costs by integrating manufacturing and accelerating factory upgrades. Third, the nature of batteries (and to a lesser-extent EVs) as a manufacturing-intensive technology, fundamentally differing from design-intensive combustion engines, lowered barriers to entry and encouraged players that were willing to invest in vertical integration in low-margin, hyper-competitive industries.

Consistent Policy Support

The fact that an analysis of China often focuses on policy is no accident. When China became a member of the World Trade Organisation, the state never ceased to plan and guide economic development and it shaped all levels of investment even as the market economy played a greater role in determining winners and losers. In the EV space, it was not long before the leaders saw an opportunity for China.

Policy-makers began to promote EVs as early as the 2000s. This was based on advice by leading officials who contended that international automobile manufacturers were lagging in this field and that China could build on its competitive advantages in manufacturing in order to get ahead of foreign players.[23] This resulted in the inclusion of NEVs in China's Mid-to-Long-Term Development Plan for Science and Technology 2006 to 2020[24] and the launching of several pilot programmes at local level; particularly in the use of buses. Electric buses and taxis were also piloted in the lead-up to the 2008 Beijing Olympic Games.[25] Major battery technologies were also listed in government catalogues of R&D priorities.[26] Chinese firms were encouraged to invest in R&D centres abroad and to acquire technologies.

The speed and success of these efforts made policy-makers confident that China had comparative advantages in the field and could successfully localise EV and battery manufacturing and technology. That led to the adoption of additional policies, such as the more ambitious local EV pilots under the 'Tens of Cities, Thousands of Vehicles' programme.[27] To localise technology, market access terms for foreign automobile manufacturers were adjusted and NEV targets were developed with the industry. Coordination of EV policy was achieved in part through EV 100: an industry organisation set up under the guidance of the State Council to coordinate between industry and government. NEVs were included as a Strategic Emerging Industry in 2010[28] and prominently featured in the 'Made In China 2025' policy adopted in 2015.[29] Already in 2014, President Xi Jinping noted that EVs were vital for China's strategy of transitioning from a "big car country" to a "strong car country"[30], and that EVs afforded the potential to get ahead of Western automobile manufacturers. State policy also included explicit elements of industrial policy regarding technology transfer, publicly-funded research and innovation, and, above all, domestic content and localisation requirements. (These will be discussed in Chapter 3). All of these policies, leader statements, and generally supportive policy signals from the central government guided state-led investments in EV manufacturers, battery R&D, and the scale-up of manufacturing capacity along the entire supply chain.[31]

Although China has adopted a series of far-sighted strategic industrial policies and followed up with high levels of administrative and financial support, China's support policies have not always been consistent. Each of the clean energy sectors now dominated by China has undergone booms, busts, and periods of stagnation owing to short-term policy shifts. One example of this was the 2016 investigation of subsidy fraud in the EV and battery space that led to major changes in that programme and slowed the NEV market for some time.

Despite China currently exceeding its NEV targets to a great extent, it is also worth noting that at an early EV policy target – the Tens of Cities, Thousands of Vehicles programme set in 2010 – it fell far short of its objectives in many cities. That was especially the case in the early phases due to insufficient funding and a perceived lack of urgency at local level. At the end of the programme, some pilot cities had deployed zero EVs, and a small minority of participating localities were responsible for almost all deployment.[32] The policy's results are not only a reminder of China's size and diverse market conditions, but also of the varying results of policies pushed at central level.

Fast-Moving Manufacturing Entrepreneurs

Entrepreneurship is an additional layer that builds on policies that supported China's EV transition. While the story of the entrepreneur as a scrappy risk-taker and skilled inventor is often exaggerated, China's battery and EV space is filled with individuals who fit this mould. China's private sector leaders have often risen to prominence not due to their financial expertise, but their technical knowledge combined with experience in scaling up manufacturing.

The success of China's battery champion, CATL, is a case in point. The founder and CEO of CATL, Robin Zeng, holds a PhD in physics and initially founded the Chinese lithium-ion battery technology company ATL (Amperex Technology Limited) in 1999. This was later sold to the Japanese company, TDK. According to Zeng's own account, an approach from BMW's Herbert Diess – then head of purchasing and later CEO – persuaded Zeng that making larger batteries for electric vehicles could become a major market, which led him to spin out CATL from TDK as its own company, with BMW as one of its first major clients.[33] Zeng's technical knowledge and experience supplying BMW, led CATL to compete in the field of nickel-manganese-cobalt (NMC) batteries and to then become dominant in the global EV battery space. This strategy also enabled CATL to quickly grow at a time when China's EV subsidy policies had begun to prioritise higher energy density in batteries, which NMC batteries offer. In Zeng's case, a combination of business acumen, knowledge of industry trends, and his technology background proved a winning combination – enabling CATL to achieve scale first and dominate the EV battery industry in a way that no other company (Chinese or otherwise, SOE or private) can even begin to rival.

Several of China's leading EV companies also formed around charismatic, business-savvy founders with unique stories and ambitions. China's entrepreneurs had already begun building the industry when China's policy-makers identified the sector as a space where China could develop policies that would enable Chinese firms to get ahead of major international players. In particular, BYD and Geely established leadership positions in the EV field at an early stage, before it was settled as a strategic priority at national level.

Wang Chuanfu, the founder of BYD, came from a technical background. Originally from a poor farming family in central China, Wang obtained a Master's degree in research on batteries. In 1995, Wang relocated to Shenzhen, which was then developing as a Special Economic Zone, to found a company to develop cheap batteries for mobile phones and other electronics largely based on designs from leading Japanese players.[34]

Once the central government began to support the New Energy Vehicle sector, BYD focused on keeping costs down and creating mass-market products. At first, the aim was not to dethrone Tesla or major international brands, but rather to create a mainstream market for NEVs – especially through PHEVs using less-expensive LFP (lithium-iron-phosphate) batteries.[35] Eventually, BYD's strategy culminated in an ambition to 'demolish' old brands and create international brands based in China.[36]

In many clean energy fields, such as solar, batteries and EVs, labour costs are a minor factor, with greater importance having been placed on the economic gains from scale, flexibility, and immediate access to related parts of the supply chain.[37] As early as 2011, research has shown that China's solar scale-up could be attributed to manufacturing scale and supply chain localisation, as opposed to labour costs or other country-specific advantages.[38] Indeed, as Nahm and Steinfeld (2014) showed, China's dominance in this field was largely achieved thanks to the speed of scaling up, which has enabled this and other industries to both benefit from and speed up the learning rate for manufacturing-intensive technologies.[39]

In the EV space, proximity to local supply chains and intense competition have contributed to accelerating the pace of innovation and new product cycles; these are critical for growing and maintaining market share in China's ultra-competitive markets. China's NEV manufacturers can move faster than their US and European counterparts. Recent media reports indicate that Shanghai-based EV startup Nio can produce a new model in 36 months, while Geely's Zeekr sub-brand can produce a new model in only 24 months – both far faster than their counterparts abroad.[40] Chinese EV models average just 1.3 years of market life before updates or new versions are released, compared with the 4.2-year cycle of foreign brands. What is more, the strong consumer interest in premium onboard electronics and software gives rise to particularly strong innovation and rapid turnover in this field compared with US and European firms, whose EV customers are more focused on range and battery performance.[41]

There are several explanations as to how China's automobile manufacturers can make products so quickly. These include: (1) longer experience with and greater long-term commitment to EVs as a core business strategy than legacy automobile manufacturers; (2) more direct relationships with suppliers, including tier two and tier three suppliers and especially suppliers in the critically important onboard IT systems; and (3) greater choice and willingness to switch suppliers when problems arise. In some cases, such as Nio's partnership with Hefei-based JAC, access to a legacy automobile manufacturer's production line without the responsibility for managing its entire business has given Nio greater flexibility over design and marketing.[42]

It is true to say that entrepreneurs have taken advantage of state support, and both local and national policy-makers have directed resources and R&D funding to the private sector. China's energy sector has long been viewed as the preserve of large state-owned companies (SOEs), particularly in the electric power sector. SOEs are also leading players in the automotive and electronics industries. Many of the most powerful SOEs have a regional base and benefit from local government support, which they can use to monopolise local markets and quash new entrants from the private sector. Yet in other cases, private entrepreneurs can launch businesses in fields left open for competition, or even partner with SOEs to scale up production with mutual benefit – as in the case of Nio, which utilised capacity at a state-owned automobile manufacturer's plant to produce its own vehicles, as mentioned above. So while entrepreneurship and the private sector have played important roles, and not simply slotted into government programmes funded as a unified grand strategy under 'China Inc.', the private sector is better understood as part of a mixed economy that has welcomed start-ups and assisted them to rapidly scale up and compete in critical and strategic areas of the economy.

Technology Characteristics and Manufacturing-Centred Innovation

To beat the 'China price', traditional automobile manufacturers often focus on seeking low-cost input from any qualified supplier, and disaggregating production to drive cost efficiency. In this context, innovation could focus on product design, final assembly, or basic R&D in the hope of obtaining leapfrog technologies in specialised fields.

In contrast, China's innovation in clean energy has concentrated on process- and manufacturing-oriented innovations, which reflects both China's latecomer status and its role in manufacturing supply chains.[43] To many, this may appear to represent a lower value aspect of innovation that cannot be compared with breakthroughs achieved through basic science and university laboratory research, which may carry greater prestige. However, as the history of batteries and EVs shows, the commercialisation and scale-up of technology require ongoing innovation, leading to new intellectual property and expertise that are essential for developing an industry that can compete with incumbent technologies.[44] After a standardised design is established and commercialisation is achieved, (process-oriented) innovation could accelerate due to improved perceptions of a technology's legitimacy, value to society, and prospects for growth. This drives further scale-up, which leads to the emergence of well-known learning rates in manufacturing-intensive technologies such as solar and batteries – giving rise to cost reductions to the same or a greater extent than entirely novel technologies and materials would.

Two factors drive China's dominance in manufacturing-intensive and process-oriented innovation: industrial clusters and vertical integration on one hand, and a fiercely competitive domestic market, on the other. In a steady state, where an industry changes slowly and market shares are relatively static, competition benefits from disaggregating production to benefit from the well-known gains from trade and comparative advantage. Yet, in a rapidly-growing industry undergoing radical disruption and creative destruction, disaggregation leads to firms losing access to the tacit know-how and knowledge networks that they need to develop compelling products, ensure production is upgraded ahead of competitors, and reduce costs through process efficiencies. Today, it is clear that Western players are not only at the back of the line when it comes to the latest battery technologies out of China, but they face challenges in rapidly upgrading production and producing new models at lower cost because the core EV and battery expertise is located elsewhere.

Proximity to a thriving domestic market is essential, too. China's intense domestic competition requires rapid innovation and product turnover. With China's EV output rising by over one million units per year, it may seem like China's automobile manufacturers can sell whatever they make – but this is far from the truth. Even generous subsidies and state support cannot help a player like WM Motors that falls behind technologically. Interaction with customers remains essential for producing a compelling product. Whereas, historically, Japanese automobile manufacturers benefitted from testing and perfecting new technologies in their domestic markets, leading to advances in high-quality and fuel-efficient sedans and hybrid vehicles,[45] this advantage now seems to benefit China for EVs: not only are they low-priced, but also have flashy onboard information technology and innovative styling tailored to the domestic market. China's recent shift towards plug-in hybrids, extended-range vehicles, and fast-charging batteries can all be attributed to a strong connection with the domestic buyer's preferences for long range and convenient charging – even though these were not set out by any policy or mandate. This then feeds back into the upstream of China's manufacturing-intensive battery or parts sectors, as suppliers quickly adapt to meet these new needs.

Chapter 3 – Industrial Policy, but Not Tariffs

While the three factors cited above all connect to industrial policy, this paper discusses the most critical industrial policies in a single chapter so as to help underscore the options available to those in other countries hoping to emulate China's success. Four industrial policy factors stand out: (1) technology transfer requirements, (2) domestic content requirements, (3) market pilots and (4) policies to support manufacturing technology clusters.

Tech Transfer

Technology transfer requirements have long been among the most controversial aspects of China's industrial policy. In some cases, requirements are explicit, and in others, they have been more concealed. The automobile sector is perhaps the most well-known. Policies adopted in the 2000s required foreign automobile manufacturers to form joint ventures (JVs) with local players in order to gain access to the Chinese market. Notably, this requirement was relaxed for Tesla, but the goal was explicitly to encourage technology transfer, as Tesla was by far the leading EV player at that time. This is despite the fact that China already had many domestic EV players. By manufacturing locally, Tesla could reduce costs and expand sales, exploiting the already growing local supply chain for batteries and components. Although domestic players would face a stronger competitor, they would be forced to upgrade their products while also potentially benefitting from knowledge spillovers from local workers and suppliers. Former Minister of Industry and Information Technology Miao Wei referred to the strategy as the "catfish effect": like throwing a catfish into a pond of smaller fish, they would be forced to swim faster or be gobbled up.[46]

In terms of fundamental technology, licensing battery patents was an important factor, including in LFP batteries, where a unique patent case played a huge role in China's eventual dominance in the space. In a 2010 patent dispute adjudicated in the Chinese courts, Canadian electric utility Hydro-Quebec was unable to enforce its LFP patent claims against a Chinese manufacturer.[47] In the competing battery-chemistry tech field of NMC batteries, Chinese automobile parts manufacturer Wanxiang, a company with strong links to the government, acquired American LFP battery startup A123 in 2013. In the competing NMC battery chemistry, Chinese firms were able to license foreign technologies, encourage US and other firms to establish JVs with Chinese partners (such as that between Umicore and Jinmen Xinchang for NMC production) and localise this battery technology.

Localisation Requirements

Domestic content requirements in exchange for market access – this has been the fundamental design underpinning China's industrial policy for such a long time that it eventually almost came to be taken for granted by China's trade partners. Yet a closer look at the EV case shows that China's domestic content requirements are not a simple trade, but include sophisticated structures designed to ensure not just tech transfer, but the emergence of home-grown players and innovation.

When China launched its New Energy Vehicle programme in 2009, subsidies for EV and EV battery production were tied to technology transfer. The qualifying recipient firms had to demonstrate mastery of one of three core elements of EV manufacturing: batteries, motors, or control systems.[48] In particular, for batteries with energy density suited for EVs (over 110 Wh/kg), the minimum domestic content was set at 50 percent.[49]

Subsequently, a battery 'white list' was established for companies qualified to receive NEV subsidies, and no foreign automobile manufacturer ever qualified for the list up until shortly before the list was cancelled altogether in 2019. It was at this point that China already dominated battery supply chains.[50] These policies pushed Chinese automobile manufacturers to shift battery purchases from leading Japanese and Korean suppliers to domestic players. Later, in 2017, requirements for recipients were set even higher, requiring domestic firms to demonstrate competency in all core areas of EV production. This ruled out the Chinese supply chain's specialisation in just one element in the manufacture of EVs, and in effect localising the industry from top to bottom.[51]

The above-cited central government policies may represent only the tip of the iceberg. At local level, government approvals could depend on arranging suppliers locally. Implicit local content requirements may exist, but are never put down on paper. Tesla's willingness to shift to Chinese components was a key factor that led to Shanghai's decision to lobby the government in favour of loosening restrictions to bring Tesla in. Today, 95 percent of Tesla Shanghai's suppliers are Chinese.[52] Other European and American players have underscored how changing suppliers – not just to Chinese players, but to local players – was critical for obtaining required permits or approvals.[53]

Policy Pilots

As already mentioned, the central government has used pilot projects to test out EV policies, starting with electric buses and then continuing to the 'Tens of Cities, Thousands of Vehicles' programme. While pilot programmes sometimes result in overcapacity or copycat development policies, pilot programmes initiated at central level in the EV space have incorporated far-sighted designs that promoted development of manufacturing alongside other necessary ingredients for success. In particular, in the past, Chinese regions have sometimes adopted copycat development policies, resulting in duplication and waste, and even provincial protectionism. To guard against this, China established requirements for EV pilot regions, limiting some policy incentives to regions selected on the basis of their existing manufacturing base, local policy incentives to promote EVs, and charging infrastructure. After designating pilot regions, Beijing monitored progress on each of these fronts, and tied future support from the central government to metrics related to each.[54] This strongly deviates from policies in other countries where EV purchase subsidies are one thing, support for manufacturers another, and any support for charging even more separate. This means that manufacturers or suppliers may be located in regions with poor charging infrastructure and low EV adoption, which leads to a vicious cycle in which manufacturers report that local market demand cannot support rapid scale up, and cannot learn what customers want without going outside the domestic base.

Industrial Clusters

As already mentioned, vertical integration and physical proximity between upstream and downstream and end-users has been a critical element of China's transition from a backward, low-cost and low-quality EV manufacturer, to a technology leader. The Chinese private manufacturing players have long recognised the benefits of vertical integration for learning-by-doing and technology co-evolution through supplier interaction. However, there is an explicit policy component to vertical integration and clustering, too.

China's national and regional policy-makers have tended to focus on promoting innovation connected with manufacturing clusters. As already noted, pilot programmes for EV subsidies were tied to local manufacturing bases at provincial or city level. Local governments have also encouraged clustering and supply chain integration. Besides offering cheap land and low-cost loans to suppliers that relocate into a related cluster, provinces have also explicitly designated industrial parks and clusters for a given technology; even requiring the previous firms occupying the sites to move out to make space for firms within the chosen technology field – in some cases, without compensation.[55] The case of Tesla, where the Shanghai government encouraged suppliers to move their facilities closer to Tesla's, was explicitly aimed at creating a vertically-integrated manufacturing cluster. Such clusters are not aimed at reducing transportation cost, but rather at forcing technology upgrading and enabling tacit learning and pooling of skilled labour.

Chinese manufacturers also perceive the benefits of geographical clustering. Some of the largest solar manufacturers have sought to attract suppliers to settle in areas nearby their manufacturing facilities. Here, too, proximity is not just a matter of reducing transportation and logistics cost, but it also enhances interaction on process design and innovation in components and quality control. In the case of the solar industry, Chinese manufacturers recounted how, in the mid-2010s, China still lagged far behind Europe and North America in the supply of high-end tools and parts. This was despite the fact that China had long dominated the manufacturing of modules and cells. Still, while foreign tools and production lines were superior in reliability and efficiency, local equipment was cheaper, and language differences made it difficult to resolve problems when they arose. Gradually, Chinese players began to work with local tool providers. As the industry upgraded and scaled up, Chinese manufacturers were eventually able to meet or exceed the quality of foreign manufacturers, demonstrating the direct benefits of supplier interaction in manufacturing-intensive fields.

Chapter 4 – Lessons for Europe and Conclusions

Recently, many people have wondered whether China's leading position in various clean energy technologies is such that others could never catch up. This creates a self-defeating notion that Europe or European companies could never manufacture vehicles once EVs from China or Chinese companies get cheap enough and good enough that no tariffs can keep them out. This is politically unacceptable, and potentially economically ruinous for regions and countries like Germany with major automobile industries. But even more so, it ignores many of the lessons of China's rapid rise to dominance, driven not only by subsidies, but by the nature of battery and EV technology itself. As has been shown, manufacturing-intensive technologies not only exhibit greater returns to scale, but also lower barriers to entry and a higher proportion of learning-by-doing or process-oriented innovation that can enable many players to thrive; provided the right conditions are available. After all, only five years ago, China's EV players looked at Tesla with awe. Tesla itself was the object of ridicule by major global automobile manufacturers just over a decade ago.

The European automotive industry needs to draw the right lessons from China's success, which demonstrates that economic success and innovation can be fostered by smart policies. The industrial policy tools that China deployed do not depend on central planning or a first-mover advantage, nor do they rely on cheap energy or cheap labour – often assumed as underpinning China's supposed 'comparative advantage' in these relatively newly-emerging technologies. Industrial policy must adopt an integrated approach to EV. Purchase premiums, support for manufacturers, and the expansion of the charging infrastructure must be considered together; ideally as a comprehensive approach at EU level. EU industrial policy should encourage vertical integration and cluster formation to pool resources and promote domestic innovation. An active industrial and foreign direct investment policy that makes technology transfers and local production a prerequisite for market access is needed.

The main obstacles to a faster transition to EV in Europe are the high prices and lack of affordable models. Purchase subsidies alone cannot solve this problem. Further incentives and requirements are needed for manufacturers to bring affordable electric cars onto the market as quickly as possible. The public charging infrastructure must be expanded quickly and comprehensively. There must not be any isolated solutions, and the charging infrastructure needs to be easier to use for everyone; especially with regard to interoperability, price, payment methods, and maintenance. Debates about a possible delay of the 2035 deadline for ending new sales of internal combustion engines are rather symbolic and do not really matter in the context of an inexorable transition process of the automotive industry to EV at global level.

Indeed, as China assumes the mantle of a free trade champion to protect itself and its automobile manufacturers from protectionist policies, Europe is already actively adopting many industrial policies from the China EV playbook. These include licensing, technology transfer requirements, and domestic content policies. Europe is already considering requiring technology transfer and licensing as a condition for receiving subsidies.[56] Domestic content requirements for critical minerals and batteries are on the cards or under discussion. In many cases, such policies do not need to explicitly exclude Chinese players. On the contrary, Europe and other regions are now in a position where they need to work together with Chinese suppliers to ensure access to the latest technology and processes.

Perhaps surprisingly, Chinese companies often see eye-to-eye regarding the need to localise production and develop regional economic clusters in Europe. Chinese companies are also drawing the lesson on the benefits of vertical integration as they expand abroad. Battery manufacturing leader CATL recently announced plans to establish a USD 1.5 billion fund to invest in local parts and suppliers in Europe.[57] CATL already makes batteries in Europe, but production and quality lag behind its facilities in China because local suppliers do not meet its needs or cannot respond quickly enough to its requirements. Even more recently, CATL and Stellantis announced plans to jointly produce LFP batteries in Spain.[58] In effect, like Tesla in Shanghai, CATL is becoming the 'catfish' for the European battery industry.

One notable industrial policy that Europe is considering was never a prominent feature of Chinese industrial policy. China employs tariffs, including during trade disputes, but these have not been a prominent aspect of the country's EV policies. Shutting out competition could have helped China's incumbent automotive industry, but it is difficult to imagine how China's local players – whether start-ups or state-owned players like SAIC or Great Wall – could have leaped to the top of the global EV race on the back of tariff policy. For one, in light of their need for key technologies, other industrial policies were more critical.

Ultimately, the future of Europe's automotive industry will never fully resemble China's, nor will Europe's policies. Europe's automotive industry cannot and does not have to be like China's in order to be competitive. In particular, the above-cited slow growth of Europe's domestic EV adoption puts the region at a disadvantage when it comes to technology innovation. Yet, the presence of major differences should not lead to the conclusion that German players cannot compete, or that Chinese products and technologies need to be kept out. The nature of EV technology implies a radical reorientation of supply chains, but not necessarily the wholesale transfer of these supply chains to Asia. China may have taken advantage of a unique combination of industrial policy and technology characteristics to get ahead for now, but many of those same factors that led to its success can and will be adapted and put to work elsewhere.

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Decoding China's Electric Vehicle Success: Lessons for Europe

It is an open question whether European companies can become as successful EV producers as the Chinese. However, this policy brief suggests that critical factors in China's EV success can be identified. It examines its structural underpinnings and shows that it was neither a linear, magical success story nor a monocausal planning process. Although it is not easily replicable, there are lessons to be learned for Europe.

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