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# Global Technology: China's Industrial Innovation and Internationalization

The newsletter is based on discussions and fruitful interaction on the topic of "Global Technology: China's Industrial Innovation and Internationalization" which happened in Bologna, during the China Goes Global Conference, in July 2023. The OEET promoted this panel session to discuss the radical change taking place in the Chinese system of industrial innovation. The main purpose of the Panel was to share comparative conceptual and empirical insights, drawn from case studies on different key industries. The panel shed light on the evolving landscape of Chinese industrial innovation, related to internationalization drivers, processes and patterns. Policy implications were also discussed, in the current conflictual geopolitical environment, for global supply chains disruption and the role of other emerging economies.

The panel was chaired by Vittorio Valli, President of OEET, with presentations from Ignazio Musu (Università Ca' Foscari of Venezia), Francesca Spigarelli and Gianluca Sampaolo (China Center - University of Macerata), Hua Wang (EmLyon Business School) and conclusions from Giovanni Balcet (University of Turin).

The newsletter summarizes main trends, challenges and perspectives of three key sectors of the Chinese economy as the energy, chips and car industries, including economic, geopolitical and industrial implications.

**Technological innovation in China's energy transition**
*by Ignazio Musu*[1]

Energy has been the foundation of China's extraordinary economic growth; China overtook the United States to become world's largest energy consumer and now it represents almost 25 percent of the world's energy consumption.

China's economy is still based for 86% per cent on the use fossil fuels; 60 percent of China's total energy relies on carbon, 20 percent relies on oil, and only 6 percent on natural gas; it increasingly depends on imports of fossil fuels as in the past few years, it has imported more than 70 per cent of its crude oil and more than 40 per cent of its natural gas.

The reliance of Chinese economic growth on fossil fuels energy has implied an increasing trend of CO2 emissions; China continued its yearly emissions of CO2, overcoming, since 2006, those of the United States to become the world most important country emitting greenhouse gases; CO2 China's emissions per unit of GDP are one and a half higher than those of the US; in 2019 China's greenhouse emissions overcame those of all the developed countries jointly considered.

Commitment to research and investments towards a low-carbon economy started in China since the 11th 2006-2011 Five Year Plan; low-carbon related research and investments have been undertaken by a number of state institutions and by private institutions with a strong support of the government; in 2020 China invested in clean energy almost twice the amount of money invested by US.

Generation of solar and wind power has been continuously increasing, but the most important factor of the presence of China on the international stage towards a low-carbon economy is its now being biggest world producer of batteries, that allow to storage energy thus dealing with intermittent solar and wind energies.

China controls 90 percent share of the global production of rare earths and critical metals (such as copper, graphite, lithium, and cobalt) required to produce batteries; Chinese companies have invested in mines in the Democratic Republic of Congo (DRC, cobalt), Chile and Argentina (lithium), and other countries; and only recently a fight started by western countries to contrast China's domination in the field.

CATL (Contemporary Amperex TechnoLogy) in Fujan became the largest world batteries producer, covering one third of the world's market, and the United States seems to depend on China' technological

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advances in components for batteries, such as lithium, after the price of another batteries' component, nickel, more than doubled in the past years.

Tesla, the largest US electric vehicles producer, uses Lithium Iron Phosphate or Lithium Ferro Phosphate (LFP) batteries supplied by CATL for its cars sold in China, expanding the use to cars sold in the US; Ford also announced that it will use technology from CATL to make LFP batteries.

The pace of China's emissions reductions over the coming decades will be crucial in determining whether the world will succeed in preventing global warming from exceeding 1.5 °C over the early 20th century.

In 2020, President Xi Jinping announced that China will aim at a CO2 emissions peak before 2030 to achieve carbon neutrality before 2060; as an application of this strategy, China committed at the United Nations General Assembly in September 2021 to discontinue building coal-fired power projects abroad and to step up support for clean energy.

An expression of Chinese willingness to seriously address the climate change challenge is the study "An Energy Sector Roadmap to Carbon Neutrality in China", committed by the Chinese government to the International Energy Agency (IEA) and published in 2021; the study has been prepared with the cooperation of many Chinese researchers and Chinese research institutions.

According to the IEA scenario, by 2060 the contribution to energy of the fossil fuels will be drastically reduced to 25 per cent: coal's contribution will shrink to 3 per cent (from the actual 57 per cent); oil's contribution will shrink to 8 per cent (from the actual 20 per cent); only gas's contribution will grow to 14 per cent (from the actual 8 per cent).

On the contrary, according to the IEA scenario, to contribution to energy of renewable energy sources will heavily increase: by 2060, the contribution to energy of solar power will rise to 22 per cent (from the actual 1 per cent), of wind power will rise to 17 per cent (from 3 per cent); also, nuclear energy will rise to 8 per cent (from the actual 2 per cent).

The last China's Five Year Plan accepted the outcomes of the IEA document; but clearly these target will not be at all easy to be achieved, even if in 2024 China is expected to account for half of the world's new solar power projects, and almost three quarters of the world's wind projects.

China is now accounting for half the renewable energy capacity added worldwide, but it China continues to remain the dominant world source of CO2 emissions mainly because it continues to be the world's largest producer and user of coal.

President Xi Jinping has recently confirmed China's commitments to reducing emissions and reaching carbon neutrality, but he also declared that the path towards this goal, the manner, pace and intensity of efforts to achieve it, should be decided by China according to its means.

China's energy security, which recently intensified because of the US-China tensions, plays a crucial role in determining this path, together with the perception that the huge effort in developing batteries and energy storage systems to face the intermittency of solar and wind energy still do not seem to have reached the appropriate level in terms of infrastructures and flexible grids.

Until now China has successfully reacted to the tech war with the US particularly in the field of solar energy; Chinese companies have been subject to US and EU tariffs for dumping solar panels on the international market, but the impact of these restrictions on China remained limited.

The recent US Inflation Reduction Act includes heavy subsidies for manufacturers of solar panels; the EU is likely to spend more than US on subsidies to solar; but these measures do not seem to have had a significant impact on Chinese dominant position in the field.

As a reaction to US and western measures, China is also considering restrictions on exports of technology to produce materials for renewable energy; an example is given by the recent measures to block rare earths such as gallium and germanium, used in producing solar panels.

But further tensions (particularly between China and US, but also between China and EU), continuing to push for competition in technological innovation, may end up in compromising further efforts of China towards building a low-carbon economy; the disappointing results of the recent Conferences of Parties (COPs) of the United Nation Framework Convention on Climate Change (UNFCCC) confirm a very risky and dangerous situation.

On the contrary, all countries should be aware that without an international cooperation, a successful dealing with the challenge of climate change is increasingly unlikely to take place.

The issue of climate change confirms that the only way to avoid the Thucydides trap is a relationship between the United States and China which remains competitive but not at a point to prevent cooperation when it is required on shared interests; and the fight to climate change to build a low carbon economy is a crucial example of these shared interests.

**Semiconductors dominance and global supply chain: de-coupling or simply de-risking?**

*By Gianluca Sampaolo[2] and Francesca Spigarelli[3]*

## Introduction

A semiconductor device is an electronic component that relies on the electronic properties of a semiconductor material (primarily silicon, germanium, and gallium arsenide, as well as organic semiconductors) for its function.[4] An integrated circuit or monolithic integrated circuit (also referred to as an IC, a chip, or a microchip) is a set of electronic circuits on one small flat piece (or "chip") of semiconductor material. This global industry exceeds $500 billion, projected to reach $1 trillion by 2030,[5] and is crucial for technology sectors like AI, autonomous driving, and 5G,[6] as well as a large market for less advanced chips in industries such as automotive, healthcare, and manufacturing. The very same industry is today at the center of strong geostrategic interests and at the core of the global technological race for innovation capacity of states.

Recent shifts in global and geopolitical dynamics have led to a heightened recognition of technological leadership as a vital and central element of national security, prompting more proactive policy measures and interventions aligned with national strategic objectives, against the backdrop of a shift from multilateral to regional trade-investment agreements.[7] Geopolitical tensions, trade restrictions and the Covid-19 pandemic resulted in disruption and highlighted the vulnerability of global semiconductor supply chains, ultimately underscoring the need for resilient and diversified supply chains, domestic production capacity and innovation. A case in point is the current "Chip War" between the US and China.[8] Amongst others, this has exposed deep-seated structural deficiencies in the European Union (EU) semiconductors supply chain that have been tackled by a recent industrial policy initiative with the objective of making the Union more resilient and self-sufficient to a greater extent in the production and supply of semiconductors.

Despite decades of strategic initiatives and targeted investments in the pursuit of semiconductor technology independence, a critical void remains in the form of significant technological challenges in producing competitive high-end semiconductors devices, limitations in expertise, equipment, and technological capabilities faced by Chinese companies. In this context, it is intriguing to understand whether the industrial policies efforts pursued by the US first and then by the EU will, on the one hand, succeed in slowing down China's technological advancement and, on the other hand, in building more regional and independent value chains.

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[4] Holmes-Siedle, "Semiconductors Devices"; Kreher, "Fundamentals of Semiconductorss – Physics and Materials Properties"; Grundmann, *The Physics of Semiconductorss*; Orton, "Perspectives."
[5] Purkayastha, "US Chip Ban de Facto Declaration of War on China?"
[6] Li, "The Semiconductors Industry."
[7] Baldwin and Evenett, *COVID-19 and Trade Policy*; Kimura et al., "Dynamism of East Asia and RCEP."
[8] Miller, *Chip war.*

## China's policy path for technological supremacy

Although China has yet to cultivate any world leading semiconductor companies, it has established presence in almost every step of chipmaking, thanks to decades of investment and development.[9] As reported by Li,[10] this journey began with the "March towards Science" in 1956 and gained momentum with the "Opening-up and Reform Policy" in 1978. Notable milestones include the formation of the "State Council Lead Group for the Promotion of Electronics Industry" in 1984 and the introduction of "Several Policies to Encourage Software and Integrated Circuits Industry Development" in 2000. The emergence of the Semiconductor Manufacturing International Corporation (SMIC) in 2004 marked a significant leap in technological sophistication. In 2006, the Chinese government officially embraced "indigenous innovation" as a national strategy with the issuance of the "Outline of the National Medium- and Long-term Programme on Science and Technology Development (2006–2020)." Subsequent initiatives, such as the "Guidelines to Promote National Integrated Circuit Industry" in 2014 and the establishment of the National IC Industry Investment Fund, further underscore China's commitment to advancing its semiconductor industry. These efforts culminated in both the 2015 national strategic plan and state-led industrial policy *Made in China 2025* and the 2020 *Policies to promote high-quality growth in IC and software industries*, aiming at making China dominant in global high-tech manufacturing, with a strong emphasis on ICs.[11] A strategic look at the supply chain shows that China's semiconductor industry is resilient even under US pressure, despite significant weaknesses.[12] There are numerous weak links in China's domestic semiconductor supply chain, particularly in supporting industries such as IC manufacturing equipment, materials, and Electronic Design Automation (EDA) tools. Chinese companies are hampered by several technological bottlenecks, making it challenging to produce competitive high-end semiconductors domestically. They lack the expertise and equipment to master the sophisticated process of fabricating advanced chips.[13] Even China's most advanced semiconductor companies are much smaller and technologically lagging compared to international leaders.[14] .

As a consequence, although China has become the world's largest electronics producer, the country remains heavily reliant on foreign companies to supply this critical technology. Since 2006, the import of semiconductors, including ICs and other types of silicon devices, has surpassed crude oil to become China's largest imported commodity. By 2018, China's annual import value for ICs had reached 300 billion US dollars, highlighting the country's dependence on foreign technology.[15] As tensions with the US increase, it is only logical to assume that China would have doubled down on a path of indigenous development to supply crucial technology highlighting the importance of increasing domestic production capacity and reducing dependence on foreign sources. Such strategic necessity gained wider resonance in the political discourse of President Xi Jinping and the Chinese Communist Party's technocrats. Indeed, on one side, this is demonstrated in China's *14th Five-Year Plan* (FYP), which incorporates the aforementioned policies into the objective of kējì zìlì zìqiáng (科技自立自强), which means "science

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[9] Hu and Xinlu, *Road to Chips*; Lazonick and Li, "China's Path to Indigenous Innovation"; Li, "State, Market, and Business Enterprise"; Li, "The Semiconductors Industry."
[10] Li, "The Semiconductors Industry."
[11] The State Council of the PRC, "Notice of the State Council on Issuing 'Made in China 2025'"; The State Council of the PRC, "Promote the Integrated Circuit Industry and Software Industry in the New Era. Several Policies for High-Quality Development."
[12] Li, "The Semiconductors Industry."
[13] Grimes and Du, "China's Emerging Role in the Global Semiconductors Value Chain."
[14] Li, "The Semiconductors Industry."
[15] Li.

and technology self-reliance and self-improvement",[16] and which is further embedded in the broader political and economic agenda of the dual circulation strategy.[17] On the other hand, the *Law on Science and Technology Progress of the PRC* aims to develop and strengthen those areas identified as priorities in the 14th FYP, such as AI, Quantum Technology, IC, neural networks, genomics, biotechnology, and health sciences.[18]

### The US strategy: from chokepoint measures to comprehensive innovation initiatives

The US government's strategic imposition of restrictions on China's access to advanced semiconductor technology, as observed in the hi-tech cold war,[19] has evolved from initial measures under the Trump administration in 2016 to a more assertive policy by the current Biden Administration, particularly in addressing national security concerns[20] The "National Defense Authorization Act for Fiscal Year 2021" ("the 2021 NDAA") established the "CHIPS program" for semiconductor manufacturing and R&D, further fortified by the "CHIPS Act of 2022", which allocated $50 billion to the U.S. Department of Commerce.[21] Of this, $11 billion is designated for R&D, leading to the establishment of the National Semiconductor Technology Center (NSTC) as a public-private consortium, functioning as an innovation hub for research, prototyping, and the development of new industries based on advanced chip capabilities. [22] Additionally, the CHIPS program includes the National Advanced Packaging Manufacturing Program (NAPMP), overseen by the director of the National Institute of Standards and Technology (NIST), responsible for establishing Manufacturing USA institutes to advance semiconductor manufacturing technologies and conduct R&D programs.[23]

### Strategic imperatives and policy responses in the EU

The EU confronts distinct challenges in the dynamic realm of global digital technology, particularly in micro-electronics and cloud computing. [24] A reliance on foreign suppliers for chip design and manufacturing underscores critical structural deficiencies in the EU's semiconductors supply chain.[25] Paramount to the EU's trajectory is the imperative to establish a resilient semiconductors ecosystem, central to the digital and green transition and aligning with broader EU Policy Priorities.[26] The European

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16 State Council of the PRC, "中华人民共和国国民经济和社会发展第十四个五年规划和 2035 年远景目标纲要_滚动新闻_中国政府网 (Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035)."
17 Sampaolo et al., "La politica industriale della Cina: tendenze in corso e prospettive future."
18 The Standing Commitee of the NPC, "中华人民共和国科学技术进步法_中国人大网 (Law of the People's Republic of China on Progress of Science and Technology)."
19 Li, "The Semiconductors Industry."
20 Bown and Kolb, "Trump's Trade War Timeline: An Up-to-Date Guide."
21 U.S. Dept. of Commerce, "A Strategy for the CHIPS for America Fund."
22 U.S. Dept. of Commerce, "The National Semiconductors Technology Center Update to the Community."
23 U.S. Dept. of Commerce, "A Strategy for the CHIPS for America Fund."
24 EU Commission, COMMISSION STAFF WORKING DOCUMENT Strategic dependencies and capacities Accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery.
25 Ciani and Nardo, "The Position of the EU in the Semiconductors Value Chain."
26 EU Commission, COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND

Economic and Security Strategy (EESS) advocates for dedicated efforts, as exemplified by the European Chips Act (ECA), to bolster chip security and development.[27] This comprehensive strategy emphasizes economic security, de-risking, and investments in green and digital transitions. Essential to the de-risking endeavor is a meticulous risk analysis, acknowledging the inherent tensions between economic security imperatives and the imperative to uphold an open economy. As a matter of fact, the EU navigates a nuanced stance towards China, balancing partnership, competition, and systemic rivalry while maintaining a steadfast transatlantic alliance with the US. The ECA additionally underscores the importance of international cooperation with third countries to fortify the Union's standing in the global semiconductor ecosystem.

## Complex interdependencies in the global semiconductors value chain

In the context of developing industrial policies aimed at technological autonomy, the reality is that the value chain remains highly complex, characterized by robust interdependencies and distinctly varied roles among the US, China, and the EU. A comprehensive analysis of the global semiconductor industry reveals its status as one of the most globally integrated sectors. Additionally, it stands out for its considerable strategic significance, featuring a notably unbalanced geography within its global value chain. The essential intellectual property linked to semiconductor design is concentrated in the United States, South Korea, Taiwan, and certain European locations. Meanwhile, a significant portion of production, assembly, and testing occurs predominantly in Asia, with China and Taiwan playing a particularly prominent role in these phases.[28]

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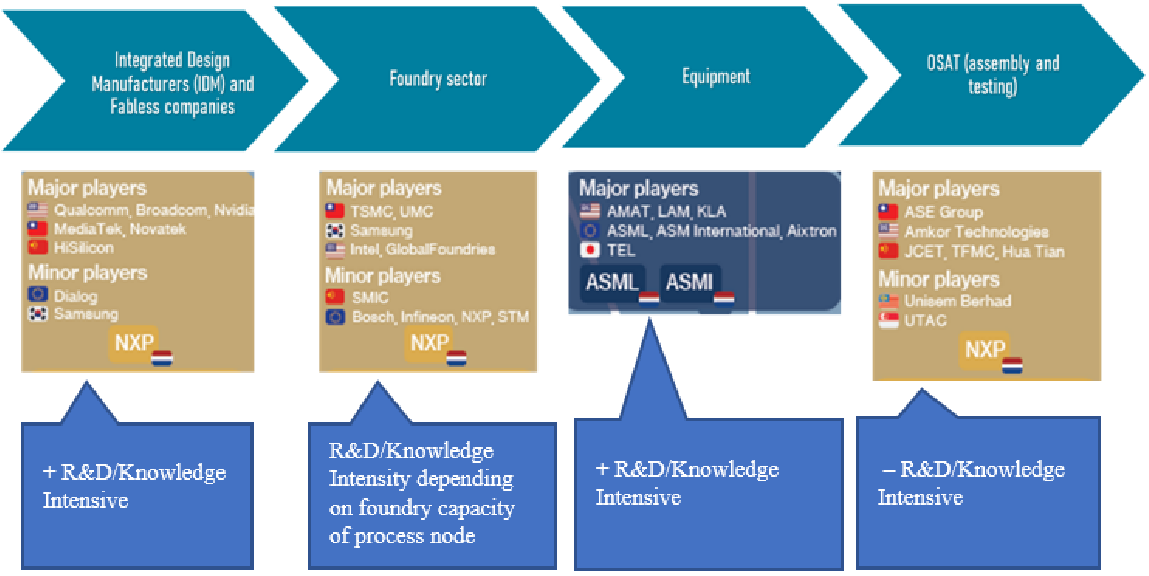
THE COMMITTEE OF THE REGIONS The European Green Deal; EU Commission, Proposal for a DECISION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing the 2030 Policy Programme "Path to the Digital Decade."

[27] EU Commission, JOINT COMMUNICATION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL AND THE COUNCIL ON "EUROPEAN ECONOMIC SECURITY STRATEGY"; EU Commission, Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a framework of measures for strengthening Europe's semiconductors ecosystem (Chips Act).

[28] Grimes and Du, "China's Emerging Role in the Global Semiconductors Value Chain."

*Figure 1: The global semiconductor supply chain.*




*Source: Authors' elaboration from Teer & Bertolini 2022*

Future research studies are essential to examine the extent to which various countries are genuinely capable of assuming a leading role or strong strategic positions concerning technological independence. From initial analyses conducted by the authors on import and export flows[29], a profound interdependence of the value chain emerges, along with a central position of China in exchanges across various geographical areas. Further research is crucial to elucidate the concrete prospects of developing a less globalized industry.

## Conclusion

The events of the past year have created opportunities as well as heightened dangers. Russia's attempts to use energy as a weapon have underlined the threat to the US and other countries of excessive dependence on potentially hostile foreign powers for critical manufactured products and materials. The US export controls designed to freeze-in-place China's leading-edge chip development are a powerful brake on Beijing's ambitions to become self-sufficient in foundational technologies. The US goal, ultimately, is to prevent the Chinese rise in semiconductors from being as preponderant as that which has occurred in other technology sectors as well as achieving a balance of the semiconductor production for Western allies by restructuring some critical supply chains away from China.[30] These dynamics suggest a selective deglobalization with strong connections to friendly countries and weaker ones with politically distant ones.

[29] Spigarelli et al. "Chips Dominance: How Industrial Policies are Affecting the Global Production and Supply Chains" paper presented at the "Economic Statecraft and Industrial Policy" conference, September 21-22, 2023, Institute of East Asian Studies, Berkeley.

[30] U.S.-China Economic and Security Review Commission, "2022 Annual Report to Congress."

This evolving landscape of the global semiconductor industry underscores the burgeoning capacity being built by China in markets reliant on mature process nodes.[31] Should the US and its allies attempt to outpace China in establishing manufacturing capacity for mature process nodes, it would necessitate substantial time, resources, and a willingness to tolerate potentially higher prices. Moreover, China may explore the development and diversification of its value chain, particularly amid regional trade-investment agreements.[32] Concurrently, the effectiveness of the US "Chips Act" in bolstering the techno-industrial structure and sustaining technological supremacy remains a focal point for assessment. For Europe, the next decade presents a pivotal yet intricate opportunity to cultivate its semiconductor ecosystem and expand its global market share. The strategic objective, however, is not self-sufficiency, acknowledging the enduring strength of interdependencies in the supply chain. Instead, the emphasis is on an EU semiconductor ecosystem that is open to international collaborations for R&D inputs while being shock-resilient against geopolitical tensions, global crises, and market volatility. Navigating this complex geopolitical terrain involves addressing emerging U.S. export controls, signaling a policy of "technological containment" that compels Europe to grapple with the implications of defining China as both a "strategic competitor" and a "systemic rival."

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[31] Kleinhans et al., "Running on Ice: China's Chipmakers in a Post-October 7 World."
[32] Kimura et al., "Dynamism of East Asia and RCEP."

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## Trajectories from reverse engineering to platform strategy in the Chinese EV industry

*By Hua Wang*[33]

### China's electric vehicle industry

China has been the largest market for new energy vehicles (NEVs) since 2016

(China Association of Automobile Manufacturers, CAAM). In 2022, China accounted for 65% of global NEV sales, and its volume reached 6.88 million units[34].

Chinese carmakers are taking the leadership among global players in terms of volume of sales (INSIDEEVs.com). The number of Chinese carmakers among the top 20 global NEV carmakers has constantly increased, expanding from seven in 2020, to eight in 2021, then 10 in 2022. However, it is noteworthy to mention the issue of "proliferation": there are over 100 carmakers in the country based on 2022 data. A wave of consolidation can be expected in the coming years.

BYD, SAIC-GM-Wuling (a Sino-US joint venture), GAC, SAIC, Changan, Chery, Geely, Dongfeng, Volvo (the affiliate of Geely), etc. are key players, followed by new entry in the market, like NIO (which entered the global top 20 list in 2020), Xpeng (in the global top 20 list in 2021, whose 5% of share was acquired by Volkswagen in 2023), Li Auto, and Hozon (in the global top 20 list of 2022).[35]

In this context, it is interesting to investigate how Chinese new energy carmakers are evolving and, at the same time, how those companies managed to shift from reverse engineering to the new platform strategy in the EV segment, then to gain the global competitiveness.

In this short contribution, the platform strategy is used as the theoretical approach to conduct the analysis based on the examination of two Chinese companies, BYD and Geely. These two companies have similar transition from reverse engineering to platform strategy, but they have distinctive features in terms of approaches to realize the platform strategy.

### Cases of BYD

The trajectory of automobile electrification by BYD is unique in the world, and cannot be duplicated by any other carmakers. The transition from the reverse engineering for the internal combustion engine (ICE) cars, to the forward engineering for hybrid and electric cars, is embedded in its unique technology know-how of battery design and mass production since the creation of the company.

BYD debuted its consumer batteries business since 1995. Starting from scratch, and with very limited technology know-how, one of the key drivers to the success is the logic of reverse engineering, by duplicating matured technology from Korea, and Japan. After years of development, the company

[33] EmLyon Business School, hwang@em-lyon.com.
[34] Source: China association of automobile manufacturers (CAAM, http://en.caam.org.cn/Index/show/catid/60/id/1902.html).

[35]Source: https://insideevs.com/news/651947/global-plugin-car-sales-december2022/. Compiled by author.

became the supplier of Motorola and Nokia etc. in 2003. In 2002 the company was listed on the Hong Kong Stock Exchange.

In 2003, BYD made a radical strategic move, decided to access to the auto industry, via the acquisition of one Chinese company that has the license of car production (Xi'an Qinchuan). The launch of the first sedan F3 had recognized the big success.

During this phase, the product architecture of BYD cars has been essentially based on the reverse engineering. For example, the model F3 launched in 2005 was based on Corolla of Toyota. The compact car F0, was a copy of Toyota Aygo, then the sedan "S6" was based on Toyota Previa, and its F3R, has similarities with GM Buick HRV. In addition, BYD's "S8" was based on the Benz CLK, as of its "M6", was an imitation of Toyota Previa. BYD's engine model "476ZQA 1.5T" has lots of similarities as that of Volkswagen EA111 1.4T.

When expanding to the hybrid cars, since there are few carmakers offering matured car models to make the reverse engineering, BYD was forced to increase the percentage of in-house technology development, including electric motors, electric control, among the other. Thanks to its cumulated technology advantage in the battery field since the foundation of the company, this process of integration of core technology of hybrid and EV cars is much easier than other car companies. This unique technology roadmap has marked the significant difference with any other carmakers.

In 2008, BYD started production of PHEV (plug-in hybrid electric vehicle). The PHEV mass production model is F3DM (with the following technical feature: 1.0 gasoline engine, 50KW and two electric motors, M1 25KW and M2 50KW, and pure electric endurance of 100km). This stage was identified as DM1.0 hybrid system.

In 2017, BYD's technology on new energy vehicles further upgraded, and was featured as DM2.0 hybrid system. Internally, it was summarized as "542" technology: 5 stands for the 100 km acceleration within the 5 seconds, 4 means 4-wheel drive hybrid model (a typical P1+P3 structure, consisting of a 1.5T engine and a 6DCT transmission and an 110kW drive moto), 2 stands for less than 2L per KM fuel consumption. Between 2019-2021, BYD introduced the third-generation battery system, the blade battery, in its car model "Han".

In 2021, BYD pure electric platform E-platform 3.0 was launched. A deep integration of various systems is named as 8-in-1, the electric powertrain integrates the Vehicle Control Unit, the Battery Management System, Power Distribution Unit, Drive Motor, Motor Controller, Transmission and On-Board Charger. Such highlevel integration is unique compare to the competitors.

The high-level integration is also embodied in the inter-linkage between its own developed BYD OS (operation system) and its hardware, this provides better driving performance in terms of safety and intelligent driving.

In 2022, BYD sold 1.85 million vehicles annually, with 49.5% EVs and 50.5% PHEVs. Of these, 97% of cars are sold in China. The company's operating income reached 61.4 billion USD, up 84% from 2022. BYD's net profit was 2.4 billion USD, a yearly increase of 403% (BYD 2022 financial report).

**Case of Geely**

The evolution of Geely's platform is a long and complex journey. The first phase of its development was based on the reverse-engineering quasi-open product architecture. Based on an increasing demand for new car models and multiple brands, Geely understood the necessity to build the forward engineering-based platform strategy. While during the transitional period, facing both the pressure of quick success of sales, and huge investment on the platform building, Geely had to make the concession and focus on developing new car models based on quasi-open product architecture, while with more technology improvement (FE, KC, NL, then followed by BMA). The creation of CEVT and the CMA platform has been the first systematic learning for Geely on how to make the forward engineering and the creation of the platform. A brand-new pure EV platform (the PMA) was developed in China, instead of at CEVT in Sweden, out of considerations for further internalization of R&D capacity by Chinese engineering team as well as for a safer technology transfer from Volvo.

Geely's first stage development in the late 1990s was mainly based on reverse engineering of different popular car models from foreign car companies. The very early car model, the *Haoqing*, started its production in the 1998, was based on the Charade model of FAW *Xiali*. Technology of Charade is from Daihatsu, Toyota's affiliate. Since then a series of cars were produced based on the reverse engineering and quasi-open product architecture strategy (Fujimoto, 2007).[36] The quasi-open architecture design, via the reserve engineering, also requires technological and engineering capability than simply copying. It requires the innovative supply chain management so as to make the balance between quality, cost effectiveness, and mass production.

The second stage of product development started from 2006, when the company announced its ambition to launch platform strategy. One Chinese returnees with rich auto technology experience was recruited as the senior vice president in charge of this plan (Wang et al, 2021).[37] From 2006 to 2013, Geely Group experienced a critical strategic dilemma between the quick development via reverse engineering driven quasi-open architecture, and the shift towards the forward engineering platform design, which requests time and huge resources (which requires a delicate balance between the short-term profitability and long-term development).

In 2014, Geely's new vision was released, "Making Refined Cars for Everyone." Accordingly, the new branding strategy was to centralize the resource to build one brand: Geely. Three previous brands, Emgrand, Gleagle, and Englon merged to one Geely brand. In terms of platform, there was a further rationalization into three platforms, covering A00 till B segments, while still those so called platforms were still based on quasi-open architecture, and based on various Toyota car models.

It was only d. In 2017, three years after the R&D, the CMA platform, covering cars from B to C segment, was built by CEVT (China Euro Vehicle Technology AB), an affiliate of Geely in Sweden, while mainly with the technology support from Volvo.

Years later, Geely further internalized the capacity of forward engineering, by creating BMA (B-segment Modular Architecture) and PMA platform (Pure electric Modular Architecture) in China with its own R&D team, while still with some technology support from Volvo. This project of BMA kicked off in

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[36] Fujimoto, Takahiro. "Architecture-Based Comparative Advantage - A Design Information View of Manufacturing." *Evolutionary and Institutional Economics Review* 4:1 (2007), 55-112.
[37] Wang, Hua, Giovanni Balcet, Wenxian Zhang, 2021, Geely Drives Out, The Rise of the New Chinese Automaker in the Global Landscape, New Jersey: World Scientific, 316 p.

2014, one year after the CMA project, in China. Based on the learning of CMA, the efficiency of R&D further increased. The number of engineers for BMA platform was around 500, versus over 2,000 for CMA. The development time reduced to less than 24 months, almost half of the regular time of development of 40 months. It took over four years to complete the design, with nearly 100 modular architecture experts from over 20 countries.

The PMA platform (Pure-electric Modular Architecture), a strategic platform for pure electric vehicles, was announced by Li Shufu in May 2017 in China. This platform is composed of two sub platforms, PMA1 and PMA2. The former one covers A and B class, 5-7 seats EVs, and PMA2 is for mini 2 seat EVs. This platform was developed via the joint venture between Geely and Volvo in China. As China is the biggest EV car production and market and has almost complete supply chain, the R&D of EV platform, aiming for the volume sales, is more efficient in China than in Sweden.

In 2022, Geely reached total annual sales volume of 1,432,988 units, up 8% YoY, and the share of new energy and electrified vehicles reached 23%, or 328,727 units, including Geely Auto, Geometry, Lynk & Co, Zeekr, Livan brands (Geely 2023 annual report).

**Analysis and Conclusion**

Platform strategy is the hidden competitiveness of a car company. The case of BYD and Geely reveals different trajectories of product architecture, and the platform strategy. The architecture innovation can be identified as one of the key successful factors for BYD and Geely, to become emerging global carmakers.

While the difference between BYD and Geely is that BYD is taking an approach of high vertical integration, especially the internalization of battery and related technologies, and the mass production of those components for other carmakers as well. While Geely is taking the cross-border M&A to realize its first forward engineered platform.

Both companies have taken audacious technology move, upgrading from ICE technology to electrification technology. Without the decision at the corporate strategy level, the architectural innovation could not happened. Despite BYD and Geely are all listed companies, subjecting to the constrains of shareholders, quite often in search of short-term profitability, the vision of two funders, WANG Chuanfu and LI Shufu, are the core to make the balance between short-term financial result, and long-term sustainability. This might be the significant difference compared to those listed auto company lead by top professional managers.

## Concluding Remarks

*by Giovanni Balcet*[38]

Globalization is at a turning point. The shift from a dominant optimistic free-trade approach to neo mercantilist policies opened the way to present times trade wars and (even more important) technology wars. They involve mainly the US and China, but also the EU and other global and regional actors, reducing cooperation areas and expanding areas of new conflicts.

This panel proposed a comparative overview of three key industries, in order to shed light on the radical changes taking place in the innovation and internationalization processes in Chinese industry in the new global scenarios, with special attention to the disruption of global supply chains.

Ignazio Musu focused on industrial dynamics and technological innovations in China's fast energy transition.

Francesca Spigarelli and Gianluca Sampaolo deeply discussed the evolving geopolitics and technology rivalry in the Semiconductors industry.

William Hua Wang analyzed technological trajectories and strategies in the Chinese automotive industry, focusing on new energy vehicles.

Together, these synergic case studies provided relevant empirical insights and an improved conceptual network on the evolving landscape of Chinese industrial innovation.

Network analysis and in-depth comparative company case studies proved to be crucial instruments in empirical research and a way to future research achievements.

A growing divergence appeared between States policies and the strategies developed by Transnational Corporations (TNCs). A good example is provided by the interdependence between CATL and Tesla in the field of advanced components and batteries for electric vehicles, produced for the Chinese and for the global market. The US-China rivalry for technology leadership in the Semiconductor industry and related policies has deeply impacting company strategies as well as global and regional supply chains.

Reshoring, nearshoring or friendshoring were different answers by TNCs to evolving scenarios and to the pressure of the States neo mercantilist policies, after decades of cost-saving offshoring strategies. De-coupling, in the worst case, or de-risking moves may result from those processes. In any case, a major shift in the difficult balance between competition and cooperation is under way, in the "great game between great powers" for global technology leadership.

Beside tariffs, export or import limitations, R&D incentives and other subsidies, attractiveness policies have been a growing component of industrial policies implemented by States and by local administrations (such as provinces and municipalities) worldwide. These policies are consistent with the new (but old

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fashioned) economic nationalism, affecting not only trade but increasingly international production, global technology and FDIs.

Other implications of the industry case studies concern theory as well. As Peter Buckley pointed out in the panel during the discussion, the choice between internalization and vertical integration or open platforms, especially in the case of new energy vehicles, is a crucial theoretical issue in international business studies.

These contributions also suggested conclusions on policy implications in the current conflictual geopolitical environment. In this context, EU industrial policies tend to be very late and insufficient.

A possible concluding remark is that a good amount of international cooperation in industry and technology is highly needed in order to face today's global challenges, including climate change, energy transition and the building of a low-carbon economy. Global economy is so complex and integrated that a process of sharp and deep fragmentation would be very costly not only for involved companies and for single countries, leading to a lose-lose game, but also for the future of the planet.