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# China: Navigating the push towards technology leadership

Sustainable Investing Expertise by ROBECOSAM

White paper

For professional investors
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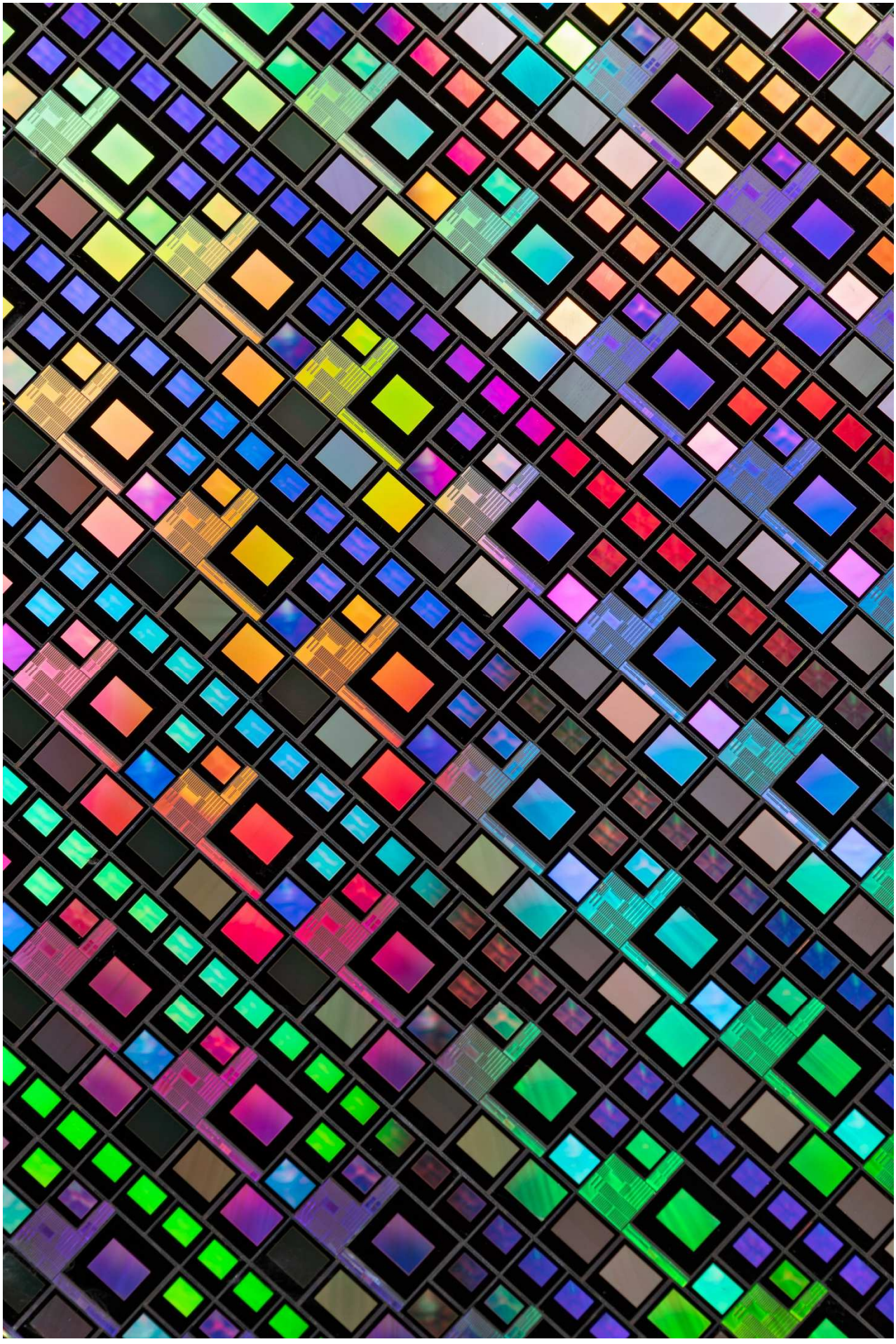

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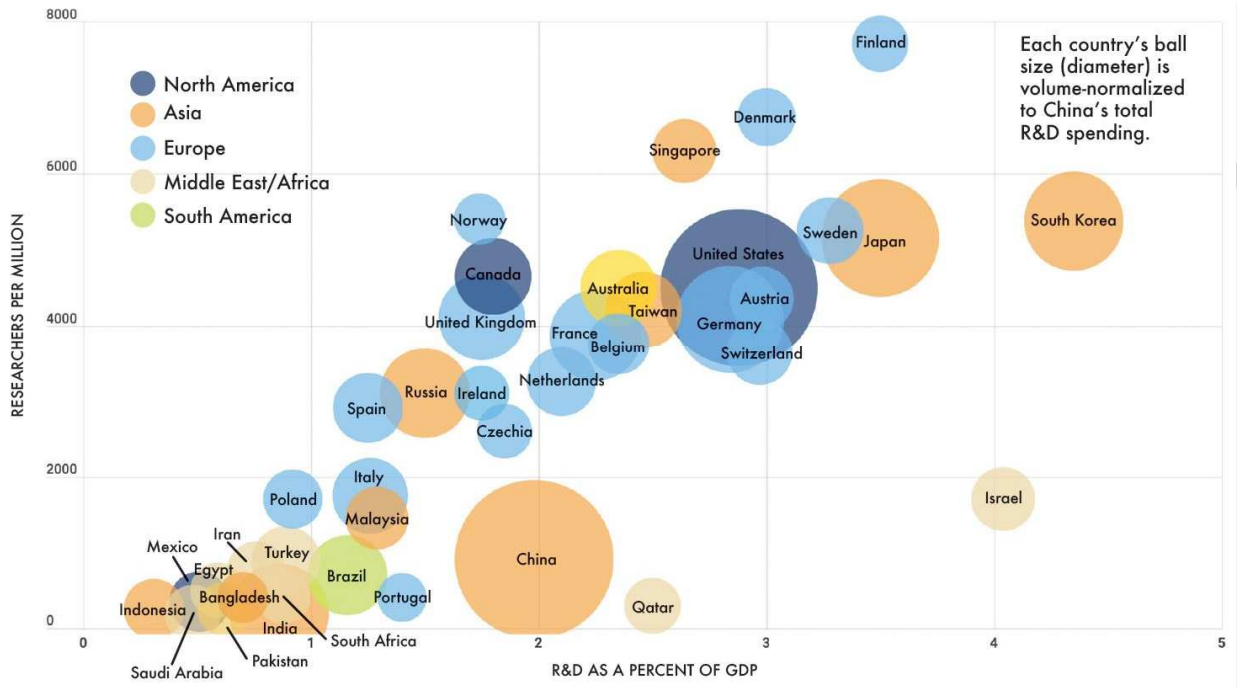
# Introduction: What China's technology push really means

After more than three decades of accelerated catchup with more advanced economies, China is now engaged in a race for global technology leadership.

Having turned into 'the world's factory', China now aspires to become the planet's innovation barycenter too. Research and development (R&D) statistics illustrate this ambition. Supported by higher economic growth, China is actually expected to take global R&D leadership this year, and outspend the US for the very first time.[1] China now leads the pack in many areas such as artificial intelligence (AI), 5G telecommunication networks, ultra-high voltage electricity networks and high-speed rail.

Figure 1 | 2021 expected R&D spending for selected countries




Source: R&D World, April 2021.

While China's technology push is hardly news, rising geopolitical tensions with Western countries, in particular with the US, have put it under the spotlight. Over the past few years, Chinese officials have increased their emphasis on the need to become less dependent on foreign technology. Some have even theorized a so-called 'technology decoupling', advocating self-sufficiency in a number of critical industries like industrial robotics, power equipment, and next-generation IT.

Meanwhile, the recently adopted 14th Five-Year Plan (2021-2025) explicitly seeks to boost technology innovation and self-sufficiency, domestic demand and national security. More specifically, the plan positions the mastery of a number of core technologies as a matter of national security. This means that while foreign partnerships will still be necessary in

[1] Source: R&D World, April 2021.

order to avoid supply chain disruption, China will seek to rely increasingly on its domestic companies and talents to drive home-grown innovation.

However, one important consideration to bear in mind is that China's technology push amid rising tensions with the US does not necessarily herald a complete economic decoupling, nor an era of deglobalization, as some have argued.[2] For now, US restrictions on exports to China issued in 2020 remain essentially focused on a few select technologies, in particular semiconductors, for which US exporters clearly dominate globally, and where non-US alternatives are difficult to find.

Meanwhile, China's main policy goal remains to improve the country's manufacturing capability to produce higher value-added goods and services, and keep the economic growth engine roaring. Policy makers acknowledge that this will be impossible without importing advanced technologies from the US, Europe, Japan, or South Korea. And while reducing dependance on foreign technology may be important, this may not necessarily be their top priority in the short term.

Of course, risks related to a potential escalation of these geopolitical tensions must not be downplayed, nor those related to mounting regulatory pressure on some industries, especially in the technology space. From this perspective, the recent ban on US investments in dozens of Chinese defense and surveillance technology companies,[3] or the crackdown on ride-hailing group Didi Chuxing, could well be another taste of things to come.

That said, we believe the recent crackdown on China's internet giants, consistent with stated policy goals of tackling social inequality and data privacy issues and ensuring national security, should not be seen as an indiscriminate attack technological innovation. Chinese officials know they need a thriving private sector for technology innovation to take place. In our view, the crackdown is more about priority shift, away from 'consumer' technology towards so-called 'core' technologies, such as semiconductors, AI, and robotics.

In any case, while the recent warning signals do not represent an insurmountable roadblock for foreign investment in China, they leave no room for complacency. Investors should carefully assess and monitor risks related to a fast-changing backdrop, and distinguish relevant information from noise. From this perspective, we believe thorough, on-the-ground analysis and a deep understanding of the Chinese political economy are essential.

## Here to stay

Beyond the noise, the drivers behind China's technology push are here to stay. With tensions with Western countries likely to persist for several decades, the technology progress will play a critical role for the country to sustain growth and keep or improve its competitive advantages in a context of relatively fast-rising labor costs. In many ways, the technology push will be vital for China to avoid the so-called 'middle-income trap' and 'become rich before it gets old'.

In this race against time, China has several advantages compared to other emerging markets. For one, with a massive domestic market, many Chinese companies do not necessarily have to look abroad for growth. They can focus on their domestic market to establish their dominance before eventually moving abroad. The digital economy provides a good example. Chinese internet firms rapidly leapfrogged many of their foreign counterparts as they innovated in their local market.

In this publication, we review the structural drivers behind China's broad-based technology push, and the areas on which it is focusing. We also look at the progress achieved and the challenges ahead regarding some key core technologies. Finally, we discuss three major themes investors may use to uncover opportunities, namely the rise of new energy vehicles[4] (NEVs), the advent of fourth industrial revolution in China, and an increased focus on localizing supply chains.

[2] Hale, T., 27 July 2021, "US and China face bumpy ride as talk of decoupling intensifies", Financial Times news article.
[3] Sevastopulo, D., 4 June 2021, "Washington to bar US investors from 59 Chinese companies", Financial Times news article.
[4] NEVs are vehicles which are not fueled by common energy sources, such as unleaded petrol or diesel fuel, for example. These include in particular, plug-in electric vehicles, either plug-in hybrid electric ones or an all-electric plug-in battery electric ones.

# China rises as a global technology superpower

China's ambitions to become once again a global (technology) superpower are hardly new. After all, the country already enjoyed that status on many occasions throughout history.

But the strength of those ambitions increased considerably since Xi Jinping took power, back in 2012, and set out his "great rejuvenation of the Chinese nation" project. The idea behind this is for China to regain its position as a global political, economic, and military leader, having lost it during the last couple of centuries of the Chinese imperial era. As part of this ambition, Xi Jinping established two important economic milestones, sometimes referred to as the "two centenaries".

The first milestone has now been officially achieved. Its aim was to see China become a "moderately well-off" society by 2021, the official centenary of the foundation the of Chinese Communist Party: a milestone recently celebrated with great pomp. The second milestone is about becoming a "fully developed nation" by 2049, which corresponds to the centenary of the foundation of the Chinese People's Republic of China, after more than two decades of civil war.

From this perspective, China's government-supported technology push is perceived as instrumental for the country to avoid the infamous so-called 'middle income trap', which describes economies "squeezed between the low-wage poor-country competitors that dominate in mature industries and the rich-country innovators that dominate in industries undergoing rapid technology change," according to the researchers who coined the term.[5]

Chinese leaders have long been wary of this trap, with some of them publicly voicing their concerns over the country's ability to avoid it. Back in 2015, for instance, Lou Jiwei, then finance minister of China, warned at a forum at Tsinghua University that without further reform and citing a rapidly aging population and shrinking labor force, the country had a "50/50 chance" of sliding into the middle-income trap.

And although the Chinese official has since then updated his prognosis,[6] indicating that it should be "no problem for the China to avoid the middle-income trap", given the reforms implemented in recent years, further developments will likely be closely monitored in the coming years. For example, one of the main goals of the country's current five-year economic plan is to achieve high-income status by 2025.

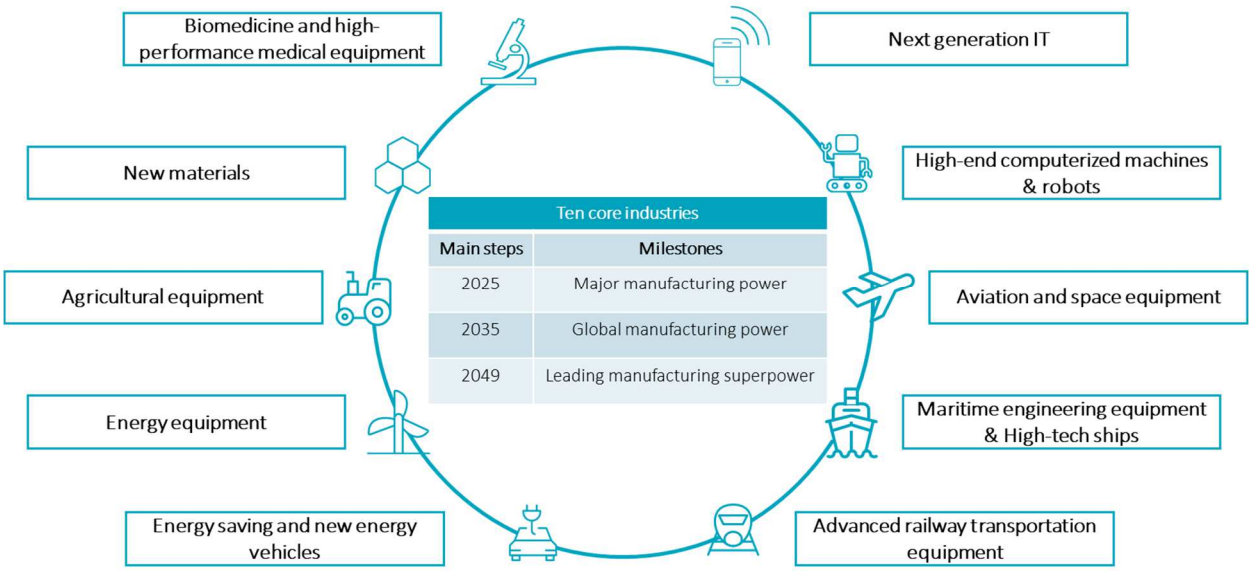
## The 'Made in China 2025' roadmap

With these broader goals in mind, China's technology ambitions were formally articulated in 2015 with the 'Made in China 2025' (MIC 2025) initiative, a ten-year comprehensive blueprint aiming to modernize further the country's industrial base. MIC 2025 essentially focuses on intelligent manufacturing. It identifies ten strategic sectors, including aerospace equipment, medical devices, or high-tech ships (see Figure 2), in which China intends to excel and secure a leading position.

In many cases, Chinese leaders' ambitions are not only to catch up and match their best-in-class competitors, but to take advantage of the country's relative lag and lack of legacy infrastructure to leapfrog more advanced nations and leave them behind. Some large companies have actually started to divert their R&D activities to China, especially in emerging industries. For example, several European carmakers have already opened up facilities for electric vehicle R&D in China.

[5] Gill, I. S. and Kharas, H., 2007, "An East Asian Renaissance: Ideas for Economic Growth." World Bank.
[6] Zhang Z., Liu J., Wang X., 23 October 2017, "China Focus: How China can avoid middle income trap in a new era", Xinhua news article.

Figure 2 | MIC 2025's ten strategic industries




Source: China State Council, MERICS, Robeco, September 2021.

On paper, the strategy laid out in the MIC 2025 initiative does not fundamentally differ from the path other East Asian economies such as Japan, South Korea, Taiwan, and Singapore have been following during the second half of the 20th century. To a large extent, it is also inspired by Germany's "Industry 4.0" (I40) strategy, launched in 2013 to consolidate the country's technology leadership in mechanical engineering.

Yet China's strong ambitions and initial blunt stance caused considerable unease among political and business circles in many Western industrialized countries. MIC 2025 fueled concerns that foreign competitors would be pushed out of Chinese markets and face fiercer competition in other export markets. For one, the plan set semi-explicit goals for each sector to increase the share of production by Chinese firms.

Chinese officials have responded by toning down their references to MIC 2025, but their ambition to reduce reliance to imported technologies and boosting high-tech exports remains intact, and the policy tools to achieve this are still in place. In practice, MIC 2025 supports technology development in various ways, including tax incentives, insurance compensation schemes, subsidies and facilitated funding from state-owned banks.

The diversity of tools involved make it difficult to determine how much financial muscle is concretely being put to work as part of MIC 2025-related projects, and more generally China's government-led technology initiatives. But orders of magnitude are impressive. For instance, trillions of yuans in government subsidies have already been channeled directly towards MIC 2025-related projects over the years.[7]

## Landmark achievements

Given the very diverse nature of the many individual policies, targets, and tools that MIC 2025 encompasses, measuring progress in a comprehensive and consistent way is inherently difficult. To make any assessment even harder, MIC 2025 has not been static over time but adjusted to match changing circumstances. Moreover, the communication shift adopted by Chinese officials over the past couple of years also complicates any type of analysis.

Still, some landmark achievements can be highlighted. Over the past years, spectacular progress has been made in areas such as 5G infrastructure, high speed rail and ultra-high voltage electricity transmissions. Mid-July 2021, the country boasted the world's largest 5G standalone network, with 961,000 5G base stations built across the country and

[7] As of March 2018, an estimated 1,800 government guidance funds linked to MIC 2025 were collectively valued at USD 426 billion, according to a US Congressional Research Service note released in August 2020.

365 million 5G terminals connected in May 2021, respectively up from 819,000 and 310 million according to official figures.[8]

China has also built the longest high-speed rail network by far, with almost 37,900 kilometers of tracks operated at the end of 2020, up 2,900 kilometers from 2019, and almost double the length in 2015, according to the China State Railway Group. And ambitions remain high for the coming decades. Chinese authorities plan to extend the total length of the country's high-speed rail system to 70,000 kilometers by 2035.[9]

Another very concrete outcome of the current technology drive is the growing number of Chinese unicorns. While China remains way below the US regarding the number of privately-owned startups valued above 1 billion USD, the country has been catching up fast in recent years. This is especially the case in those areas where government has set priority, such as AI, as well as cars and transportation (see Table 1).

Table 1 | Valuation breakdown of Chinese unicorns per sector

| Sector | Number | Valuation |
|---|---|---|
| **Artificial intelligence** | 15 | 175.3 |
| **Autos and transportation** | 14 | 90.6 |
| **Ecommerce and direct-to-consumer** | 31 | 87.0 |
| **Hardware** | 12 | 50.2 |
| **Education tech** | 11 | 32.3 |
| **Mobile telecommunications** | 13 | 20.9 |
| **Supply chain, logistics and delivery** | 8 | 20.2 |
| **Health** | 5 | 15.0 |
| **Consumer and retail** | 4 | 14.3 |
| **Internet software and services** | 8 | 12.0 |
| **Fintech** | 6 | 10.0 |
| **Other** | 5 | 9.8 |
| **Travel** | 3 | 5.0 |
| **Data management & analytics** | 2 | 3.1 |
| **Cybersecurity** | 1 | 1.3 |

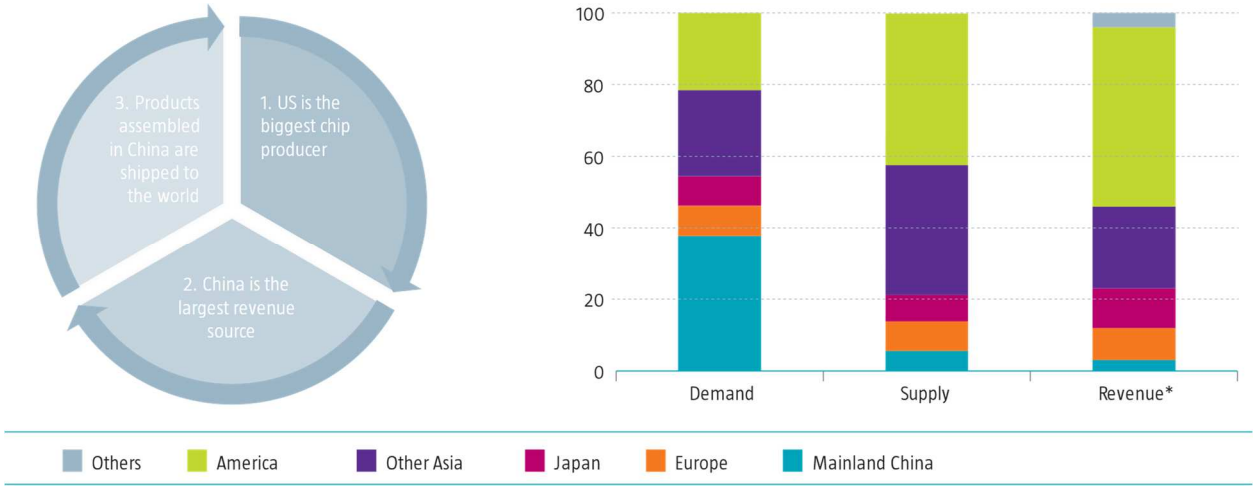
Source: Natixis, CB Insights, June 2021. In USD billion.

Despite these advances, Chinese companies do remain reliant on foreign technology in a number of crucial areas, and technology leadership remains a long shot. Recent hiccups in the global semiconductor supply chain are a good illustration of such mutual dependencies. While China accounts for more than a third of global semiconductor demand, it only represents a small portion of global supply (see Figure 3).[10]

This vulnerability is also evident in other fields, such as new materials and advanced machinery. For example, although China has been the world's top market for industrial robots for many years already, it still remains heavily reliant on foreign supply. In these areas, Chinese suppliers are still struggling to catch up with their foreign counterparts, as these often continue to dominate from a technology and a reliability perspective. However, even in these more challenging areas, important progress has been made, and investment opportunities are arising.

[8] Xinhua, 19 July 2021, "China reports expansion in 5G network coverage", Xinhua news article.
[9] Chu, D., 20 January 2021, "China's high-speed rail lines to extend to 70,000 km in 2035", Global Times news article.
[10] Source: : Garcia Herrero, A. and Ng, G., 3 June 2021, "The semiconductor champion today and future trends", Natixis client note.

Figure 3 | Global semiconductor market breakdown




Source: Natixis, Financial statements, TrendsForce, IC Insights, International Data Corporation, SEMI, Bloomberg. Note: Including foundries for demand and supply, data as of 2020. Excluding foundries for revenue, data as of 2019.

# Implications for selected key technologies

While the technology push is a broad-based endeavor, with the overarching goal of moving China's economic base up the value chain, efforts have essentially concentrated on a number of key areas.

Even under the more focused MIC 2025 umbrella, the designated ten core industries are clearly not all being pursued with the same intensity. In recent years, it has become apparent that China is prioritizing efforts in a small number of emerging technologies, with colossal efforts being deployed from a human and a financial perspective. This is especially the case in areas related to next-generation IT and smart mobility.

In some of these areas, China has already become a global reference. Self-sufficiency has largely been achieved, and it is now all about maintaining the country's leadership. In other areas, the country is still lagging, remaining largely dependent on foreign technologies, and more time and effort will be necessary to catch up. However, there is no reason to doubt about the ability of Chinese companies to innovate even in the most challenging industries, provided the appropriate incentive measures are implemented.

For one, China boasts three key characteristics that make it a fertile ground for innovation. First, the country has high savings and well-developed capital markets to help it finance innovation. Secondly, it also has a large domestic consumer market that enables future global leaders to first gather strength in their home market before they eventually have to look aboard for further expansion. Finally, the country has a vast pool of highly educated professionals ready to take the innovation baton. In this section, we review China's achievements and challenges ahead in four critical areas.

## AI: Challenging US leadership

AI is perhaps the area in which China has achieved the most spectacular results and secured a clear leading position at global level.[11] According to Tsinghua University researchers, China's worldwide share of research papers in the field of AI has soared from 4.3% (1.086 papers) in 1997 to 27.7% (37,343 papers) in 2017.[12] China currently surpasses every other country in the world, including the US, in terms of scientific publications and AI-related patents.[13]

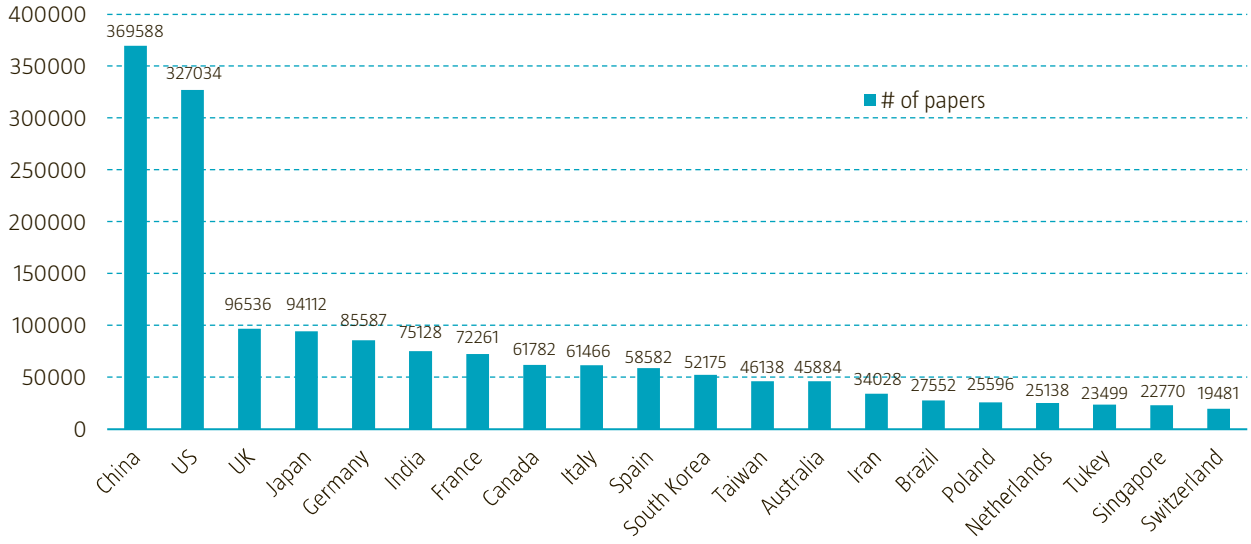
The Chinese AI-related ecosystem benefited from a combination of supporting factors, including the country's gigantic market size which provided a unique opportunity to assemble large datasets, and a long-standing friendly policy environment with relatively loose privacy regulations. Besides MIC 2025-related policies, Chinese AI activities have benefited from various dedicated specific policy initiatives,[14] including the critical 'Next Generation Artificial Intelligence Development Plan'.

This plan, released in 2017, outlines China's strategy to build a domestic AI industry worth over CNY 1 trillion (approximately USD 150 billion) in output value, and thus become the world's leading AI power by 2030.[15] This marked a shift in the development of AI technologies and the advent of AI as a national priority. In fact, AI is frequently cited as a critical area for development in President Xi Jinping's public speeches.

[11] Li, D., Tong, T. W., and Xiao, Y., 18 February 2021, "Is China Emerging as the Global Leader in AI?", Harvard Business Review article.
[12] China Institute for Science and Technology Policy, July 2018, "China AI Development Report 2018", Tsinghua University.
[13] Xinhua, 9 July 2021, "China tops world in AI patents", Xinhua news article.
[14] There are currently 9 AI-related policy initiatives in China according to the OECD. See for example: "Action Outline for Promoting the Development of Big Data," "Next Generation Artificial Intelligence Development Plan"
[15] China State Council, 20 July 2017, "China issues guideline on artificial intelligence development", Policy release.

Another important success factor is that Chinese people tend to trust AI more than their US and European counterparts. A 2020 MIT-BCG survey showed that 86% of Chinese users trust AI-made decisions, while only 39% of Americans and 45% of Europeans do so. In fact, 87% of Chinese companies deploy AI because their clients demand it, and 89% of them because their suppliers demand it. This compares to just 61% and 72%, respectively, in the US, and 63% and 69% in the EU.[16]

Figure 4 | Top 20 countries in AI paper output 1997-2017




Source: China Institute for Science and Technology Policy, July 2018, "China AI Development Report 2018", Tsinghua University.

China seems therefore poised to become a leader in AI-empowered businesses, such as speech and image recognition applications. At global level, the main AI services providers remain large US technology giants, such as Google, Amazon, Apple, IBM, and Microsoft, but Chinese competitors are catching up fast. China already employs the world's largest cohort, by far, of AI professionals, with already over 12,000 AI jobs in 2019, versus roughly 7,500 for the US.[17]

Business activity is also booming. In 2018, the size of China's AI market reached CNY 33.9 billion (USD 5.3 billion) and the compound annual growth rate (CAGR) was more than 44% between 2015 and 2018, according to Daxue Consulting, a consultancy company.[18] The market size is estimated to have reached 71 billion CNY, or USD 11 billion, in 2020, with most AI-related companies belonging to the security, speech interaction and healthcare industries.

## Semiconductors: Gradually moving up the value chain

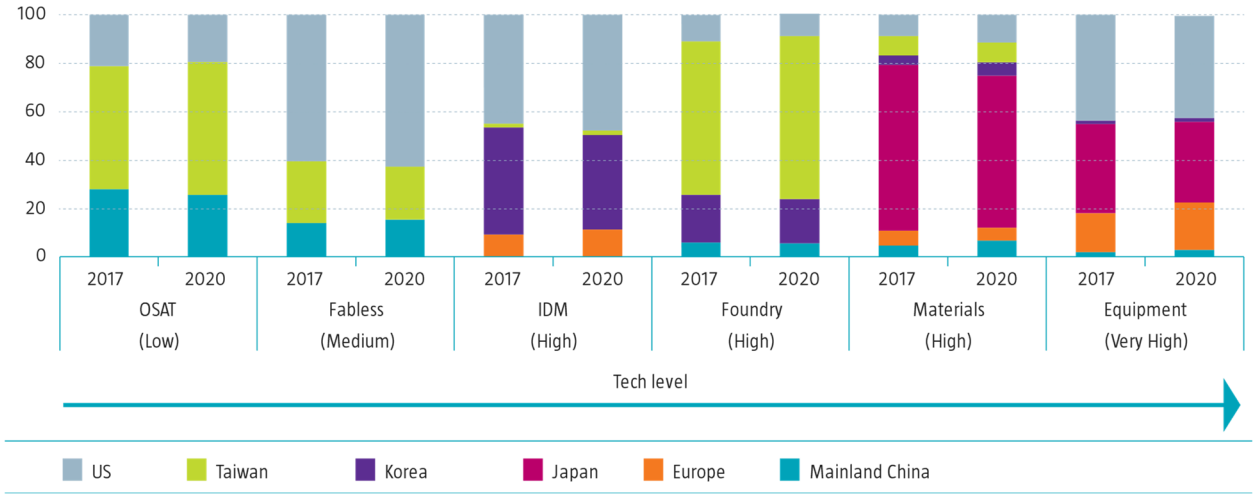
China's dependency in terms of semiconductor capabilities have been exposed by the recent global shortage. As the Covid-19 pandemic triggered an unexpected surge in global demand for semiconductors, manufacturers have been struggling to keep up with production while their clients scrambled to secure procurement. The semiconductor supply chain is extremely concentrated, with a small number of highly specialized players from a handful of countries competing for market share.

China is by far the largest market for semiconductors, accounting for over a third of global demand. But it only accounts for a tiny fraction of supply. The country is therefore highly dependent on imports, essentially from the US and South Korea, although a large share of these are components for products that are later sold abroad. Integrated circuits have been the country's top import item, surpassing oil, since 2014. Semiconductors account for roughly a fifth of all China's imports.[19]

[16] Candelon, F., Jacobides, M. G., Brusconi, S., and Gombeaud, M., 2 July 2021, "China's business 'ecosystems' are helping it win the global A.I. race", Fortune commentary article.
[17] United Nations Conference on Trade and Development (UNCTAD), February 2021 "Technology and innovation report 2021 – Catching technology waves: Innovation with equity", UN Report.
[18] Daxue Consulting, 17 January 2020, "The history of Artificial Intelligence (AI) in China", China market insights.
[19] Source: Natixis, CEIC, 2019 data.

Moreover, Chinese semiconductor companies remain essentially present – with relatively limited market shares – in lower-value stages of the production process, namely outsourced assembly and testing (see Figure 5). Some Chinese players also compete in the arena of manufacturing (foundry) but with even lower market shares. Finally, the higher end of the value chain, equipment makers, is dominated by US and Japanese players, and no Chinese firm can be found among the top players.

Figure 5 | Global market share of semiconductor supply by sub sector




Source: Natixis, Financial statements, TrendsForce, IC Insights, Bloomberg, June 2021. Including foundries.

Chinese officials have long been aware of these shortcomings and therefore strongly support the development of a domestic, high-value-added semiconductor industry, as well as the acquisition of controlling stakes in leading semiconductor companies based abroad. To that end they have promoted consolidation of the country's domestic industry, which remained highly fragmented until the mid-2010s.

The creation of giant, government-backed investment funds, as well as smaller local investment vehicles, has been another important policy tool. In March 2018, for example, the Chinese Government introduced the second recapitalization round of its flagship semiconductor investment fund of up to 200 CNY billion (USD 32 billion), which was equivalent to one-third of global investment in the semiconductor industry.[20]

High barriers to entry – illustrated by the quasi-oligopolistic nature of this industry – as well as increasingly tight scrutiny from other countries regarding potential foreign acquisitions, mean that achieving significant breakthroughs will take time and effort. However, the battle is far from lost and things are already changing. For instance, China has seen its market share of wafer capacity rise from 10% in 2015 to 14% in 2020, even if part of this capacity is controlled by foreign companies.

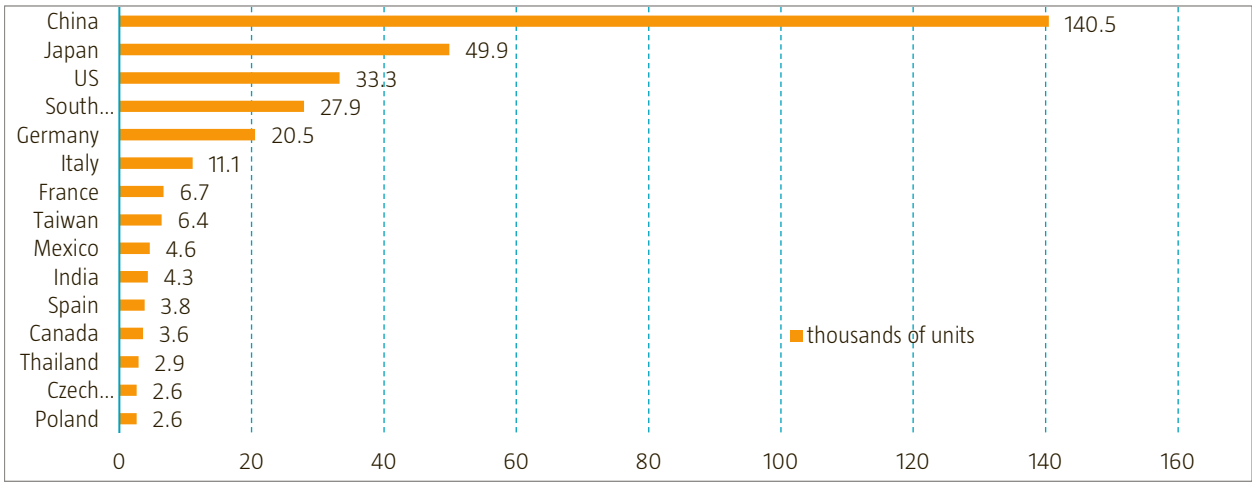
## Robotics: A buoyant market

Industrial robotics is another technology in which Chinese authorities have long been seeking to improve the country's position in an attempt to secure a competitive edge for the country's industrial base. Back in December 2013, the Chinese government released a "Guidance Promoting the Development of the Robot Industry", which included goals through to 2020.[21] This was followed, among other initiatives, by a five-year plan for the robotics industry released in April 2016.[22]

[20] Source: Garcia Herrero, A. and Ng, G., 17 April 2018, "China semiconductor: Money rain not enough to achieve 'Manufacturing 2025'", Natixis client note.
[21] China's Ministry of Industry and Information Technology (MIIT), 30 December 2013, "Guidance Promoting the Development of the Robot Industry".
[22] China's Ministry of Industry and Information Technology (MIIT), 27 April 2016, "Notification of Three Ministries Releasing Robotics Industry Development Plan, 2016-2020".

Spurred on by public incentives, industrial robotics has become a booming industry in China, with authorities encouraging domestic companies to automate large swathes of their production processes. Although it is still lagging other more advanced economies in terms of installed base, the country has been the largest market in the world for industrial robotics since 2015 (see Figure 6),[23] and its early recovery form the Covid-19 pandemic has only reinforced this leadership position.

Figure 6 | Annual Installations of industrial robots – 15 largest markets 2019




Source: International Federation for Robotics, World Robotics 2020 report, September 2020.

In 2020, China accounted for close to 45% of all industrial robots installed across the world, according to the International Federation for Robotics (IFR), or 167,000 of the total 376,000 units. After a small dip in 2019, Chinese demand for industrial robots rebounded strongly last year, as global robot installations fell by 2%, mainly due to the impact of the pandemic on economic activity.

But China's buoyant robotics market also has a less rosy side, illustrating the country's still significant dependance on foreign technology. Only approximately 44,000 industrial robots, up 8% year-on-year, were provided by domestic suppliers last year. This is just over 25% of units installed when MIC 2025's initial target for 2020 was closer to 50%.[24] Meanwhile 123,000 units, representing a 24% year-on-year increase, were shipped from abroad, in particular from Japan.[25]

China still has a long way to go to catch up with rival countries such as Japan and Germany and become a self-sufficient robotics powerhouse. But it is taking important steps to remedy this situation. In its latest attempt to boost innovation in this field, the country's Ministry of Science and Technology released its fourth set of guidelines: the "Key Special Program on Intelligent Robots of 2020" in March 2020, with allocated funding of approximately CNY 66 million, or USD 10.2 million USD.[26]

More initiatives of this type are likely to follow in the coming years and will help China catch up with players from more advanced countries, such as Japan, Switzerland, and the US, to achieve China's longer-term ambitions in this field. Since the acquisition of Germany's robot maker Kuka by Midea group in 2016, China has entered the very small group of nations boasting truly worldwide leaders in the field of robotics.

[23] Wang, Y., 19 September 2019, "China remains top robot market", China Daily news article.
[24] Zhou, C., 20 February 2021, "China's robotics revolution falls behind target as technology gap with rivals Japan, Germany persists", South China Morning Post news article.
[25] International federation of robotics, 1 July 2021. "China leads post-pandemic recovery", press release.
[26] International federation of robotics, April 2021, "World Robotics R&D Programs", report.

## NEVs: Dominating the supply chain

Chinese authorities started paying attention to the NEV industry well before the advent of MIC 2025. As early as 2009, they issued "Guidelines for Adjusting and Promoting the Automobile Industry". These were followed in 2012 by an "Energy Saving and New Energy Vehicle Industry Development Plan" that focused on expanding the NEV market through production and sales targets.

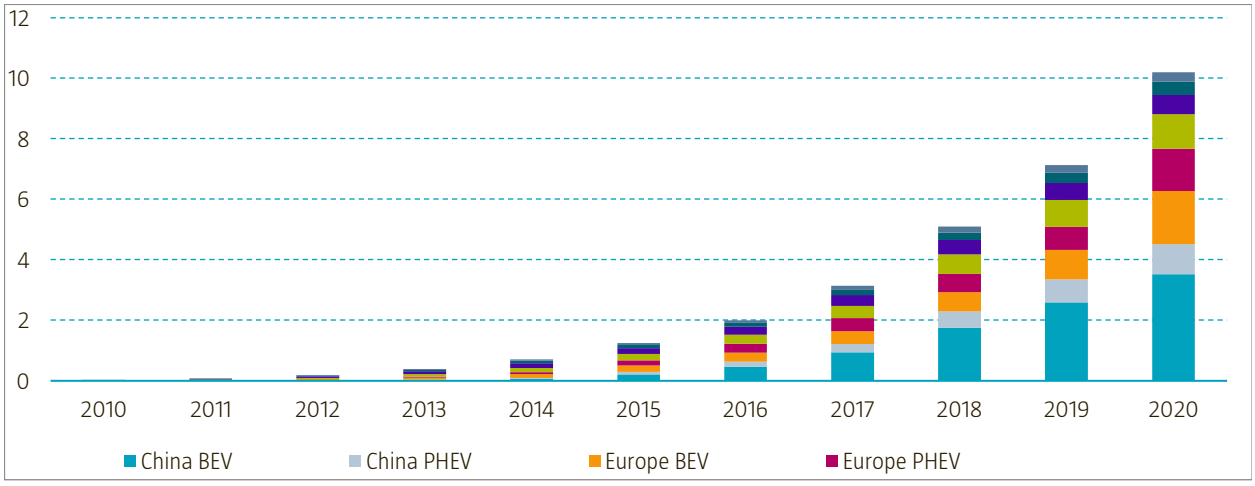
More recently, Chinese policy makers doubled down on their bet on NEVs with a "New Energy Vehicle Industrial Development Plan" for 2021 to 2035. This plan targets a 20% share for NEVs in new vehicle sales by 2025 – up from 5.4% last year – as well as a number of other development goals for the industry.[27] The 20% NEV sales target for 2025 is lower than the previously stated target of 25%, as it takes into account the rough patch experienced in 2019 and 2020.

Importantly, the objectives set in this 2021–2035 plan go well beyond basic output targets and essentially aim to create a robust, more sustainable, and internationally competitive Chinese automobile industry. This includes all aspects of the industrial value chain, so not just actual vehicles and components but also charging infrastructure, battery swapping and hydrogen refueling facilities.

The plan also considers broad cross-industry collaboration with sectors such as energy and transportation services or information and communications to promote NEVs. For instance, it encourages utilizing more electricity generated from renewable energy for battery charging. The plan also envisions an intelligent traffic control system to provide more accessible travel services, and this involves cooperation between NEV manufacturers and mobility service businesses.

Although the fruits of this 2021–2035 plan will take time to materialize, some important breakthroughs of previous policies can already be highlighted. China currently has the world's largest fleet of NEVs in circulation, far ahead of Europe and the US, as well as the world's largest battery-charging network. And although the country's NEV car registrations were overtaken by European ones last year, it remains one of the most dynamic markets in the world, largely dominated by local manufacturers.[28]

Figure 7 | Global electric passenger car fleet




Source: International Energy Agency, April 2020, "Global EV Outlook 2021", report. In million units.

From a technology perspective, China has also managed to secure a leading position in various areas of the NEV supply chain. This is especially the case for electric battery production, where the largest Chinese manufacturers such CATL and

[27] Yu, C., 4 November 2020, "High-quality growth of new energy vehicle sector prioritized", China Daily article.
[28] According to a recent article by McKinsey, Chinese automobile OEMs had an 85% share of sales volume in 2019. See: Dabelstein, C., Schäfer, P., Schwedhelm, D., Wu, J. and Wu T., 4 May 2021, "Winning the Chinese BEV market: How leading international OEMs compete" McKinsey article.

BYD have emerged as global leaders along with their South Korean and Japanese competitors. Altogether, China accounts for over 70% of global battery cell production capacity.[29]

Significant resources have been mobilized to secure procurement of key material resources needed to manufacture EV batteries and meet the booming demand for NEVs at home and abroad. China not only has among the world's largest lithium reserves, but its companies have also acquired shares in overseas lithium reserves. Chinese companies also own many large cobalt mines in Congo, where the vast majority of the world's cobalt resources are located. Finally, China is a leading producer of cathodes.

The country also leads the way in terms of efforts to develop standards for the mega-chargers that are necessary to take the electrification of automobile transport beyond light-duty vehicles. For instance, the CHAdeMO association and the China Electricity Council have jointly developed an ultra-high power charging standard (up to 900 kW), called 'ChaoJi'.[30] Such mega-chargers are indispensable for charging trucks operating over long distances reasonably quickly.

Finally, while China wants purely electric cars to account for the majority of sales by 2035, according to its 2021–2035 plan, the country has also taken important steps regarding hydrogen-powered vehicles, mainly for heavyweight transport. China accounts for 94% of global fuel cell buses and 99% of fuel cell trucks.[31] The government has released plans to promote the development of hydrogen technologies, in particular to reduce the costs of production, storage and transportation.

[29] International Energy Agency , April 2020, "Global EV Outlook 2021", report.
[30] CHAdeMO, 24 April 2020, "CHAdeMO 3.0 released: the first publication of ChaoJi, the new plug harmonised with China's GB/T", press release.
[31] International Energy Agency, April 2020, "Global EV Outlook 2021", report.

# Three themes to uncover investment opportunities

The combination of fast technological progress and maturing domestic corporate ecosystems is offering opportunities in many industries.

However, finding these opportunities may not always be straightforward. Indeed, not all initiatives have lived up to expectations, so far, and political will does not warrant success. Yet that does not mean opportunities in areas where results have been mixed are entirely absent, nor that policy success will necessarily lead to attractive returns for investors. Excessive policy support and/or investor enthusiasm can sometimes be counterproductive. The photovoltaic sector's ups and downs over the past decade are a testament to that.

Many investment opportunities related to the current technology push can be found as more and more Chinese companies continue to move away from 'basic sweatshop' status to become global technology leaders in their industry. While uncovering such opportunities can be difficult, and typically requires investors to be both patient and willing to scratch beyond the surface of bombastic policy announcements, the effort is often worthwhile.

From this perspective, we have identified three major investment themes worth considering: the relentless rise of NEVs, the advent of 'industry 4.0' in China, and an increased focus on the localization of supply chains. These three themes are underpinned by a number of secular socioeconomic shifts occurring in China, including a rising middle-class, a fast-aging population, and the necessity to avert climate risk and preserve resources.

## The relentless rise of NEVs

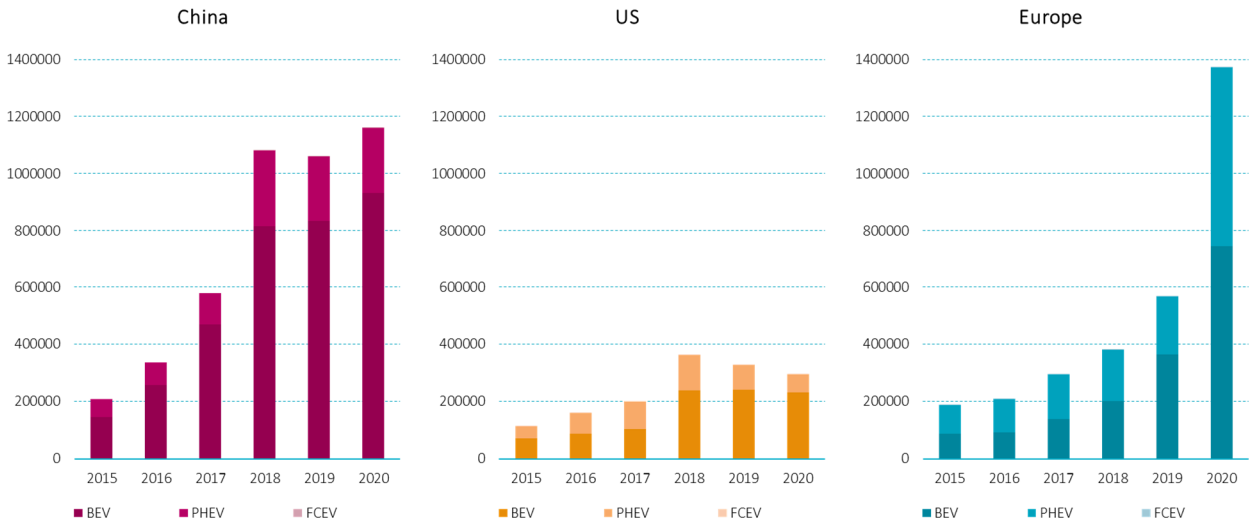
Despite Europe's spectacular catch-up last year, China remains one of the most dynamic markets for NEVs, helped by strong policy support. The country's net zero commitment in September last year makes it very unlikely that public support will disappear in the near future. In fact, under the IEA's sustainable development scenario,[32] Chinese electric vehicle sales are expected to grow almost tenfold by 2025, to approximately 10 million units, and then reach 14 million units by 2030.

While battery-manufacturing certainly is one of the most critical links of the NEV value chain, we also see opportunities rising in other segments in the entire supply chain. As mentioned in the previous section, China has been securing key material resources needed to manufacture EV batteries. For instance, Chinese lithium compounds manufacturers such as Gangfeng Lithium and Tianqi Lithium have acquired strategic shares in overseas lithium reserves.

But the rise of NEVs in China is not just about attractive domestic sales growth prospects. It is about Chinese manufacturers taking the lead in global technology. As mentioned in the previous section, Chinese companies are already dominating various segments of the NEV supply chain. The clearest case in point is battery manufacturing. CATL and BYD currently account for almost 40% of battery installations, according to SNE Research.

[32] This scenario assumes a global transition to a low-carbon economy consistent with the Paris Agreement, as well as international objectives to achieve universal access to modern energy services by 2030, reduce the severe health impacts of air pollution and tackle climate change by 2030. See: IEA, 2020, 'World energy model documentation – 2020 version', report.

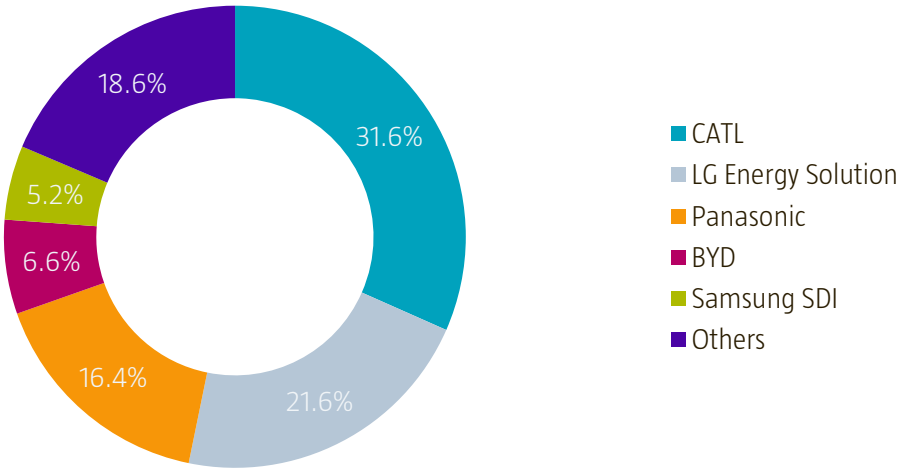
Figure 8 | NEV 2020 sales for selected geographic areas




Source: International Energy Agency, April 2020, "Global EV Outlook 2021", report. In thousand units.

China also has a stronghold in key components for EV battery manufacturing, such as cathodes, anodes, separators, and electrolytes, with leading producers such as Yunnan Energy and Shanshan. Therefore, the country can ensure that it has sufficient resources to meet the booming demand for new energy vehicles at home and abroad. NEV equipment producers will benefit from the surging capacity expansion from existing and new battery makers as the NEV penetration increases.

Figure 9 | Market share of top five battery makers

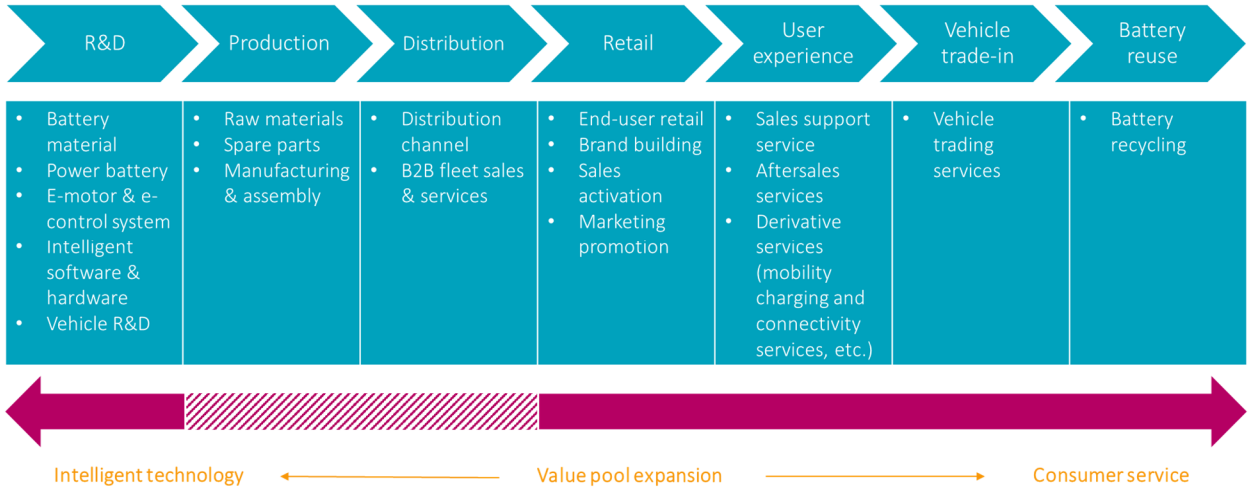



Source: SNE Research, March 2021.

Another area where we believe opportunities are arising is automotive software. Improved connectivity, thanks to the 5G infrastructure rollout, as well as improvements in fields such as the 'internet of vehicles' and autonomous driving are boosting demand for software applications in cars. Firms like Thundersoft, Desay, or Arcsoft that provide automotive operating systems, infotainment software, automatic parking assistant systems or AI vision algorithms are benefiting from this trend.

Other opportunities can be divided into two main categories, those regarding solutions aimed at accelerating the deployment of NEVs – with improved charging infrastructure, for example – and those aimed at producing NEVs more responsibly and more sustainably – using renewable energy, and recycling, for example.

Figure 10 | The NEV value chain




Source: Deloitte, Robeco.

Fast-expanding charging networks, for instance, are boosting Chinese equipment makers and operators. At the end of June 2021, China had about 1.95 million charging piles installed, up 47% from a year ago, according to the China Electric Vehicle Charging Infrastructure Promotion Alliance.[33] Roughly 923,000 were public charging piles, with a handful of large operators owning the vast majority of these piles.

## The advent of 'Industry 4.0' in China

Having become the 'world's factory', China is now in the enviable position to become the 'world's smart factory', and lead what some economists now refer to as the fourth industrial revolution.[34] This fourth industrial revolution is about combining more traditional means of production with novel digital technologies, such as the internet of things (IoT), AI, robots, drones, autonomous vehicles, 3D printing, cloud computing and nanotechnology – to name but a few.

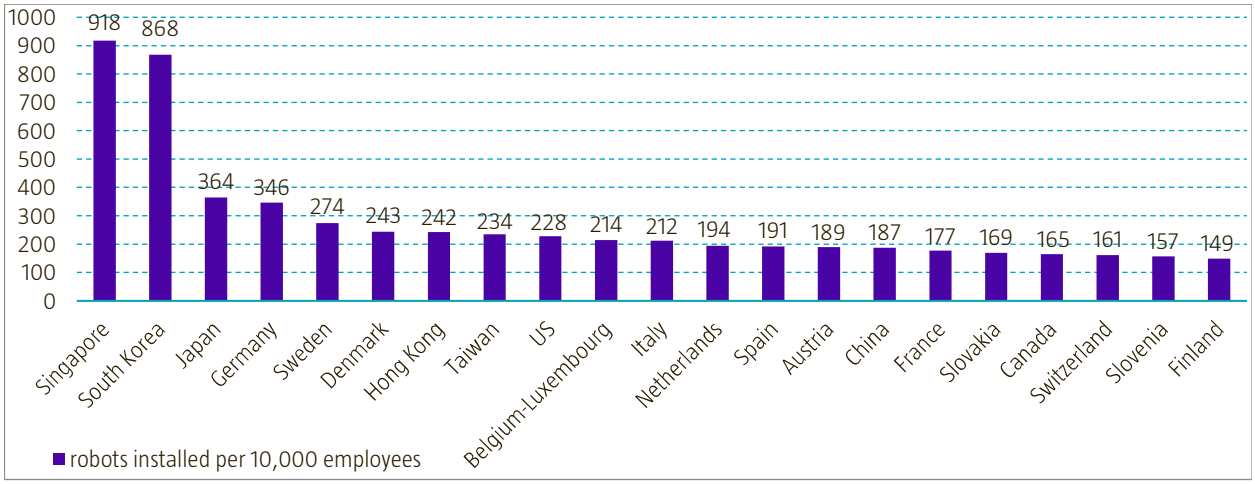
This combination ensures producers, consumers and other stakeholders can communicate, analyze, and act upon information much more quickly and accurately, increasing their flexibility. The fourth industrial revolution started a couple of decades ago, but has been gaining considerable traction over the past few years, with the acceleration of technology progress in areas like the IoT, big data and AI.

One sector that could benefit from the advent of this fourth industrial revolution or 'industry 4.0', is automation systems in general, and robotics in particular. Industrial robots are increasingly seen as a necessity, not only to enhance China's industrial capability, but also to address the labor shortages the manufacturing sector is increasingly confronted with as the flow of migrant workers – upon which the sector has been heavily reliant over the past four decades – gradually dries up.

Migrant workers currently account for roughly two-thirds of China's total manufacturing workforce, but their number is expected to shrink drastically over the coming years, on the back of shifting demographics and improving job prospects in other areas of the economy. In fact, the migrant worker population in the manufacturing sector peaked already in 2012, and the decline has been accelerating in recent years.

[33] http://www.evcipa.org.cn/
[34] The term 'The Fourth Industrial Revolution' was coined in the 2010s by Klaus Schwab, founder and executive chairman of the World Economic Forum.

Figure 11 | Robot density in the manufacturing industry 2019




Source: International federation of robotics, 27 January 2021, "Robot Race: The World´s Top 10 automated countries", press release.

Given China's relatively low level of automation (see Figure 11), the potential for rapid growth is significant. According to Bernstein, automation could mitigate the labor shortage by 30% to 50% in the most coveted manufacturing jobs.[35] Because China remains reliant on foreign technology in this area, leading Japanese and US robot makers would likely be the big winners of this trend. But Chinese players, such as Estun, Han's Laser, or Innovance, to name few, also stand to benefit.

## Increased focus on the 'localization' of supply chains

The current context of rising political tensions between China and the US has led may western companies to rethink their supply chain strategies in order to reduce geostrategic risks, leading to serious negative consequences for established Chinese suppliers in some cases. Conversely, however, these tensions have also prompted many Chinese companies to increasingly consider localizing their supply chains, whenever possible, thus offering new opportunities for investors.

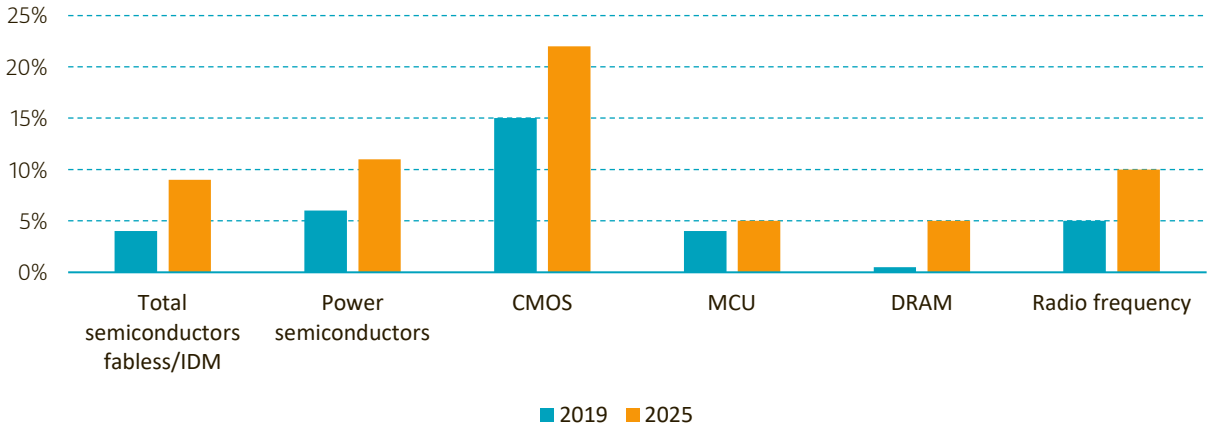
While this 'localization' of supply chains phenomenon remains difficult to measure, mounting anecdotal evidence suggests a ramp-up of this trend. This is especially the case in the semiconductor industry, where Chinese chip manufacturers are more and more actively looking for ways to reduce their reliance on foreign technology.[36] But companies from other sectors such as the automobile and the aerospace industries are also adopting – or at least considering – similar strategies.

Given the sheer size of the Chinese economy, its relatively high growth prospects, and the rising predominance of local consumer brands in their domestic market – in areas going from consumer electronics to automobiles, as well as home appliances and industrial equipment – this growing focus on localizing supply chains in China could lead to the emergence of a next generation of long-term winners.

In the semiconductor industry, for instance, Chinese manufacturers have been making considerable efforts to localize their supply chains, from foundries to integrated circuit design and production equipment manufacturing, despite the still significant technology gaps with foreign competition (see dedicated section in chapter 2). This trend should persist, as Chinese firms continue to close the technology gap with their foreign counterparts and expand their product and services offerings (See Figure 12).

[35] Huang, J., 30 June 2021, "Global Automation: Seeing is believing - manufacturing labor shortage may kick off an automation super cycle in China", Bernstein client note.
[36] Cheng T.F. and Li, L., 13 May 2021, "US-China tech war: Beijing's secret chipmaking champions", Nikkei Asia news article.

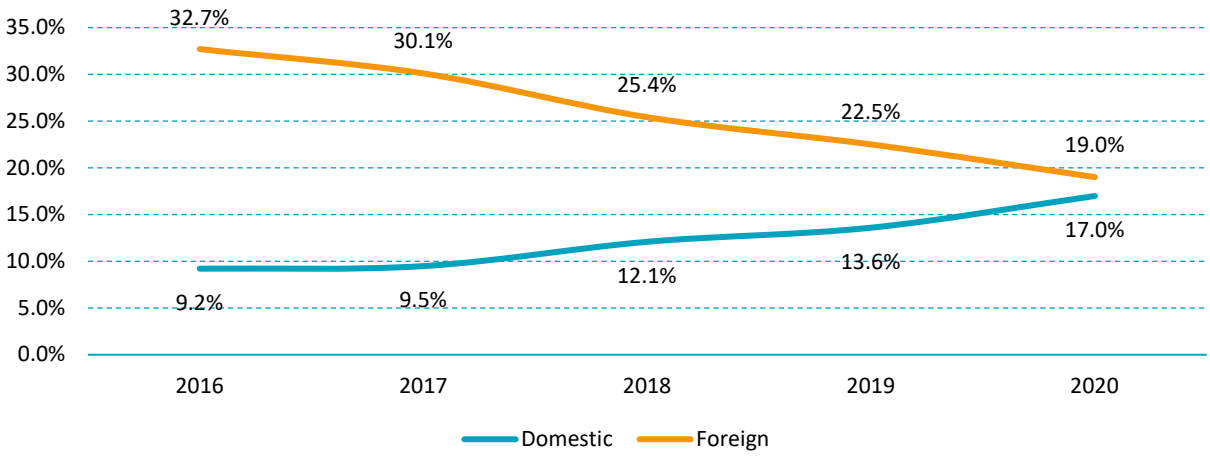
Figure 12 | Chinese companies' market share in global semiconductor supply expected to grow




Source: Company annual reports, Morgan Stanley, CICC, Robeco estimates. IDM: Integrated device manufacturer. CMOS: Complementary metal–oxide–semiconductor. MCU: microcontroller unit. DRAM: Dynamic random-access memory.

Beyond semiconductors, many other sectors also stand to benefit from this local substitution trend, including industrial software companies and industrial automation systems makers. Ultimately, however, not all Chinese substitution suppliers will emerge as long-term winners. From this perspective, investors will need to focus on the leaders of their field – those companies able to gradually close the technology gap – while also offering reliable products at competitive prices.

Figure 13 | Domestic vs. foreign software companies' market share in China




Source: Morgan Stanley Research.

# Conclusion

After decades of catching up, China is now well on course for global technological leadership in many critical areas.

Helped by often highly supportive policy measures, Chinese companies have made considerable efforts to move up the value chain towards best-in-class goods and services in many industries. China is actually expected to take global R&D leadership this year and outspend the US for the very first time. Moreover, the country now leads the pack in many areas, such as artificial intelligence (AI), 5G telecommunication networks, ultra-high voltage electricity networks or high-speed rail. And the journey is far from over.

Despite uncertainty exacerbating the tensions with the US and the recent crackdown on some sectors, in particular the internet industry, we believe this technology push offers many investment opportunities. To help investors uncover these opportunities, we have identified three major investment themes worth considering: the relentless rise of NEVs, the advent of 'industry 4.0' in China, and an increased focus on the localization of supply chains. Given the bright prospects these three trends offer, we believe this is where some of the most interesting opportunities are to be found.

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