PROSESS21

Process Industry in China

Future developement and government regulation

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Table of contents

Executive summary

As the second largest economy in the world since 2010, China is on its way of transforming into a more service-oriented society. While developing the tertiary sector, the country in the latest years focus very much on quality growth and upgrading the manufacturing industry, in which the process industry is an important part. China accounted for 28 percent of global manufacturing output in 2018. For many of the process industry individual sectors, such as steel and aluminum China has more than 50 percent of the world production. China's output of non-ferro metals has kept increasing the last 10 years. State Owned Enterprises (SOEs) play an important role in Chinese process industry.

The process industry in China has been developed rapidly since the adoption of opening-up policy in 1980s. Influenced by global economic recession and the US-China trade war, China's real estate investment and manufacturing like automobile decreased from 2018, consequently influenced process industries such as crude steel, aluminum and ferro alloy. China's ferro alloy production capacity is about 50 million tons/year, with annual production about 30-35 million tons only, and more than 60 percent were concentrated in Inner Mongolia, Ningxia Guangxi and Shandong provinces. In recent years, the gravity of China's process industry is moving to the mid-west for more supportive policies from local government, lower cost of labor and energy. Six million tons of primary aluminum production capacity had migrated to Yunnan province with the capacity relocating policy.

Process industries are under high pressure from Chinese economic transformation, with energy efficiency, pollution control, technology upgrading and increasing human resources cost. Increasingly strict policies and regulations had been issued to reduce the energy consumption and GHG emission, in order to keep the country's commitment to the Paris Agreement, and protect the environment from pollution as well. The emission control in process industry is becoming increasingly strict, such as regulations in deSOx, deNOx and waste control. The environmental protection tax imposed since 2018 enforced the legal obligations of polluters, many of them are engaged in process industry. Revenues are secured after switching to tax regime from discharging fees in the old administrative system. In Sep 2020, China had declared the country will reach maximum CO_2 emission in 2030 and reach carbon neutral in 2060.

High energy consumption, high polluting and resource-dependent process industry is not getting preferential policies such as export tax rebates. Low value-added products such as unwrought aluminum alloy and ferroalloy are even imposed with export tariffs. Process industry players are obliged to manage their carbon footprint and optimize product portfolio instead of seeking extensive growth. Seven pilot Emission Trading Schemes (ETS) was built up and a national ETS is expected within 2020. New requirements were issued that, by 2020, all listed companies and bond issuers must disclose an environmental, social and governance (ESG) report. A growing number of enterprises start to publish their Corporation Social Responsibility (CSR) Report or Sustainable Development Report.

The power consumed by manufacturing industry accounted for approx. 50 percent of the total national power consumption. The most energy intensive process industry segments (non-ferrous and chemicals combined) used one-third of power of the manufacturing industry. Coal is the most important primary energy for China. It took around 70 percent share of annual energy production in past 20 years and it will still maintain its irreplaceable position in the energy mix in China's industrialization process. Central government's call for energy transition has strong implications to the process industry on improving energy efficiency and reducing emissions. Meanwhile, the process industry benefited from energy transition policies which have brought new market opportunities such as new energy vehicle, power battery, wind turbine and solar panel. The rapid growth of these segments expanded the scope and volume of demand side for process industry.

The strong political power accumulated with increasing economic strength through the past decades dominated the national governance system. Through the top-down administrative organizations,

national strategies are implemented through directive policies, decisive mandates and definite execution schemes, among which, China's process industry developing models are greatly influenced. Since energy conservation and emission control has been put on the agenda of the industry development plan, it has led to a chain reaction of industry reshuffle. The industry players must relocate some of their production facilities to places with renewable energy is available. Production process with backward technologies must shut down or upgrade to less energy-consuming, less pollutant production methodology, guided by circular economy developing model.

Process industry in China imbedded deeply in the price mechanism between mining industry and the manufacturing of various end products. The fast expansion of Chinese foreign trade as well as the massive domestic market triggered huge investment impulse throughout the supply chain of national industry sectors. This endogenous growth momentum magnified by the excessive pursuit of GDP growth and the reaping of demographic dividend, are inevitably facing overcapacity and environmental constrains.

Overcapacity has been a complex problem in China's process industries. The profit and cost space in different process industries left by SOEs, who are less efficient, ran more costly, often more bureaucratic even, were always the motivation of Private Owned Enterprises to enter the market. Local governments' investment-driven model in developing the regional economies with redundant process industrial projects which had not been effectively controlled, also played an important role in creating overcapacity. The situation is getting worse by the outbreak of COVID-19 in 2020, which has impacted both the supply chain and the market demand.

The market drive also challenged by global and regional political situation and trade relations. Ambitious plans such as Belt and Road Initiative (BRI), Made in China 2025 (MIC 2025) and a series of financial and taxation reforms aimed to expand market demand and to promote the sustainable development may increase competitiveness of the process industry in the long run. But the technological drive must be the prerequisite for it. Process industry in China has become much more focused on IPR with huge R&D investments and achievements.

To some extent, China has a leading position in the digital economy and e-commerce, based on the rapid development of China's logistic industry in recent years and the Chinese big tech companies. The pandemic has also speeded-up the digitalization and smart manufacturing in the China's process industry.

Digitalization and logistic infrastructure are re-shaping the domestic supply chain of the process industry as well as the whole manufacturing sector. Price transparency of raw materials and power supply has forced the producers to react on market demand swiftly. Efficient logistic services contribute to capital turnover as well as shortened time to market which lead to competitiveness.

In general, the final products of Chinese process industry as well as the manufacture industry, are perceived to be low-tech content, instead of high value added in the international market despite of enormous production capacity. China is aiming for overall industry upgrading through technological innovation. But the efforts have been seriously impacted after the US-China trade war started in 2018. China will have to strive for being self-dependent in critical technologies in order to keep its economic development and shake off the "middle-income trap".

The "Internal Circulation" was raised for exploring and developing the domestic market, in dealing with the trade war and tech war with the US but was soon replaced by "Dual Circulation". In the face of rising global uncertainties associated with an increasingly hostile external environment, the new "Dual Circulation" indicates China's attempt to establish a new paradigm that attaches balanced importance to both internationalization and self-sufficiency to cope with external vulnerabilities.

China's Outbound Direct Investment (ODI) peaked in 2016, then decreased rapidly from 2017 with its focus transferred from US and Europe to Asia, especially to the BRI countries. The cooperation with

Europe had been unprecedentedly emphasized with the aggravation of US-China trade war. Besides investment, export and consumption, urbanization is also one of the unique engines for Chinese industrial development, with about 200 million people migrated into cities within the last decade.

China central government launched the "New Infrastructure Campaign" (NIC) in March 2020 targeted to offset the economic impact of the coronavirus pandemic and boost sustainable growth. In the coming years, about 34 trillion yuan will be invested into the following fields: 5G networks, Artificial Intelligence, Industrial internet, inter-city transportation and inner-city rail systems, Data centers, Ultra-high voltage transmission Grids (UHVs) and New Energy Vehicles charging stations. In near future, some metals' production and demand will increase, such as copper, aluminum and cobalt. It will alleviate the overcapacity situation in some process industries but will not change it fundamentally because this NIC will focus more on new economy or technologies like AI, big data, IoT or industrial internet, instead of concrete constructions, opposite to the situation in 2008. The Public Private Partnership (PPP) model will play an important role in the implementation of this strategic policy, which means more market- oriented involvement than governmental planned investment.

Due to spreading of COVID-19 pandemic and escalating of China-US trade war, the upcoming 5 years action plan of national social and economic development (2021-2025) are perceived critical to copy with present crisis and to embrace emerging opportunities. Economists and think tanks in China are rolling out their analysis on the key elements of 14th FYP in which certainly contains the continuation of previous polices on urbanization and regional economic integration, industry consolidation and upgrading etc. While transforming the supply side with technologies such as 5G, AI and IOT, stimulating the demand side is bound to be prioritized even more, especially for the domestic market.

With the support of existing programs of MIC 2025, the push for indigenous innovation shall prosper the foreign trade and investment in the technology domain. As far as Norwegian process industry concerned, strategic materials and relevant technologies, specialized components, processing and system integration solutions will see further growth.

The foundation of business cooperation between Norway and China is with the feature of reciprocity and irreplaceability. Long lasting and proven businesses of Norwegian exporting IPR intensive products and sourcing mass-produced, low value-added products from China will still grow. Norway will maintain its market position as an important supplier of high-end equipment, particularly to those niche markets. Export of specialized materials to China in combination with advanced production system imprinted with solid faith of sustainable development will see growth of customer base, among those key industry sectors such as high-end machines, robots, new materials and new energy vehicles are prioritized by MIC 2025.

The economic cooperation between Norway and China has broad prospects, particularly in the field of sustainable development, such as environment protection technologies, energy efficiency solutions, competence building and consultancy services in process industries, as well as in special areas like CCUS. Norwegian high-tech products and solutions suppliers shall be able to find more opportunities to cooperate with Chinese process industry in the years to come.

Preface

This report is correspondingly drafted with the *Prosess 21* Report for the Ministry of Trade, Industry and Fisheries of Norway. The data used in this report is till the end of 2019, and some data were also taken for the year 2020, while few from 2018 due to availability.

Compared with Norway, China's process industry mainly points to petrochemicals, steel, machinery and other manufacturing such as textile and chemistry, of course, with a certain proportion of various metals or non-metallic materials. In China, the statistic caliber and analysis normally cover manufacturing or different process industries itself, instead of process industry as a general.

Data collection is one of the challenges in preparing this report. It's difficult to acquire the necessary data in China, especially for process industry as a whole. Data with the scope of manufacturing or each process industry separately are more available, which is not the same data scope with Norwegian process industry. After discussions with the *Prosess 21* leading team in Norway, we selected to use the data of China manufacturing, and process industries like aluminum, non-ferro metals and ferroalloy as a focus, as well as the NEV and battery industry in China's process industries for this report. Great efforts had been made to keep the same scope of process industry with Norway.

Most of the policies and regulations in the Chinese Ministries' website are in Chinese language only, which is a shortcoming of digitalization of Chinese government. Unfortunately, they are the only authoritative links can be used.

At the end of September 2020, when this report was finished, there was still not certain information from Chinese authorities about China's 14th FYP. The COVID-19 and US-China trade-war has impacted the governments' pace in preparing it. So, we had to give up this chapter and a separate study or report can be delivered later under project with Innovation Norway Beijing.

This report is drafted specifically for the Prosess 21 Project, and should not be used in any other purpose.

Acronyms and abbreviations

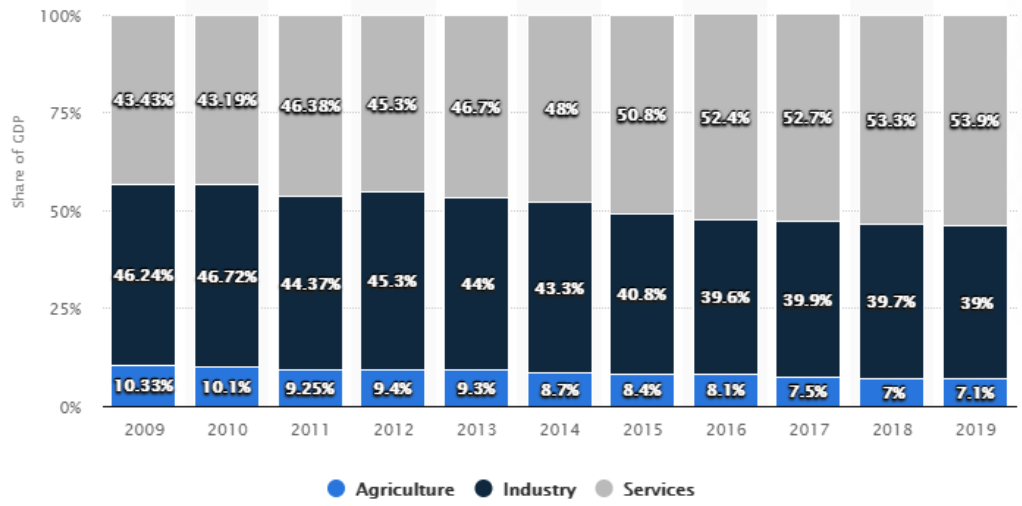
BRI	*Belt and Road Initiative*
CAE	*Chinese Academy of Engineering*
CAI EU	*China Comprehensive Agreement on Investment*
CAS	*Chinese Academy of Sciences*
CBIRC	*China Banking and Insurance Regulatory Commission*
CIIF	*Circuit Industry Investment Fund*
CAGR	*Compound Annual Growth Rate*
CNPC	*China National Petroleum Corporation*
CNPIA	*National Intellectual Property Administration of China*
CNY	*Chinese Yuan (RMB, yuan)*
CSR	*Corporation Social Responsibility*
CSRC	*China Securities Regulatory Commission*
DRC	*Development and Reform Commission*
EUCCC	*European Chamber of Commerce in China*
ESG	*Environment social Governance*
ETS	*Emission Trading System*
FAI	*Fixed Assets Investment*
FDI	*Foreign*
HSE	*Health, Safety and Environment*
IoT	*Internet of Things*
IPC	*International Patent Classification*
IPR	*Intellectual Property Rights*
MIC	*Made in China 2025*
MIIT	*Ministry of Industry and Information Technology*
MLP	*Medium and Long-term Plan for the Development of Science and Technology, 2006-2020*
MOF	*Ministry of Finance*
MOST	*Ministry of Science and Technology*
MOT	*Ministry of Transportation*
NBS	*National Bureau of Statistics*
NFGA	*National Forestry and Grassland Administration*
NDRC	*National Development and Reform Commission*
OEM	*Original Equipment Manufacturer*
OFDI	*Oversea Foreign Direct Invsetment*
PBC	*People's Bank of China (Central bank of China)*
POEs	*Privately owned enterprises*
PPP	*Public-Private Partnership*
SAFE	*State Administration of Foreign Exchange*
SASAC	*State Asset Supervision and Administration Commission*
SAT	*State Taxation Administration*
SME	*Small and Medium-sized Enterprise*
SOE	*State-Owned Enterprise*
SPZ	*Special Economic Zone*
WIPO	*World Intellectual Property Organization*
WTO	*World Trade Organization*
YoY	*Year-on-Year*
13FYP	*13th Five-Year Plan*
14FYP	*14th Five-Year Plan*

1. China's process industry in general

China, as the second largest economy in the world from 2010, is on its way of transforming into a more service-oriented society, while the development of the tertiary sector in China had been constrained by the country's focus on manufacturing industry. In most developed countries, service sector contributed to more than 70 percent of the economy. In the year 2018, China's GDP has reached 16 percent of the world, and the percentage will be higher in 2019, predicted both by China Statistics Bureau and IMF.

Premier Li Keqiang announced at the National Parliament Conference (NPC) in May 2020 that China will not set its economic growth target on GDP in 2020, due to the influence from COVID-19, and unpredictable situation both in China and the world.

Fig. 1-1 Distribution of GDP across economic sectors of China from 2009 to 2019



Source: NSB

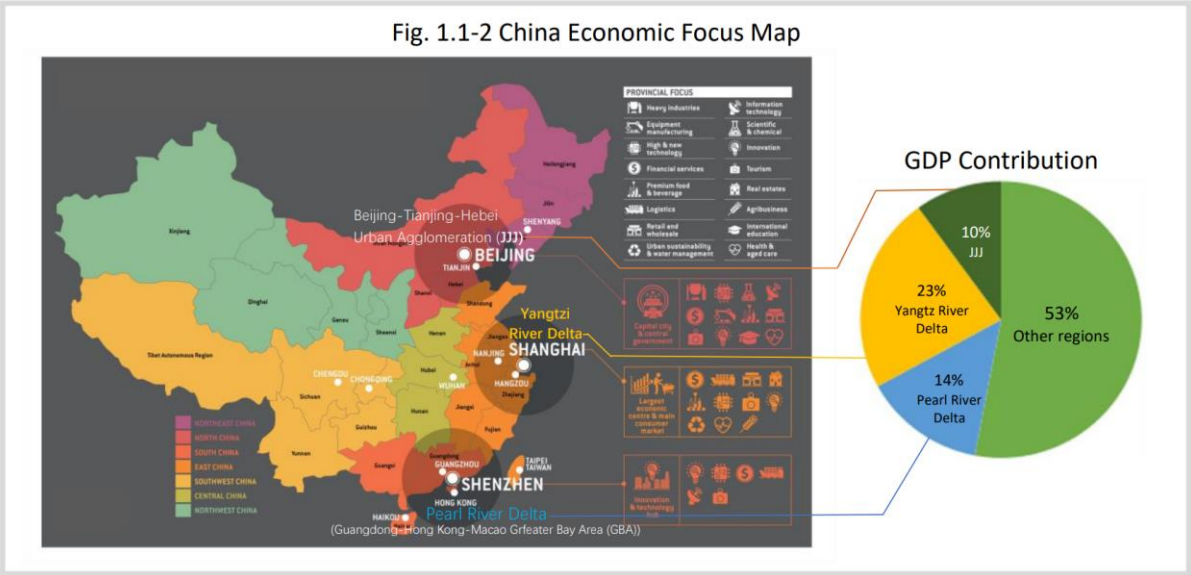
Although China's GDP growth has slowed down in recent years, its economy was still expanding at more than two-times the pace of the United States' in 2018. According to data published by the United Nations Statistics Division, China accounted for 28 percent of global manufacturing output in 2018. That puts the country more than 10 percentage points ahead of the US, which used to have the world's largest manufacturing sector until China overtook it in 2010. With total value added by the Chinese manufacturing sector amounting to almost $4 trillion in 2018, manufacturing accounted for nearly 30 percent of the country's total economic output with process industry an important part of it.

In the period of 2013-2017, 21 percent of global mining and quarrying imports went to China vs 7 percent during 2003-2007. Many Chinese process industry rely on the imported raw materials. According to the Geological Data, China has about 550 million tons of proven bauxite reserves as of 2018, showing that the reserves are not rich and of less than satisfactory quality, with 110 million tons mined in 2018. In 2019, China's metallurgical-grade alumina production was 71.55 million tons, and the import volume from January to November was 1.39 million tons, with annual consumption of about 72.02 million tons. The import of refined/iron ore is over 1 billion tons in 2019, with a growth of 0.5 percent from 2018, values 101.462 billion USD (average 94.017 USD/ton).

Fig. 1-2 illustrates the economic focus and distribution of China. In recent year, the Pearl River Delta was increasingly replaced by the Guangdong-Hongkong-Macao Great Bay (GBA) concept, which is

the largest city group area in the world, especially after the huge bridge of Hongkong-Macao-Zhuhai was built.

Fig. 1.1-2 China Economic Focus Map



However, at the other end of the country, the North-East part of China (Heilongjiang, Liaoning and Jilin provinces) is struggling for their economic development. North-East region is a traditional heavy industrial base of China and well-known for its agriculture production as well, but now fell into the Rust Belt of this country, even the population is shrinking from their smaller cities and rural areas.

Many Chinese process industries selected to base in these three regions (JJJ, Yangtze river Delta, GBA) for a better international connecting and talent human resources. For example, from 2015 China became the largest EV battery manufacturer in the world, after surpassed Japan. The manufacturing capacity located within these three regions has been more than half of the world EV battery manufacturing capacity.

1.1 Chinese Process Industry brief introduction

"China has become the only country in the world to obtain all the industrial categories listed in the United Nation's industrial classification" said Miao Wei, the Minister of MIIT in a news conference in 2019. The biggest industry in China is manufacturing, in which process industry is an important part.

According to the World Steel Association, global crude steel production had reached 1,869.9 million tons in 2019, while China's crude steel production in 2019 was 996.3 million tons, up 8.3 percent YoY and rising to 53.3 percent globally, up 3.4 percent YoY (China's share of global crude steel production was 50.9 percent in 2018). Compared with Norway, China's process industry mainly points to petrochemicals, steel, machinery and other manufacturing, of course, with a certain proportion of various metals or non-metallic materials.

SOEs

Differing from many other countries, SOEs play a particularly important role in Chinese process industry. The top five power SOEs supply about half of the electricity in China, through the only two grid SOEs (State Grid and Southern Grid). Three oil & gas SOEs occupied most of oil business in China (Sinopec, CNPC and CNOOC).

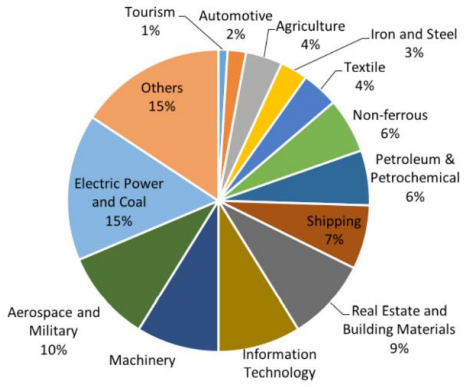
In recent years, SASAC has been continuously reforming the Central SOEs by strategic integrating. The total number of Central SOEs have been reduced to 96 in 2019, from 142 in the year 2009. As a result

of it, the mother company of China Blue Star (owner of Elkem), ChemChina had been merged with another giant Central SOE SinoChem, which had formed the largest chemical group in the world.

CHINALCO (CHALCO) as one of the biggest Aluminum and Non-ferro manufacturing company both in China and in the world, is also a Central SOE under SASAC.

There are totally 124 Chinese companies (include Hongkong) listed in the Fortune Global 500 in 2020, among which 80 of state-owned enterprises, and with 48 Central SOEs under SASAC. Sinopec, State Grid and CNPC ranked the second, third and fourth largest company in the world. It's the first time for more Chinese companies than the US's (121) in the list, however, China only has four in the year 1997.

Fig 1.1-1 China SOE's industries



Source: SASAC

In 2019, the total operating income of the Central SOEs was RMB 30.8 trillion, up 5.6 percent YoY, with a cumulative net profit of 1.3 trillion yuan, up 10.8% YoY. From this year, SASAC will focus on the reorganization and integration of SOEs in areas such as equipment manufacturing, chemical industry, offshore equipment & engineering, overseas oil and gas assets etc. In July of 2020, after the COVID-19, SASAC added grain reserves, oil and grease processing into the SOEs' reformation name list for the second half of this year.

Private Sector

The private sector of China's process industry is normally more competitive, like other private business in China, comparing with the giant SOEs, who had been supported from different level of governments and banks, or even mono-playing within certain industries. In general, SOEs are well-known for their low efficiency and higher operation cost, sometime even bureaucratic. The profit and cost space left by them in different process industries were usually the motivation of private enterprises' decision for entering into SOEs' business fields, which is one of the inducements for overcapacity in China.

Chinese private process industrial enterprises are very flexible and competitive, as well as eager to update their technology and equipment. For example, after the outbreak of COVID-19 in China, BYD (Build Your Dreams) as one of the largest EV manufacturer in the world, had successfully built up their own face mask production lines within just two weeks, with more than 90% of parts self-produced. After several weeks of duplication, it became the world's largest face masks plant, with more than 100 production lines and 5 million pieces of mask production per day, together with 300,000 bottles of disinfectant daily output, and even though, this would not bring much affection to BYD's main business- electric vehicles manufacturing. Not only because of their strong engineering capability, the mature and reliable supply chain in China is also a very important factor. Some other countries who also had tried to build up their own facial mask plant within short time during the pandemic period, unfortunately, their plans were either postponed or even stopped by the short supply in raw materials or necessary parts and equipment. Till the June of 2020, BYD had got over 1 billion USD of mask orders from US, Japan and other countries, with its daily production increased to 50 million pieces.

During the "Chip Battle" between China and US in the middle of 2020, BYD even formed a semi-conductor company within short time, based on their excellent engineering capacity and the IGBT (Insulated Gate Bipolar Transistor) technology. The newly built company will focus on EV chip development with partners, which had been valued over 10 billion yuan by investors when it was founded.

Overcapacity

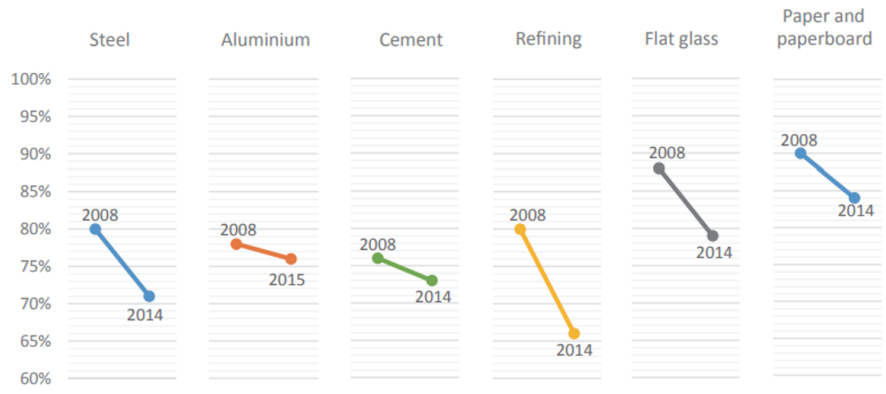
China's overcapacity problem is a complex issue lasted for long time, which has significant influence on its economy and to the world. It became very destructive, particularly after the financial crisis in 2009. The global economic crisis of 2009 led to a sharp drop in foreign demand for imports from China. In response to the crisis, the Chinese government has issued a massive stimulus package in infrastructure construction which led investments in new capacities consequently. The imbalance between industry capacity expansion and real market demand caused by the stimulus has exacerbated overcapacity in many industries with easy access to credit.

The scale of overcapacity in China's process industries such as steel, aluminum and cement highlights the severity of the problem: steel production has become completely untethered from real market demand, and is now more than double the combined production of the four next leading producers: Japan, India, the United States and Russia; in China's aluminum industry, large proportion of production capacity has negative cash flow; and according to data from NBS and the US Geological Survey, in just two years—2011 and 2012—China produced as much cement as the US did during the entire 20th century.

This wave of fixed asset investment (FAI) in infrastructure projects, as well as further FAI that has resulted from smaller subsequent stimulus measures, has created short-term demand for input supplies. This is substantiated by the growing total excess production and declining utilization rates found in the following process industries:

- Crude steel
- Electrolytic
- Aluminum
- Cement
- Chemicals
- Refining
- Flat glass
- Shipbuilding
- Paper and paperboard

Fig 1.1-2 Some typical process industrial capacity utilization rate (2008-2014)



Source: NBS, OVERCAPACITY IN CHINA-An Impediment to the Party's Reform Agenda

The booming infrastructure investments led the expansion of Chinese SOEs' and private enterprise' production capacity. As a result, the manufacturing companies' FAI expands at an average of 18.8 percent year-on-year from 2009 to 2014, which made worse for their capacity utilization rate.

From 2008 to 2020, China State Council has issued a series of documents trying to control the overcapacity situation, some typical as follows,

- Notice of the State Council on speeding up the restructuring of overcapacity industries.
- The State Council approved the notice of NDRC and other departments on curbing overcapacity and duplication of construction in some industries to guide the healthy development of the industry.
- Notice of the State Council on further strengthening the elimination of backward production capacity
- Guidance of the State Council on resolving the serious overcapacity contradiction
- Notice of the MIIT on the replacement of capacity in some industries with serious overcapacity
- The State Council's opinion on the steel industry to resolve excess capacity to achieve the development of relief from hardship.
- NDRC: Key points for resolve steel over capacity in 20192019
- Notice on the work of resolving over capacity in key areas in 2020

The governmental policy endeavor is summarized in Table 1.1-1:

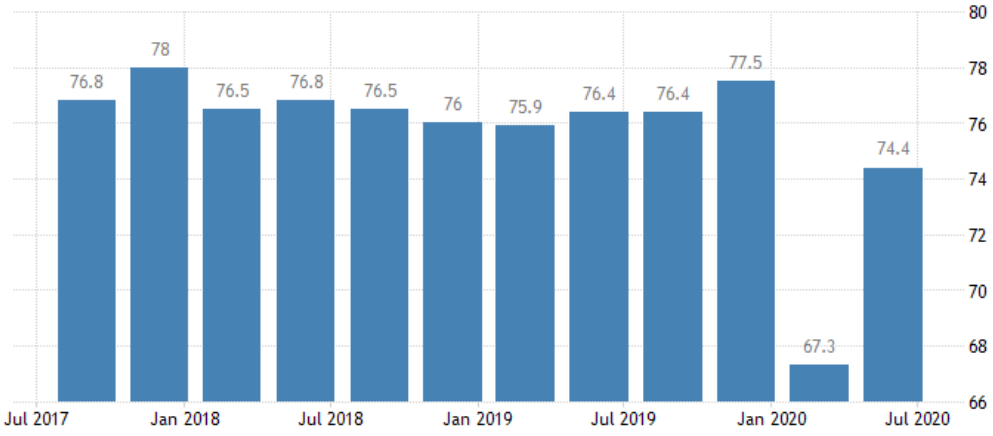
Table 1.1-1 Summary of policy content in over capacity control from China governments

Boost demand	Domestic demand	Promote urbanisation	Balance urban-rural development, build up more towns, promote the population of towns and expand infrastructure construction
	Overseas demand	Export	Encouragement of export by providing financial support and tax benefits
		One Belt One Road and AIIB	Construct and connect infrastructure between countries, cooperate in the energy field, construct trade and investment alliances
Restrain Supply	Incremental capacity	Loans and credits	Stricter control on loans and credit
		Stricter standards	Higher market entry and project approval standards with regard to several factors such as technology, capacity scale, emission control and equipment standards of production lines
		Accountability system	Implementation of accountability system for local governments and related institutions
		Better supervision and enforcement	Strengthening of the supervision and inspection of overcapacity enforcement
	Existing capacity-Upgrade	Less raw material and energy subsidies	Standardisation of the energy pricing system and curbing energy subsidies (especially in the aluminium sector)
		Better land resource allocation	Improve land resources supply and management
	Existing capacity-Eliminate	Transparent information system	Build an industrial database to be able to provide market information on the capacity status of affected industries
		Industry restructuring, consolidation	Granting of fiscal, tax, finance, debt and social welfare support to encourage industry consolidation and to accelerate the elimination of backward capacity
		Social support	Provision of social support for unemployed labour

Source: OVERCAPACITY IN CHINA-An Impediment to the Party's Reform Agenda

Even though, overcapacity as a complex issue and still exists in China on a fairly large scale. Industrial capacity utilization rate in China declined to 74.4 percent in the second quarter of 2020 from 76.4 percent in the same period a year ago, as the world's second-largest economy continued to battle with the coronavirus outbreak. The utilization rate dropped for all categories: manufacturing (74.8 percent vs 76.9 percent in Q2 2019); mining (72.1 percent vs 74.6 percent); and electricity, heat, and gas, water production (70.6 percent vs 70.8 percent). Considering the first six months of the year, industrial capacity utilization was at 71.1 percent, down 5.1 percentage points from the same period of 2019. Still, it compares with 67.3 percent in the first quarter of the year, when the COVID-19 impacts.

Fig. 1.1-3 Industrial capacity utilization rate in China (Jul 2017-Jul 2020)



Source: NBS, Trade economics

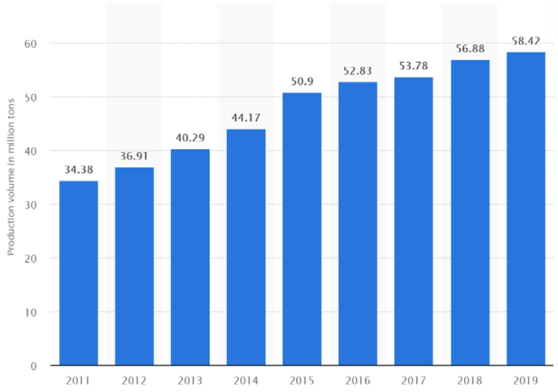
1.2 Some of the relevant process industries' development

1.2.1 Development of China process industry

Like steel and other process industry production, China's output of non-ferrous metals kept increasing in the last decade. In 2019, China's total import and export trade of non-ferrous metals was US$ 173.9 billion, down 12.4 percent YoY, of which imports amounted to US$ 144 billion, down 13.5 percent YoY, and exports amounted to US$ 29.8 billion, down 6.7 percent YoY.

In 2019, the production of 10 non-ferrous metals was 58.42 million tons, up 3.5 percent YoY. The FAI in the non-ferrous metals industry grew by 2.1 percent year-on-year, including 6.8 percent year-on-year in mining, 1.2 percent year-on-year in smelting and processing industries. The investments in energy conservation and emission reduction technology has accelerated, as well as in high-end materials and other fields.

Fig. 1.2.1-1 Production volume of non-ferrous metals in China 2011-2019 (million tons)



Ten major non-ferro metals:

- Copper
- Aluminum
- Lead,
- Zinc
- Nickel
- Tin
- Antimony
- Mercury
- Magnesium
- Titanium

Source: World Bureau of Metal statistics. National Bureau of Statistics of China

The overseas mining projects of Jinchuan Group, CHINALCO (CHALCO), and NORINCO have successfully started production as planned. CHIALCO's alumina mine project in Guinea has already begun supplying domestic factories. Jiangxi Copper and Zijin Mining increased their capital of overseas copper resources leading enterprises.

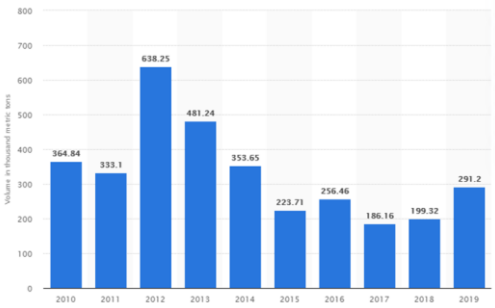
According to MIIT, in 2019, China's electrolytic aluminum production capacity has been relocated more than 3 million tons across provinces, of which 2.46 million tons will be replaced Yunnan, where rich in clean energy. Intelligent and high-end materials production accelerates the development: Nonfemet's lead and zinc mine mechanized unmanned mining rate reached 83 percent; China Molybednum industry will apply 5G technology to unmanned mining equipment; Chinalco-Sapa high-end aluminum alloy intelligent manufacturing production line put into operation.

In 2020, the risk of overcapacity in the non-ferrous metals industry still exists, the task of greening and intelligent transformation is arduous. The international trade environment is complex and changeful; therefore, the consumer market needs to be further expanded. The whole industry needs continue to deepen the supply-side structural reform in accordance to promote qualified growth.

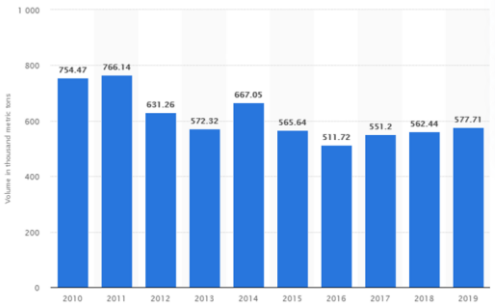
As the largest aluminum manufacturer in the world, China not only exports, but also imports large quantity of aluminum, as well as many other process industrial products. In 2019, the re-melted aluminum imported 62,000 tons, more or less the same quantity of exports, which is 67,000 tons.

The International Aluminum Institute has issued the "ASSESSMENT OF ALUMINIUM USAGE IN CHINA'S AUTOMOBILE INDUSTRY 2016-2030" which predicts that the amount of aluminum used

Fig. 1.2.1-2 Aluminum import/Export volume in China 2010-2019



Import volume of aluminum in China from 2010 to 2019 *(in 1,000 metric tons)*



Export volume of aluminum in China from 2010 to 2019 *(in 1,000 metric tons)*

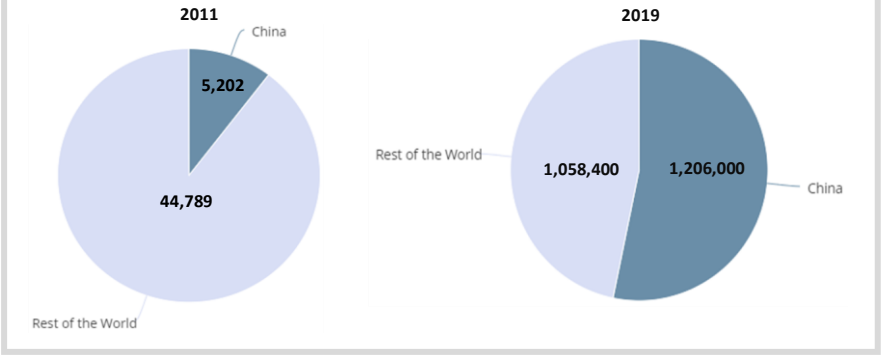
Source: World Bureau of Metal statistics, National Bureau of Statistics of China, China General Administration of Customs

in China's automotive industry will reach 9.1 million tons by 2030. China's NEV (New Energy Vehicles) market is forecast to reach 11.6 million units in 2030, representing a CAGR of 21.4 percent. Notably, BEV (Battery Electric Vehicle) production is forecast to grow at a CAGR 23 percent over the same period, from its 2018 level of 0.77 million units to 9.2 million in 2030. This forecast growth is likely to drive strong aluminum growth, given projections for intensity of use in the sector.

EV & Battery

In December 2019, the Chinese MIIT announced that new energy vehicles, composed mainly of plug-in electric vehicles (PEVs), would represent 25 percent of overall vehicle sales by 2025. This is a bold target given that less than 5 percent of total cars sold in 2019 were EVs. Just a decade ago few expected China to develop an EV industry, let alone become the world's largest market and manufacturer.

Fig. 1.2.1-3 EV Sales in China vs. World, in year 2011-2019

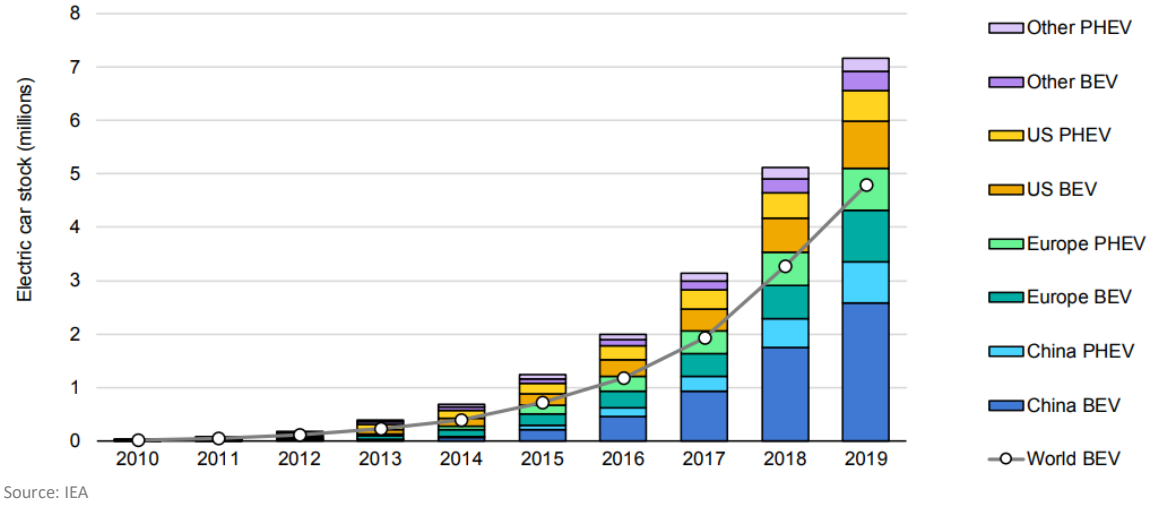


With announced launches of new EV models spiking, both automakers and suppliers are increasing their global footprints in target markets by localizing the production of vehicles and components. For example, Tesla began construction of its Shanghai plant in January 2019 and delivered the first locally produced EV that December. The company plans to build its next production plant in Germany by 2021. Similarly, Volkswagen and Toyota have announced plans to set up EV plants in China.

China's EV sales in 2019 declined to 1,206,000, with a 4% drop from 2018, as a result from the government's subsidy cut. Its EV sales in the first season of 2020 was still quite low due to the outbreak of COVID-19. However, NEVs are still a top priority for the Chinese government and will play an important role in its post-coronavirus stimulus plan. In April 2020, the MOF, MIIT, MOST and NDRC jointly issued the "Notice on Improving the Policy of Financial Subsidies for the Promotion and Application of New Energy Vehicles" to extend NEV subsidies by two more years, till the end of 2022.

However, in principle, the 2020-2022 subsidy standard is 10%, 20% and 30% less respectively, on basis of each last year. In addition, RMB 10 billion ($1.4 billion) will be invested to expand the charging network for EV industry this year. China's NEV production in 2019 was 1.177 million units, down 3.4% year-on-year. There were only about 17,000 electric cars on the world's roads in 2010, but by 2019,

Fig. 1.2.1-5 Global electric car stock, 2010-2019



Source: IEA

that number had swelled to 7.2 million, with 47 percent of which were China.

Overall, increased government purchases will probably drive the market. Nevertheless, achieving the 25 percent target by 2025 will be a challenge and probably require additional policy instruments and new business models to spur sufficient consumer demand. For example, Shenzhen as a Special Economic Zone in southern China where the BYD locates, all city bus and taxi are EVs.

With a similar development rhythm, EV battery manufacturers are increasing their production capacities in target markets. The total lithium-iron–battery market for EV passenger cars grew by 17 percent, up 16.6 percent YoY to 117 GW in 2019, enough to power 2.4 million standard BEVs. Most of the new capacity will be established in central Europe, with companies preparing to meet demand throughout the region. Company announcements suggest that the global market should expand to about 1,000 GWH by 2025. Since 2015, China had overtaken Japan as the world's largest supplier of EV batteries. According to GGII, China's EV battery output was nearly 71 GWh in 2019, up 9.4 percent year-on-year and slowing from 2018. The slowdown was mainly due to the decline in production and sales in China's NEV market.
As the biggest EV battery manufacturer in the world, the China EV battery maker CATL once again won the first place in global power battery supply with its output of 32.5 GWh, which takes the largest market share in 2019 at 28 percent, while its absolute capacity grew by 38.89 percent YoY, increased 4.47 percent of market share from 2018, up 19.10 percent YoY. CATL has recently continued its global expansion, signing new contracts with several international OEMs and setting up a factory in Germany.

The China EV and battery industries are also haunted by overcapacity problems, like in many other process industries. In the year 2017, it was estimated about two million EV manufacturing capacity will be available in 2020. According to data released by the China Circulation Association, from 2015 to the end of June 2017, more than 200 NEV projects have landed in China, the relevant investment amount is more than 1 trillion yuan, all kinds of automobile enterprises had announced NEV production capacity planning of more than 20 million vehicles, which is 10 time higher than the target set by the "Energy-saving and NEV Industry Development Plan (2012-2020)" by NDRC. The same target, 2 million NEV by 2020 was mentioned again in the "Win the Three-year Action Plan of the Blue Sky Defense War" issued by State Council in 2018.

In order to deal with it, the NDRC issued the "Regulations on investment management in the automotive industry" in the end of 2018, which means new EV projects would be tightly controlled for its approval. Even though, the planned capacity from existing China's EV manufacturers will close to 10 million within 2020, with about 400 billion yuan investment. In the end of 2019, the EV battery manufacturing capacity in China was over 100 GWH.

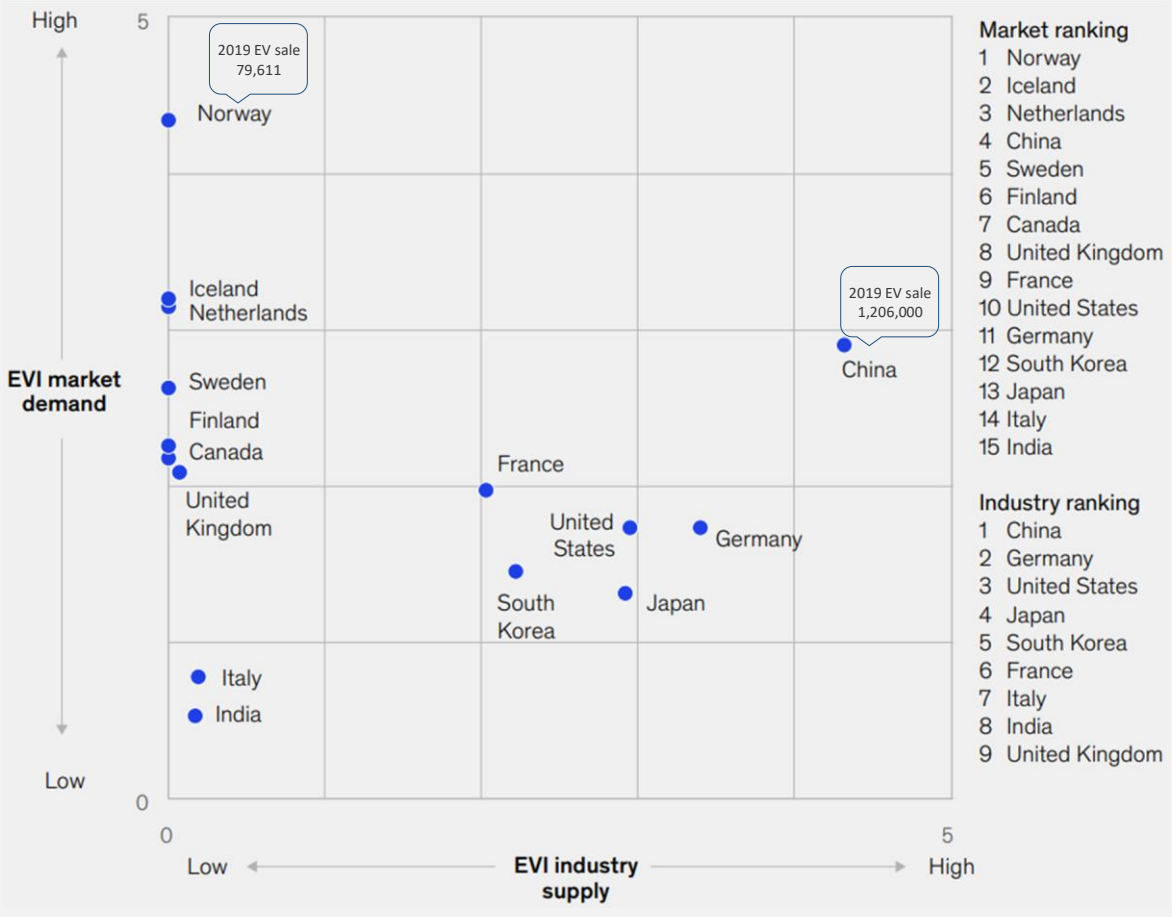
Table 1.2.1-1 EV Battery Technological Development Target of China

Year	EV Requirement	Energy Density	Specific Power	Cost	Recycling life
2020	>300km	350Wh/kg, 650Wh/L	1000W/kg	0.6 Yuan/Wh	2000 times
2025	>400km	400Wh/kg, 800Wh/L	1100W/kg	0.5Yuan/Wh	2500 times
2030	>500km	500Wh/kg, 1000Wh/L	1200W/kg	0.4Yuan/Wh	3000 times

Although the overcapacity situation is quite serious, South Korea's three big battery companies, including Samsung, LG and SKI launched a new round of investment in China. At present, Japan's Panasonic, South Korea's LG Chemical, Samsung SDI power battery in the international market share of up to 76 percent.

In *The Catalogue of Encouraged Industries for Foreign Investment 2019* (Full list in Chinese) took effect on July 30, 2019, China encouraging EV battery investment. Japanese and South Korean EV battery manufacturers are eager to enter this word-largest market, and the domestic power battery enterprises will face the impact of foreign competitors, industry shuffle will be greatly accelerated.

Fig. 1.2.1-4 Electric Vehicle Index (EVI) 2020



Source: McKinsey Electric Vehicle Index

1.2.2 Some process industries are moving to the mid-west of China

Till the end of 2019, there are about 82 primary aluminum enterprises in China, with a total production capacity of 41 million tons, accounting for about 63.68 percent of the world's total production capacity. The primary aluminum production decreased by 1.84 percent compared to 2018, and within the near future, China's primary aluminum production would be stabilized between 34-36 million tons/year, predicted by Antaike.

In February 2019, the second largest steel producer in the world, Chinese steel giant BAUWU Steel Group, purchased Tongren Aluminum company in Henan Province, accounting with 51 percent of the shares, and then renamed the company Baowu Aluminum Co., Ltd., with a total production capacity of 600,000 tons/year and the all main equipment imported. China steel company JISCO also estabiliched Dongxing Aluminum Co., Ltd. years ago, which is now one of China's main double roll cast aluminum manufacturers.

In 2019, China giant Aluminum company Zhongwang Group has extended their Aluminum production from extruding, rolling and processing into primary aluminum as well with a new project of 800,000 tons/year. After merged German aluminum extruder ALUnna in 2017, it also purchased the Australian yacht company SilverYachts, and in 2019 delivered the first aluminum luxury yacht "Bold". Their extension is towards both upstream and downstream of the value chain.

By the end of 2018, China has 4 million tons (per year) of primary aluminum production capacity to achieve cross-provincial relocation. Till the end of 2019, there're about 6 million tons of primary aluminum manufacturing capacity has been relocated into Yunnan Province, Wenshan Zhuang Miao Autonomous Prefecture in southern Yunnan and the Red River Hani Dai Autonomous Prefecture are closely linked, the region is vast, rich in green renewable hydropower energy.

The relocated capacity with their own capacity allowance, can enjoy the "low energy price and full load" local policy for the first ten years. Primary Aluminum can enjoy preferential electricity price 0.25 yuan/kWh in the first five years, and from the 6th to 10th year on this basis to increase within 1.2 cents/year, the 10th year is 0.3 yuan/kWh; Deep processing aluminum enterprises can enjoy 0.20 yuan/KWh. The lower energy price and government support are attractive to Chinese Aluminum enterprises, as well as to other process industries.

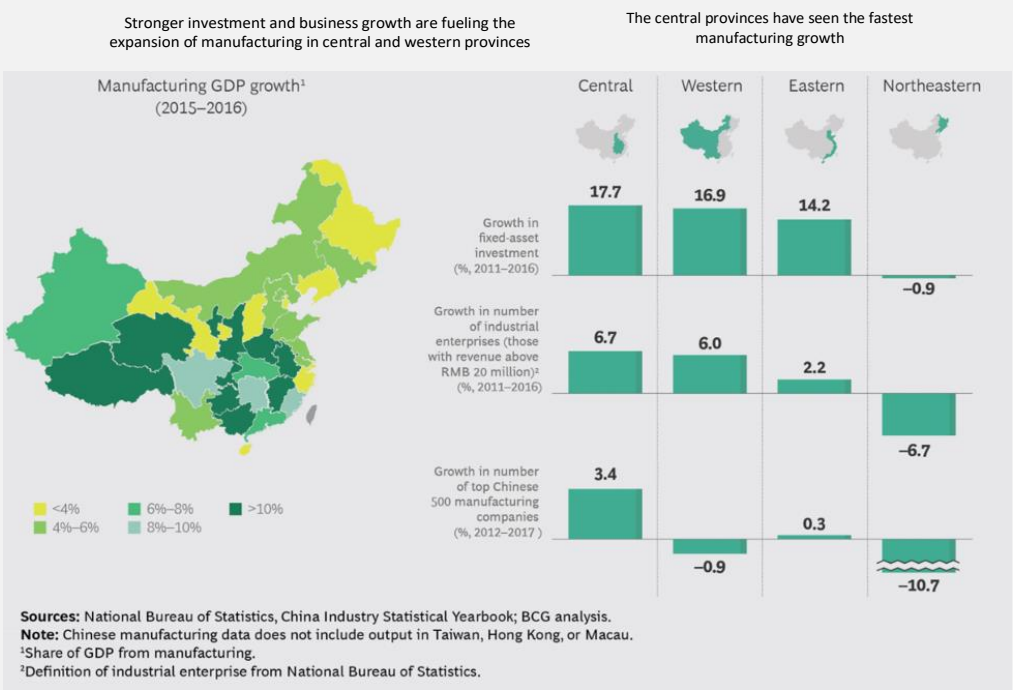
In recent year, two giant Chinese aluminum enterprises Chinalco and Shandong Weiqiao Aluminum Co., Ltd. entered Yunnan, the former with a total primary aluminum production capacity of about 8.2 million tons/year, and the latter more than 6.1 million tons/year. Chinalco Group has signed an strategic agreement with Yunnan government as early as in 2017, with complex M&A operations, Chinalco has owned Yunnan Aluminum Group, China Yun Copper Group, Yunan Chihong Zn & Ge Co.Ltd., and Yunana Metallurgy Group. Besides its original 1.58 million tons/year of primary aluminum capacity in Yunnan, Chinalco plans to bring another 1.2 million tons/year of primary aluminum capacity into Yunnan, so its production capacity in Yunnan will reach 2.78 million tons/year.

On October 15, 2015, Shandong Weiqiao Group and Yunnan Provincial Government signed a series of agreements to jointly build a green aluminum innovation industrial park, making full use of Yunnan's hydropower advantages and regional advantages facing Southeast Asia, building a green aluminum industrial base with global influence, and increasing the proportion of China's aluminum industry using renewable energy. Weiqiao Group has earlier withdrawn from the primary aluminum production capacity of 2.03 million tons/year in Binzhou, and registered a subsidiary of Yunnan Hongtai New Materials Co., Ltd. in the Wenshan, responsible for the construction of 2 million tons/year of Primary aluminum project there.

In addition to Chinalco Group and Weiqiao Aluminum Co., Ltd. in Yunnan, there are also Shenhuo Group, XiaoShun Holding Co., Ltd., Qiya Group, Jiangsu Kailong Aluminium, Jiangsu Jiangmen Industrial Group and Jiangyin Tianyang Metal Products etc. Nearly 13 billion yuan will be invested to build approx.

two million mt/year of aluminum processing capacity, covering plate, strip, wire and cable, light high-strength alloy, and car parts etc.

Fig. 1.2.2-1 The center gravity of Chinese manufacturing gravity is moving inland



Source: National Bureau of Statistics, China Industry Statistical Yearbook, BCG Analysis

By the end of 2019, the total primary aluminum capacity been transferred into Yunnan's has reached 6.15 million tons/year, coupled with Yunnan's own capacity, the total primary aluminum capacity had reached about 8 million tons/year, and is still growing. Several years later, Yunnan will be the largest province in Aluminum production. The Yunnan provincial government is also working hard on balancing its process industrial development with environment protection, because Yunnan is well-known for its tourism, rainforest, Chinese herb and tobacco plantings.

Similar migration happens also in other process industries such as non-ferro metallurgy, chemistry as well as manufacturing. Support from local government, cheaper energy and lower labor cost weighted more than higher logistic cost and city reliance. The center of gravity of Chinese process industry is moving into inland.

The central government is considering new promotion for this trend, in order to pull up the economy in the western China. NDRC recently published the inquiring draft of "Encourage Catalogue of Industries for the Western China", more active policy can be expected in the near future.

1.3 Cooperation with Norway

The cooperation already had between Norway and China in process industries, as well as some potential opportunities and fields. This chapter provides major bilateral cooperation projects (G2G) between Norway and China with relevance to the process industry of Norway. Commercial activities involving Norwegian players in process industry are also elaborated as examples of Sino-Norwegian B2B co-operations.

1.3.1. Government cooperation projects

On December 2, 2011, a Contractual Service Agreement was signed by the Ministry of Foreign Affairs (MFA) of Norway and UNDP, where MFA has contributed funds to UNDP on a cost-sharing basis for the implementation of two climate change related projects with the Government of China.

Project 1. Establishment of National Registry System for Domestic Emissions Trading Scheme and Voluntary Carbon Emission Reduction (the ETS Project)

The project is under the framework of UNDP programs aimed to support Chinese government policies on voluntary GHG reductions by designing and building technical measures to regulate and supervise the voluntary market. The goal of the project is to contribute to the development of measures aimed at reducing the carbon intensity in the Chinese economy as set in China's 12th Five-Year Plan. The objectives of this project are threefold: 1) Establish national voluntary emission reduction project registry system to maintain a common voluntary market with centralized information disclosure and standardized trading commodities; 2) Establish a national registry for regional and nationwide emissions trading schemes to materialize the national objective to build carbon market gradually; 3) Capacity building by carrying out education and training activities to build and enhance the capacities of stakeholders in the voluntary project market, and regional and national emissions trading market.

Three objectives of this project embody at the following four project's outcomes: (1) National Voluntary Emission Reduction Project Registration and Management System; (2) National Registry System for Emissions Trading Scheme; (3) Capacity building, and;(4) Project execution report.

The program period was from 2011-2013, with total budget of NOK 35,460,700. The implementation bodies were National Development and Reform Commission (NDRC) of China and the Norwegian Climate and Pollution Agency (Klif).

Project 2. Provincial Greenhouse Gas Emissions Inventory Capacity Building and Greenhouse Gas Emissions Accounting Methodology for Enterprises of Key Industries

Also proposed and implemented in the period from 2011-2013, this project set the goal to assist the Chinese Government to better address climate change through capacity building at the provincial level and building up a sound Greenhouse Gas emission accounting system at enterprise level for carbon trading. The total budget of the project was NOK 33,509,300. The implementation bodies were National Development and Reform Commission (NDRC) of China and the Norwegian Climate and Pollution Agency (Klif).

The deepened bilateral cooperation on ETS between Norway and China was highlighted by the **Phase Two of the Establishment of National Registry System for Domestic Emissions Trading Scheme and Voluntary Carbon Emission Reduction Project (2016-2019)**. Norwegian Ministry of Foreign Affairs allocated 35,000,000 NOK into the project which was implemented by the Ministry of Ecology and Environment of China in collaborating with Norwegian Environmental Agency and UNDP.

The project is a comprehensive package focused on complementing on-going efforts and filling the needs-gaps to create enabling conditions for a successful national ETS. The overall goal of this project is to assist Chinese government and enable it to build and launch a national ETS on time and ensure the smooth implementation. To achieve the goal, the project is composed of 4 outcomes that will enable: 1) Assessment and Improvement of Allowance Allocation Methods for ETS in China; 2) The supporting activities to deepen and expand capacity building; 3) To support the design of China Carbon Trading Info Platform; and 4) Supervision and Management Mechanism of the Third-Party Verification Body in the National ETS.

Sino Norwegian project Environmentally Sound Management of Hazardous and Industrial Wastes in Cement Kilns in China (Phase I and Phase II)

From 2006 to 2010, the Foreign Economic Cooperation Office, Ministry of Environmental Protection (FECO, MEP) and the Norwegian Foundation for Scientific and Industrial Research (SINTEF) jointly

implemented the Sino-Norwegian project of "Environmentally Sound Management of Hazardous and Industrial Wastes in Cement Kilns in China" (Phase I: 2006-2010). This project introduced international practices of co-processing of wastes in cement kilns under the Chinese situations, developed the technical guidelines (proposed draft) and standards (proposed draft) for co-processing of wastes in cement kilns. In order to deepen the exchange and cooperation on co-processing of wastes in cement kilns between China and Norway, and based on the outcomes of project Phase I, both parties deeply developed the Phase II, which lasted from 2011 to 2018. In Phase II, the guidelines and standards for cement kiln co-processing developed in Phase I were verified and improved, the capacity building for monitoring and supervision and operation of waste co-processing was carried out, wider information dissemination was conducted to improve recognition of co-processing enterprises and governmental authorities about feasible and limiting factors of co-processing in cement kilns, the information basis of pretreatment and pollution control technology were established, and the advanced environmentally sound management of solid wastes was achieved to further enhance China's capacity of Stockholm Convention and Basel Convention implementation. For phase I and II, the total financial contribution from MFA is NOK 14,500,000 and 18,610,000 respectively.

The cooperation between Norway and China is based on a MoU between MFA and MOFCOM on technical cooperation stating that "projects in technologically and geographically most needed areas in China will be given priority, within the field of environment and climate…". The priorities for cooperation are further outlined in the MoUs between the Environmental Ministries of the two countries. The first MoU was signed in 1995 and then later replaced by a new MoU in 2008. The objective of the present MoU is "to promote cooperation between the Parties in the field of environmental protection and sustainable development on the basis of equality and mutual benefit." The MoU outlines the following priority areas for cooperation on environmental policy and management: (main priority areas for this project corresponding with the MoU priorities in italics) (1) Water and air pollution; (2) **Waste disposal and management**; (3) **Chemicals and hazardous waste**; (4) Nature conservation, biological diversity and natural resources; (5) **Climate change issues**; (6) The integration of environmental concerns into sector policy; (7) Public environmental awareness; (8) **Environmental industry and technology**; (9) Other areas as mutually agreed upon.

Desk Study Project on" Roadmap to meet 30 percent renewable energy share in China by 2030"
The purpose of the project was to produce a reference document that will guide the government in its efforts to further the use of renewable energy in the overall energy mix. The study built on previous work that contributed to setting renewable energy government targets for 2020.

Other relevant cooperation projects in the field of climate change and environment protection are:

Norway-China bilateral project on Capacity Building to reduce mercury pollution
Completed in 2009. NIVA was a Norwegian partner in the first international collaboration with China on mercury pollution. The project has made the Chinese see the value of supporting international negotiations on a global mercury agreement.

Sino-Norwegian Cooperative Project on Persistent Organic Pollutants (POPs); Capacity building on implementing the Stockholm Convention

Urban Atmospheric Multi-Pollutant Prevention and Control in China

Other relevant Norway-China bilateral cooperation agreements are:

Norway-China bilateral cooperation agreement in science and technology
Signed in June 2008 between Norwegian Ministry of Education and Research and Chinese Ministry of Science and Technology (MOST). The key cooperation fields are environment protection, climate change, renewable energy, polar research, ocean science, aquaculture, life science etc.

1.3.2. Commercial cooperation between Norway and China in the process industry

Many Norwegian process industry players have been doing business in China decades ago. Companies like Elkem, Hydro, Yara etc. are well established in China. Innovation Norway China office was involved in some of the business cases which are briefly listed below.

Elkem:
Meeting arrangements with Chinese authorities and research institutes on promoting micro-silica related products.

Tomra
Seeking cooperation partners and promoting of municipal solid waste (MSW) handling systems, reverse vending machine (RVM) and relevant technical cooperation. Tomra is also engaging in the ocean plastic pollution control projects.

BecoTek AS
Establishment in China and searching for production site of bronze processing.

Johnson-Metall AS
Manufacturing partner search in China for bronze parts.

Cambi
A leading sludge treatment system for wastewater treatment both for industrial and municipal applications.

NEO MONITORS
Supplying laser-based gas analyzer for real-time monitoring systems applied to steel industry and environmental protection projects.

Lattix AS
Assisting in business talks with local partners and customers for the application of its passive safety and frangible mast solutions in airport/aviation market segment.

1.4 Influence from the trade war with US-in China's perspective

2019 can be described as a trend toward a combination of protectionism and deglobalization, and even made worse by the COVID-19 and US-China trade war. The US-China Trade war is increasingly becoming a cold war which has brought fundamental influences towards Chinese process industries.

Export and import
The export to US market is becoming increasingly difficult for Chinese manufacturing. Lots of final products to US were influenced by the high tariff, and consequently affected the upstream process industry. The market demand also reduced significantly due to economic recession and COVID-19.

The import from US to China, especially high-tech products becomes more and more difficult. For those products that US expected to export to China, for example soybeans, met the countermeasures of tariff from Chinese side, thus China had to seek for soybeans from other countries to meet with huge domestic demand.

The drop of oversea orders in the first half of 2020, made worse by the pandemic situation, brough a sharp drop for Chinese process industries, especially to those rely on export, or suppliers to export industries.

It's also difficult for the domestic market to play the role of "rebalancing" within a short period, due to the impact from COVID-19. Fortunately, after the pandemic situation in China get controlled in April, the whole society had been brought back on its track, and its economic is recovering rapidly. More information can be found at 1.5

M&A and investment

China's oversea M&A and OFDI dropped sharply in 2020, which has reached the lowest level in the past ten years. For example, its M&A in Europe has dropped 65 percent YoY in the first half of 2020. To most peoples' surprise, China's M&A in US increased 15 percent with 4.18 billion USD, mainly due to a large M&A in fintech field. Chinese process industry which is facing the challenge from the trade-war and COVID-19, concentrated more on keeping normal operation instead of expansion.

In the recent announcement from the US government, some large Chinese process industry SOEs such as ChemChina and SinoChem were placed on the "Entity List", which means their import and oversea investment will be strongly influenced by American intervention. Some large Chinese construction SOEs were also included into the list, such as China State Construction Group Co., Ltd. and China Communications Construction Company. It will influence their construction and engineering contracts in US and Europe, but not too much in Asia and Africa.

In September 2020, China MOFCOM also issued Provisions on the Unreliable Entity List, aimed at foreign companies endanger its national sovereignty, security or development interests, as a countermeasure against the United States.

Fig. 1.4-1 Most European companies remain committed to China

Source: European Chamber, Business Confidence Survey 2020

Some Chinese process industrial companies have selected to move to other east Asian countries, especially to Viet Nam and Cambodia, to avoid the tariff for exporting to US. Thailand and Indonesia also benefited by this transfer, and furthermore, Myanmar, Malaysia, and The Philippines.

US and Japan government provided subsidy to their companies in China to move out from this country, after the outbreak of COVID-19, as they hope can reduce their rely on Chinese manufacturing, because during the pandemic period, many countries found their medical supply relies too much on Chinese production. But as the supply chain is already here in China, it's not easy for a company to move out of this country where with qualified labors, efficient supply chain and a huge market.

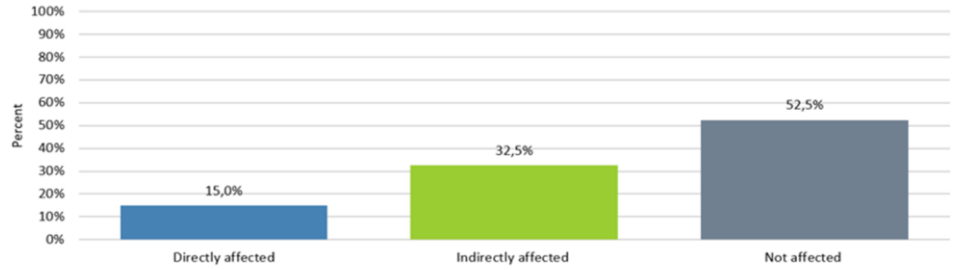
Some US and Japanese companies did move out of China with subsidy from their government, but there are also some companies invested into China simultaneously, like Tesla's EV plant in Shanghai. From the Survey of EUCCC, most European companies in China keep confidence in China.

Production and Cost

For process industry, after the outbreak of the trade-war, some of the supply chain to china process industry had been impacted, especially those high-tech products from the US or controlled by the US. The US government had banned many high-tech exportations to Chinese process industries, if any US technology had been used in the products, for example the high-level chips for mobile phone production. The prohibition has global influence, TSMC in Taiwan had to stop its 5 nano chip supply to HUAWEI in the middle of Sep, which will affect the production of HUAWEI's new version of mobile phone.

Higher tariff will also cause some production cost increasement to Chinese process industry thus will change the situation of the global competition. The prohibition towards technology export to China will stimulated the Chinese investment in R&D.

Fig. 1.4-2 How your business in China **has been** affected by the escalation of the ongoing China-US Trade war

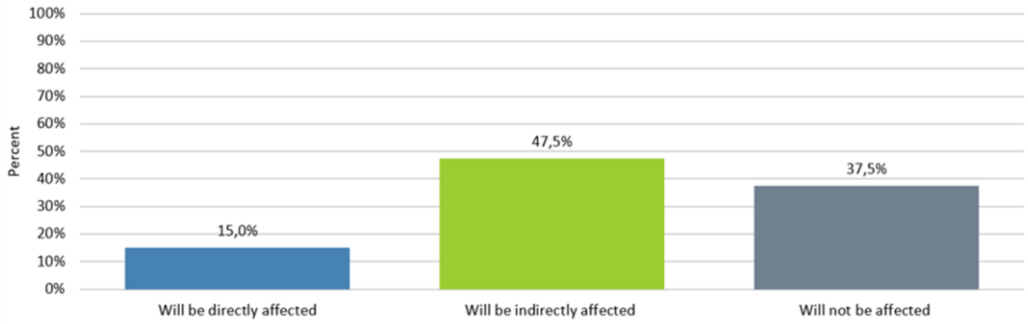


If your business has been affected, please specify in what ways:

exporting
we are seafood company exporting white fish to China, Cod, Haddock, Saithe, Red fish and Halibut etc, these raw materials normally will be processed in China and reexport to other countries for instance US market, these products will be lavied at extra tax in US. The export of these products volume to China might be influenced, we will closely monitor the market trend.
there is an effect on the cargo/passenger flow worldwide, which has indirect effects on the vessel type we provide.
as we do import goods from our manufacturing plants in USA
Export volume to US is significantly decreased since 2018.
General uncertainty and slowing of business affects overall demand and budgets.
Market access

Some foreign invested process industry based in China, but export to US, also impacted by the traded war.

Fig. 1.4-3 How your business in China **will be** affected by the escalation of the ongoing China-US Trade war



If your business will be affected, please specify in what ways:

our end customers exporting business
less cargo / passenager flow worldwide.
our US made products would be taxed heavily or restricted for public procurement
Export volume will be less than today.
See previous.
Delayed market access

Source: Market Survey of Norwegian Companies in China, 2019 by Innovation Norway China

EU-China cooperation

The EU-China relationship became strategically important after the trade-war started. China is trying to seek more cooperation with Europe to reduce the negative influence from the trade war with the US and take EU as its strategic partner in business cooperation. Many Chinese process industry is seeking to transfer their export to Europe from US. Actually, it is fairly difficult for this year because EU's economy was impacted seriously by the pandemic and was struggling for recovery. The influence of the trade war not only affected Chinese and American business, but also spreading to

other countries. The best strategy China can take is continuously open to the world. EU as the largest economy outside the US, will be critically important to China. An EU-China leaders meeting was held on the 14 September 2020 via videoconference with attendance from Charles Michel, Angela Merkel and Xi Jinping. The meeting follows the 22nd EU-China summit held by VTC with Prime Minister Li Keqiang and the VTC with President Xi Jinping on 22 June 2020. Climate change, economic and trade issues, as well as COVID-19 pandemic were discussed. Both parties Committed to the completion of the *EU-China Comprehensive Agreement* negotiation within the year.

Some measures from China

The long-lasting trade war has caused China economic loss on its international trade sector, which has been driving China's economic growth for decades. Following measures were taken by Chinese government,

- Explore and develop domestic market: internal circulation
- Explore and develop oversea market: dual circulation
- Upgrade industry, from low value added to the high-tech and environment-friendly industries
- Enlarge open to the world, open more market to attract more foreign investors

If the trade war continues and develops into a cold war, even decoupling US with China, the situation of Chinese process industry will be more difficult, and its influence will be transferred to the whole supply chain, as well as to other part of the world.

The trade/cold war triggered by US is becoming increasingly unpredictable. The US are taking measures globally against China, even considering decoupling from China. The US president election in November 2020 will be a key time node for its further development.

1.5 Influence from COVID-19

According to statistics from the China NEA, in the first two months of 2020, industrial electricity consumption was 622.1 TWh, down 12 percent year-on-year. Major influence on process industry is regarding the resumption of work and production as the widespread panic and outbreak prevention measures have affected most labor-intensive production activities. It will take some time for the central government's subsidy plan to reach affected enterprises at the local level. With the spread of the pandemic and weakened international shipping capacity, many export-oriented companies are suffering from a decrease and cancelation in overseas orders.

Supply chain

According to the survey to 8,169 enterprises in China by US Chamber of Commerce of China, 47 percent are facing the break of supply chain within China, and 17 percent globally. The center of COVID-19, Hubei province is an important manufacturing base in China, many process industries were influenced when Hubei province was locked down from February.

The strict control of transportation both globally and domestically during the pandemic period also impacted the supply chain. Many process industries were struggling with raw material, spare parts and equipment supply for their production. According to Mining Weekly, there were 275 large mines stopped their operation due to the pandemic globally, some non-ferro metal production which depending on the import raw materials, such as copper and nickel, were mostly influenced.

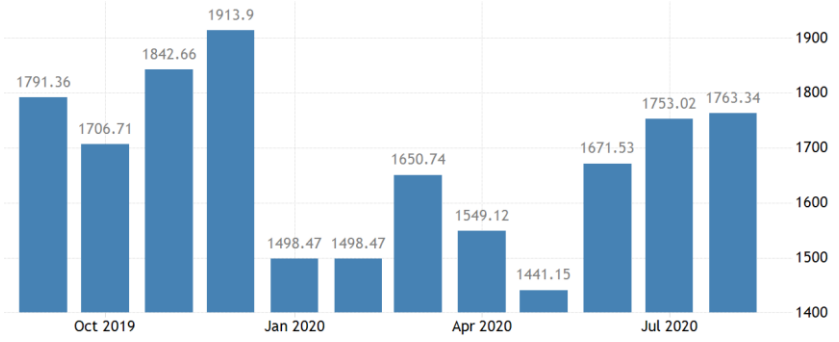
This situation has gradually eased with China's control of its epidemic, and by June 2020, the supply had almost returned to normal. The Caixin China General Manufacturing PMI rose to 53.1 in August 2020 from 52.8 in the previous month, beating market consensus of 52.6. The latest reading pointed to the biggest improvement in the health of the sector since January 2011, adding to signs of an economic recovery after the pandemic hit the economy earlier this year. Output and new orders grew by the most since the start of 2011 with new export sales rising for the first time since December 2019.

Market demand, import and export

Due to the strict measures taken by both China and other countries against COVID-19, the market demand for final products dropped quickly. This kind of decline transferred to Chinese process industry rapidly. The sharp reduction in the frequency with which people travel and use cars led directly to a collapse in domestic consumption of refined oil products by at least 80 percent in February. Falling consumption of refined oil products will affect the overall benefits of upstream refineries.

At the same time, in some petrochemical industry sub-sectors, China's external dependence is high, the outbreak increased these products import difficulties in a period, and thus affect the development of related industries. For example, China's import dependence on polycarbonate as high as 70 percent, which is widely used in auto parts, consumer electronics, household appliances, medical equipment and other fields of materials.

Fig. 1.5-1 China import Sep-2019-Aug 2020

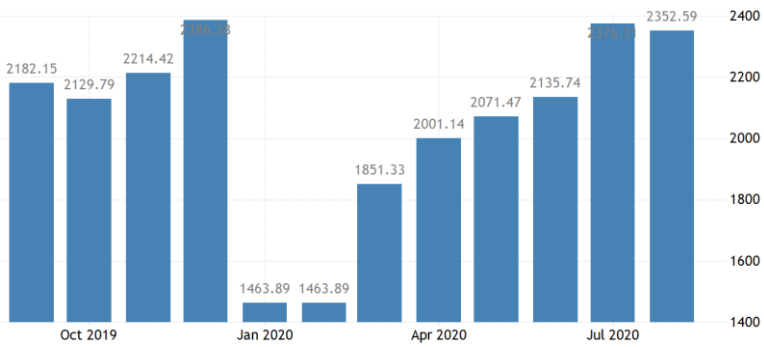


Source: Trading Economics, General Administration of Customs

Imports to China fell by 2.1 percent YoY to USD 176.3 billion in August of 2020, following a 1.4 percent drop a month earlier. This was the second straight decline in imports, due to weak domestic consumption. Compared to the previous month, imports fell for major commodities including crude oil, iron ore and soybeans. Imports of copper were down 12.3 percent from a record high in July but were still up by 65.5 percent from a year earlier. Imports of crude oil were 47.48 million tons in August, down from a record high in July but increased 12.6 percent from a year earlier. Iron ore imports fell 10.9 percent to 100.36 million tons, easing from a record high on fewer shipments from big miners and port congestion, but were still 5.8 percent higher over a year earlier.

In August of 2020, exports from China soared 9.5 percent year-on-year to USD 235.3 billion, above market forecasts of a 7.1 percent growth and after a 7.2 percent rise a month earlier. This marked the third straight month of increase in overseas sales and the fastest rate since March of 2019, amid further improvement in global demand as more countries lifted coronavirus-led restrictions. Chinese exports have been boosted by record shipments of medical supplies and robust demand for electronic

Fig. 1.5-2 China Export Sep-2019-Aug 2020



Source: Trading Economics, General Administration of Customs

products. Sales of refined products increased 33.1 from the previous month and those of unwrought aluminum and products went up 6.87 percent. In contrast, shipments fell for steel (-0.62 percent), rare earths (44 percent) and grains (-36.77 percent). Exports to the United States rose 20 percent to USD 44.8 billion while those to the European Union declined 20.1 percent to USD 35.7 billion.

Human resources

The migrant worker takes a dominant proportion in the process labor market. Many of these workers were still in their hometown, rural areas when the strict control measures were put in place. They were stopped at home while process industry was lacking workers. When the COVID-19 peak passed, economic recovery started.

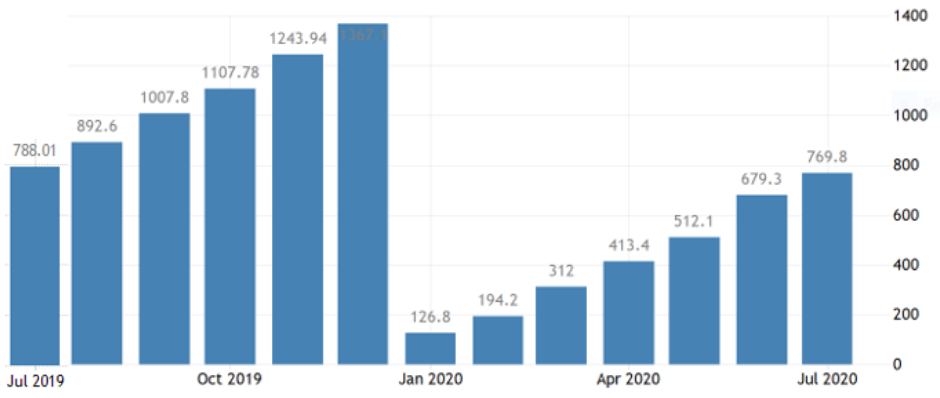
According to Caixin PMI index, buying activity continued to increase, while staffing levels fell fractionally, hinting that employment was close to stabilization as firms registered a further increase in backlogs of work. On the price front, both input costs and output charges increased at a softer pace. Finally, business optimism eased to a three-month low less. More information can be found at chapter 2.3

FDI

In the first four months of 2020 FDI into China dropped 6.1 percent year-on-year to CNY 286.55 billion, due to the Covid-19 outbreak. Still, investment in the high-tech service industry rose by 2.7 percent. Among them, information services, e-commerce services, and professional technical services increased by 46.9 percent, 73.8 percent, and 99.6 percent respectively.

Meanwhile, the investment from countries along the Belt and Road went up by 7.9 percent, and that from ASEAN countries rose by 13 percent. But the investment from the EU dropped by 29.1 percent. In April only, the FDI surged 11.8 percent from a year earlier as a signal of its economic recovery. In the period of Jan-May, the YoY drop declined to 3.8 percent, and during Jan-Jul, only 1.3 percent.

Fig. 1.5-3 FDI into China July 2019-July 2020



Source: NSB, MOFCOM

Support policy from Chinese government

In dealing with the COVID 19, Chinese government had issued series of policies and measures to support enterprises to resume production amid the outbreak. Process industries benefited from this, especially the policy for financial support, tax and cost reduction.

Table 1.5 Policies and measures issued to support enterprises to resume production amid the outbreak		
Policy Category	**Main Content**	**Key Points**
Financial Support	Encourage relevant entities to provide preferential loans, approve loan extension, and lower loan interest rates for SMEs	Measures (e.g. adjusting repayment methods, moderately lowering interest rates, offering loan extension and renewals) to help SMEs who face temporary difficulties but still have solid development prospects; measures to increase the first loan ratio23 and proportion of credit for SMEs.
Preferential Taxes	Reduce or exempt SMEs from VAT and other taxes	1. From March 1 to May 31, 2020, small-scale taxpayers in Hubei Province, should be exempted from VAT on taxable sales revenue if their tax rate is at 3%. For projects applicable for a 3% prepaid VAT rate, the prepaid VAT should be suspended. Small-scale taxpayers in the rest of the country will pay a lower VAT rate (pre-paid VAT rate) of 1% for taxable sales revenue (or pre-paid VAT projects) if their rate is set at 3%. 2. Production and donations that support the outbreak prevention and control shall be exempted from VAT. 3 The longest carry-forward period for losses of enterprises in the transportation, catering, accommodation, and tourism sectors is extended from five to eight years.
Preferential Social Insurance Policies to Support Work and Production Resumption	Support employees with flexible work arrangements, exempt or reduce social insurances contributions	1. From February to June, SMEs can be exempted from endowment, unemployment and work-related injury insurance premiums in all provinces, except Hubei. Large enterprises can pay half of the premiums from February to April. All participating enterprises in Hubei Province are exempted from insurance premiums from February to June. 2. As of February, under the premise of ensuring the medium and long-term balance of funds, a 50% reduction of the employee medical insurance paid by employers will be implemented for no more than five months.
Service Optimization	Organize free skill training, simplify procedures and postpone the deadline for tax declaration and payment	1. Organize Micro-Lecture Online Training for Enterprises, encourage SMEs to attend the online training and provide them with support in terms of policies, technology and management. 2. For taxpayers and withholding agents that declare and pay taxes monthly, the legal deadline for February tax declaration and payment was postponed to February 24, 2020. In Hubei and other regions hit hard by the outbreak, the deadline may be further postponed in accordance with local conditions. Taxpayers and withholding agents may apply for further postponing the deadline.
Reduction of Costs	Reduce the electricity and natural gas rates, temporarily return part of tourism service quality deposit to travel agencies	1. From February 1, 2020 to June 30, 2020, power grid enterprises will charge electricity users (including common industry and commerce electricity users, large industry, and those engaged in market deals, excluding high-consumption electricity users) 95% of the original electricity rate. 2. Gas stations for non-residents will implement the pricing for off-season. Chemical fertilizer and other sectors related to spring ploughing shall be provided with more preferential pricing policies. 3. The tourism service quality deposit is be temporarily returned to tourism agencies.

The COVID-19 greatly **promoted E-commerce** in China and **accelerated the digitalization** in Chinese government and process industries. More information can be found in chapter 5.6.

2. Government influence on China's process industry

2.1 Policies and regulations

In the year 2019, China was listed as No. 100 in the Index of Economic Freedom among other countries, while Norway was listed No. 27. However, Hong Kong as a Special Administration of China was continuously the No.1 for 19 years long in the list, but was replaced by Singapore in 2020, with China listed No. 103. The Chinese governmental regulation to process industry is in all aspect, from the pre-approval to liquidation, from water usage to human resources etc. The reformation of Chinese government always focused on the simplification of administration process, release the power to lower level of governments or directly back to market, which was considered as part of the liberation to the economy.

From approval to negative list and encourage catalogue

From 2018, China has started the implementation of "Negative lists" instead of former complex approving system. This is a significant reformation from the central government to process industries. The negative list had been updated in 2020, with shorted by 17.5 percent from the 2019 edition, which took effect on July 23, 2020. Full list in Chinese available here:

The Special Administrative Measures on Access to Foreign Investment (2020 edition)

Besides the negative list, there is Catalogue for Market Access which also applicable to all foreign and domestic stakeholders, took effect on the 1st, January of 2020. Unlike the FI negative list, which only applies to foreign companies, the above list standardizes market entry rules for all players, including state-owned firms, private companies, joint-ownership firms, and foreign firms. The newest MA negative list was issued in October 2019 and divided industries into two categories – "prohibited" and "restricted" industries. Of the 131 items on the MA negative list, five are completely prohibited and the rest of the 126 sectors are restricted, requiring government approval.

The list not only outlines prohibitive regulations, but also required technical standards and qualification criteria to enter restricted market, and the government departments in charge of each industry, filed or business. Sectors that are omitted from the list are considered "permitted" industries, meaning that both domestic and foreign entities can enter on an equal footing and theoretically do not need an approval process.

The MA negative list was first piloted in 2011 across several cities, including Shanghai, Tianjin, Fujian, and Guangdong province, before being expanded to 11 more provincial regions in 2017. The list was then finally applied to the whole country in 2018 and annually updated in 2019. NDRC is in the process of updating it in 2020 by inquiring to the society.

Catalogue for Guiding Industry Restructuring

The most recent *The Catalogue for Guiding Industry Restructuring (2019 edition)* was released in 2019. It is an important reference basis for Chinese governments to manage local investment projects and formulate fiscal, tax, credit, land, import, and export policies to various sectors. Similar to the MA negative list, the *Catalogue* applies to all businesses. But this catalogue is more comprehensive and reflects China's policies on the overall industrial restructuring. The guidance catalogue includes three categories – "encouraged", "restricted", and "obsolete" sectors. Among them, "obsolete" sectors cause huge wastes of resources, serious pollution to the environment, and practices unsafe production.

Local governments are enabled to take measures, such as withholding loans from financial institutions, to eliminate those sectors. Foreign investors should avoid projects falling under this category. The "restricted" sectors either adopts backward technologies that causes waste and damages to the environment or is not conducive to the optimization and upgrading of industrial structure.

Government policies will curb the development of projects in this category. Foreign investors should keep an eye on policy changes in these areas.

The FI encouraged catalogue

Opposite to the negative lists, there is also the "positive list" or "encouraged catalogue". Foreign capital is encouraged to enter the sectors listed in *The Catalogue of Encouraged Industries for Foreign Investment 2019* (Full list in Chinese). The 2019 editions took effect on July 30, 2019. The FI encouraged catalogue is a list of industries where foreign investment is welcome and may be able to enjoy preferential treatment from respective local governments, such as through tax incentives, streamlined approval procedures, and discounted land prices.

The 2019 FI encouraged catalogue consists of two sub-catalogues – one applies to the whole country and one is applicable to 22 provinces in China's central, western, and northeastern regions ("FI encouraged catalogue in the central and western region"). The FI encouraged catalogue for the central and western region was first released in 2000 and the 2019 edition of this regional catalogue is the fifth revision. The national encouraged catalogue, however, is derived from the "encouraged" category of *the Catalogue of Industries for Foreign Investment (2017 revision)* and was updated in 2019.

Test of policies and regulations

Due to the complexity of administration and large scale of industries, as well as geographical differences, China's industrial policy often takes a regional or small-scale of pilot to test, comprehensive promotion will only occur after successful experiences had been proved. For example, initiated from 1998, with two phases of "Natural Forest Protection Program" and nearly 360 billion Yuan of continual funding, China National Forestry and Grassland Administration had been continuously enlarging the area of termination commercial logging started from Heilongjiang and Jilin province with pilot policies. Until 2017, the policy implemented to the whole country finally, with more than 6 million jobs had been rearranged to keep the employment. Process industries like wood processing, paper manufacturing, furniture etc. were influenced fundamentally, while import of timber increased.

Special Economic Zones (SEZ) and National New Areas (NNA)

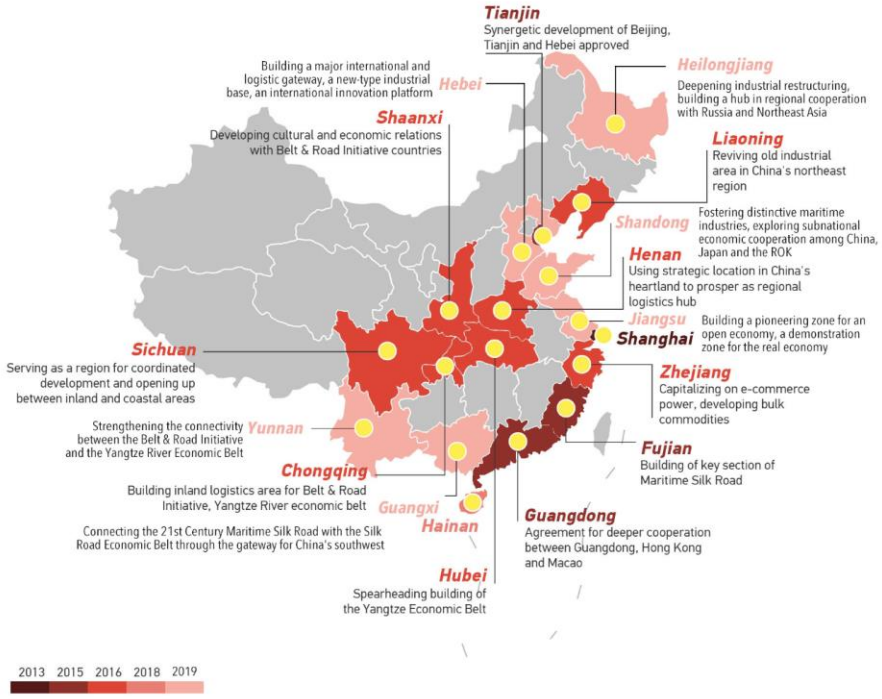
Some trial industrial policy will be tested or piloted in the Special Economic Zones (SEZ) or Industrial Parks. Till 2019, there are totally 628 national-level development zones in China and 2,053 provincial development zones, as well as more than 15,000 industrial parks of all kinds, contributing more than 30 percent to the entire Chinese economy. Shenzhen, as one of the four first tier city in China (the other three are Beijing, Shanghai and Guangzhou) was developed from a small village some 40 years ago, started as the first SEZ in China, now developed into a dynamic modern city with more than 13 million inhabitants. There are officially seven SEZ announced by the central government, the other six are: Zhuhai, Xiamen, Shantou, Hainan, Kashi and Huoerguosi. Besides SEZs, there are 19 National New Areas in China who also have the privilege of pilot policies, including Shanghai Pudong New Area and Binhai New Area in Tianjin. The last National New Area announced in 2017 is Xiong An New Area nearby Beijing, in which a pilot green smart city with 5 million inhabitants will be built up within 10 years.

China Free trade Zones (FTZ)

China keeps on its steps of opening to the world. In 2013, China has built up its first Free Trade Zone (FTZ) in Shanghai. Till the end of 2019, there are 18 FTZ totally in China that covered most of the industrial and advanced region of the country. Special policies including zero tariff had been implemented in these FTZs. Many favorable policies were issued to promote these FTZs, especially on tariffs, e.g. *The Free Trade Zone Special Administrative Measures on Access to Foreign Investment*

(2020 edition Chinese).The negative list for FTZ had been reduced 18.9 percent from the 2019 edition, the 2020 edition took effect from July 23, 2020.

Fig. 2.1-1 China Free Trade Zone



Foreign businesses located in the pilot FTZs should first examine the 2019 FI FTZ negative list to check whether the investment is permitted at all in a sector or through what ownership structure is the investment allowed. Subsequently, they must check the 2019 MA negative list to see if any further licensing or certification requirements are required. Finally, they must refer to the 2019 guidance catalogue to see if their specific technology, equipment, and products are blocked in the country.

Free Trade Agreement (FTA)

More than 20 countries/regions had signed FTA with China, with 13 (including Norway) under negotiation and 8 under consideration. Norway-China FTA was initiated a decade ago, the No. 16 round of FTA negotiation between was held in Wuhan in September 9-12, 2019. On September 11, 2020, China and Norway held a video negotiation on FTA, issues such as trade in services, trade relief, competition, e-commerce, IPR, environment etc. had been discussed. It was expected to be signed by the end of 2020.

Table 2.1-1 China Free Trade Agreement (FTA)		
FTA Signed	**Under Negotiating**	**Under Consideration**
China-Mauritius FTA	Regional Comprehensive Economic Partnership, RCEP	China-Colombia FTA Joint Feasibility Study
China-Maldives FTA	China-GCC (Gulf Cooperation Council) FTA	China-Fiji FTA Joint Feasibility Study
China-Georgia FTA	China-Japan-Korea FTA	China-NePal FTA Joint Feasibility Study
China-Australia FTA	China-Sri Lanka FTA	China-Papua New Guinea FTA Joint Feasibility Study
China-Korea FTA	China-Israel FTA	China-Canada FTA Joint Feasibility Study
China-Switzerland FTA	China-Norway FTA	China-Bangladesh FTA Joint Feasibility Study
China-Iceland FTA	China-New Zealand FTA Upgrade	China-Mongolia FTA Joint Feasibility Study
China-Costa Rica FTA	China-Moldova FTA	China-Switzerland FTA Upgrade Joint Feasibility Study
China-Peru FTA	China-Panama FTA	
China-Singapore FTA	China-Korea FTA second phase	
China-New Zealand FTA	China-Palestine FTA	
China-Chile FTA	China-Peru FTA Upgrade	
China-Pakistan FTA	China-Cambodia FTA (negotiation completed)	
China-ASEAN FTA		
Mainland and Hong Kong Closer Economic and Partnership Arrangement		
Mainland and Macao Closer Economic and Partnership Arrangement		
China-ASEAN FTA Upgrade		
China-Chile FTA Upgrade		
China-Singapore FTA Upgrade		
China-Pakistan FTA second phase		
Source: China MOFCOM		

Regulations and improvement

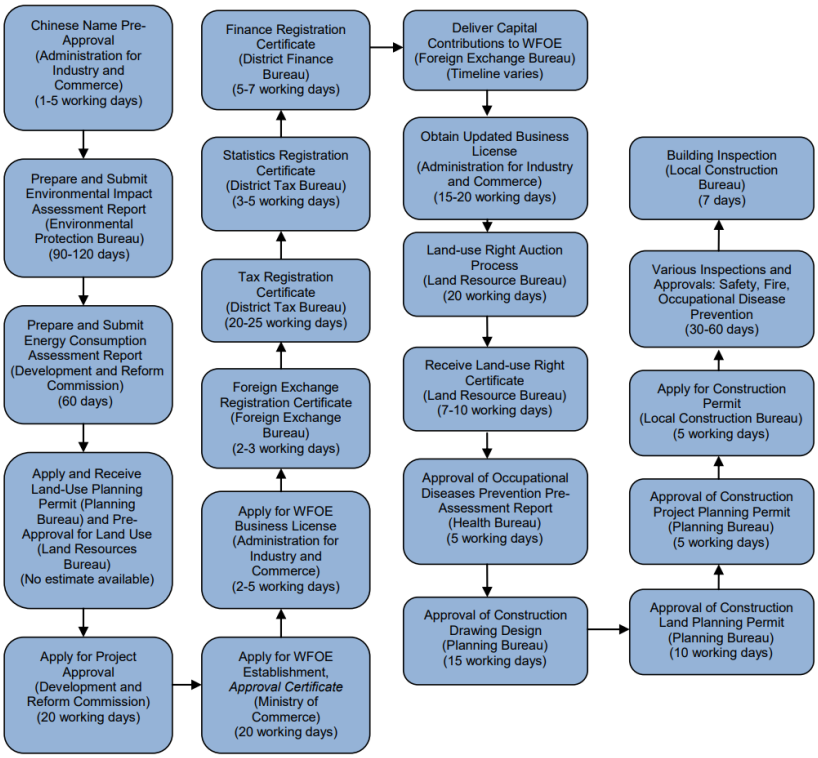
The influence from the government to process industry is significant in China. Both central and local governments have some favorable industries to develop and some dis-favorable to limit. The Chinese government's industrial policy is constantly adjusting to meet the needs of the market, from 2018 onwards, the industrial investment policy has been changed to a negative list system instead of Approval system. As long as the industry is not on the negative list of regulation, greatly improve the freedom and efficiency. There is a negative list in the MOFCOM and NDRC for national level from 2018, and each local government has some prohibitions among it. Before 2018, companies must follow the complex process of application to build up their business in China, as follows,

Pre-approval (name etc.)	*Air pollution and emissions*
Land, site selection (red line)	*Waste, hazardous and noxious substance*
Environmental Protection	*Fire control*
Water usage	*Prevent lightning*
Electricity usage	*Construction Permission etc. (if needed)*
Wastewater treatment	*Civil air defence*

Others (different industries, regions have different regulations)

A typical application process for a WOFE made by the US Chamber of Commerce with estimated time consuming is shown in Fig. 2.1-2.

Fig. 2.1-2 Process for an WOFE application in China in 2016

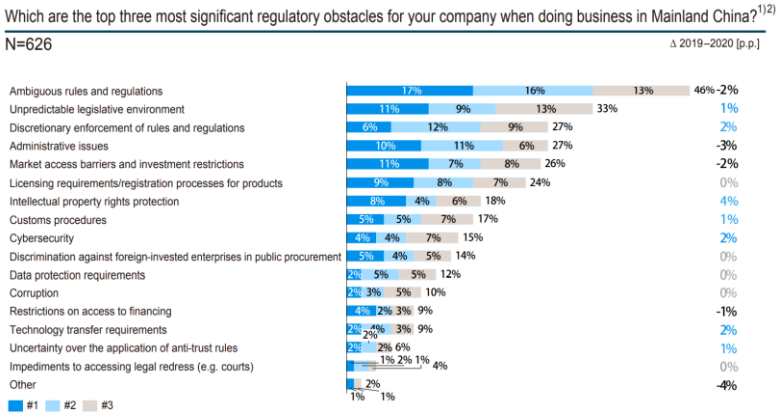


Source: China's Approval Process -US Chamber of Commerce

In recent years, the situation has been improved a lot. In fact, in some SEZ, FTZ or even local industrial parks, all government branches concerned with business registration or approval were gathered in an administration hall to work jointly as "one stop solution" model. Application can be treated rapidly with immediate responses. Some business can be registered even within 1-3 days.

In 2020, EUCCC took a Business Confidence Survey within the European companies in China. In their answer towards regulatory obstacle, Ambiguous rules and regulations, unpredictable legislation and discretionary enforcement are the main obstacles for European business.

Fig. 2.1-3 Ambiguous rules and regulations, unpredictable legislation and discretionary enforcement are the main obstacles for European business



Note: 1) Figures represent the proportion of respondents who rated each issue their #1–3 most significant regulatory obstacles. 2) Percentages divided by number of respondents

Leading policies: New Infrastructure Program

Besides policy pilot and regulation, the China industrial policy also plays a role in guiding the industry into the sectors promoted by the government.

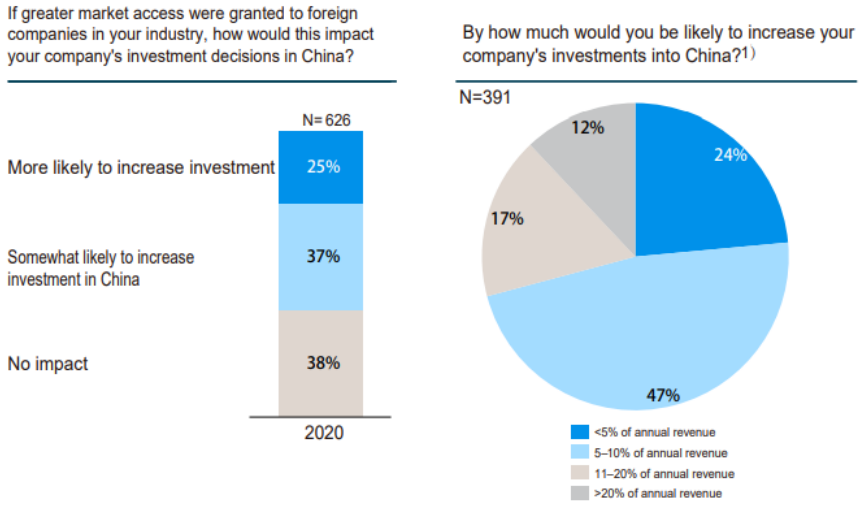
China launched the "New Infrastructure Campaign" in March of 2020 in order to offset the economic impact of the coronavirus pandemic and boost sustainable growth. In the coming years, about 34 trillion yuan will be invested into the following 7 fields:

5G networks	*Artificial intelligence*
Industrial internet	*New energy vehicle charging stations*
Data centers	*Ultra-high voltage transmission Grids (UHVs)*
Inter-city transportation and inner-city rail systems	

Analysts says that soon, some metals' production and demand will increase, such as copper, aluminum and cobalt. PPP model will play an important role in the implementation of this strategic policy.

The European companies in China also expect a more opening policy towards industry access, as the following Business Confidence Survey demonstrated.

Fig. 2.1-4 EUCCC Business Confidence Survey 2020



Note: 1) Asked only if the answer to "If greater market access were granted to foreign companies in your industry, how would this impact your company's investment decisions in China?" was not "No impact".

With the influence from pandemic and US trade war, China will be more open to the world, especially to Europe. On 28 July 2020, Chinese Vice Premier Liu He had an online meeting with European Commission Executive Vice President Valdis Dombrovskis for the 31st round of EU-China Comprehensive Agreement on Investment. It was mentioned that China and the European Union will accelerate negotiations in order to conclude a China-EU investment agreement by the end of this year. China and the EU will also continue to strengthen macro-economic policy adjustments and implement effective fiscal and monetary policies to push forward global economic recovery.

2.2 Tax

Enterprises in manufacturing industry may be charged up to 17 taxes in China. Some of these such as Corporate Income Tax (CIT) had relatively long history but the law on the tax had been amended and revised many times to adapt to the national economy development and to adjust according to the changes of the industry policies. Some were very newly introduced such as the Environment Protection Tax to comply and implement the political agenda on tackling environmental challenges.

Taxable objects identify of taxpayers, tax rates, tax collection measures and possible deduction or exemptions were explicitly regulated by respective laws on different taxes. Company types, location, scope of business activities, property, resources and pollutions discharged etc. – these variables result in the total tax burden for a specific company.

Based on different taxable objects, Chinese taxes can be divided into six categories:

1) Taxes on income: Corporate Income Tax (CIT), Individual Income Tax (IIT)
2) Turnover taxes: Value Added Tax (VAT), Consumption Tax (CT), Customs Duties (tariffs)
3) Taxes on resources: Resource tax; Urban and town land use tax
4) Taxes on properties: House Property Tax, Deed Tax (Contract Tax), Motor Vehicle and Vessel Taxes
5) Taxes on purpose and conducts: Farmland Occupancy Tax, Land Appreciation Tax, Stamp Tax, Urban Maintenance and Construction Tax, tax for vehicle purchase, shipping vessel tonnage due
6) Environmental Protection Tax

2.2.1. Corporate Income Tax (CIT)

The rate of corporate income tax (CIT) has been uniformly regulated at either 20 percent or 25 percent according to the "CIT Law" which took effect at the end of 2018. The law applies to both Chinese companies, foreign invested enterprises (FIEs) in China and foreign companies without legal entities in China.

CIT law has openings for tax deduction and/or exemption for companies engaged in industries or projects the development of which is specially supported and encouraged by the Chinese government. The preferential treatment on CIT deduction or exemption are subject to policies, laws and regulations at central and local administration levels. Companies whose income tax preferences are offered under the terms and conditions of geographic locations (administrative regions or special economy zones), industry sectors, taxpayer's status, technology level, environment protection and energy saving projects, expenses on R&D, social responsibilities etc.

As enterprises in the process industry concerned, the CIT on following incomes may be exempted or reduced:

- Income from eligible environmental protection, energy saving or water conservation projects;
- Income tax on "High-and-New Technological Enterprises" needing special support of the state shall be reduced to 15 percent;
- The autonomous authority of a national autonomous region may decide to reduce or exempt the portion of corporate income tax payable by enterprises in such area, which is to be shared by local government;
- The income earned by an enterprise from the manufacturing of products in conformity with relevant industrial policies of the state through comprehensive use of resources may be deducted when calculating its taxable income.

- The investment by an enterprise in the purchase of special equipment for environmental protection, energy saving, water conservation and work safety may offset the amount of tax payable at a certain ratio;
- Weighted deduction may be applicable to the following expenditures of an enterprise for calculating the amount of taxable income:
    - Research and development expenses incurred in the development of new technologies, products or techniques; and
    - Wages paid to the disabled employees or other employees the employment of whom is encouraged by the state.
- Where accelerated depreciation of the fixed assets of an enterprise is necessary due to technological advancement or other reasons, the number of years for the depreciation may be lessened or the accelerated depreciation method may be adopted.

"High-and-New Technological Enterprises" mentioned above refer to the resident enterprises that continuously engage in the research and development as well as transformation of technological achievements in the "*High and New Technology Sector under the Key Support of the State*", have formed their own independent core intellectual property rights and carry out business activities based thereon and have been registered within the territory of China (excluding Hong Kong, Macao and Taiwan regions)

257 specific fields under 8 sectors were designated by the government as "high and new technology sectors". Quite a few of these are in the process industry.

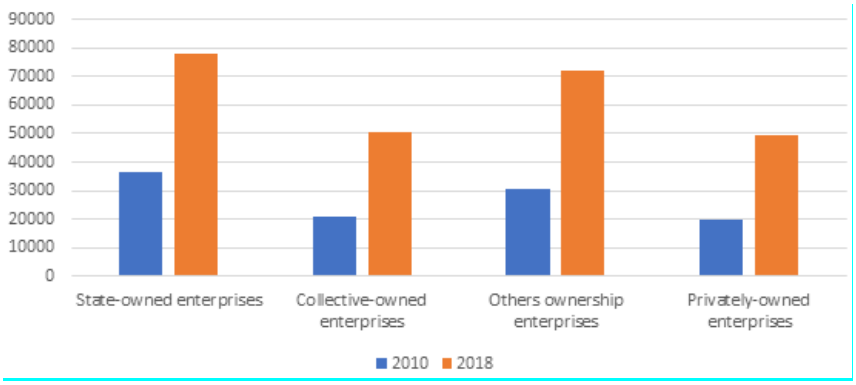
- Clean production and deep-processing technology of aluminum, copper, magnesium, titanium and alloys
- High quality production technology of rare metals and rare earths
- Nano materials and new powder metallurgy materials, production and application technology
- New metallic materials and metal-based composite materials, production and application technology
- New semiconductor materials-graphene, large-size monocrystalline silicon, OLED, GaAs/Si material production; distillation of high purity metal gallium, indium, arsenic, germanium, phosphorus, cadmium semiconductor etc.
- Superconducting material, high efficiency battery materials
- Materials used in energy saving and new energy sector, production technology
- Environment friendly materials
- High performance batteries with green technology content
- New types of power batteries and energy storage batteries
- Fuel cell technology
- High performance super capacitor and power exchange technology
- Clean production technology
- Natural resource survey, exploration and recycling
- Separation and extraction of precious metals and associated minerals
- Process control technology applied in manufacturing and control system
- New sensors, automatic measuring apparatus and analytical devices and testing systems
- CNC equipment and processing technology
- Robots
- Smart production system and specialized processing technology
- Precision manufacturing-parts, processing equipment and new technology applications

2.2.2. Individual Income Tax (IIT)

The law governing Individual Income Tax was initially published in 1980 has been revised and amended many times with the growth of economy and average individual incomes. Although individual income tax is paid by employees, employers are obliged to file and collect IIT for all employees by regulations of the "IIT law". Taxable incomes of their employees are primarily salaries or wages and bonuses. Tax rates are designed on the principle of progressive tax scheme ranging from 3 percent to 45 percent.

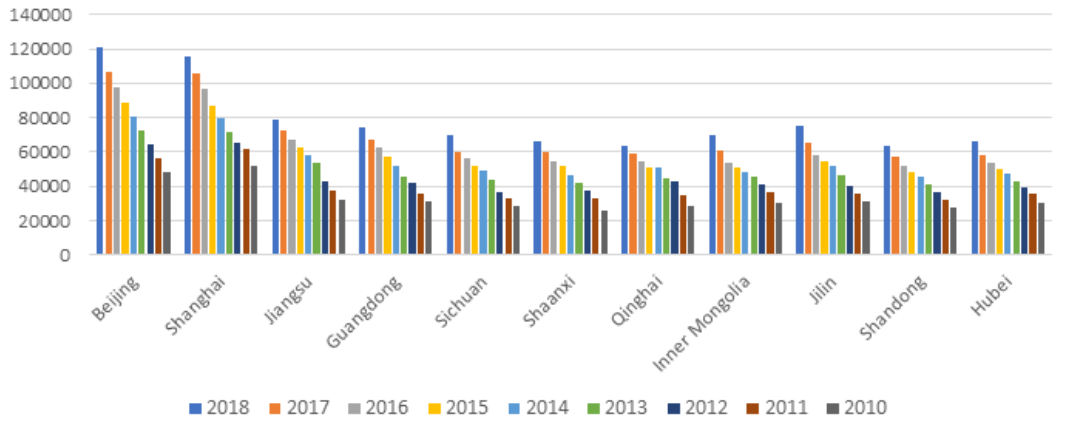
The rates on IIT have influenced salary levels of different working positions in a company. Other factors are the social insurance (medical, pension etc.) fees to be paid both by the employers and the employees.

Fig. 2.2.2-1 Manufacturing industry annual average wages (CNY)



Source: National Bureau of Statistics

Fig. 2.2.2-2 Manufacturing industry annual average wages by regions 2010-2018



Source: National Bureau of Statistics

According to the statistics, salaries varies significantly between companies with different ownerships. And the gaps of incomes maintained in the past years. The chart below illustrated the annual average wages of manufacturing industry employees. The state-owned enterprises provided highest salary level than other types of ownership structured enterprises, and the amount of annual salaries of 2018 had almost doubled than those of 2010.

Income level of employees in the manufacturing enterprises varies by regions as well but generally below the average of that of the whole industry. For instance, the statistics figure of Hubei province shown that the workers average wages of manufacturing industry (66094 yuan, 2018) are below that of the average of total industries (73777 yuan, 2018).

2.2.3. Value Added Tax (VAT)

In China, a tax rate of 17 percent is levied on sales or import of goods, leasing of movable property or conducting processing, repairing and assembling services. The deducted rate of 11 percent is levied on goods such as gains and vegetable oil, water, gas, heat, newspaper and books, feed, fertilizer, agricultural chemical etc.

Offering general services or selling intangible assets, 6 percent rate is applied.

For taxpayers exporting goods, the tax rate shall be 0 percent, except as otherwise stipulated by the State Council (ref. customs duties below).

The adjustment of VAT rate and the policies for the deduction or exemption of VAT is decided by the State Council and implemented by the State Taxation Administration (STA). It serves as a tool of public finance and guidance of industry development.

One example is where enterprises manufacture products out of waste and obtain raw materials out of recycled waste, the taxation authority, in accordance with relevant State regulations, will reduce their value-added tax or exempt them from such tax.

To prevent and control of outbreak of COVID-19, STA released and enforced a series of preferential tax policies focusing on the key fields and major industries critical to win the battle again the coronavirus. Taxpayers involved in the production, transportation and services of major guarantee materials will be exempt from paying VAT. Other taxes such as CIT, import duty, IIT etc. are also subject to deduction or exemption according to the preferential tax policy guidelines specially made for COVID-19 pandemic.

2.2.4. Consumption Tax (CT)

Consumption tax applies to specific consumer products produced in China or imported products. tobacco, alcoholic beverages, cosmetics, fuel oil, moto cars and some luxury goods as yachts, golf equipment are taxable items.

Consumption tax is not considered directly relevant to the process industry.

2.2.5. Custom duties (tariffs)

The process industry of Norway has significant important role of export. The total export from the process industry account for about 17 percent of the total export of goods from Norway. The important goods of export of Norway's process industry are:

- Metal products and alloys: Aluminum, Nickel, Zinc, Cobalt, copper, ferro-alloys, silicon etc.
- Chemical products: Ethylene, propylene, butylene and butadiene, cyclic amides, paper and chemical pulps

The General Administration of Customs in China (GACC) is the main authorities dealing with general import and export matters. Tariff valuation and duty collection, commodity inspection and anti-smuggling etc. are the responsibilities of GACC and more than 600 of regional and local customs offices nationwide.

The Customs Commission of the State Council decide and publish import and export tariffs with adjustments of tariffs whenever necessary. GACC safeguard the implementation of border control, license, commodity inspection and quarantine conditions. The tables below provided detailed tariffs of import and export duties of relevant items that Norwegian process industry players concerned most, based on tariff handbook published by GACC.

MFN rate: Stands for the Most-Favored-Nation duty rate (%), apply to import goods originated from members of the World Trade Organization (WTO).

General import duty rate: Stands for general duty rate (%) apply to import goods originated from countries or regions other than MFNs or under bilateral trade agreements or to the import goods of undetermined origins.

Export tax-refund rate: China's current export tax refund scheme apply to encourage the export of those products to the international market and to consolidate their competitiveness worldwide. To avoid double taxation, the value-added tax (VAT) paid domestically by the exporter will be refunded or partly refunded. The export tax-refund rate is ranging from 5 percent to 17 percent.

Export tax and export duty rate: China imposed export tax on a few resource-related goods starting from 1992. The duty rates range from 20 percent to 40 percent. In 1992, 47 goods were required to pay export tax when exporting and in 2019, it was increased to 108 different goods. Starting from January 1, 2020, export tax was imposed on 107 goods in which most are the same with or without adjustments on the duty rates (provisional export duty rates). Export tax is considered as an instrument to regulate un-rational exploration of important natural resources of China, to secure the supply to domestic industry and to avoid price competition among domestic exporters. In the current list of 107 goods considered important resource products, highly energy-intensive products and those processed with high pollution, such as eel fry, goat skin, powder of bovine, sheep or goat, certain non-ferrous metal ore and concentrate, raw antimony, phosphorus, potassium fluorotantalate, benzene, certain ferro alloys, scrap iron and steel, copper and aluminum raw materials and their products, nickel ingot, zinc ingot, antimony ingot etc.

Export tax is a double-edged sword of China's international trading. Resource and processed products with export taxes imposed on them are less competitive in the world market. However, the tax forced domestic process industry to optimize the product portfolio with more advanced, value-added and greener products.

Provisional import and export duty rates: Adjustments on the import and export tariffs applied on specific goods are made by the Customs Commission of the State Council usually on the yearly bases. The provisional import duty rate will replace the Most-Favored-Nation duty rate on the certain item in valuation of import duty by the customs. Provisional export duty rate on certain item will be used instead of export duty rate in the customs clearance of export. Provisional import duty rates are lower that the MFN rates imposed on the particular goods. Sometimes they are significantly lower than MFN rates or even exempted. Currently, provisional import tariffs imposed on 859 goods to provide additional benefits for MFN members who export these goods to China.

Among 107 goods levied on export tax, 77 of them apply to provisional export duty rates which are often much lower or exempted, meaning the lowered thresholds for the attempts for export. This regulatory mechanism designed by the central policymakers allowing the state to enforce the industry policies, to copy with the market failure and to react on the changes in the world social and economic environment.

Table 2.2.5-1 Import and export tariffs of most relevant metals for Norwegian process industry

Item	MFN %	Export refund %	Export tax %
Aluminum and its products			
Unwrought aluminum, bars, rods and profiles; not alloyed	5	0	20 or 30
Bars, rods, hollow profiles, alloyed	5	13	20
Plates, sheets and strips; alloyed and not alloyed	6	13	20
Plates, sheets and strips (non-rectangular and non-square in shape)	8	13	20
Tubes and pipes	8	13	0
Aluminum doors, windows and their frames containers, tanks	9	13	0
Zinc and its products			

Unwrought zinc and alloys	3	0	20
Bars, rods, profiles and wires	6	0	0
Plates, sheets, strip and foil	6	0	0
Nickel and its products			
Unwrought nickel	3	0	40
Bars, rods profiles; alloyed and not alloyed	6	13	0
Plates, sheets, strip and foils; not alloyed	6	13	0
Plates, sheets, strip and foils; alloyed	6	0	0
Electroplating anodes	4	0	40
Copper and its products			
Unrefined copper, copper anodes for electrolytic refining	2	0	30
Bars, rods and profiles; refined	4	13	30
Plates, sheets and strips; refined	4	13	30
Tubes and pipes; refined	4	13	30
Other copper products, cast, molded, stamped or forged without further processing, for industry use	9	0	0
Ferroalloys			
Ferromanganese	2	0	20
Ferrosilicon	2	0	25
Other ferro alloys	2	0	20
Silicon and its products			
Monocrystals doped for use in electronics, in the form of cylinder or rods, 30 cm or more in diameter	4	16	0
Monocrystals doped for use in electronics, in the form of cylinder or rods, 7.5cm or more in diameter	4	0	0
Solar-grade polysilicon	4	0	0
Other polycrystalline silicon	4	0	0
Cobalt and its products			
Unwrought cobalt, intermediate products of cobalt by wet process	4	0	0
Mid-product smelted with cobalt and sulfur and others	4	0	0
Other cobalt products	8	0	0

Table 2.2.5-2 Import and export tariffs of most relevant chemicals for Norwegian process industry

Item	MFN %	Export refund%	Export Tax %
Mineral fertilizers-cyclic amides			
Meprobamater(INN)	6.5	13	0
N-dimethylformamide	6.5	13	0
Fluoroacetamide (ISO, monocrotophos (ISO), and phophamidon (ISO)	6.5	0	0
Dicrotophos, bromoacetamide, propamocarb, cellocidin, allidochlor, dimethyl phthalate, salts of meprobamate (INN), other acyclic amides	6.5	0	0
Ethylene, propylene, butylene and butadiene			
Ethylene	2	13	0
Propylene	2	13	0
Butylene and isomers thereof	2	13	0
Butadiene	2	10	0
Paper and chemical pulp			
Newsprint, in rolls or sheet	6	0	0
Photo paper base, wallpaper base	6	0	0
Paper and paperboard weighing less than 40g/m2	6	0	0
Various papers weighing between 40-150 g/m2	5	0	0
Papers weighing above 150 g/m2	5	0	0
Toilet or facial tissue stock, towel or napkin stock and similar	5	0	0
Uncoated kraft paper and paperboard, in rolls or sheets	5	0	0
Unbleached kraft paper weighting above 225 g/m2	2	0	0
Fluting paper, recycled liner board, sulphite wrapping paper, filter paper, felt paper, paper for electrolytic capacitor	6	0	0
Corrugated paper and paperboard, perforated or not perforated	6	0	0
Cartons, boxes and cases made of corrugated paper board	5	0	0
Pulps of various kinds (mechanical, chemical, recovered, scrap etc.)	0	0	0

2.2.6. Resource tax

The State Council promulgated *Law of the People's Republic of China on Resource Tax* [Order No. 33] on August 26, 2019 which will take effect on September 1, 2020.

The range of taxable resources is specified in the *Table of Resource Tax Items and Rates* attached to this law (Table 2.2.6-1, metal mineral resources only).

According to the law, the actual tax rates shall be specified within the prescribed range by the local government under the holistic consideration of the grades and mining conditions of the taxable resources.

For minerals mined from depleted mines, a 30 percent discount is offered on the corresponding resource tax. Depleted mines refer to mines with a designed mining life of more than fifteen years, whose remaining recoverable reserves have fallen below 20 percent of the original designed recoverable reserves, or whose remaining mining period does not exceed five years.

In order to meet socioeconomic development needs, the State Council may waive or reduce the resource tax for businesses that facilitate conservation and intensive use of resources and environmental protection efforts. Local government of the provinces, autonomous regions and municipalities directly under the central government may also decide to waive or reduce the resource tax under the circumstances such as suffering significant losses due to natural disaster occurred during mining or taxable product operations. Taxpayers who extract concomitant ores, low grade ores and tailings may also enjoy resource tax deduction or exemption.

The biggest change with previous regulations-*Interim Regulations of the People's Republic of China on Resources Tax* [Decree No. 605, effective since Nov. 1, 2011] is the big reforms of the *Table of Taxable Items and Tax Rates of Resources Tax* attached (Table 2.2.6-2). Resource Taxes on ALL items are levied on the product price (value) according to the current law instead of the volume (quantity) regulated in the previous law. Another big change was that the new table of taxable items is much more specific on actual resources and corresponding rates. Totally 164 taxable items were listed, covering all the natural resources discovered in China.

Tracing back to the original interim regulations on resource tax which was effective since January 1, 1994 [NO. 139 State Council], All taxable items were levied on the quantity of the output of the production at the time (Table 2.2.6-3).

Table 2.2.6-1 Resource tax items and rates (2020)

Category	Resource tax item	Taxable object	Tax rate
Metal mineral resources			
Ferrous metals	Iron, manganese, chromium, vanadium, titanium	Raw ore, ore dressing	1%-9%
Non-ferrous metals	Copper, lead, zinc, tin, nickel, antimony, magnesium, cobalt, bismuth, mercury	Raw ore, ore dressing	2%-10%
	Bauxite	Raw ore, ore dressing	2%-9%
	Tungsten	Ore dressing	6.5%
	Molybdenum	Ore dressing	8%
	Gold and silver	Raw ore, ore dressing	2%-6%
	Platinum, palladium, ruthenium, osmium, iridium, rhodium	Raw ore, ore dressing	5%-10%
	Light rare earth	Ore dressing	7%-12%
	Medium and heavy rare earth	Ore dressing	20%
	Beryllium, lithium, zirconium, strontium, rubidium, cesium, niobium, tantalum, germanium, gallium, indium, thallium, hafnium, rhenium, cadmium, selenium, tellurium	Raw ore, ore dressing	2%-10%

Table 2.2.6-2 Taxable items and tax rates of Resources Tax (2011, abolished)		
Taxable items		**Tax rates and tax amount range**
1. Crude oil		5-10% of the sales
2. Natural gas		5-10% of the sales
3. Coal	Coking coal	8-20 yuan/ton
	Other coal	0.3-5 yuan/ton
4. Other non-metal ores	Common non-metal ores	0.5-20 yuan/ton or cubic meter
	Precious non-metal ores	0.5-20 yuan/kg or carat
5. Ferrous metal ores		2-30 yuan/ton
6. Non-ferrous metal ores	Rare earth ores	0.4-60 yuan/ton
	Other non-ferrous metal ores	0.4-30 yuan/ton
7. Salt	Solid salt	10-60 yuan/ton
	Liquid salt	2-10 yuan/ton

Table 2.2.6-3 Taxable items and tax rates of Resources Tax (1994, abolished)	
Taxable items	**Tax amount range**
1. Crude oil	8-30 yuan/ton
2. Natural gas	2-15 yuan/1,000 cubic meter
3. Coal	0.3-5 yuan/ton
4. Other non-metal ores	0.5-20 yuan/ton or cubic meter
5. Ferrous metal ores	2-30 yuan/ton
6. Non-ferrous metal ores	0.4-30 yuan/ton
7. Salt	
- Solid salt	10-60 yuan/ton
- Liquid salt	2-10 yuan/ton

2.2.7. Urban and Town Land Use Tax

This tax is levied on companies who are using the land within the scope of cities, counties, administrative towns, industrial and mining areas (non-agricultural land). The annual amount of land use tax is as follows:

1) 1.5-30 yuan/sq.m. in large cities
2) 1.2-24 yuan/sq.m. in medium cities
3) 0.9-18 yuan/sq.m. in small cities
4) 0.6-12 yuan/sq.m. in counties, administrative towns, industrial and mining areas

Local authorities may decide on the actual tax amount within the ranges specified above. Economically under-developed areas may lower the tax amount within 30 percent of the minimum amount of above specified range. Developed areas may raise the tax amount after approval by the Ministry of Finance.

2.2.8. House Property Tax

Housing property tax is calculated and paid based on the residual value after one-off deduction of an amount ranging from 10 to 30 percent of the initial value of housing property. The local governments specify the range of deduction with separate regulations. For housing property with no information of initial values, the local tax authorities will decide the initial values with references to the properties of similar conditions. The tax rate is 1.2 percent of the residual value. If rental income will be used as the basis of the housing property tax, the tax rate is 12 percent.

2.2.9. Deed Tax (Contract Tax)

The deed taxpayers are organizations and individuals accepting transfer of the ownership of land and house. The tax rate is ranging between 3-5 percent. The base for the calculation of the deed tax are either 1) transaction price for the assignment of the right to use the state-owned land, the sale of the land use right and the purchase and sale of houses; 2) the price difference between the exchanged

land use rights and houses or 3) the market price for the sale of the land use right and the purchase and sale of houses which is verified and determined by the tax authority.

Local tax authorities decide on the actual rate of their administrative region and report to the Ministry of Finance and the State Administration of Taxation for the record.

2.2.10. Motor Vehicle and Vessel Taxes

The owners or operators of motor vehicles and vessels pay this annual tax according to cylinder capacity, dead load or size depending on the type of vehicles or vessels. As an example, a truck will pay its annual motor vehicle tax ranging from 16 yuan/ton to 120 yuan/ ton of its dead load.

2.2.11 Farmland Occupancy Tax

The Law governing this tax was rather new, promulgated in the end of 2018 with a view to making reasonable use of land resources and protecting farmland. Using farmland for constructing buildings or engaging in non-agricultural activities will pay farmland occupancy tax.

The actual amount of farmland use tax is to be decided by the local authorities, within the range of tax amount prescribed in the law. The differences are quite big between industrial regions and remote, less developed provinces. For instance, the tax amount for Beijing is 40 yuan and 45 yuan for Shanghai, while only 12.5 yuan for Inner Mongolia, Tibet and Xinjiang.

2.2.12. Land Appreciation Tax

The land appreciation tax is levied when taxpayers who receive income from transferring the rights to the use of state-owned land, above-ground structures and their attached facilities. A Four-level progressive rates is adopted in calculating of the land appreciation tax, ranging from 30 percent to 60 percent.

2.2.13. Stamp Tax

Stamp tax shall be paid on executing or receiving contracts or documents in the nature of a contract with regard to purchases and sales, the undertaking of processing, contracting for construction projects, property leasing, commodity transport, warehousing, loans, property insurance, technology etc.

Documents for transfer of property rights, certificates evidencing rights or licenses and other documents determined by the Ministry of Finance are also taxable.

2.2.14. Urban Maintenance and Construction Tax

The draft of the Law on Urban Maintenance and Construction Tax was published in the end of 2019 for public comments. Organizations and individuals who are entitled to pay VAT or consumption tax will be the taxpayers of this new tax. After the law is officially effective, the tax rate will be 7 percent for taxpayers located in urban areas, 5 percent for county or town-based taxpayers and 1 percent for those in other locations, levied on the amount of VAT or consumption tax.

2.2.15. Tax for Vehicle Purchase

Any entity or individual acquiring an automobile in China will pay this tax with 10 percent rate on top of the taxable price which refers to the full amount of the price actually paid by the taxpayer to the seller excluding the value-added tax. It is applied on one-off collection basis in the transaction.

The State Council may decide deduction or exemption of this tax under certain circumstances. For instance, purchasing new energy vehicles (NEV), including pure electric vehicles, plug-in hybrid electric vehicles and fuel cell vehicles are exempted from paying this tax.

This incentive measure was set to expire at the end of 2020 but it was extended to the end of 2022, in order to support NEV industry which suffer from the impact of COVID-19 pandemic.

2.2.16. Shipping Vessel Tonnage Due

Shipping vessels entering the ports within China shall be subject to payment of vessel tonnage dues in accordance with law made in the end of 2017 and revised in October 2018. Tax rates are different on the registered nation, net tonnage and the term of the tonnage dues license of the vessel.

2.2.17. Environmental Protection Tax

The Environment Protection Tax is regulated by *the Law of the People's Republic of China on Environmental Protection Tax* which is effective since October 26, 2018. The purpose of Law is formulated with a view to protecting and improving the environment, reducing the discharge of pollutants, and advancing ecological civilization.

All enterprises, public institutions and other production and business operators who directly discharge taxable pollutants to the environment within the territory of China shall be taxpayers of environmental protection tax, in accordance with this Law.

Taxable pollutants include air pollutants, water pollutants, solid wastes and noise prescribed by the ***Table of Taxable Items and Tax Rates of Environmental Protection Tax*** and the ***Table of Taxable Pollutants and Their Equivalent Value*** appended to the law. (Table 2.2.17-1, Table 2.2.17-2, Table 2.2.17-3)

Pollution equivalent refers to a comprehensive indicator or unit of measurement by which the pollution caused by different pollutants to the environment is measured according to the degree of harm caused by the pollutants or pollutant-discharging activities to the environment and the technical and economic feasibility of pollution treatment. The pollution level of different pollutants in the same medium and with the same pollution equivalent shall be largely the same.

Under some circumstances, environmental protection tax can be waived, such as sewage treatment plants or landfill projects if the discharges of taxable pollutant are not exceeding the national and local discharge standards.

Table 2.2.17-1 Taxable items and tax rates of environmental protection tax

Taxable item		Unit of measurement	Tax amount (yuan)
Air pollutants		Pollution equivalent value	1.2 to 12
Water pollutants		Pollution equivalent value	1.4 to 14
Solid wastes	Coal gangue	ton	5
	Tailings	ton	15
	Hazardous wastes	ton	1000
	Smelting slag, fly ash, furnace clinker, other solid wastes	ton	25
Noise	Industry noise	Exceeding standard 1-3 dB	350/month
		Exceeding standard 4-6 dB	700/month
		Exceeding standard 7-9 dB	1400/month
		Exceeding standard 10-12 dB	2800/month
		Exceeding standard 13-15 dB	5600/month
		Exceeding standard above 16 dB	11200/month

Table 2.2.7. Taxable pollutants and their equivalent value, water pollutants			
Category 1			
Water pollutants	**Pollution equivalent value (Kg)**		
1. Total mercury	0.0005		
2. Total cadmium	0.005		
3. Total chromium	0.04		
4. Lexavalent chromium	0.02		
5. Total arsenic	0.02		
6. Total lead	0.025		
7. Total nickel	0.025		
8. Benzopyrene	0.0000003		
9. Total beryllium	0.01		
10. Total silver	0.02		
Category 2			
Water pollutants	**Pollution equivalent value (Kg)**	**Water pollutants**	**Pollution equivalent value (Kg)**
11.Suspended solids (SS)	4	37.PCP and sodium pentachlorophenate	0.25
12. BODs	0.5	38. Trichloromenthane	0.04
13. CODcr	1	39. AOX	0.25
14. TOC	0.49	40. Carbon tetrachloride	0.04
15. Petroleum pollutants	0.1	41. Trichloro ethylene	0.04
16. Animal and vegetable oil	0.16	42. Tetrachloroethylene	0.04
17. Volatile phenol	0.08	43. Benzene	0.02
18. Total cyanide	0.05	44. Methylbenzene	0.02
19. Sulfide	0.125	45. Ethylbenzene	0.02
20. Ammonia nitrogen	0.8	46. O-xylene	0.02
21. Fluoride	0.5	47. P-xylene	0.02
22. Methanal	0.125	48. M-xylene	0.02
23. Anilines	0.2	49. Chlorobenzene	0.02
24. Nitrobenzenes	0.2	50. O-dichlorobenzene	0.02
25. Anionic surfactant (LAS)	0.2	51. Santochlor	0.02
26. Total copper	0.1	52. P-nitrchlorobenzene	0.02
27. Total zinc	0.2	53. 2,4 dinitrochlorobenzene	0.02
28. Total manganese	0.2	54. Phenol	0.02
29. Color developer (CD-2)	0.2	55. M-cresol	0.02
30. Total phosphor	0.25	56. 2,4 dichlorophen	0.02
31. Elemental phosphor	0.05	57. 2,4,6 trichlorophenol	0.02
32. Organophosphorus pesticide	0.05	58. Dibutyl phthalate (DBP)	0.02
33. Dimethoate	0.05	59. Dioctyl phthalate	0.02
34. Parathion-methyl	0.05	60. Acrylonitrile	0.125
35. Malathion, carbofos	0.05	61. Total selenium	0.02
36. Parathion	0.05		

Table 2.2.17-3 Taxable pollutants and their equivalent value, air pollutants			
Air pollutants	**Pollution equivalent value (Kg)**	**Air pollutants**	**Pollution equivalent value (Kg)**
1. Sulfur dioxide	0.95	23. Xylene	0.27
2. Nitric oxide (NOx)	0.95	24. Benzopyrene	0.000002
3. Carbon monoxide (CO)	16.7	25. Methanal	0.09
4. Chlorine	0.34	26. Ethanal	0.45
5. Hydrogen chloride	10.75	27.Propenal	0.06
6. Fluoride	0.87	28. Methyl alcohol	0.67
7. Hydrogen cyanide	0.005	29. Phenols	0.35
8. Sulfuric acid mist	0.6	30. Asphalt fume	0.19
9. Chromic acid mist	0.0007	31. Anilines	0.21
10. Mercury and its compound	0.0001	32. Chlorobenzenes	0.72
11. General dusts	4	33. Nitrobenzene	0.17
12. Asbestos dust	0.53	34. Acrylonitrile	0.22
13. Glass wool dust	2.13	35. Chloroethylene	0.55
14. Carbon black dust	0.59	36. Phosgene	0.04
15. Lead and compounds	0.02	37. Sulfuretted hydrogen	0.29
16. Cadmium and its compounds	0.03	38. Ammonia	9.09
17. Beryllium and its compounds	0.0004	39. Trimethylamine	0.32
18. Nickel and compounds	0.13	40. Methyl mercaptan	0.04
19. Tin and its compounds	0.27	41. Dimethyl sulfide	0.28
20. Smoke	2.18	42. Methyl disulfide	0.28
21. Benzene	0.05	43. Styrene	25
22. Methylbenzene	0.18	44. Carbon disulfide	20

Local authorities can decide on the actual tax rate within the given range based on the overall considerations of environmental carrying capacity and the pollutant discharge status quo of their respective regions, as well as their respective economic, social and ecological development objectives and requirements.

For instance, Shanghai municipality has published local tax rate for SO2 and NOx at 7.6 yuan/pollution equivalent value from January 1, 2019. Comparing with the rate applied one year ago, it has increased about 1 yuan/pollution equivalent value or 15 percent.

The Southwestern province of Yunnan will much less environmental stresses has made a much lower rate of 2.8 yuan/pollution equivalent value for air pollutants started from January 1, 2019. One year ago, it was 1.2 yuan/pollution equivalent value applied from January 1, 2018.

Useful links and info sources:

State Taxation Administration of the People's Republic of China (STA)

AGREEMENT BETWEEN THE GOVERNMENT OF THE PEOPLE'S REPUBLIC OF CHINA AND THE GOVERNMENT OF THE KINGDOM OF NORWAY FOR THE AVOIDANCE OF DOUBLE TAXATION AND THE PREVENTION OF FISCAL EVASION WITH RESPECT TO TAXES ON INCOME AND CAPITAL

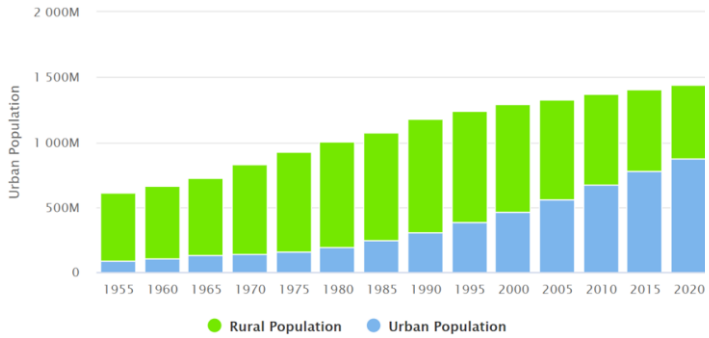
2.3 Human resources

2.3.1 Human resources in China

China is experiencing the largest urbanization in human society history, with about 200 million people migrated from rural area into cities within last decade, which is also considered as the engine of Chinese economic development. Even though, by the end of 2019, its urbanization rate has only reached 60.6 %. On the other hand, the large number of migrant workers produced by it had provided an abundant labor force for China's industrial development.

China's decades of rapid economic growth are inextricably linked to the contribution of the demographic dividend, especially among the large number of migrant workers from rural area. But since 2007, coastal areas of China begun to experience a shortage of workers, especially for the experienced ones, which became increasingly serious in the following years, by 2010 the Pearl River Delta region alone had an employment gap of around two million. The migration of process industries to the interior and the Midwest in recent years was also driven by it.

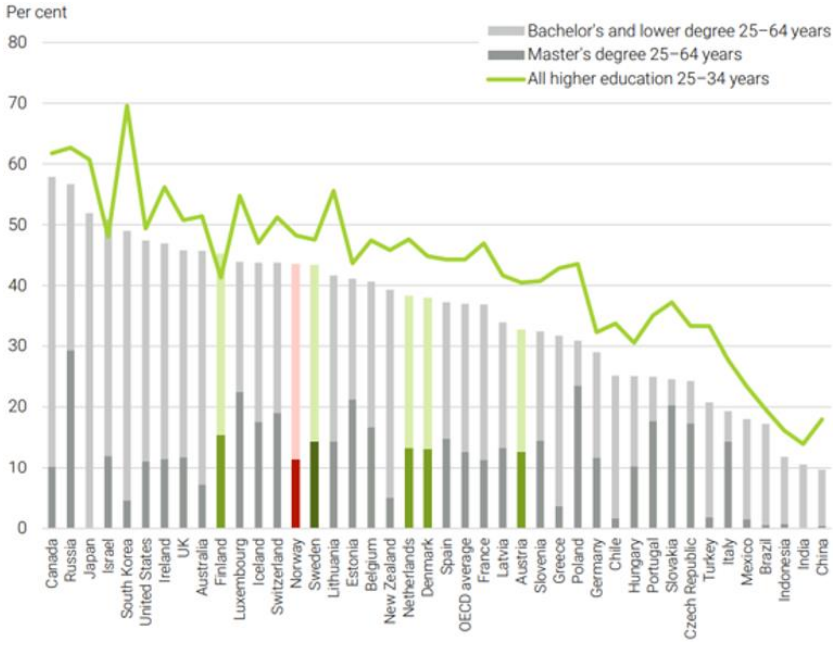
Fig. 2.3.1-1 China Urban vs. Rural Population 1955-2020



Source: NSB

The education level of labors in Chinese process industry is quite low, in comparing with advanced countries per capita. From 1977, China restored the policy of entrance exam for college and universities, after 40 years, the accumulated number of Bachler Degree college graduates has only reached 3.69 percent of the nation's population.

Fig. 2.3.1-2 Proportion of the population with higher education by age group and level of education. selected countries. 2017



Source: OECD, Education at a glance 2019

After decades of rapid development, the world's second largest economy now slowed down its growing speed. Under the influence of the global economic downturn and the US-China trade war, many Chinese enterprises engaged in international trade are having tough times, which leads to a recession in China's labor market.

In 2019, the employment rate in China decreased to 65.2 percent, from 65.7 percent in the previous year. China is the world's most populous country and its rapid economic development over the past decades has profited greatly from its large labor market. While the overall working conditions for the Chinese people are improving, the actual size of the labor force in China has been shrinking steadily in recent years. This is mainly due to an aging population and a low birth rate in the country. The population born during 2000-2010 are 47 million less compared with in the 1990s.

Demographics Dividend

During the years of double-digit growth, the manufacturing sector capitalized on China's massive supply of young able-bodied workers. High birthrates during the 1960s and 1970s contributed to a demographic dividend that flooded the labor market with cheap, young, and strong workers – prime for the physical demands of manufacturing. Children born during these years entered their late teens and early 20s during the 1980s and 1990s, coinciding with the government's shift from a planned economy to an increasingly market-based one open to foreign investment. This fortuitous combination greatly contributed to China's historic growth and industrialization.

These same workers, however, are aging and beginning to retire from labor-intensive manufacturing jobs. The amount of people aged 60 and above are projected to grow from 200 million in 2015 to over 300 million by 2030. In contrast, the number of young workers is dwindling as a result of urbanization, rising living standards, and the one-child birth control policy. While China's elderly population is ballooning, the amount of youth aged 20-24 is expected to decline from 125 million to 68 million over the next decade. Furthermore, this generation is better educated than previous ones, and thus has less interest in poorly paid and physically demanding manufacturing jobs.

Prospects for the Future

While a diminishing workforce and stronger government enforcement of regulations are increasing the costs of labor, China aims to remain competitive by boosting productivity and producing higher value goods. As certain labor-intensive industries such as apparel shift to lower cost locations like Vietnam and India, China is responding by encouraging manufacturers to move up the value chain and produce more innovative products. The "Made in China 2025" campaign promotes in manufacturing advanced technology in place of cheap and low value-added products. This process requires significant financing to develop innovative R&D, train skilled workers, and upgrade factories to include more automation and robotics. With enough resources, the government hopes China can break through the dreaded "middle income trap", where a country loses its cost advantages in manufacturing and exports but is unable to compete with developed economies in value-added products.

The expiration of China's demographic dividend, growth of the service sector, and westward diffusion of factories have resulted in a smaller and less concentrated labor pool. However, China remains an attractive destination for manufacturing overall and holds many advantages over its competitors. While wages have risen, so too has worker productivity as the workforce becomes more skilled with higher quality resources to work with. China also has a developed shipping and logistics infrastructure and is increasingly a market for manufactured goods rather than just a producer, letting businesses take advantage of the proximity for reduced shipping costs.

Although the country has not yet fully transitioned from low cost to high value manufacturing, capitalizing on government incentives promoting the sector can potentially pay dividends. Investors can also take solace in the fact that the factories they contract are gradually providing their employees with better conditions and benefits, thus providing often marginalized groups with improved living standards. Though the manufacturing sector risks being caught in the middle-income trap, China's vast

financial resources and significant domestic market present lucrative opportunities during the industry's transition phase.

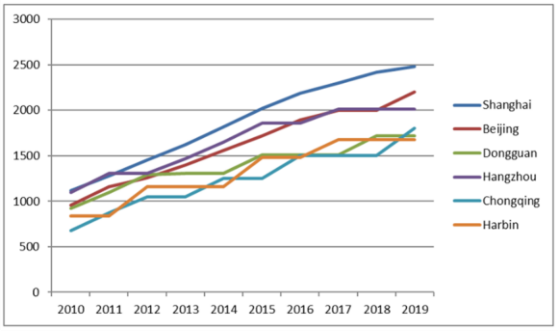
2.3.2 Human capital

As China's economic policy shifts more to consumption-driven growth from that of investment—and yet China remains cost competitive in a wide range of industries, especially in manufacturing and process industries, but with its increasement of income, the competitiveness is decreasing. Chinese average salary or income is a complex social issue, to simplify it here, this report just focuses on the process industry, which are within 2), 3) and 4) in the following aspects:

1) Lower Income class: Trainees, farmers etc.
2) low-income class: Labors, workers etc.
3) Middle-income class: Engineers, senior staff etc.
4) High-income: Senior managers, professionals and talents etc.
5) Riches: entrepreneurs, tycoons etc.

The minimum wages vary from different regions, but almost keep same increasement with the urban average salary.

Fig 2.3.2- 1 Monthly minimum wages in some Chinese cities

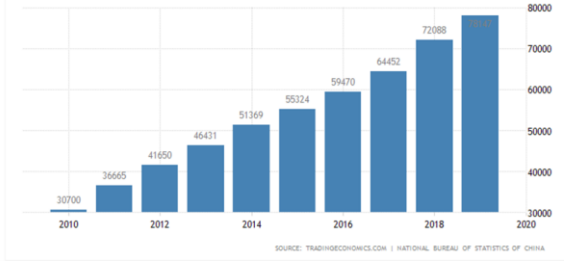


yuan Source: NSB

According to NSB, the urban average wage in China increased to 90,501 CNY/year in 2019 from 82,413 CNY/year in 2018, with about 10 percent increasement. The average salary of process industry and manufacturing is a little bit lower than the average level. This data is from non-private organizations.

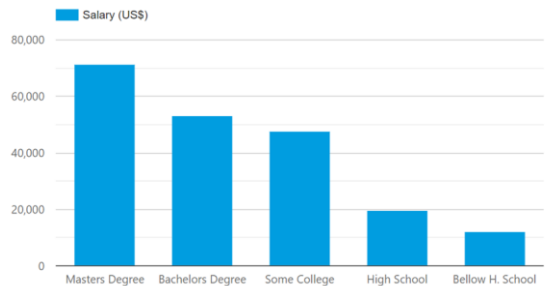
Fig. 2.3.2-2 China average annual salary

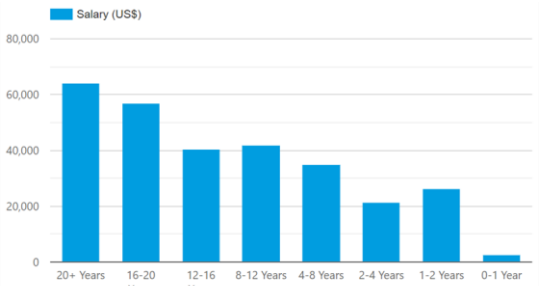
China average annual salary in manufacturing



Normal workers' or company staffs' salary are around this amount, which reflects largest proportion of employees. The salary increases substantially each year, due to the country's rapid economic

Fig. 2.3.2-3 China average annual salary, and with education level and working experience





development and inflation. With the development of knowledge economy in China, as well as the industrial upgrading, the well-educated and experienced talents are cherished by process industries. Their salary is much higher than normal workers, in some process industries even close to the level of Europe or US.

Career

According to the analysis from ROBERT WALTERS, average salaries in China can vary greatly based on a career field. Management and business enjoy the highest gross average salaries (CNY 510,626), followed by construction and labor workers (CNY 454,322), and fashion (CNY392,780). Lower average gross salaries in the China are earned by those in arts, culture, performance (CNY 103,500) and those in customer services positions (CNY 147,044). The difference between the most paid and the lowest paid fields is 404.39 percent.

Education

Manufacturing employees holding Masters' degrees enjoy the highest average gross salaries in China, which is CNY 463,333. While Manufacturing workers with below high school education earn the least, with an average gross income of CNY 80,000. This is 486.05 percent lower of what Masters' degree holders earn.

Experience

Manufacturing workers in China with more years of work experience outperform their counterparts with less experience. Workers with 20+ years of experience earn a gross average of CNY 407,846 compared to CNY 17,500 for their counterparts with 0-1 year of experience. The difference between workers with 20+ years of experience and 0-1 Y is 2307.25 percent.

Fig. 2.3.2-7 China average annual salary, and with education level and working experience

ROLE	PERMANENT SALARY PER ANNUM CNY (¥)	
	2019	2020
Technical Director	800k - 1.3m	**800k - 1.3m**
R&D Director	800k - 1.3m	**800k - 1.3m**
Engineering Director	700k - 1.2m	**700k - 1.2m**
Intelligent/Digital Manufacturing Director	800k - 1.0m	**800k - 1.0m**
R&D Manager	450 - 650k	**450 - 650k**
Engineering Manager	450 - 650k	**450 - 650k**
Automation Manager	350 - 650k	**350 - 650k**
Maintenance Manager	300 - 500k	**300 - 500k**
Project Manager	250 - 650k	**250 - 650k**
IE Manager	300 - 500k	**300 - 500k**
Design Engineer	200 - 400k	**200 - 400k**
Tooling Manager	300 - 450k	**300 - 450k**
ME Engineer	180 - 300k	**180 - 300k**
Application Engineer	180 - 350k	**180 - 350k**

NB: Figures are basic salaries exclusive of benefits/bonuses unless otherwise specified.

Source: SALARY SURVEY 2020 GREATER CHINA & SOUTH EAST ASIA, Robert Walters

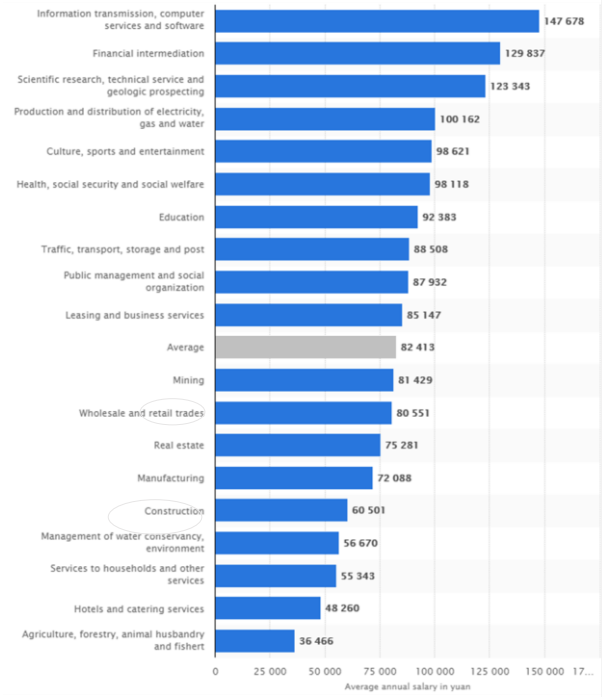
Regional and sectors

Aside from regional discrepancies, the respective industry had a large influence on the average annual salary of employees in urban China. Employees in the IT sector of China earned about 147,700 yuan on average, whereas people employed in the manufacturing sector had an average annual salary of about 72,000 yuan, and agricultural industries ranked at the lower end with an average annual salary of around 36,500 yuan in 2018. As an economically unbalanced country, large income disparities still existed between different regions in China, while employees in Beijing enjoyed the highest annual salaries with about 145,800 yuan on average, Heilongjiang province in northeastern China displayed

the lowest average annual salary with only about 60,800 yuan per year. Regions with lower income levels are mainly located in remote area or underdeveloped area, whereas the coastal regions and municipalities in general still provide comparatively higher salaries. Northeast China, the former centers of steel and heavy industry, maintain a very low salary level.

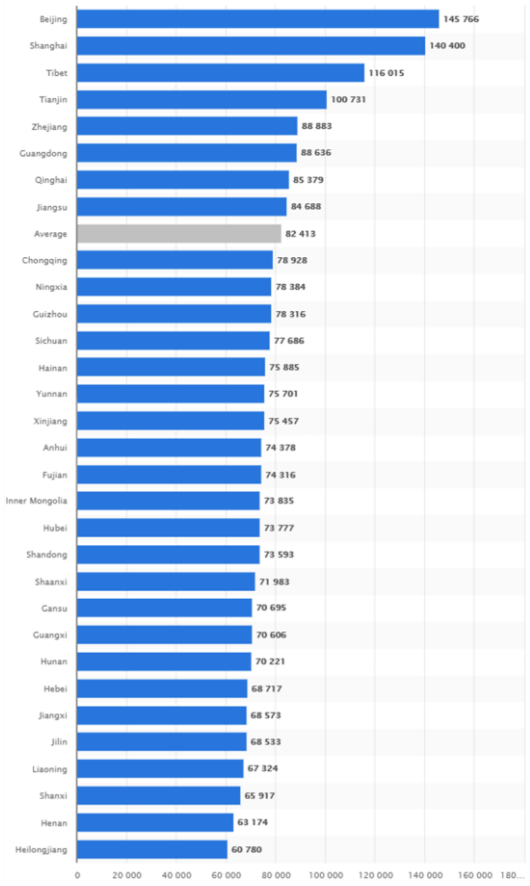
In some process industry, the income of key staffs of managements and technology has reached nearly

Fig. 2.3.2-4 Average salary in urban China in 2018, by sector



Source: Average salary survey 2018

Fig. 2.3.2-5 Average salary in urban China in 2018, by region



the level of Europe, which brought some influence on the competitiveness of process industries.

The US-China trade war affected the hiring volumes in some industries. The biggest impact on the recruitment landscape was seen in process industry and manufacturing. The slide in demand and the

Fig. 2.3.2-6 Average salary in China industry

ROLE	PERMANENT SALARY PER ANNUM CNY (¥)	
	2018	2019
Plant Manager	800k - 1.2m	**800k - 1.2m**
Quality Director	600k - 1.0m	**600k - 1.0m**
R&D Director	1.0 - 1.5m	**1.0 - 1.5m**
Regulatory Affairs Director	600k - 1.0m	**600k - 1.0m**
R&D Manager	500 - 800k	**500 - 800k**
Operations Manager	450 - 750k	**450 - 750k**
Quality Manager	400 - 600k	**400 - 600k**
Regulatory Affairs Manager	400 - 600k	**400 - 600k**

Source: SALARY SURVEY 2019 GREATER CHINA & SOUTH EAST ASIA by ROBERT WALTERS

relocation of some labor-intensive manufacturing production abroad caused a significant decline in hiring. Manufacturing companies also cut down functional hiring, such as finance, HR and supply chain, to reduce operation costs. Despite these headwinds, manufacturers made the next leap to upgrade to high-tech and higher value products, leading to a demand for talent with skills and experience in research and development (R&D), innovation and technology. On the other hand, sectors related to domestic consumption and services, such as healthcare, food and beverages, and education, were comparatively less affected. For healthcare, the investment from local players was particularly strong, from pharmaceuticals to medical devices and healthcare services. However, there was scarce supply of talent, particularly in those with higher education level and international working experience.

China process industries were influenced by this trade war too. Slowdown in hiring is one temporary measure, although they are always looking for well-educated and skilled technicians and engineers, because the industry has developed into a more technical oriented stage. The competition from other sectors for human resources are intensive because the payment from financial or IT sectors are much higher comparing with traditional process industries. Their location is another disadvantage, since the whole industry had been moved out from the first-tier cities of China, or city centers to the more underdeveloped area such as western, Northern part of China due to environment protection regulations, examples can be found at Chapter 1.2.2 in this report. Some process industry took steps to adapt the situation by adding value to their existing products and considering expansion into international markets through FTZs and BRI. This drove demand for candidates with strong technical skills, solid business development capabilities and international work experience.

Above all, in China average salary variates dramatically due to the employee's education, region, career, experience, capability etc., and changes a lot if it's including income tax, health insurance, housing provident fund and enterprise annuity or not. Lots of migrant workers in process industry prefer to have salary without social security, because they came from rural area where had not been covered by social security yet.

The following links just for reference:

301,333 yuan/year by average salary survey

29,300 Yuan/Month, 352,000 yuan/year by Salary Explorer

273,709 yuan/year for manufacturing by average salary survey

Fig. 2.3.2-8 Mainland China Salary Benchmark

Production, Manufacturing & Plant Operations

Base salary range for 12 months (RMB'000)

Role	Min	Median	Max
Production Supervisor	300	350	400
Production Manager	400	500	600
Manufacturing Engineer	200	250	300
Manufacturing Consultant	600	800	1000
Manufacturing Director	800	1100	1500
Vice President Manufacturing	1200	1500	2000
Associate Operations Director	800	1000	1200
Operation Manager	400	500	600
Plant Manager	500	700	900
Plant Management Director	800	1000	1200

Source: Michael Page

2.3.3 Health, Safety, and Environment (HSE)

In China process industry, normally the sequence of priority is Safety, Health and Environment (SHE). To avoid accident is the most important and critical target of a process industrial plant manager, far more important comparing with some 20 years ago.

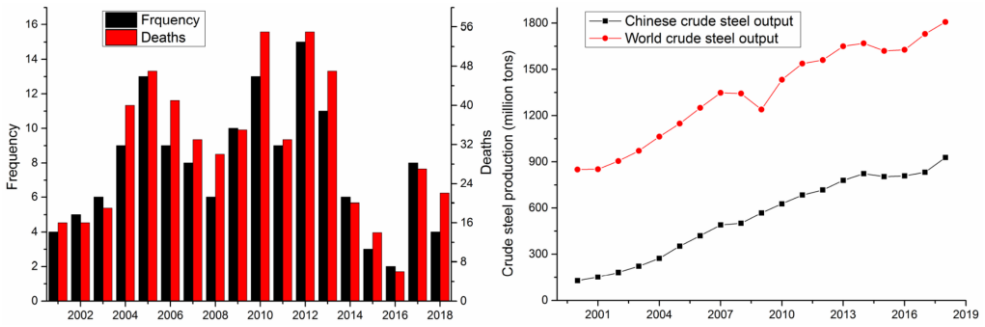
Law of the People's Republic of China on Work Safety issued in 2002 is the key regulation for work safety. Almost every Chinese process industrial plant has their own Safety Department, normally combined with guard management, some even with environment management, while 'health' normally belongs to HR department.

Currently, regulating HSE of the Chinese process industry mainly relies on international and national standards. International Standardization Organization specifies requirements for occupational health

and safety management systems in the standard ISO 45001. The ISO 45001 takes HSE into account other international standards, like Occupational Health and Safety Assessment Series 18,000 (OHSAS18001), aiming to assist organizations in managing risks and improving health and safety performance. Based on them, China has enacted an Occupational Health and Safety Management System Specification, which contains general principles and procedures for risk management.

In recent years, Chinese central and local governments continuously emphasized the importance of safe production and issued many laws and regulations to avoid safety accidents in process industries. The government's control over safety management measures is becoming more stringent, factories not only must have safety management departments and personnel, but also acquire different certification accordingly. Safety plans and accident response measures are required. In some region, process industry must pay deposit for accident, for safety accident punishment and rehabilitation matters. For some serious accidents, the person responsible for the factory may even be held criminally responsible, and the relevant department managers of the local government will receive severe punishments. The measures are very functional, for example, China has the world increasingly production of metals, such as crude steel rising to 53.3 percent globally, but the accident in metallurgy industry has been significantly dropped according to the production quantity.

Fig. 2.3.3-1
Major accidents and deaths in China metallurgical industry Crude steel output between 2000 and 2018



Source: Statistical Analysis and Prediction of Fatal Accidents in the Metallurgical Industry in China, Int. J. Environ. Res. Public Health 2020, 17, 3790; doi:10.3390/ijerph17113790

Most Chinese enterprise has annual health check to their employees as a kind of welfare. Occupational disease is still a serious issue in Chinese process industries, especially in those metallurgical or Chemical factories where has dust pollution and noxious gases.

Overtime working still exists in many process industries, especially during the busy delivery time. The situation has been improving, and mostly workers can get some extra payment for their overtime works, in this way or that. The migrate workers prefer to work longer time to get more payment, and even prefer direct payment than social security, because they do not have the social security when they return to their home in rural areas.

2.4 Corporate Social Responsibility

Corporate social responsibility (CSR) in China is a concept that over the last 20 years has changed nearly as dramatically as its economy and skylines. Something largely seen as driven by the top, or as a result of western influence, over the last 20 years Chinese firms have made great progress in it.

It is a trend that has grown more noticeable as Chinese companies have begun to expand overseas, and that has forced many to reassess their strategy. A strategy that now goes well beyond meeting the basic expectations that stakeholders have for an economy, or brands, that are “low cost producers” and whose social responsibilities was largely set by government regulation (or their foreign clients), towards a level that is equal to those of global brands.

It is a change that started more than 10 years ago, but as indicated by the number of CSR rankings (Forbes China Philanthropy list | Southern Weekly CSR Ranking) that are regularly published, Chinese companies are making progress on CSR practices.

The development of CSR in China

Moving from low cost producer with poor labor and environmental standards to a global brand expected to share best practices has taken time over three stages:

The starting point: In the 1990s and early 2000s, CSR was a framework that was largely imported by external international retailers seeking to protect their brand. At that time, Chinese companies did not see CSR as a core value, but a task to complete, and as a result a wide range of product quality, labor, and environmental problems continued to break out.

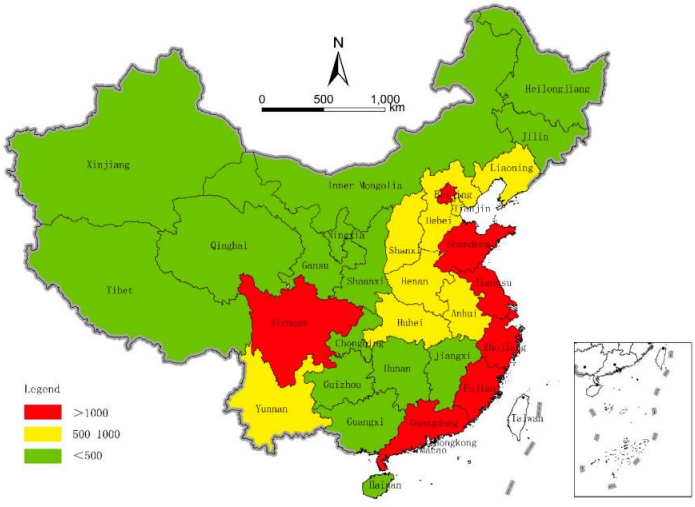
Turning point: In 2006 the concept of CSR was included in Chinese Corporate Law, and it shifted from optional to "must do" for Chinese companies, and as a result many companies began to publish their first CSR reports. It was a time where local academic institution, NGOs and some international organizations also started researching the topic and educating those around them on best practices.

Soon after, in May 2008, the Sichuan earthquake would wake up the civil consciousness of the Chinese people, who expected enterprises to make contribution on social welfare and disaster relief. Ten days after the earthquake, donations by Chinese firms reached RMB 1.6 billion, and those who had yet to give (or failed to give enough) were the subject of online campaigns. Following this event, and for the several years, the concept of CSR gained recognition and practice.

A Strategic Shift: After ten years of exploring, Chinese companies generally accept the concept of CSR, seeing it as an important investment on social asset to keep up with their global counterparts.

CSR is also redefining through the years from simple charity giving, traditional volunteering programs to long-term plan aligning with companies' core values and the country's strategy development, which in the end creates much bigger social impact.

Fig. 2.4-1 Distribution map of CSR initiative in China



Source: Corporate Social Responsibility Practices in China, MDPI

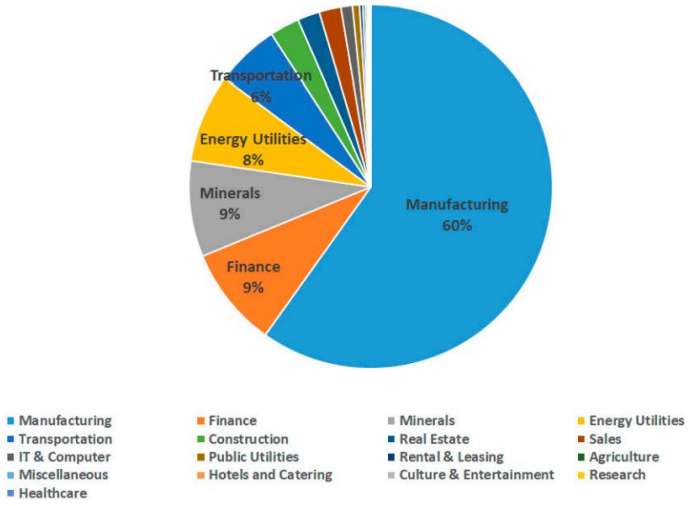
With many new regulations on social responsibility being put into effect, including ESG investment being recognized by mainstream investors, and a general reduction in the value of programs built off one-off events, it is reasonable to expect that leaders will look transition towards better practice in the future.

Instead of working in silo on CSR initiatives, Chinese companies are beginning to build multi-stakeholder platforms and seeking strategic partnerships as a way scale up their efforts and establish a better sustainability image internationally. The number of CSR reports from Chinese enterprises has increased remarkably in recent years, especially in the developed coast regions.

With the new mandatory environmental information disclosure system now in place, the amount (and type) of information reported will force firms to be more systematic and transparent. Process industry is one of the most active sectors in responding to the CSR report. More than half of the China's enterprises' CSR Report were contributed by process industries.

According to "Top 10 CSR Trends For 2018 In China" by Syntao, the importance of environmental protection, poverty alleviation, healthcare, food safety, education will become increasingly prominent in the future, requiring increased attention from enterprises.

Fig. 2.4-2 Proportion of CSR reports according to industry type



Source: Corporate Social Responsibility Practices in China, MDP

CSR Report

China's Securities Regulatory Commission (CSRC) has requirements for listed companies on the disclosure of social responsibility-related information and some local authorities, such as those in Shanghai and Shenzhen, have also issued guidance on corporate sustainable development and social responsibility.

In the coming years, as Chinese firms accelerate their pace to meet with ever increasing expectations of local stakeholders, we expect that the lesson and practices that they learn will become globally recognized for their innovation and impact.

Example: CSR Report of LONGi

Sustainable Development Report

For China, sustainability reporting remains an important entry point to implementing its 2030 Sustainable Development Agenda, which was first introduced in 2016. The Chinese government is now rapidly improving its corporate reporting landscape and striving to integrate sustainable development strategies into business' daily operation and management activities.

Example: Sustainable Development Report of Sinopec

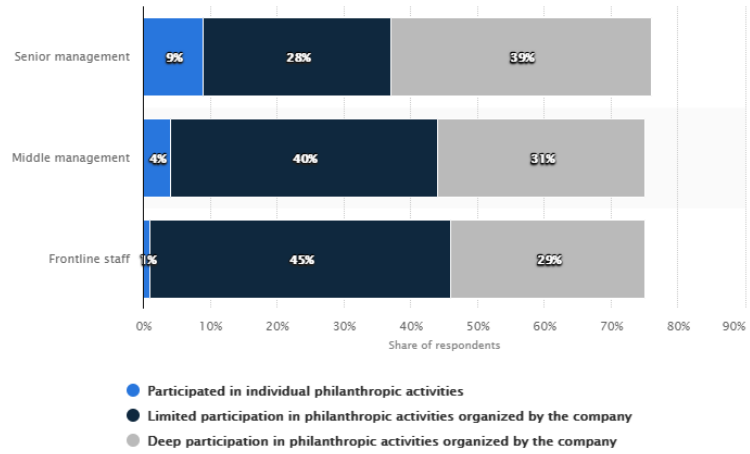
Environmental, Social, and Governance (ESG) Report

The China Securities Regulatory Commission (CSRC), in collaboration with China's MEE, has introduced new requirements that, by 2020, will mandate all listed companies and bond issuers to disclose environmental, social and governance (ESG) risks associated with their operations. That is not only because the ESG label can add value to their assets but because of the risk management requirements.

Example: Environmental, Social and Governance Report of CHALCO.

According to the survey conducted by McKinsey on the personal impact of working through the COVID-19 crisis, most of the respondents and their companies had engaged into Cooperate Social Responsibility activities during the COVID-19 outbreak. Senior executives tend to engage most deeply in such activities. About 39 percent of them had deeply participated in philanthropic activities during the crisis.

Fig 2. 3 Share of employees who participated in philanthropic activities during coronavirus (COVID-19) outbreak in China as of March 2020, by employment level



Source: Mckinsey

2.5 Logistics

2.5.1 China logistics in general

In June 2017, speaking at the “Global Smart Logistics Summit”, the Chairman of the Chinese Federation of Logistics and Purchasing (CFLP), announced that the “total social logistics costs (TSLC) in 2016 for China exceeded RMB 11.1 trillion (USD 1.6 trillion)” making China the world’s largest logistics market.

Investment in infrastructure and the improvement of the regulatory environment by the Chinese State Council has supported the rapid growth of the logistics services industry in China. This can be traced back to policies outlined in the 11th Five-Year Plan in 2005, followed by the release of the "Plan for the Adjustment and Rejuvenation of the Logistics Industry" and the Medium and Long-term Planning on Logistics Development (2014-2020).

China’s transport and logistics sector is hugely complex and competitive. Tens of thousands of companies are fighting for a share of this rapidly growing market, whose total value has more than doubled since the mid-2000s.

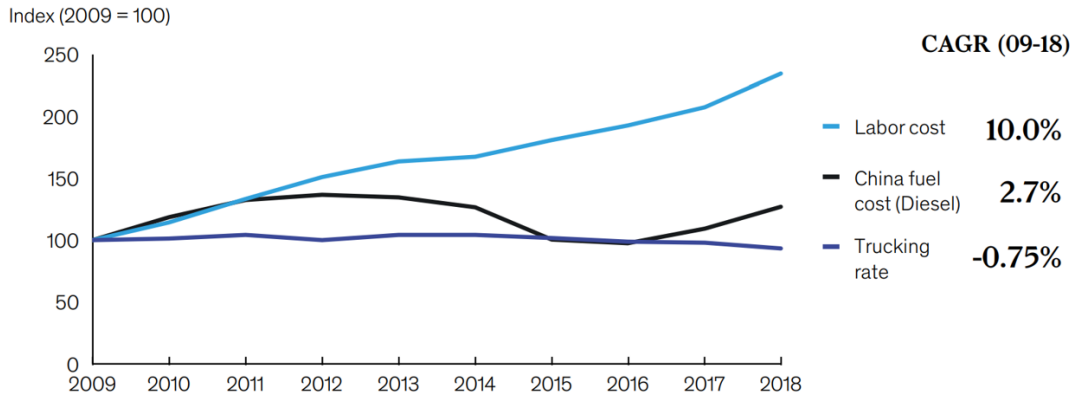
China’s move towards a more consumption-driven economy, combined with the improved accessibility of inland regions, has directed the industry’s focus from being externally oriented towards meeting the needs of new internal markets. The contraction in demand for Chinese exports in 2009, in the wake of the global financial crisis, highlighted the risks of reliance on export markets and the need to further stimulate domestic demand, the situation went to an extremity during the US-China trade war, with a tariff from US to Chinese 300 billion USD exports, although something articulated in the government’s latest Five-Year Plan.

One of the challenges is for logistics to keep pace with industrial relocation within China and also with the growth of domestic demand. Moving goods within China remains particularly bumpy. For example, road tolls, almost all of them imposed by provincial or city governments striving to recover the funds they invested in their highway networks, can account for between 30-40 percent of transport costs for trucking companies. High fees can encourage transport companies to overload their trucks and breach safety measures. There are about 200,000 kilometers of toll roads in the world, and China accounts for more than 140,000 kilometers. According to the statistics in 2018, China's total annual high-speed charges have exceeded 500 billion yuan, but even though, the road industry still has a deficit of 400 billion yuan totally.

The government has also acknowledged that efficient transport and logistics are key for long-term development and it is committing huge funds to build airports, roll out a national expressway network and, expand and upgrade the country's railway system, which is key element of its internal investment policy, for the "Rail-Road and Infrastructures （铁公基）"model from 2008 in against the financial crisis.

In February 2009, in the aftermath of the global financial crisis, the government launched its Plan to Adjust and Rejuvenate the Logistics Industry. Its objective was to rationalize the industry by encouraging such practical measures as establishing technological and other standards, accelerating the rate of mergers and acquisitions, supporting training schemes, and increasing the utilization of information technology through investment in research and development and the application of new technologies relevant to the industry.

Fig. 2.5.1-1 From 2009-2018, transportation labor costs have significantly increased, fuel costs have steadily increased, and freight rates have been stagnant.



Source: China statistics yearbook; 12th five year plan on transportation; china federation of purchasing and logistics; road transportation association; CEIC; expert interview; company press

China's logistics industry is at a tipping point. As traditional models are phased out, forward looking companies have an opportunity to increase their market share in what has been a highly diffuse industry. But to do so, companies must act now, starting with taking a hard look at their unique value proposition. They can then consider how they might benefit from embracing current trends—such as becoming an end-to-end solutions provider, expanding globally, and harnessing new technologies—and succeed in meeting evolving omnichannel needs and reaching previously unreachable customers at previously unimaginable speeds.

On September 19th, 2019,the Outline for Building China's Strength in Transport (交通强国建设纲要) was released by the *State Council* and describes the future vision and roadmap of China's transport sector.

Railway in China

Riding the country's economic expansion, China's transport and logistics industry has grown impressively in recent years. In the end of 2019, its national railway fixed asset investment had reached 802.9 billion yuan, with new line of 8489 kilometers put into operation, of which 5474 kilometers is high-speed railway. The national mileage of railway in operation has reached 139,000 kilometers, of which, 35,000 kilometers high-speed railway. The national railway network density is 145.5 km/10,000 km².

In 2019, the country's total rail freight quantity was 4,389 million tons, an increase of 296 million tons, or 7.2 percent over the previous year. The country's total good moved by rail reached 3.018195 trillion tons kilometers, an increase of 125.411 billion tons km, or 4.3 percent, over the previous year.

The average cost of railway transportation is much lower than the road by trucks. Although China has continuously in its railway constructed investment, it still far from the demand, especially to the process industries which with huge amount of raw materials and products.

Fig. 2.5.1-2 China Railway Map

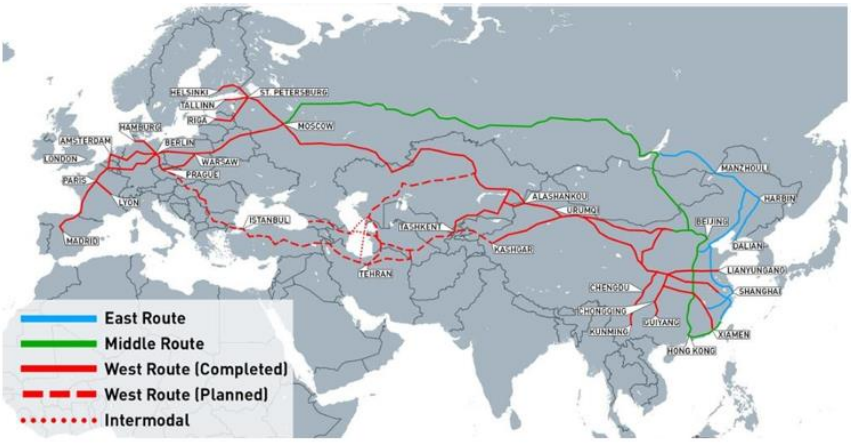
Source: China MOT

EU-China Rail Freight

EU-China Railway connection was initiated by China, which is part of its BRI strategy, and got cooperation from European countries. The transportation was subsidized by China with a lower freight price.

From January to May, the number and shipments of China-Europe freight trains surged by 28 percent and 32 percent year-on-year respectively, according to the China State Railway Group. Notably, freight trains made a new high of 1,033 trips in May, up 43 percent year-on-year, transporting a record of 93,000 TEUs. Till the end of August, there are already 6,000 trains from Chengdu to Europe, transported more than 200 billion yuan of goods.

Fig. 2.5.1-3 China-EU Rail Freight Planning Map



Source: China MOT

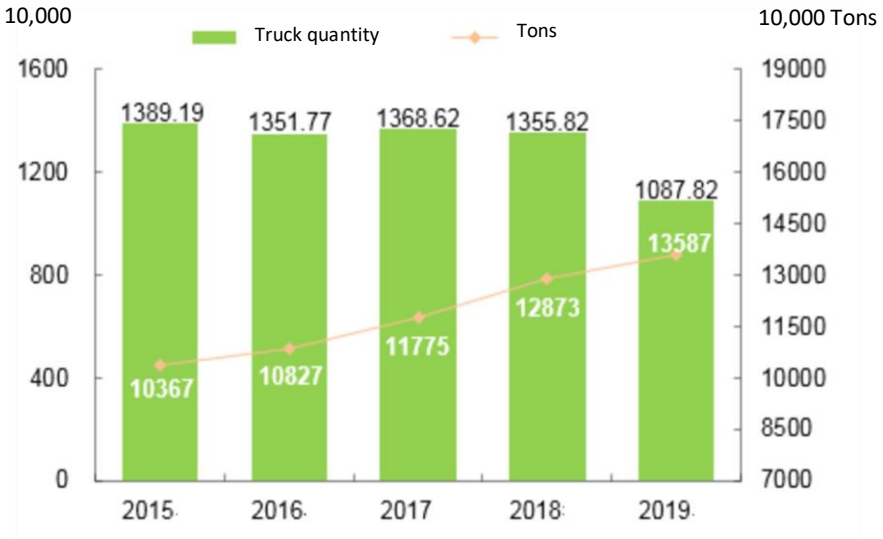
Since the COVID-19 outbreak, the freight trains have been playing an important role in supporting Europe's anti-pandemic materials by opening "green passages" for the transport of important health supplies, equipment and raw materials.

Road and truck

At the end of 2019, the country's total road mileage had reached 501.25 million kilometers, an increase of 16.6 million kilometers over the previous year. Road density is 52.21 km/100 km², an increase of 1.73 km/100 km². The total road mileage with maintenance reached 98.8%. The first highway in China was constructed in 1990, between Shenyang and Dalian. By the end of 2019, the highway mileage of China has been149,600 km, an increase of 7,000 km from 2018, with 21.895 billion yuan of investment.

The heavy truck quantity on road is decreasing, especially in 2019, partially due to the loading scale increasement (tons). The stricter regulation and development of railway also contribute to it.

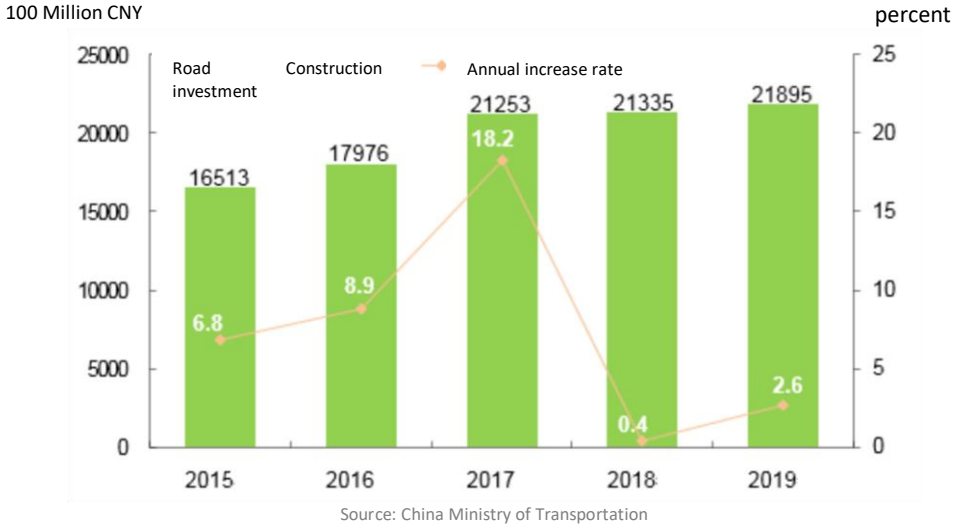
Fig. 2.5.1-4 Truck (Goods vehicles) quantity of China 2015-2019



Source: China Ministry of Transportation

According to the 13th FYP for Development of Modern Comprehensive Transport System, the CO_2 emissions intensity of China's transportation is to decline 7% by 2020 relative to 2015. China's increasingly more stringent fuel economy standards for vehicles will make an important contribution to achieving this goal. Fuel economy standards for LDVs (light Duty Vehicles) were first introduced in China in 2004 and have been tightened over time. To implement the Plan for Energy-Saving and New Energy Vehicle Industry Development (2012–2020), MIIT introduced the Phase 4 standard for domestic and imported new passenger cars in December 2014 and came into effect in January 2016. The standards require an overall fleet-average fuel consumption of 5l/100km, equivalent to approximately 120g/km CO_2, for new passenger cars in 2020 as measured over the New European Driving Cycle (NEDC). While considerable energy efficiency improvements and CO_2 emissions

Fig. 2.5.1-5 China Road Construction Investment and increasing rate 2015-2019

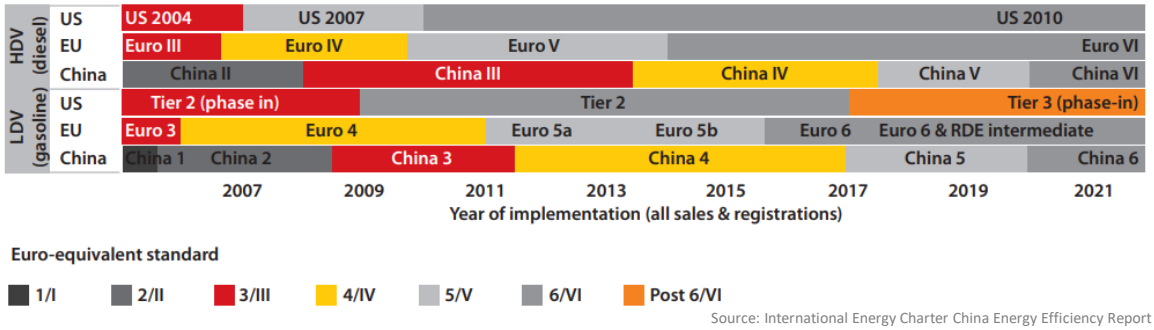


Source: China Ministry of Transportation

reductions have been achieved with the help of standards, the gains are being offset to some extent by consumer preferences with the growth in the market share of larger, heavier cars with more powerful engines.

In China, HDVs (Heavy Duty Vehicles) currently represent about 10% of the new vehicle market but they account for nearly 50 percent of China's total on-road fuel use. Earliest regulation of the fuel economy of HDVs dates back to 2012; China was the third country in the world, following Japan and the United States, to adopt fuel consumption standards for HDVs. The latest fuel consumption standards, Stage 3, released in February 2018, will regulate HDVs of weight exceeding 3500 kg with diesel and gasoline engines and went into effect on 1 July 2019.

Fig 2. 5.1-6 Timelines for LDV and HDV emissions standards implementation in China, EU, US



Source: International Energy Charter China Energy Efficiency Report

Note some of the important policies:

- The Outline for Building China's Strength in Transport by MOT
- The outline of Railway Advance Plan of the Transportation Power in New Era by NRG of China in 2020
- The Development Plan of the Transportation informationalization in the "13th Five-Year Plan" by MOT
- Notice on the implementation of Further Reduction of the Logistics Cost. By NDRC and MOF in 2020
- The Medium and Long-term Development Plan of Logistics Industry (2014–2020) by State Council

Maritime and Inland water transportation

In 2019, China's completed freight turnover of goods was 10.396304 trillion tons km, an increase of 5.0 percent. Among them, inland river transportation completed cargo volume of 3.913 billion tons, cargo turnover of 1.63201 trillion tons km; coastal transport completed cargo volume of 2.727 billion tons, cargo turnover of 3.360,356 trillion tons km; ocean transportation completed cargo volume of 832 million tons, cargo turnover of 5.405,747 trillion tons of km.

The country's ports completed foreign trade cargo throughput of 4.321 billion tons, an increase of 4.7 percent over the previous year. Of these, coastal ports completed 3.855 billion tons, an increase of 4.8 percent YoY, while inland ports completed 465 million tons, an increase of 4.3 percent YoY.

National ports completed coal and product throughput of 2.626 billion tons, an increase of 4.4 percent, completed oil, gas and product throughput of 1.214 billion tons, an increase of 7.9 percent, completed metal ore throughput of 2.220 billion tons, an increase of 2.6 percent.

Investment in water transport construction for the full year 2019 was 113.7 billion yuan, down 4.4 percent from the previous year. Among them, investment in inland river construction was 61.4 billion yuan, down 2.3 percent, while investment in coastal construction was 52.4 billion yuan, down 6.8 percent. At the end of 2019, the national inland waterway had reached 127,300 kilometers, an increase of 172 kilometers over the previous year.

Air freight

At the end of 2019, there are a total of 238 civil aviation airports in China, an increase of 3 over the previous year, of which 237 were airports for scheduled flights, and 234 cities with scheduled flights.

The air freight volume of completed cargo and postal transportation was 7.532 million tons, an increase of 2 percent over the previous year, and the freight turnover of goods and mails was 26.319 billion tons, an increase of 0.3 percent.

2.5.2 Process industry location and transportation-carbon footprint

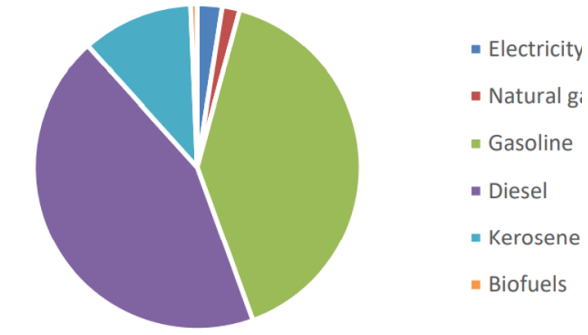
The logistic cost was normally given less weight when compared with other factors such as government approval, energy price or favorable policies in the location selection of Chinese process industry. That's also an important reason for metallurgical plants moving from the coast area to the mid-western area of China in recent years.

From 2006 China became the world largest GHG emitter and the world largest energy consumer. From the beginning of this century, Chinese central government was trying to diminish the process industries with high energy consumption or high pollution, especially from the coast areas. These process industries were given a cap for their production capacity limitation. They have to closed the old production line and purchase new modern equipment to upgrade. For example, in ferro-silicon, furnaces smaller than 12,500 KVA are not allowed in 2010, and then later the limitation was raised up to 25,000 KVA. At the same time, the limitation to smoke and waste control were also restrained. Many of these process industries moved to the west, which can also catch the policy of the State Council "Developing the West".

In 2015 NDRC issues "The national railway freight rate", increases by an average of 1 cent per ton km, from 14.51 cents RMB to 15.51 cents RMB, and as the benchmark price, allowing up and down no more than 10 percent. With this fairly low price, to be close with a railway station for goods, is one of the most important factors to all the process industries in selection of their locations.

The national railway energy consumption converted to standard coal of 16.3477 million tons, an increase of 10.57 million tons, or 0.7 percent from 2018. The combined energy consumption per unit of transport workload was 3.94 tons of standard coal/million conversion ton km, a decrease of 0.13 tons of standard coal/million conversion ton km, a decrease of 3.2 percent. The unit transportation workload main lying at 3.84 tons of standard coal/million conversion ton km, 0.03 tons of standard coal/million conversion ton kilometers, decreased by 0.9 percent compared to the previous year 2018.

Fig. 2.5.2-1 Energy consumption of transportation in China



Source: MOT

Road freight enterprises consume 1.7 kg of standard coal per 100 tons of km, a decrease of 15.0 percent. Gasoline and diesel dominate the transportation energy use Together, these two fuels accounted for 84% of total delivered transportation energy in 2018. Gasoline consumption is primarily for the movement of people, especially by light duty vehicles. Diesel fuel consumption is primarily for the movement of goods, especially by heavy-duty trucks. Jet fuel accounts for 11 percent of transportation energy consumption, while Natural gas and electricity together accounting for about 4 percent. The current oil-dominant energy consumption of transportation is an energy security issue. It is imperative to adjust and optimize the energy consumption structure of the entire transport sector

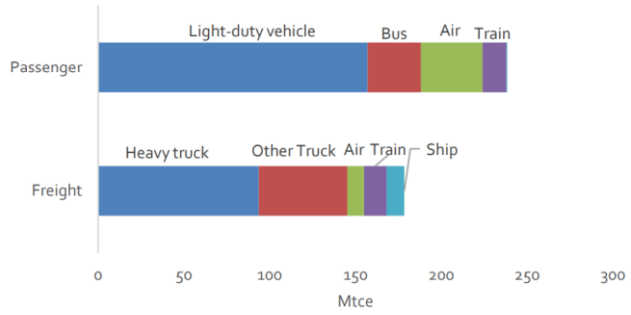
On-road vehicles demand the most of transportation energy

The above figure shows that road vehicles currently dwarf other modes of transportation in China. The energy consumed by light-duty cars accounts for 65 percent in passenger transport energy and heavy-haul trucks account 52 percent in freight transport. Air travel accounts for only nearly 11

percent of total transportation energy consumption, with trains and ships accounting for 7 percent and 4 percent respectively.

The transport sector consumes over 60 percent of oil and emits 12 percent of GHG emissions of the entire economy in China, among which on road vehicles mainly composed of cars and heavy-duty vehicles represents about 75 percent of transportation GHG emissions.

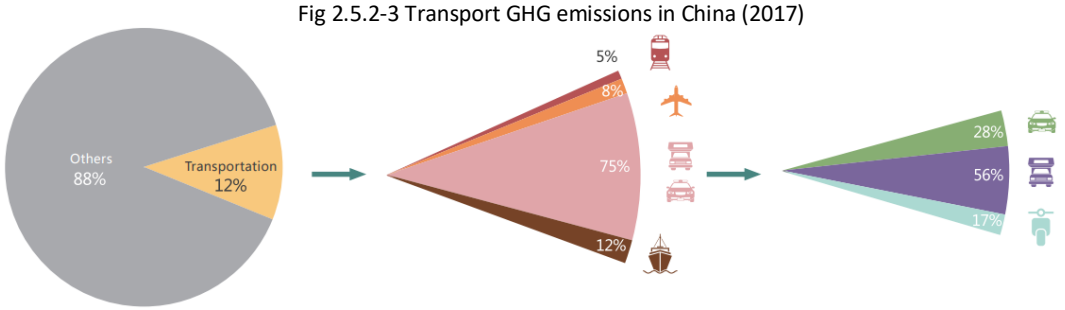
Fig. 2.5.2-2 Energy consumption of transportation in China



Source: China Ministry of Transportation

China remains the world's largest vehicle market and has maintained a record-setting annual average growth rate of 13.3 percent for new vehicle sales, driven primarily by the rapidly growing passenger car sector, for the entire past decade from 2008 to 2017. Annual new sales of motor vehicles in 2017 were nearly 28.9 million; three times that of ten years ago. China also has the world's fastest development of battery electric, plug-in hybrid, and fuel cell vehicles, also known as the new energy vehicles or NEVs, over the past five years. In 2017, China produced and sold over 0.77 million electric vehicles, representing more than half of total production and sales around the globe.

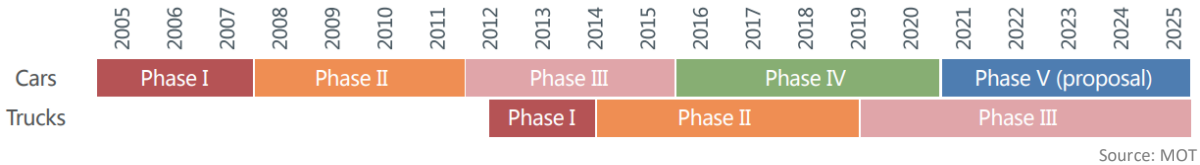
Fig 2.5.2-3 Transport GHG emissions in China (2017)



Source: ICCT Roadmap Model

Since 2004 China has published a series of energy efficiency standards to regulate new cars and heavy-duty vehicles given the significant impact of energy consumption from road vehicles. The latest standard, implemented in 2016, sets a fleet-average fuel consumption target of 5 liters/100 kilometers (L/100 km) in 2020, or about a 28 percent reduction from the 2015 level. For heavy-duty vehicles, the first voluntary efficiency standard (or Phase I) was published in 2011 and implemented in 2012, after which MIIT issued a national mandatory standard (Phase II) in 2014. In 2018, the regulatory agency released the Phase III standard to further tighten the standard for the overall fleet by about 15 percent below the 2015 level, which will become effective in 2019. Figure 2.5.2-4 presents a rough timeline of the regulatory development of China's light-and heavy-duty vehicle fuel efficiency standards in the past decade and half (details of the standards will be explained in subsequent sections).

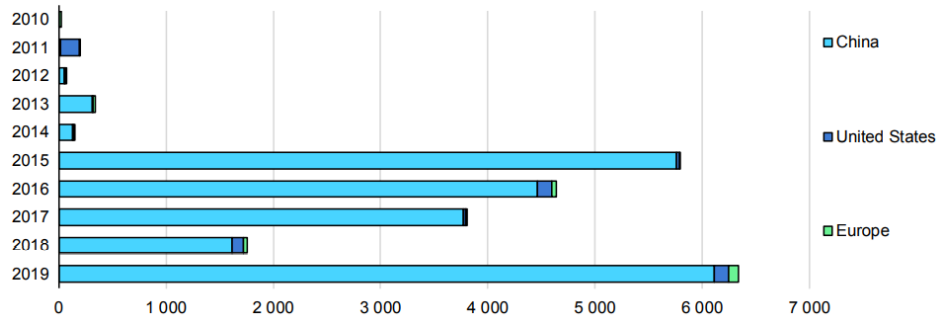
Fig 2.5.2-4 Timeline of car and heavy-duty vehicle energy efficiency standards



Source: MOT

China is among the few major vehicle markets that have enacted mandatory efficiency (or GHG) standards for heavy-duty vehicles. The others are the United States, Canada, Japan, and India. The following figure compares the relative stringency of these national standards with respect to the baseline defined when the standards were introduced for one common vehicle type across the regions – tractor trucks. The nearly 30 percent reduction in fuel consumption required from the progressing standards between 2014 and 2020 in China makes it one of the most ambitious regulated markets in improving its heavy-duty vehicle fleet efficiency.

Fig. 2.5.2-5 Global sales of medium- and heavy-duty electric trucks, 2010-19 (units sold)



Source: IEA

Despite China's strong ambition in greening its HDV sector, gaps in terms of technologies and the absolute value of vehicle efficiency still exist between the current Chinese HDV fleet and those in the U.S. and Europe. For example, average fuel consumption for new tractor trucks in China is rated at about 44 L/100 km, compared with 33-36 L/100 km in the U.S. and 31L/100 km in Europe. China lags in terms of the market penetration of nearly all engine and vehicle body efficiency technologies such as advanced turbocharging, automatic and dual clutch transmission, aerodynamic technologies, low rolling resistance tires, and energy management. The Phase III standard is expected to help narrow the gap in new HDV fleet fuel consumption between China and advanced markets by about 10-15 percent.

2.6 Power generation

2.6.1. Historical development of China's energy and electricity production

Overview of energy production, volume, growth and structure

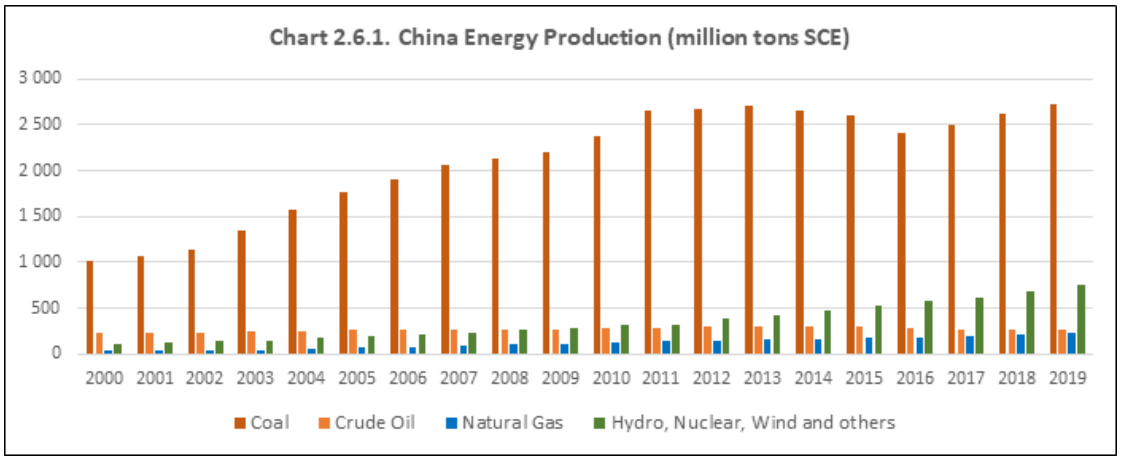
With continuous strong economy growth, China's total energy production has almost tripled in past twenty years, from 1.38 billion tons SCE in the year of 2000 to the 3.97 billion tons SCE in 2019 (Chart 2.6.1.).

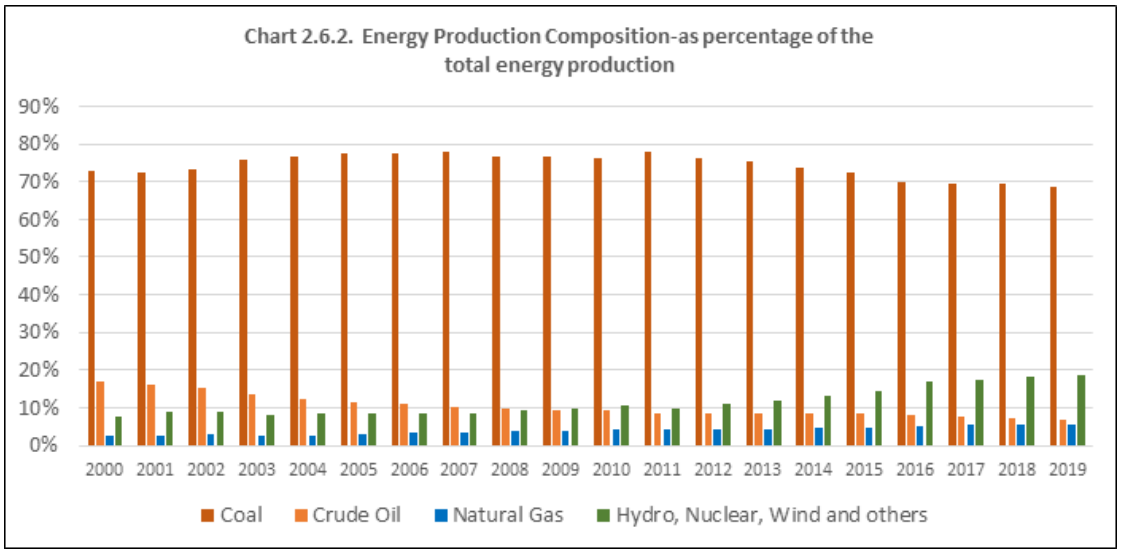
Coal production has played dominant role in China's energy production, which is by far the largest in composition of total energy production through past two decades. In 2000, Coal production contributed 72.9 percent of the total energy production while in 2019, the percentage reduced to 68.6 percent. Crude Oil's share also reduced from 16.8 percent in 2000 to 6.9 percent. The increasing energy production contributors are natural gas, from 2.6 percent (2000) to 5.7 percent (2019) and the combination of hydro, nuclear, wind and others which grew vigorously from 7.7 percent (2000) to 18.8 percent (2019) (Chart 2.6.2.).

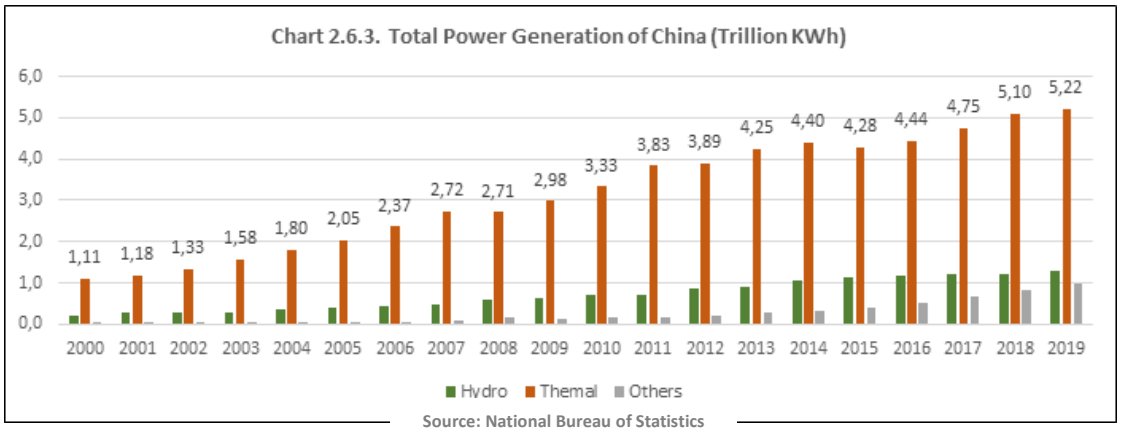
**SCE-Standard Coal Equivalent: is the coefficient for conversion of electric power which is calculated based on the data on average coal consumption in generating electric power in the same year.*

Thermal power – the dominant supplier in power generation industry

Coal also played leading role in annual electricity power generation. Thermal power generation contributed 82 percent of all the power generated in 2000 and 72 percent in 2017, a 10 percent drop in the ratio. (Chart 2.6.4.) However, statistics shown that the total electricity volume increased around 5 times from 1.36 trillion KWh to 6.6 trillion KWh in 2017. Thermal power's dominant contribution to







total power generation remained and will continue its dominating position in the near future. In the year of 2019, thermal power generation totaled 5.2 trillion KWh, grew almost 5 times as the output of 1.1 trillion KWh in 2000. It's contribution ratio in total power generation dropped below 70 percent.

Hydro power

Electricity generated from hydropower followed a slightly higher growth rate in past twenty years. From 0.22 trillion KWh in 2000 to 1.3 trillion KWh in 2019. It's contribution ratio in the total power generation slightly increased from 16.4 percent in year 2000 to 17.5 percent in year of 2019 (Chart 2.6.3.). Based on the available statistic data, nuclear power and wind power combined has a high growth rate in terms of its contribution ratio of the total power generation, from 1.2 percent in 2000 to 8.3 percent in 2017.

Wind power

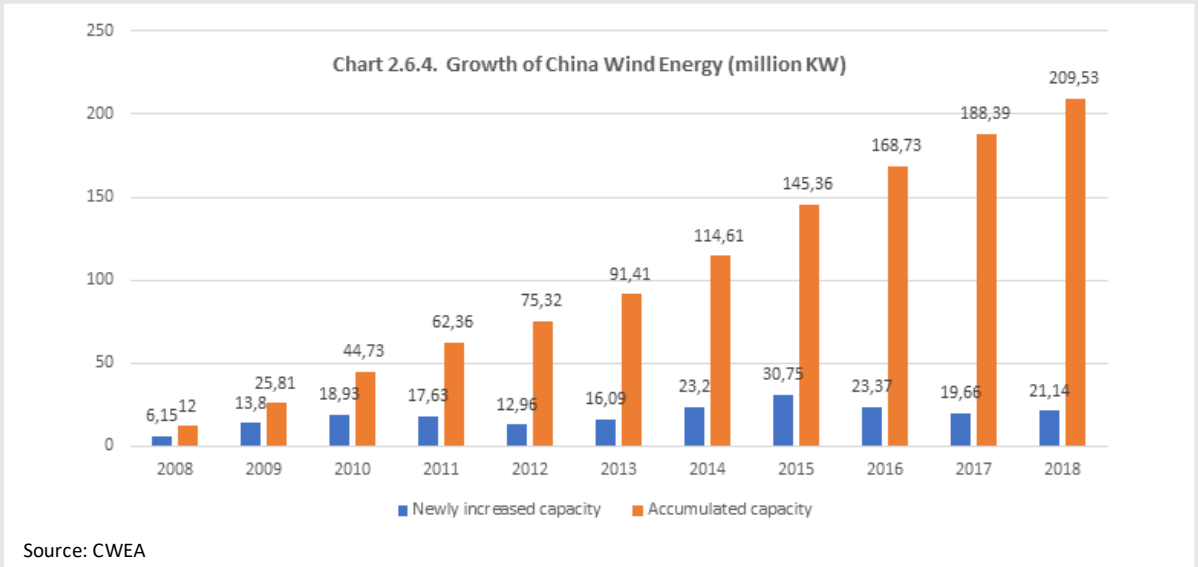
Wind Power is the driving force of renewable power generation of China. This is result from the huge investments in the new increased capacity in the past decade (Chart 2.6.4.). According to China Wind Energy Association (CWEA), China's accumulated wind power capacity has accounted 35 percent of the world total in 2017. Wind power generated 0.3 trillion KWh in 2017, accounted 4.5 percent of total power generation of the same year (Chart 2.6.6.). New installed 21 million KW capacity was made in 2018, on top of 188 million KW capacity of previous year, increased of more than 10 percent.

According to China's 13th Five-Year Plan of Wind Power Development (2016-2020), The target of Wind Power capacity is above 210 million KW, annual power generation to reach 0,42 trillion KWh and to contribute 6 percent of total power generation of by the end of 2020.

Investments in electricity production dominated the total investments made in the energy production sector. The ratio is ranging from 56 percent (in 2011) to 75 percent (both in 2016 and 2017). Considering the dramatic growth of the investments in total energy production sector(from 399 billion yuan in 2000 to 3226 billion yuan in 2017), The investments made on electricity production in 2017 reached 2429 billion yuan, 8.8 times of the investment made in 2000 (274 billion yuan).

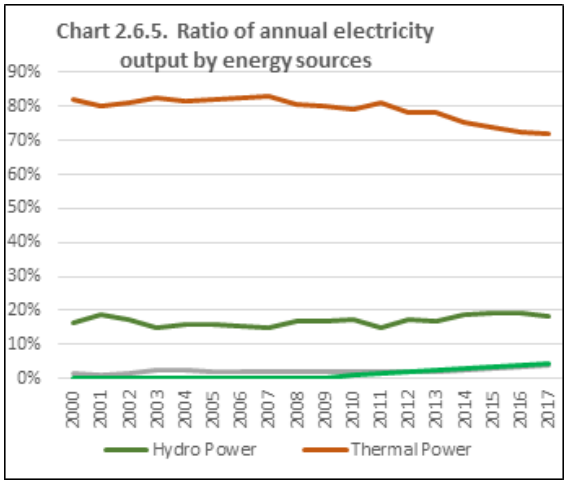
According to the historical data available, investments in the power generation sector were primarily on thermal power projects. Annual newly increased production capacity for thermal power were much more than wind, nuclear, hydro and other types of energy source. The Chart 2.6.7. and 2.6.8 illustrated the comparable size of new capacity. Unit: MW.

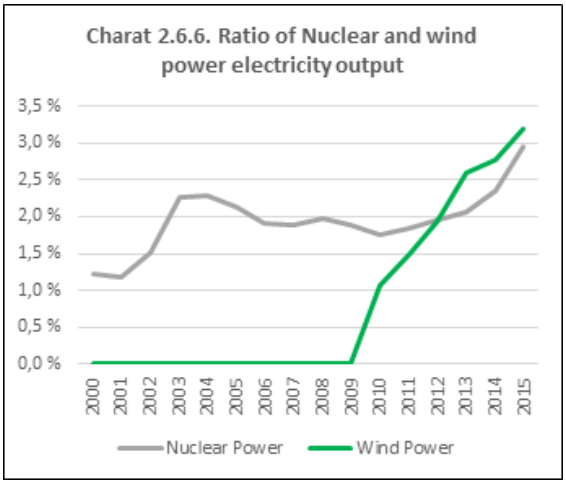
Nearly half of the annual new installation of capacities is still thermal power in 2016, (Chart. 2.6.10.) despite of the continuous decreasing of its shares in total for 16 years from 2001-2016. (Chart 2.6.9.) The annual new installed capacity of wind power increased rapidly in the same period. In the year of

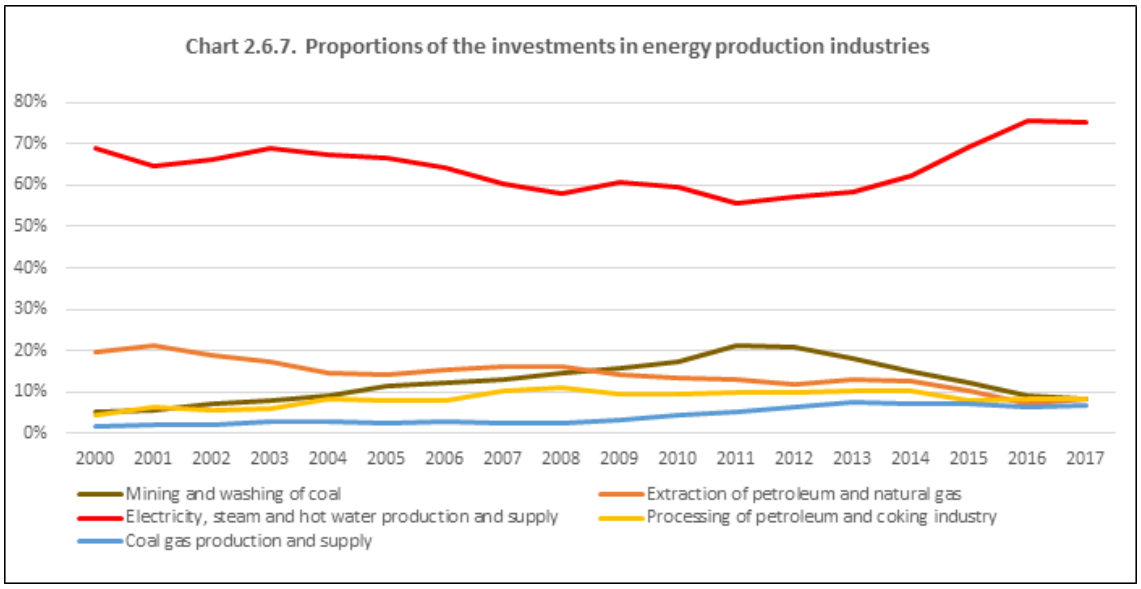


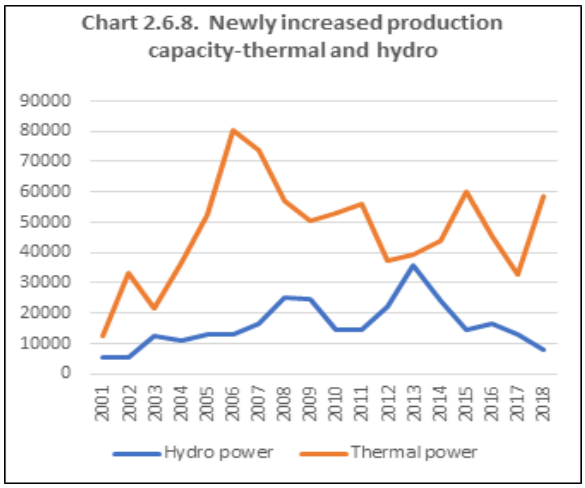
Source: CWEA

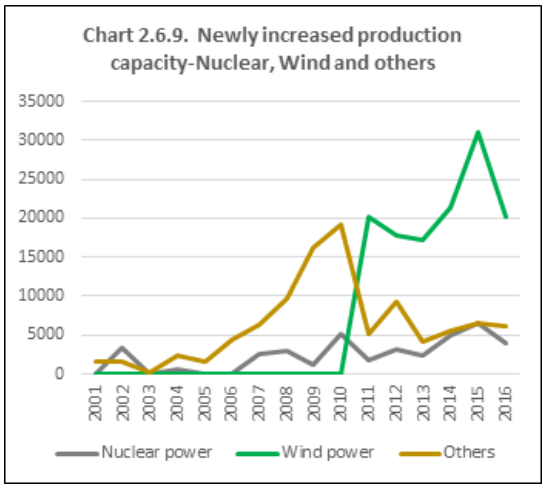
2016, the new installation of wind power accounted for around 22 percent of the total increased capacity of the year.



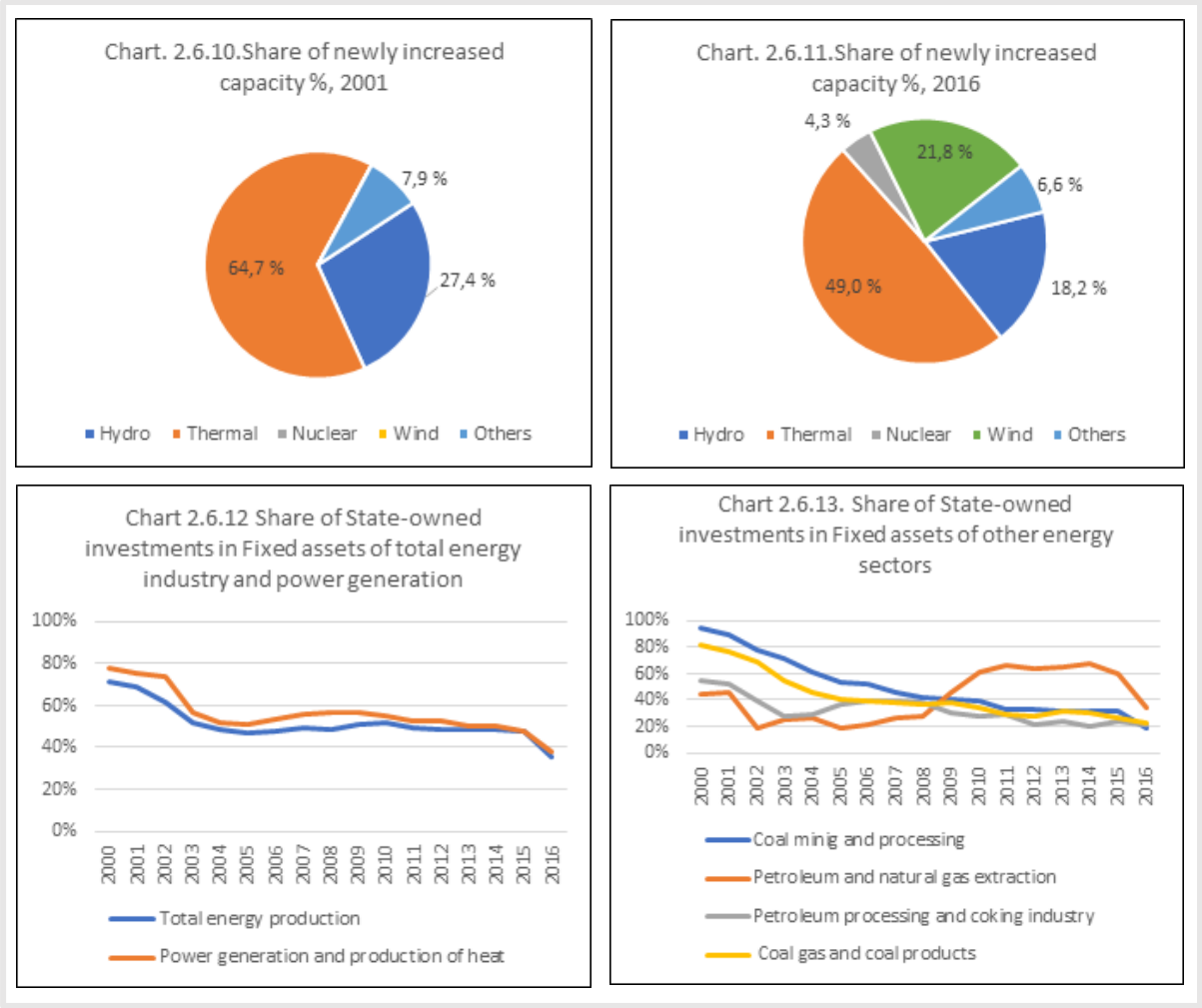








Source: National Bureau of Statistics



The share of State-owned investments in Fixed assets are reducing

State-owned investments used to be dominating the annual fixed assets investments in power generation industry as well as in the total energy production industry. Investments made by the state-owned entities on fixed assets were over 70 percent in the year of 2000 of the total investments for the power generation industry. In 2016, stated-owned investment only accounted for 36 percent of the total. As the result, state-owned investment share in the entire energy sector were reduced accordingly, from 78 percent in 2000 to 38 percent in 2016 (Chart 2.6.11.). Similar trends were found in other energy production sectors (Chart 2.6.12.).

Subsidy to renewable energy power generation

Since the effectiveness of the law on renewable energy of P.R. China in 2006, China has gradually established the pricing, public financing and taxation mechanism of utilization of renewable energy. The revised law in 2009 announced the establishment of a state fund, the **Renewable Energy Development Fund** which was raised both from special funds arranged in the state budget for the financial year and from the surcharge of renewable power price charged in accordance with the law.

Under such arrangements, the grid companies are compensated for the excessive costs of acquiring electricity generated by the renewable power projects.

Table 2.6.1 Central government budget and spending of Renewable Energy Development Fund (billion yuan)								
Renewable Energy Development Fund	**2016 Results**	**2017 Budgets**	**2017 Results**	**2018 Budgets**	**2018 Results**	**2019 Budgets**	**2019 Results**	**2020 Budgets**
Budget of surcharge income	64,78	66,00	70,55	75,50	78,61	83,50	86,81	88,35
Budget of surcharge expense	59,51	75,04	71,21	83,89	83,89	86,61	85,92	92,36
1) Central budget	50,57	65,16	64,87	75,49	76,86	78,01	77,81	83,87
2) Local budget	8,93	9,88	6,33	8,40	7,03	8,60	8,11	8,49
Source: Ministry of Finance								

2.6.2. China energy consumption and power consumption of industries

General situation of China's energy consumption

From year 2000 to 2017, China's GDP increased 8 times. The energy consumptions were 3 times more. Up to 2019, China's GDP were 9 times of that in the year of 2000. Total energy consumption were 3.3 times of 20 years ago.

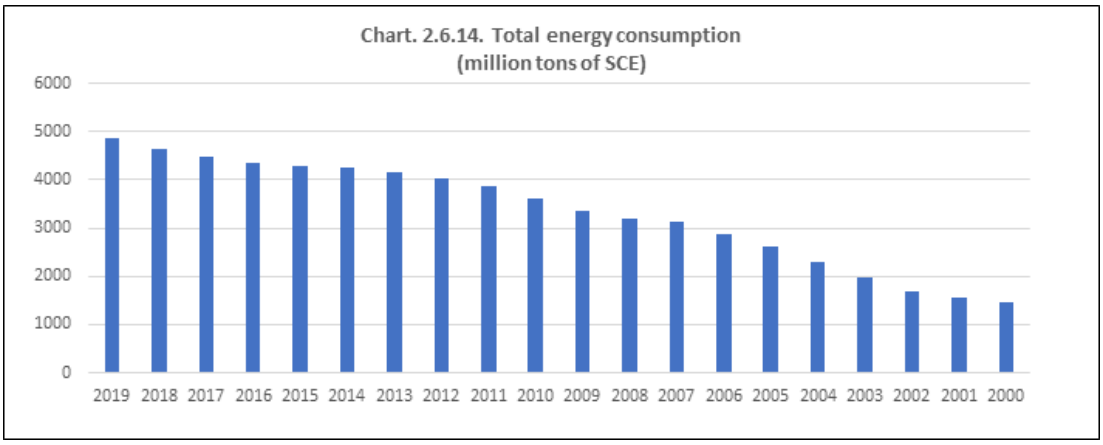
Central government's economy development policies, energy-saving regulations and practices, industry upgrading guidelines and applications of technologies were contributed to the decreasing energy intensity of total GDP.

The industry departments consumed over 60 percent of the energy of China in the past 20 years. It is by far the largest energy consumption sector of China. However, its weight in total consumption was decreasing steadily, from over 70 percent in 2000 to 65.7 percent in 2017 (Table 2.6.1.).

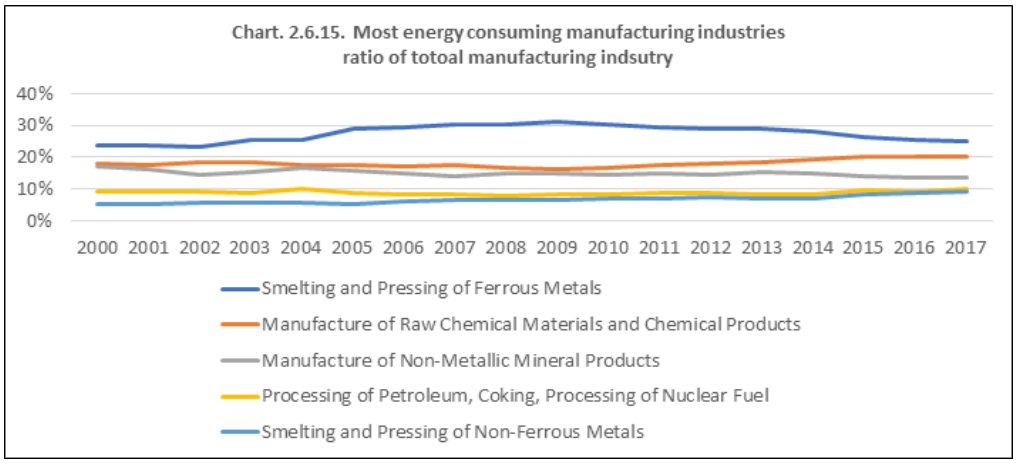
Considering the massive growth in China's economy volume, the total energy consumptions of all industries have increased exponentially (Table 2.6.2.).

Not surprisingly, among all the manufacturing industries, the top 5 energy consumption industries are related to manufacturing and processing of natural resources (Chart. 2.6.15.). Their combined contribution of energy consumption was 72 percent of total energy consumption of manufacturing industry in 2000. In 2007, they contributed more than 77 percent of the total.

Mining is also an energy-consuming sector of Chinese industry. Mining and washing of coal are by far the largest contributors of the energy consumption in quantities (Chart. 2.6.16.).



Source: National Bureau of Statistics



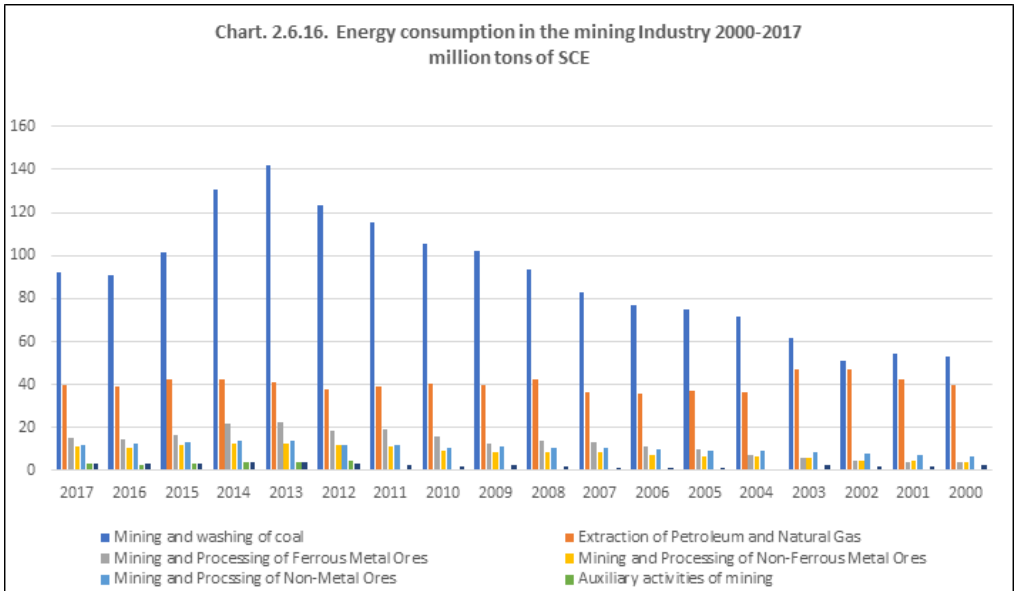


Table 2.6.2-1 Proportions of energy consumption of national economic sectors

Sectors/Year	2017	2015	2010	2005	2000
Agriculture, forestry, husbandry and fishery	2,0%	1,9%	1,8%	2,3%	2,7%
Industries	65,7%	68,0%	64,3%	64,6%	70,6%
Construction	1,9%	1,8%	1,5%	1,3%	1,5%
Transport, storage and post	9,4%	8,9%	7,2%	7,0%	7,6%
Wholesale, retail, hotel, restaurants	2,8%	2,7%	1,9%	1,9%	2,1%
Other sectors	5,4%	5,1%	3,8%	3,5%	3,9%
Residential consumption	12,8%	11,7%	10,1%	10,5%	11,4%

Source: National Bureau of Statistics

Table 2.6.2-2 Gross Domestic Product vs Total energy consumption of China

Year	2019	2018	2017	2015	2010	2005	2000
GDP*	90.1	91.9	83.2	68.9	41.2	18.7	10.0
Total energy consumption**	4.86	4.64	4.49	4.30	3.61	2.61	1.47

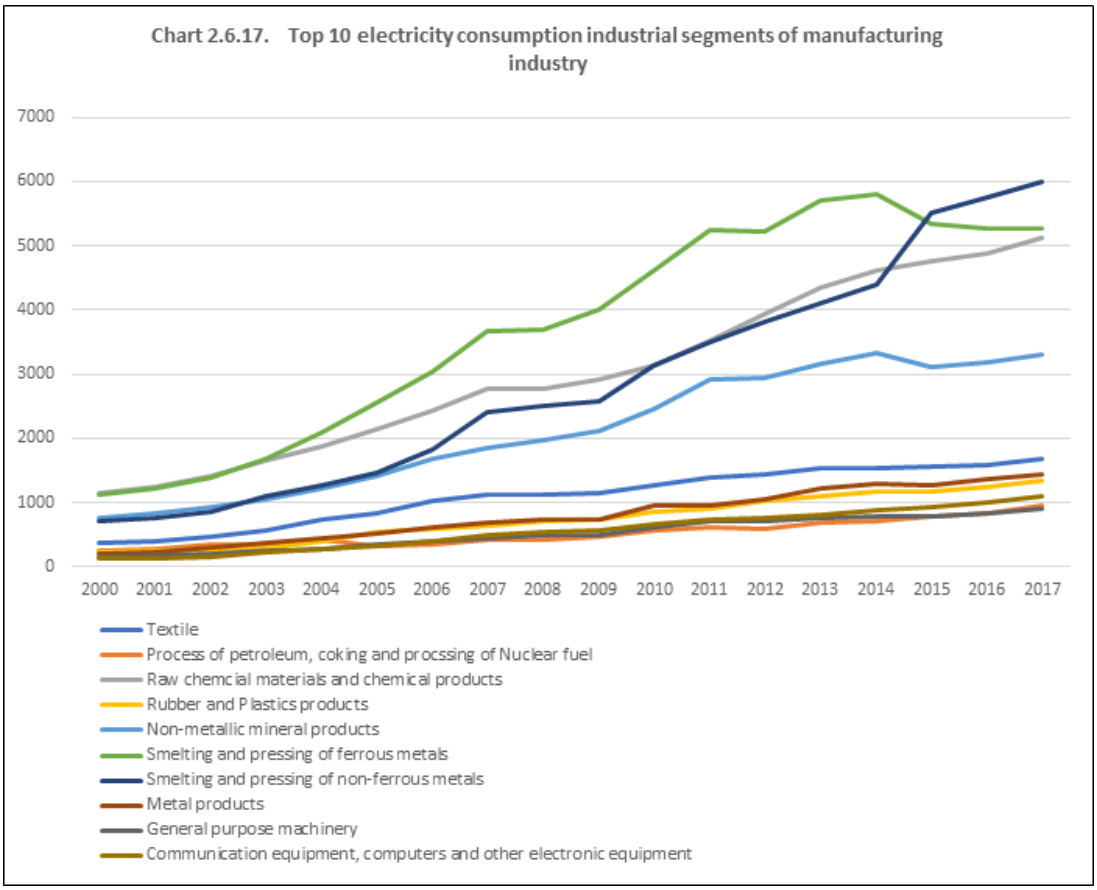
**unit: 1 trillion yuan, ** unit: 1 billion tons Standard Coal Equivalent (SCE)*

Source: National Bureau of Statistics

Electricity power consumption

China's electricity power consumption was 6.48 trillion KWh in 2017, 4.8 times of that consumed in the year of 2000. The industry department accounted for around 70 percent of the total national consumption (Table 2.6.2-3). The industry department consumed 4.4 times electricity in 2017 than that of 2000, totaled 4.5 trillion KWh. In which, the manufacturing industry consumed more than 70 percent, totaled at 3.4 trillion KWh in 2017 (Table 2.6.2-4)

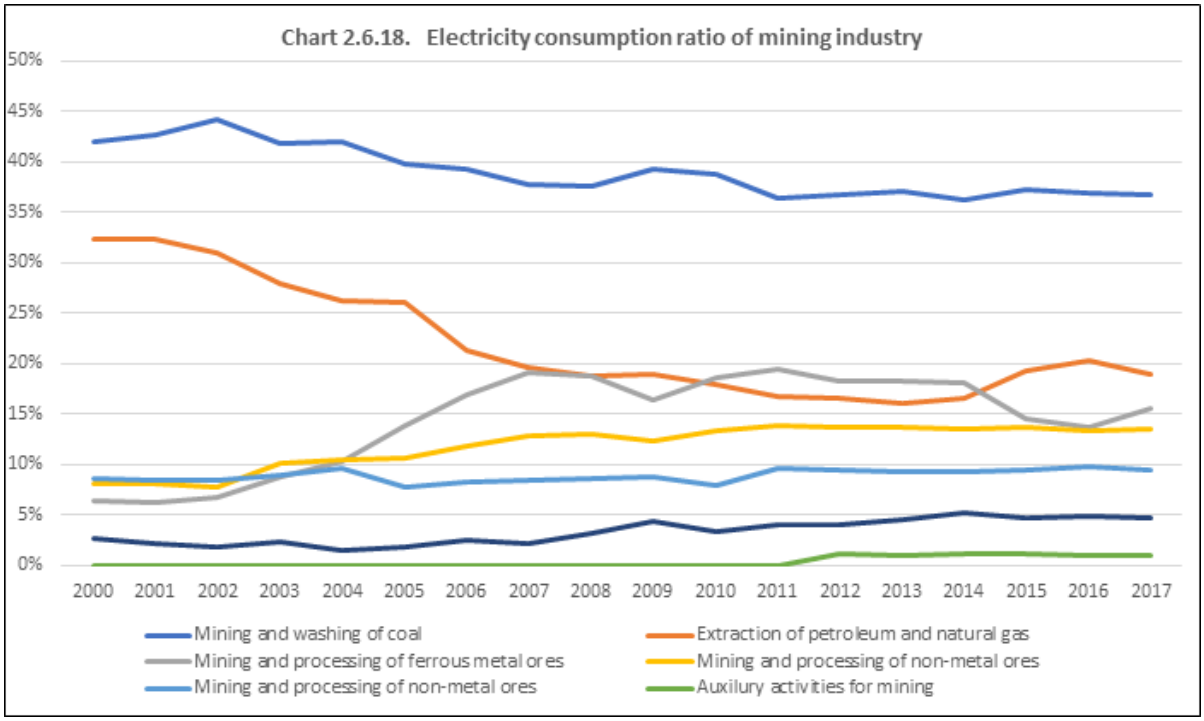
Smelting and pressing of non-ferrous metals, smelting and pressing of ferrous metals are the top two electricity consuming segments followed by manufacturing of chemical raw materials and chemical products, accounting for 17.9 percent, 15.7 percent and 15.1 percent respectively of the electricity consumption of the total manufacturing industry. The top 10 electricity consumption industrial segments in the manufacturing industry is illustrated in Chart 2.6.17 As for the mining industry, the share of its electricity consumption reduced approx. by half from 2000 to 2017, while the overall electricity consumption increased approx. 2.5 times from 99 billion KWh in 2000 to 240 billion KWh in 2017 (Chart 2.6.18.).



Source: National Bureau of Statistics

Table 2.6.2-3 Shares of power consumption by sectors					
Sector	**2000**	**2005**	**2010**	**2015**	**2017**
Agriculture, Forestry, Husbandry and Fishery	4,0%	3,1%	2,3%	1,8%	1,8%
Industries	74,3%	74,3%	73,6%	71,6%	69,4%
Construction	1,2%	0,9%	1,2%	1,2%	1,2%
Transport, storage and post	2,1%	1,7%	1,8%	1,9%	2,2%
Wholesale, retail and hotel & restaurants	3,1%	3,0%	3,1%	3,7%	3,9%
Other sectors	4,6%	5,4%	5,8%	6,8%	7,5%
Residential consumption	10,8%	11,6%	12,2%	13,0%	14,0%

Table 2.6.2-4 Shares of power consumption in the industry					
Industry	**2000**	**2005**	**2010**	**2015**	**2017**
Mining	9,9%	8,0%	6,3%	5,7%	5,3%
Manufacturing	67,3%	70,9%	74,1%	75,0%	74,7%
Electricity, gas and water supply	22,8%	21,1%	19,6%	19,2%	19,9%



Source: National Bureau of Statistics

2.7 Pollution control

The 13th Five-Year Plan for Environmental Protection published in 2016 enshrining "clear waters and lush mountains" as a national policy has marked a sharp shift, as China's authorities have started to address environmental degradation. New national pollution-control standards are being enforced by a system of requirements for production permits and a push to relocate chemical production to special chemical parks. The 2018 ban on imports of plastics waste, which has disrupted Western countries that had relied on exporting to China, is part of the same new policy

The Chinese government has taken important steps to strengthen environmental policies and legislation. The 11th, 12th and 13th Five Year Plans have progressively integrated more ambitious environmental policy objectives. This has helped to raise public awareness, focus national efforts, mobilize resources and achieve tangible environmental results. The main pollutants that have been absolutely decoupled – particularly SOx, NOx and ammonia nitrogen – have featured in these plans.

Subsidies, as well as performance evaluation and greater accountability of local leaders, have been important instruments for achieving the environmental targets in the Five-Year Plans. Substantial public financial support was provided to install end-of-pipe technologies to reduce emissions of SOx, NOx and COD, notably in the 11th Five Year Plan. While this can be an effective way to achieve targets, it contravenes the Polluter-Pays Principle, and removes incentives for enterprises to develop efficient means of reducing pollution, including by plant modernization.

With the issuance of the Implementation Plan for the Control of Pollutant Emissions Permit System in November 2016, China began to implement a new sewage permit system, implement "one-card" management of fixed pollution sources, extend the focus from pre-construction to the operational phase of enterprises, improve the system management of air pollution sources with license as a carrier, and realize the whole process management of fixed pollution sources. By the end of 2017, it has basically completed the issuance of sewage permits for enterprises in the thermal power and paper industry, with more than 20,000 sewage permits have been issued nationwide.

Table 2.7 Environmental targets in China's 11th, 12th and 13th Five Year Plans

Environmental Indicator	11th FYP (2006-2010)		12th FYP (2011-2015)		13th FYP (2016-2020)	Management
	Target	Actual	Target	Actual	Target	
Main air/water pollutant emission reduction (%)						
SO_2	-10	-14.29	-8	-18	-15	MEP
COD	-10	-12.45	-8	-12.9	-10	
NOx	-	-	-10	-18.6	-15	
Ammonia Nitrogen	-	-	-10	-13	-10	
Energy supply intensity per unit of GDP (%)	-20	-19.1	-16	-18.2	-15	NDRC
Carbon dioxide emission intensity per unit of GDP (%)	-	-	-17	-20	-18	
Share of **non-fossil energy** in primary energy supply (%)	-	-	11.4	12	15	
Water consumption per unit of industrial added value (%)	-30	-36.7	-30	-35	-20	MWR
Water consumption per unit of GDP (%)	-	-	-	-	-23	
Total use of **water** (billion cubic metres)	-	-	-	-	< 670	
Air Quality						MEP
Days with good urban air quality in cities at or above Prefecture-level	-	-	-	-	> 80	
Reduction of PM2.5 concentration in substandard cities at or above Prefecture-level (%)	-	-	-	-	-18	
Surface Water Quality						MEP, MWR
Surface water of at least Grade III quality (% of monitored sections)	-	-	-	-	> 70	
Surface water worse than Grade V quality (% of monitored sections)	-	-	-	-	< 5	

Source: MEE

2.7.1 Water

Water resources in China

China is facing severe water problems including scarcity and pollution, which are now becoming key factors restricting its economic developments. With 2.8 trillion cubic meters of fresh water, China takes 6 percent of total amount in the world's, but per capita only 1/4 of the world average. There are 400 cities lack of fresh water among the 640 cities in China totally. By 2019, China's water shortage had reached 50 billion cubic meters per year. The river chief mechanism was introduced in 2007, it assigns each part of a river/lake to a certain official, in order to protect water resources efficiently.

Water resource is a critically important factor for Chinese process industry in the plant site selection. Some even constructed small reservoir for their industrial water usage, especially those plants in North-west part of China, where lacking water resources.

Standards

After the development in over 40 years, there are 62 discharge standards of water pollutants in China now, including one standard for municipal wastewater treatment plant (GB 18918-2002) and 61 standards related to different industries. Together, these standards form the standard system of water pollution control in China and provide the basis for discharge management of water pollutants.

Industrial units need to follow the GB8978, which is a national discharge standard, to discharge wastewater. The GB8978 standard provides the maximum allowable discharge concentrations of 69 different water pollutants and the maximum allowable discharge capacities for certain industries, according to the flow direction of the wastewater. Work units constructed before and after 1st January 1998 should adhere to two levels of standards. 10 different pollutants and indicators have been selected to provide an insight into pollutant control in China; they are displayed in Table 2.7.1. Maximum Allowable Discharge Concentrations for 10 Pollutants and Indicators (work units constructed after 1 January 1998)

Water reclamation

Water shortage is and may always be an essential issue for the sustainable development of China. Therefore, water reclamation is in great need. However, the water reclamation rate from wastewater was only 11-15 in China (data from MOHURC). In order to break the bottleneck of water shortage and support the long-term development of China, it is essential to promote water reclamation.

Water Pollution Prevention and Control Action Plan' (Water Ten Plan)

On 16 April 2015, China State Council issued the 'Water Pollution Prevention and Control Action Plan' (or known as the "Water Ten Plan"). This new plan is the result of coordination & inputs from more than 12 ministries and government departments, including Ministry of Environment Protection (MEE), NDRC, MOST, MIIT, MOF, MOT, Ministry of Land & Resources, Ministry of Housing & Urban-Rural Development, Ministry of Water Resources, Ministry of Agriculture, National Health & Family Planning Commission and State Oceanic Administration.

The plan sets out 10 general measures which can be broken down to 38 sub-measures with deadlines with responsible government departments identified for each action. In general, the plan covers the following four broad actions:

- Control pollution discharge; promote economic and industrial transformation; save and recycle resources
- Promote science and technology progress; use market mechanisms and enforce law and regulations
- Strengthen management; ensure water environment safety
- Clarify responsibilities; encourage public participation.

In total, there are 238 specific actions involved. This is probably the most comprehensive water policy to date, which put some polluting process industries under spotlight.

Table 2.7.1 Different pollutants and indicators

	Parameters	Units	Application Scope	Class I	Class II	Class III
1	pH	-	All discharging work units	6-9	6-9	6-9
2	Colour (dilution ratio)	-	All discharging work units	50	80	-
3	Suspended solids ("SS")	mg/L	Mining, ore dressing, and coal dressing industries	70	300	-
			Gold-bearing vein dressing	70	400	-
			Alluvial gold dressing in outlying districts	70	800	-
			Municipal secondary wastewater treatment plants	20	30	-
			Other discharging industries	70	150	400
4	Biochemical oxygen demand ("BOD_5")	mg/L	Beet sugar processing, ramie degumming, wet method fibre board, dyes, and fur treating industries	20	60	600
			Cane sugar processing, alcohol, MSG, leather, and chemical fibre starch industries	20	100	600
			Municipal secondary wastewater treatment plants	20	30	-
			Other discharging industries	100	150	300
5	Chemical oxygen demand ("COD")	mg/L	Beet sugar processing, synthetic fatty acid, wet method fibre board, dyes, fur treating, and organophosphorus pesticide industries	100	200	1,000
			MSG, alcohol, pharmaceuticals and pharmaceutical raw materials, biological pharmaceuticals, ramie degumming, leather, and chemical fibre starch industries	100	300	1,000
			Petrochemical industry (including refining)	60	120	500
			Municipal secondary wastewater treatment plants	60	120	-
			Other discharging industries	100	150	500
6	Petroleum hydrocarbons	mg/L	All discharging work units	5	10	20
7	Vegetable and animal oils	mg/L	All discharging work units	10	15	100
8	Volatile phenols	mg/L	All discharging work units	0.5	0.5	2.0
9	Total cyanides	mg/L	All discharging work units	0.5	0.5	1.0
10	Sulphides ("S")	mg/L	All discharging work units	1.0	1.0	1.0

The new plan puts tough controls on polluting process industries as follows, with emission limits and provides stricter supervision from authorities and the public.

Paper & pulp
Leather
Textile dyeing
Dyes production
Coking
Sulphur smelting
Arsenic smelting
Oil refineries
Electro-plating
Pesticide production

Small scale factories in the above 10 process industries who did not comply with relevant national policy, standards and industrial regulation by the end of 2016, will be shut down.

The following 10 major polluting process industries are targeted for technological upgrades, emission reductions and to achieve clean production:

Paper and pulp
Coking
Nitrogen fertilizer
Textile dyeing and finishing
Agriculture Food Production & Processing
Pharmacy production
Leather
Pesticide
Electro-plating
Non-ferrous metals

Moreover, the plan ensures to stay within the 2020 cap of 670 billion m^3 of water use, with a mix of water efficiency targets and market mechanisms such as water tariff reform, revised water fees, credit financing and environment performance and eco compensation.

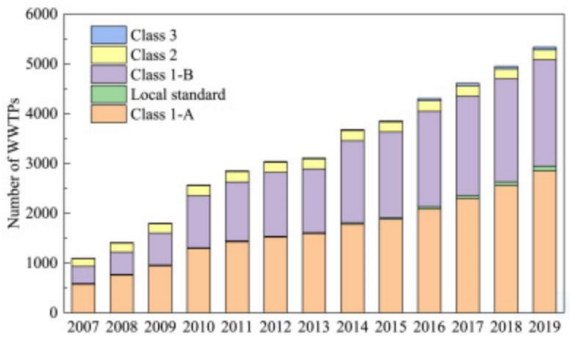
The government expects the new plan to boost GDP by around 5.7 trillion yuan and to result in 1.9 trillion yuan of new investment in the environmental protection related industries (in which 1.4 trillion yuan will go to purchasing products & services) and create 3.9 million new non-agriculture jobs.

Wastewater Treatment Plants (WWTPs) in China

In the past decade, the Chinese wastewater treatment system experienced significant development. Its daily wastewater treatment has reached 201 million cubic meter a day in the year of 2019.

The total number of WWTPs increased from 1096 at the end of 2007 to 5333 at the end of September 2019. Meanwhile, the number of WWTPs that implemented the highest discharge standard in the country, i.e. the Class1-A standard, almost quintupled in the past 12 years. In 2007, 574 WWTPs implemented Class 1-A standard in 2007, which accounted for 52.4 percent of total WWTPs. In 2019, 2847 WWTPs implanted Class 1-A standard that accounted for 53.4 percent of total WWTPs.

Fig. 2.7.1 WWTPs in China



Source: National Municipal Wastewater Treatment Management System

2.7.2 Air

The PM 2.5 in the air became an important word in China from 2011, after being revealed by the US Embassy as the main factor of air pollution in Beijing. It aroused the attention to the air quality from the public and gave high pressure for the government for taking effective measures in tackling with it.

The Air Pollution Action Plan (well-known as Ten Articles of the Atmosphere), released in September 2013, may have been China's most influential environmental policy in dealing with air pollution. It helped China to make significant improvements to air quality by setting PM2.5 targets for key regions, requiring significant reductions between 2013 and 2017 – of 15 percent in the Pearl River Delta and of 33 percent in Beijing.

In Beijing this meant reducing PM2.5 levels from 89.5μg/m³ (micrograms per cubic meter) down to 60. To do so, Beijing changed its coal-fired power plant into natural gas power plant, and replace the coal used in rural area with electricity or natural gas. These measures were costly and controversial, but they enabled the city to achieve an annual average PM2.5 level of 58μg/m³ – a drop of 35 percent.

Other cities and provinces also had to act. In the end, China's three biggest city clusters (Beijing-Tianjin-Hebei, and the Pearl and Yangtze deltas) all beat their targets.

But even so, no Chinese city yet reaches the World Health Organization's recommended annual average PM2.5 level of 10μg/m³. And as of the end of 2017, only 107 of China's 338 cities of prefectural level or higher had reached the WHO's interim standard of 35μg/m³.

The new *2018-2020 Three-year Action Plan for Winning the Blue Sky Campaign* (the *Three-year Action Plan* below) is regarded by many as the second phase of the original air pollution action plan.

The new plan matches the PM2.5 target published in 2016 as part of the 13th Five-Year Plan for environmental protection: mandating falls of at least 18 percent in PM2.5 levels on a 2015 baseline in cities of prefectural or higher level, and where standards have not already been met.

Since the implementation of Ten Articles of the Atmosphere, especially since the promulgation of the new "Boiler Air Pollutant Emissions Standard" (GB13271-2014), the treatment of atmospheric pollutants in coal-fired boilers has developed rapidly.

Particulate control

Ultra-low emissions from industrial boilers was carried out relatively early, since 2014, coal-fired industrial boiler particulate control from 200 mg/m3 to 80 mg/m3, 50 mg/m3 and 30 mg/m3, some local standards even tightened to 20 mg/m3 and 10 mg/m3. Dust removal technology from the early multi-tube, cyclone dust-based, to the rapid development of wet dust removal, and now with the emission limits of the pressure, in order to achieve the depth of particle stakes, cloth bag dust removal, electrostatic dust removal and electric bag composite dust removal has become the mainstream dust removal process.

Desulfurization

With the emission standards of industrial boiler sulfur dioxide emission requirements continue to tighten, industrial boiler sulfur dioxide control measures to apply the proportion of increasing. Before the release of GB 13271-2014, small and medium-sized boiler flue gas purification technology mainly sodium alkali method and sodium calcium double alkali method, GB 13271-2014 after the release, limestone-gypsum wet desulfurization technology in the implementation of special emission limits or ultra-low emission requirements of large boilers gradually increased the application.

DeNOx

The newly revised 2014 Boiler Atmospheric Pollutant Emissions Standard (GB13271-2014) adds emission limits for nitrogen oxides for coal-fired industrial boilers, which have been implemented since October 1, 2015. NOx treatment technology for coal-fired industrial boilers has been greatly developed in recent years, and sNCR 1 SNCR 1 "Technical Guide to the accounting of pollution sources (draft for comments)" for laminated furnaces using low nitrogen combustion technology, low nitrogen combustion and SNCR or SCR control technology.

De-Mercury

Most of the existing industrial boilers are still in the use of existing air pollution control technology in the stage of co-de-mercury, specialized de-mercury technology research is still in its infancy, there is no perfect technology can be used. There are some differences in the efficiency of co-removal of mercury between different pollutant control facilities. Mechanical dust removal and moisture removal efficiency of mercury at 20 percent left and right, but cloth bag dust removal and dry method

desulfurization/wet method desulfurization or SCR cloth bag dust removal/electrostatic dust removal and wet desulfurization to mercury collaborative removal efficiency is more than 80 percent.

Coal reduction

At the same time, in order to ensure the air quality of some large cities, vigorously promote the work of coal-fired pots and stoves to change natural gas boilers, coal-fired boilers in individual big cities have been basically replaced by gas boilers, and some local gas boilers accounted for the total number of boilers in the growing proportion. In terms of the trend of industrial boiler rigs in Figure 1-5 2010-2016, the number of industrial boiler slots reached the highest value in 2013, and the number of industrial boiler slots began to decline significantly in 2015, reaching about 530,000 industrial boilers nationwide in 2016, down about 17 percent from 2013.

VOCs

Compared with particulate matter, sulfur dioxide, nitrogen oxides and other pollution control, VOCs prevention and control lag slower in China. Given its important role in atmospheric ozone and secondary organic particulate matter, and its risk of health effects. It was mentioned that in the 13th Five-Year Plan, total VOCs emissions will be reduced by more than 10 percent by 2020 compared with 2015. Some polit VOCs Sewage Charges Pilot Work policy had been implemented in some regions within the following process industries:

Synthetic fiber single (polymerization) manufacturing	Petroleum products manufacturing in the petrochemical industry
Organic chemical raw material manufacturing	Primary morphological plastics
Synthetic resin manufacturing	Synthetic rubber manufacturing
Crude oil processing	

Bulk coal reduction

Since the 2017 reduction of about 65 million tons of bulk coal, after the implementation of "Article Ten of the Atmosphere". According to the Ministry of Environmental Protection's 2017 brick industry special rectification data, the brick and tile industry in 2017 a total reduction of 16,897 enterprises, reducing the number of bulk burning coal by about 26.4 million tons. Construction sanitary ceramics and lime backward production capacity decreased by about a quarter, with preliminary estimates reducing the amount of bulk coal by about 3.48 million tons and 2.54 million tons, respectively. Small kilns in the three industries of brick, building hygiene ceramics and lime totaled about 32.42 million tons of bulk coal.

China's coal consumption has been declining for three years since the declaration of pollution in 2013, until it rebounded for the first time in 2017. According to data released by the National Bureau of Statistics, China's coal consumption increased by 0.4 percent year-on-year in 2017. In 2018, the economy continued its steady-to-medium-to-positive trend, with the upward trend in coal consumption, with China's coal consumption increasing by 8.875 billion tons from January to September, an increase of 84 million tons and an increase of 3 percent. 40 As coal consumption picks up, the task of air pollution prevention and control will be more difficult

New Energy Vehicles (NEV)

The cumulative promotion of new energy vehicles exceeds 1.8 million units 34, achieving new energy vehicles with more than 50 percent of the world's ownership.

The country's total emissions of motor vehicle emissions fell from 4.6121 million tons in 2012 to 43.597 million tons in 2017, with an average annual decline of 1.1 percent. Among them, carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), particulate matter (PM) emissions were reduced by 1.444 million tons, 311,000 tons, 657,000 tons and 113,000 tons, respectively.

China has also introduced a NEV credits mandate, to apply from 2019, and the Electric Vehicle Subsidy Program, amended in 2018, to incentivize higher battery energy density (i.e. longer range); these initiatives are helping to drive demand for electric vehicles. These interventions build on previous Electric Vehicle (EV) support policies that have already delivered impressive results. In 2017, around a half of global sales of NEV were in China (approximately 777,000 cars). These sales added to already significant stocks as China has around 40% of the global total stock of EVs and more than 99 percent of both electric bus and two-wheeler stocks. By 2020, the new energy and clean energy vehicles in the transport industry will reach 600,000 in China.

In April 2015, four ministries – MOF, MOST, MIIT and NDRC – issued the Notice on the Financial Subsidy Policy for the Promotion and Application of New Energy Vehicles in 2016-2020, the central government subsidizes the purchase of new energy vehicles and implements the Generalized System of Preference (GSP). Since January 2017, the standard of the new energy vehicle subsidies has been adjusted, various factors are to be considered in the setting and adjustment of subsidies including: battery production cost, technological progress, vehicle driving range, battery/whole vehicle weight ratio, battery performance, battery capacity, energy density, charging rate, fuel economy. The central and local subsidy caps are set separately, and the local financial subsidies must not exceed 50 percent of the central government's subsidies of each vehicle. In February 2018, the above four ministries issued the Notice on Adjusting and Improving the Financial Subsidy Policy for the Promotion and Application of New Energy Vehicles. The new policy encourages the advanced technology using in electric vehicle and promotes vehicle enterprises to improve energy efficiency.

Some of the key policy as follows,

- Development Plan for Energy Saving and NEV Industry (2012-2020)
- Fuel Consumption Limits for Passenger Vehicles, GB 19578-2014
- 13th FYP For the Development of a Modern Integrated Transportation System

2.7.3 Waste

Waste in China general

China has the largest solid waste generation in the world. Every year there is an increase of 10 billion tons of solid waste, and China is still sitting on 60-70 billion tons of waste storage. Some cities are literally "surrounded by garbage".

According to the 2019 Annual Report on the Prevention and Control of Solid Waste Pollution in Large and Medium Cities, released by the NEE, the amount of industrial solid waste produced in large and medium-sized cities in 2018 was 1.55 billion tons, the amount of industrial hazardous waste was 46.43 million tons, the amount of medical waste produced was 81.47 million tons, and the amount of domestic waste produced was 21.1473 million tons. The comprehensive utilization rate of general industrial solid waste was 860 million tons (42.5 percent of total utilization disposal), 390 million tons (17.1 percent of total utilization disposal), 810 million tons (40.3 percent of total utilization disposal) and 46,000 tons of dumping and discards.

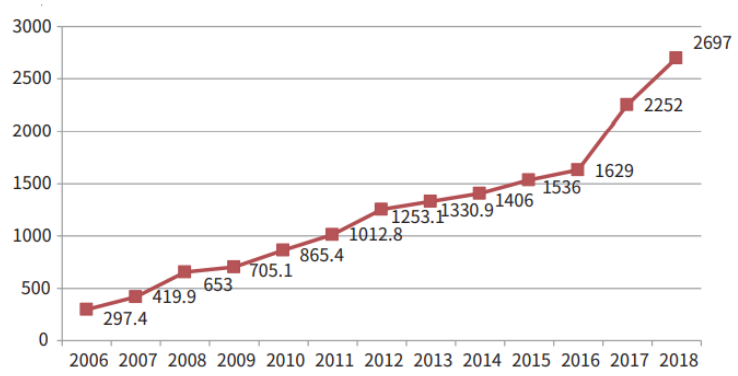
Industrial/hazardous waste

In 2018, 200 large and medium-sized cities produced 46.430 million tons of industrial hazardous waste, with a comprehensive utilization of 2.3673 million tons, disposal capacity of 2.4825 million tons, and a storage capacity of 5.624 million tons. The comprehensive utilization of industrial hazardous waste accounts for 43.7 percent of the total utilization and disposal, disposal and storage account for 45.9 percent and 10.4 percent respectively, and the effective use and disposal is the main way to deal with industrial hazardous waste, and some cities have used and disposed of hazardous waste stored in history.

Mineral tailings

In 2018, 880 million tons of tailings production from key published survey stakes in industrial enterprises, accounting for the focus on publishing surveys of industrial enterprises

Fig. 2.7.3-1 Actual collection and disposal of hazardous waste stake 2006-2018 (in 10,000 tons)



Source: MEE

General solid waste generation of 27.4 percent, the combined utilization of 240 million tons (of which the utilization of previous years storage capacity of 11.516 million tons), with a comprehensive utilization rate of 27.1 percent. The two industries with the largest tailings are non-ferrous metal mining and ferrous metals.

Mining and mining, generated at 40 000 tons and 370 million tons, respectively, with comprehensive utilization rates of 23.4 percent and 26.8 percent, respectively

Fly ash

Based on the publication of the survey from MEE of industrial enterprises, the production of fly ash 530 million tons, accounting for 16.6 percent, the comprehensive utilization of the amount of 4.0 million tons (of which 3.205 million tons were used in previous years) with an integrated utilization rate of 74.9 percent. The industry with the largest amount of fly ash production is the power, thermal production and process industry, which produces 450 million tons, with a comprehensive utilization rate of 75.7 percent, followed by raw materials and chemicals manufacturing, non-ferrous metal smelting and rolling processing industry, oil, coal and other fuel processing industry, paper and paper products industry, with a production volume of 2.5653 million tons, 1.5609 million tons, 8.878 million tons and 6.56 million tons, respectively. The combined utilization rates were 61.8 per cent, 62.1 per cent, 68.8 per cent and 78.2 per cent, respectively.

Smelting waste

In 2018, the volume of smelting waste produced by key industrial enterprises was 370 million tons, accounting for 11.6 percent, and the combined utilization volume was 330 million tons (of which 491.9 million tons were used in previous years), with an overall utilization rate of 88.7 percent.

The industry with largest production of smelting waste is the ferrous metal smelting and rolling processing industry, which produces 330 million tons, with a comprehensive utilization rate of 91.8 percent, followed by non-ferrous metal smelting and rolling processing industry with a production capacity of 26.917 million tons, with a comprehensive utilization rate 60.5 percent.

Slags

In 2018, the volume of slag produced by key published surveys of industrial enterprises was 310 million tons, accounting for 9.6 percent, and comprehensive utilization 220 million tons (of which 1.566 million tons were used in previous years), with an integrated utilization rate of 71.0 percent. The largest industry produced the most slag is the power, thermal production and supply industry, which produces 160 million tons with a comprehensive utilization rate of 71.5 percent.

The second was the ferrous metal smelting and rolling processing industry, with a production volume of 72.612 million tons, with a comprehensive utilization rate of 82.5 percent. The industry is the

chemical raw materials and chemicals manufacturing industry, with a production volume of 37.614 million tons, with a comprehensive utilization rate of 56.0 percent.

Certain Types of Solid Waste Can No Longer Be Imported

To strengthen solid waste import control, the Ministry of Ecology and Environment issued the Notice on Adjustment of the Lists of Waste Subject to Import Control , which comes into effect on 1 July 2018. As of 1 July 2019, 8 types of solid waste - such as waste steel, copper waste and scrap, and aluminum waste and scrap - were moved from the List of Solid Wastes that Can be Used as Raw Materials Subject to Import Restrictions to the List of Solid Wastes Prohibited from Being Imported.

China is Implementing New Controls on the Import of Solid Waste. The Ministry of Ecology and Environment issued different types of Technical Specifications for Application and Issuance of Pollutant Discharge Permit regarding different process industries in 2019. And there will be more to come in 2020. For example, see the:

- Technical Specification for Application and Issuance of Pollutant Permit Industrial Solid Waste and Hazardous Waste Storage, Recycling, Treatment and Disposal, HJ 1033-2019, which came into force on 13 August 2019;
- Technical Specification for Application and Issuance of Pollutant Permit Waste Resources Processing Industry, HJ 1034-2019, which came into force on 13 August 2019;
- Technical Specification for Application and Issuance of Pollutant Permit Food Manufacturing Industry – Convenience Food Manufacturing Industry, Food and Feed Additives Manufacturing Industry, HJ 1030.3-2019, which came into force on 13 August 2019;
- Technical Specification for Application and Issuance of Pollutant Permit Inorganic Chemical Industry, HJ 1035-2019, which came into force on 13 August 2019;
- Technical Specification for Application and Issuance of Pollutant Permit Polyvinylchloride (PVC) Industry, HJ 1036-2019, which came into force on 13 August 2019;
- Technical Specification for Application and Issuance of Pollutant Permit Wood-based Panel Industry, HJ 1032-2019, which came into force on 24 July 2019; and
- Technical Specification for Application and Issuance of Pollutant Permit Electronics Industry, HJ 1031-2019, which came into force on 23 July 2019.

Ministry of Ecology and Environment has announced in July that China will be banning the import of solid waste as from 2021 and therefore will no longer accept and approve import applications for solid waste, as the newly revised “Law on the Prevention and Control of Environmental Pollution by Solid Wastes” come into force on the 1st of September 2020, clarifying the legal requirements for the identification of attributes of imported goods suspected of solid wastes.

Pilot Zero Waste cities

On 30 April 2019, the Ministry of Ecology and Environment announced Work Plan on “Zero-waste City” Pilot Program in China, nominated 11 pilot cities plus five regions for “zero waste” construction, as follows:

Shenzhen	*Tongling*	*Weihai*
Baotou	*Shaogxing*	*Sanya*
Chongqing (Main District)	*Xuchang*	*Xuzhou*
Panjin	*Xining*	

Along with five regions:

Beijing Economic and Developing Zone

Xiongan New Area

Eco-city of Tianjin

Guangze County

Ruijin

Fig. 2.7.3-2 Zero Waste Cities in China

The Work Plan on "Zero-waste City" Pilot Program aims to continuously promote the source reduction and resource utilization of solid waste, minimize the number of landfills, and minimize the environmental impact of solid waste to develop eco-cities.

3. R&D development and improvement of patent

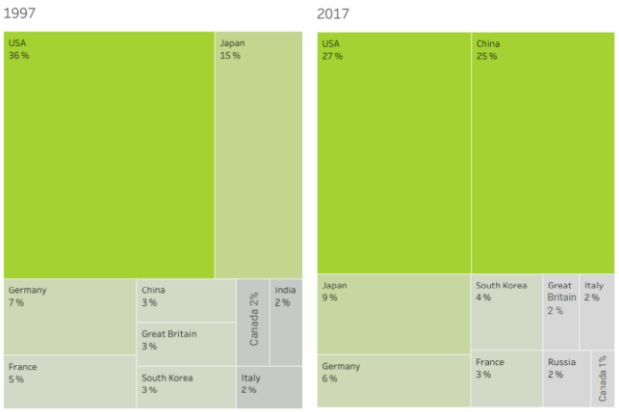
3.1 R&D development in China

3.1.1 R&D in China

In 2006, Chinese government declared its "Medium- to Long-Term Plan for the Development of Science and Technology" (MLP), the intention to transform China into "an innovative society" by 2020 and a world leader in science and technology by 2050. In 2019, China was ranked No. 14 in the Global Innovation Index while Norway ranked No. 19.

A whole-of-nation system represents a way of organizing R&D activities through the mobilization and concentration of resources in priority areas. As a mechanism of unifying resource organization, China utilizes the nation's coercive power and mobilizes the support of public finance to achieve national interests. Operating under an economic system with the nation at its core, it is also a way of planning S&T development through the state-led implementation of major projects. Under the current Chinese innovation system, public funding is biased towards emerging and frontier projects, while research in developing new technologies in traditional industries receives scant attention. The share of research personnel in total employment is also lower than in most OECD countries, and only 5 percent of total research spending was geared to basic research (as against 18 percent in the United States and 12 percent in Japan). The statistic shows internal R&D spending in

Fig. 3.1.1-1 The world's 10 largest R&D nations

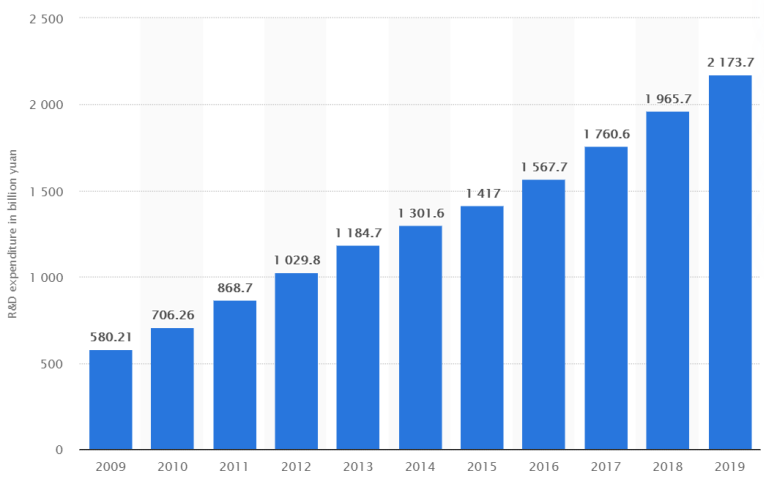


Note: Percentage of total R&D in PPP$. The rest of the world accounted for 22 percent of total R&D in PPP$ in 1997, and 19 per cent in 2017.

Source: OECD MSTI 2019–1

China from 2009 to 2019 keeps on increasing. In the year 2019, around 2.17 trillion yuan had been invested in internal R&D in China, takes 2.19 percent of GDP. Research and development funding accounted for only 0.893 per cent of the nation's GDP in 2000, and it is expected to rise to 2.5 percent of GDP in 2020.

Fig. 3.1.1-2 Internal R&D spending in China from 2009 to 2019 *(billion yuan)*

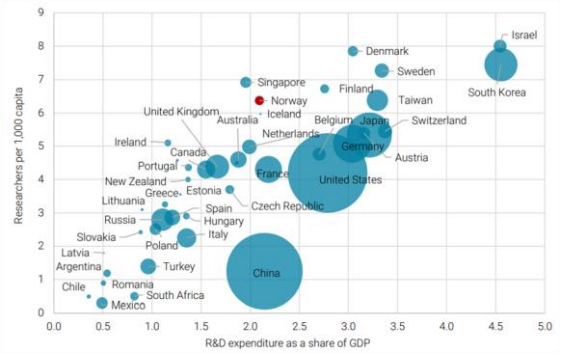


Source: MOST

It was reported that China's central government will reduce its spending on science and technology by 9 per cent this year, as the fallout from the coronavirus pandemic forces an unprecedented cut. But local governments will increase their investment to ensure growth in overall public expenditure on research and development of more than 3 per cent, according to the national budget proposal submitted by the Ministry of Finance to the National Parliament.

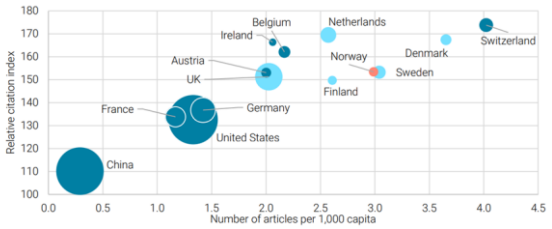
Chinese institutions of higher education perform only a small portion of China's R&D, averaging just 9.3 percent of R&D usage between 1991 and 2016. This is considerably less than that of Japan (13.5 percent), Germany (17.3 percent), and Finland (20.1 percent). The national academies system also includes China Academy of Science (CAS) and China Academy of Engineering, which is consider as a higher level of R&D with a Ministry position.

Fig. 3.1.1-3 R&D expenditure in PPP



Note: (fixed 2010 prices), as a percentage of GDP and the number of researchers per 1,000 inhabitants. OECD area and selected countries. 2017 or last available year.
Source: NIFU, based on OECD MSTI 2019–1

Fig. 3.1.1-4 Knowledge sharing and collaboration



Source: Science & Technology Indicators for Norway 2019

China also lacks well-established linkages between businesses and universities, which significantly limits knowledge transfers. Although this relationship is difficult to quantify, Times Higher Education

examined how universities work on research with industry and noted that in 2016 over "6 percent of US publications were joint efforts between the academy and industry, compared with just 2.7 percent in China."

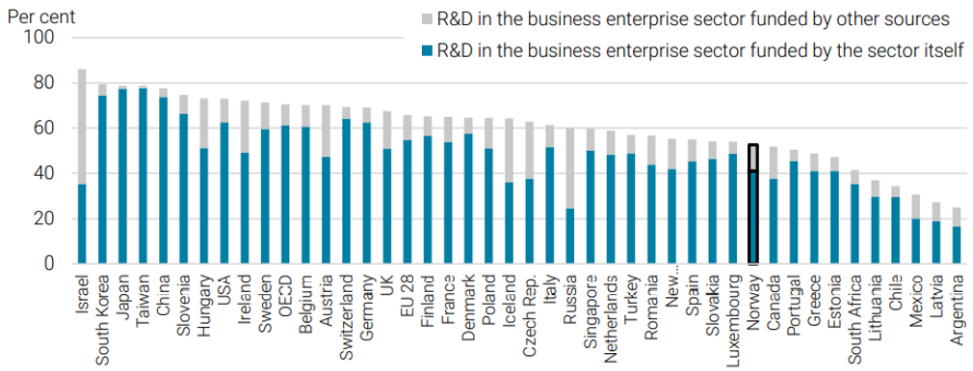
China has experienced tremendous growth and is now the world's second largest nation in this area. China's share of world production has increased from 7.3 per cent (2006–2008) to 16.4 percent in the past ten years. Next are the UK and Germany. Although the amount is huge because of its high GDP in total, but if on the per capita aspect, the average level is quite low, like all other distinguished indexes of China.

Norway has one of the highest number of articles per capita in the world, Norwegian researchers published 15,900 articles in 2018, ranking them as the world's 29th largest research nation measured in this way. The production of articles accounts for 0.65 per cent of the world production. When measuring the number of articles in relation to the population, Norway ranks as number four in the world. Only Switzerland, Denmark and Sweden have a higher scientific output per capita. Large research nations such as the United States, the United Kingdom and Germany have significantly lower relative publication volumes.

3.1.2 R&D in China's process industries

More than 70 per cent of the investment last year came from state-owned enterprises or private companies such as tech giant Huawei Technologies. Technological innovation contributed nearly 60 per cent to the nation's economic growth last year. In 1991, a mere 39.2 percent of all R&D in China was conducted by business enterprises. By 2016, that number had soared to 77.5 percent, which was greater than that of both the United States (71.2 percent) and the average for OECD economies (69.2 percent).

Fig. 3.1.2-1 R&D in the business enterprise Sector

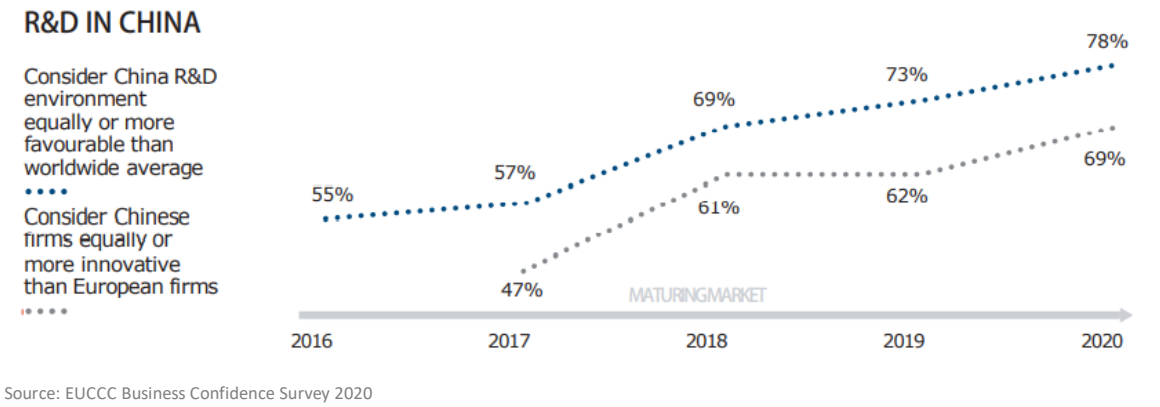


Note: R&D performed in the business enterprise sector (as a share of national R&D) financed by the business enterprise sector and other sources. Selected countries. 2017 or last available year.

Source: OECD MSTI 2019–1

According to China's National Bureau of Statistics, SOEs and companies with mixed ownership made up 65.8 percent of the R&D expenditure that went toward developing new products in 2017. Private enterprises, meanwhile, only constituted 34.2 percent. In 2017, Huawei spent some $14.3 billion on R&D – more than American firms like Apple and Johnson & Johnson. In 2019, it raised to about $18.8 billion (131.7 billion yuan, 15.3 percent of its turnover), which means 600 billion yuan investment in R&D within the last decade. This shift could prove promising for China. Some research has shown that when compared to SOEs, private companies dedicate higher portions of their revenue to R&D and often yield higher returns per yuan invested.

Fig. 3.1.2-2 R&D in China



Source: EUCCC Business Confidence Survey 2020

CHINALCO has more than ten different large R&D institutes and engineering branch companies, same as other central SOEs in China. Most of the institutes formed from the R&D Institutes under former State Ministries, such as Ministry of Metallurgy, Ministry of Petroleum, Ministry of Chemical Industry and Ministry of Coal Industry etc., which had national level of researchers and facilities. These ministries were merged into the MIIT which was founded in 2008, as a result of China's reformation to central government during that period. It also reflects that the management of process industry raised up to a more macro level instead on particular industry.

The Chinese government has launched a series of initiatives over the past few years as part of a greater push to attract more foreign R&D to China. In comparison to other innovative economies, which use non-discriminative tax incentives to foster and support R&D programs, the bulk of Chinese incentives offer tax deductions and preferential tax rates for R&D activities. These policies are generally couched in a variety of national tax incentives. As a result, there are about 1,500 R&D centers operated by foreign multinational corporations in China in 2018 vs only 200 in the year 2000.

Based on its R&D and industry strategy, China has become competitor in fast growing high-tech sectors, like nuclear energy, new energy vehicles, wind and solar PV, artificial intelligence and some parts of advanced manufacturing and robotic (drones).

Up until 2019, asked only if the answer to "Does your company have a R&D centre in Mainland China" was "Yes". In 2019, the question was asked to all participants, which explains the surge in number of respondents. Yet European companies still have a number of concerns. For example, more than a fifth of members struggle to find suitable talent. Considering the COVID-19 situation, bringing talent from other countries, or even other regions of China, will become even more difficult.

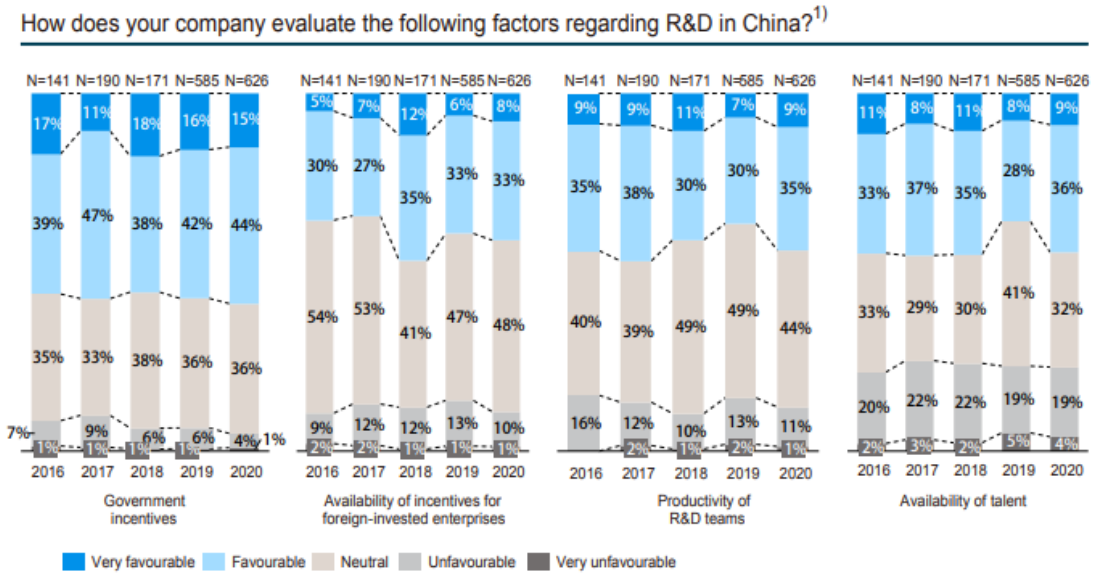
Chinese State Key Laboratories are laboratories which are connected to universities and private companies who receive funding and administrative support from the central government of China. Each lab is focused on a specific research topic.

In process industry, R&D resources were spent more on optimization of existing productions than fundamental innovation of products, such as upgrade of equipment, improvement of energy efficiency etc., are very welcomed by plant owners. In recent years, more universities and institutes are trying to promote the "Horizontal R&D Projects" in cooperation with enterprises to solve their production problems or challenges. This kind of research cooperation were encouraged both by the universities and enterprises, for a win-win situation.

From 1997, China started to allow the qualified large enterprises or Hitech Industrial Parks to set up Postdoctoral Workstation, in order to receiving graduated doctors for their R&D. Both domestic and

oversea doctor graduate can apply to work in the station for a period, with funding from the owners. This improved the R&D level of process industries, especially the steel and chemical industries, due to the scale of the enterprises.

Fig. 3.1.2-3 Availability of incentives for FIEs makes China attractive for R&D



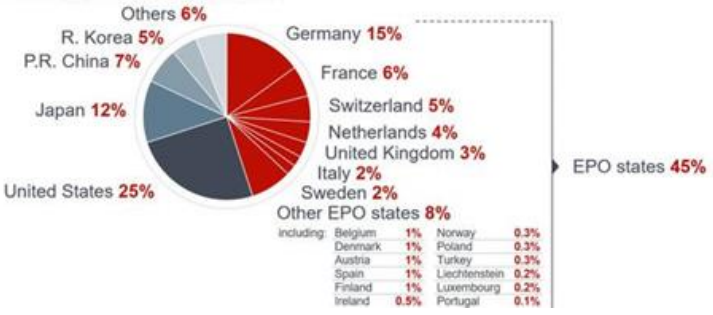
Source: EUCCC Business Confidence Survey 2020

Cultivating the research and development capability of enterprises and establishing internal R&D system requires a lot of human resources and material facilities, and in the short term it is difficult to achieve results. Many Chinese process industrial enterprises take the way of mergers and acquisitions to enhance their research and development strength, especially targeted at European and North American enterprises in the merger and acquisition, the research and development capabilities of enterprises are very important, many enterprises after the completion of overseas mergers and acquisitions, mergers and acquisitions as one of their global research and development centers. When China Blue Star purchased Elkem AS, the R&D capability and achievements of Elkem in metallurgy and materials were an important factor for the deal (see chapter 4.2).

3.2 Patent and IPR in China

3.2.1 Patent

Fig. 3.2.1-1 Origin of European patent applications in 2019



Source: EPO, Status 27.1.2020

According to **World Intellectual Property Organization (WIPO),** China's total patent applications under PCT (Patent Cooperation Treaty) was 58990 in 2019, surpassing 57840 applications from USA, thus becoming the country with most applications in the world. In 1999, WIPO only received 276 applications from China.

The **European Patent Office (EPO)** also reported 12247 Chinese applications in 2019, an increase by 29 percent from 2018. The increase

rate topped the 10 origin countries of most patent applications. Huawei alone filed 3524 applications in 2019, ranking first among all companies. Chinese patent applications are concentrated in digital communication, computer technology, electric instrument and energy sectors.

The most Chinese patent applications were still submitted through Chinese authorities. Based on the statistics of *National Intellectual Property Administration of China* (CNIPA), the granted patents for invention and utility models have shown obvious higher percentages in the sections of International Patent Classifications (IPC) which are relevant to the process industry.

Based on the statistics of *National Intellectual Property Administration of China* (CNIPA), the granted patents for invention and utility models have shown obvious higher percentages in the sections of International Patent Classifications (IPC) which are relevant to the process industry.

Fig. 3.2.1-2. illustrates the percentage of granted patents of each IPC sections vs total amount of granted patents of each respective year from 2010 till 2018. Only granted patents for invention and utility models are counted.

Based on the available statistical data from the year of 2015 till 2018, the total granted invention patents shown similar variations of the total grants for invention and utility models. **Such consistent variations may indicate that research and innovation activities are much more active and effective in some IPC sections than others.**

For instance, the numbers of patents both for invention and utility models are significantly high among Section A, B, C, G and H, consistently from the year of 2010 till 2018 (Fig. 3.2.1-3).

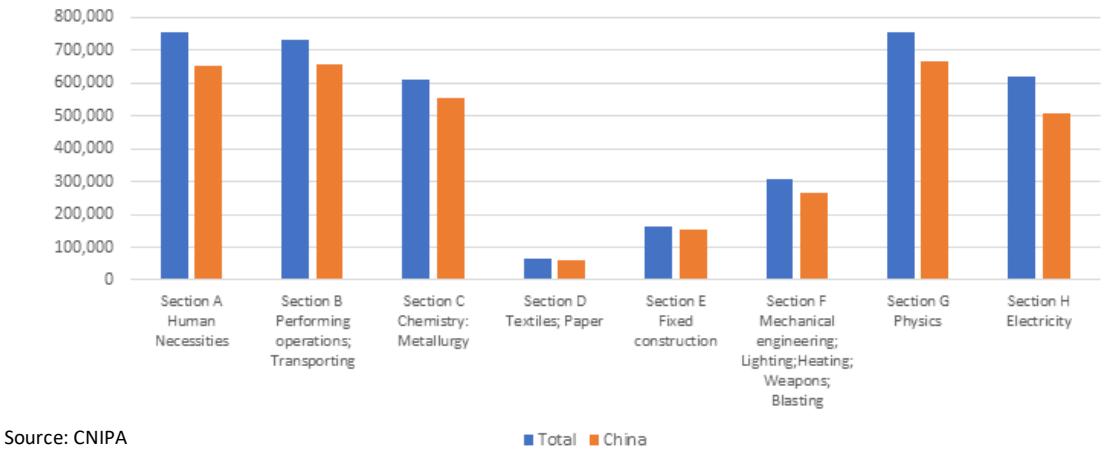
Drilling down in the data provided by CNIPA statistics, the Chinese patents granted in IPC sections has shown high numbers, reflecting the active research, development and innovation in the various industrial sections of the process industry.

The total numbers of granted patents for invention to Chinese applicants supported such conclusion that there are few invention patents granted for section D, Textile and paper. Section E Fixed construction and Section F Mechanic engineering are slightly better but still significantly lower than the *patent intensive sectors**(see page 82) which are included in Section B, C, G and H.

Norwegian applicants who were granted invention patents from 2015-2018 show similar variations. (Fig. 3.2.1-4)

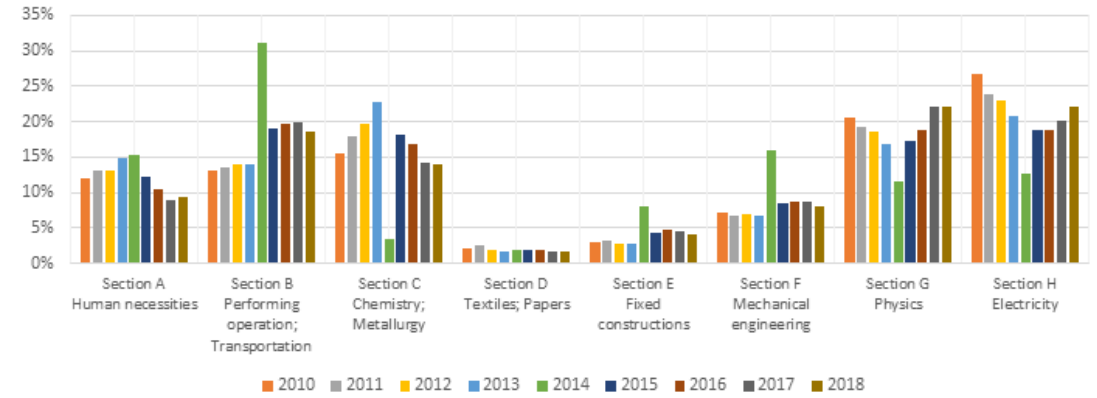
As far as the process industry concerned, Section B, C, F and G are most relevant. Table 3.2.1. provide details.

Fig. 3.2.1-3 Number of Invention Patents Granted from 2015-2018: China vs Total



Source: CNIPA

Fig. 3.2.1-2 Percentage of granted patents for Invention and utility models by sections of International Patent Classifications (IPC) 2010-1018

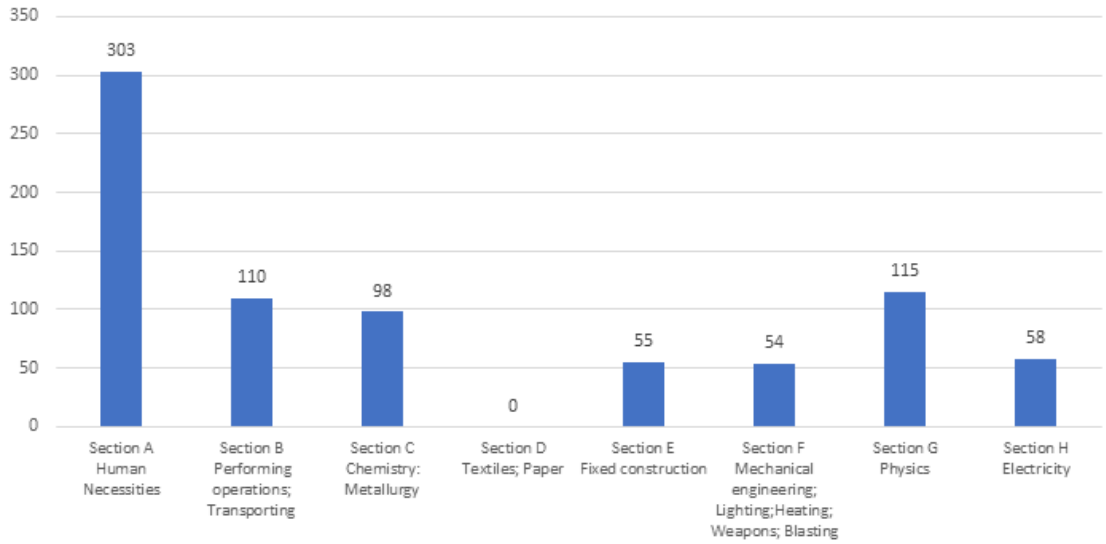


Source: CNIPA

The Directory of patent intensive industrial sectors of China highly coincide with the CNIPA statistics of granted invention patents in the past few years. From which we could see that R&D resources have been prioritized into various process industry related sectors and positive outcomes have been achieved so far.

Table 3.2.1 gives detailed industrial sectors under IPC sections with numbers of invention patents were granted to Chinese and Norwegian applicants from 2015 to 2018.

Fig. 3.2.1-4 Number of Invention Patents Granted from 2015-2018: Norway



Source: CNIPA

***Patent intensive industrial sectors**
Chinese IPR regulator CNIPA published a *Directory for Patent Intensive Industrial Sectors* in September 2016 in order to guide the implementation of the mandate of strengthen intellectual property rights proposed by the State Council (*Guofa (2015) No. 71*). The directory covered eight major industrial sectors based on China's national industrial classification (Chinese national standard GB/T 4754-2011) which was further divided into 48 sub-sectors. Sub-sectors relevant for this report are listed.

Sub-sector 4: Smart production equipment *Metal processing machinery* *Material handling equipment* *Mining, metallurgy, construction equipment*	**Sub-sector 6: New function material** *Basic chemical materials* *Fertilizer* *Coating, ink and paints* *Synthetic materials* *Specialty chemicals*
Sub-sector 7: Energy-saving and environment protection *Boiler and power generator* *Pump, valve, compressor and similar machinery* *Oven, ventilator, weighing apparatus and packaging equipment* *Chemical, wooden and non-metallic material processing equipment* *Environmental protection and social public service specialty equipment* *Power transmission, distribution and control systems* *Batteries* *General purpose and specialty instruments and apparatus*	**Sub-sector 8: Resource recycling industry** *Metal surface treatment and thermal treating processing* *Wastewater treatment and recycling* *Other water treatment, utilization and distribution*

Table 3.2.1. Invention patents granted to Chinese and Norwegian applicants 2015-2018 by IPC Sections													
		Total				China				Norway			
		2015	2016	2017	2018	2015	2016	2017	2018	2015	2016	2017	2018
All IPC sections		**1112425**	**1179583**	**1278359**	**432147**	**977775**	**1054783**	**1138549**	**345959**	**239**	**189**	**220**	**145**
Section A	**Human Necessities**	**221642**	**230465**	**263364**	**40006**	**204647**	**208164**	**208945**	**31938**	**54**	**60**	**166**	**23**
A01	Agriculture	37642	40312	49632	7536	36314	39258	48825	6985	8	13	4	7
A21-A24	Foodstuffs; tobacco	51311	53748	50180	4162	50005	52519	49429	3721	3	1	0	0
A41-A47	Personal or domestic articles	32065	35381	34649	6981	29833	33297	33062	5694	8	1	1	4
A61-A99	Health; Lifesaving; Amusement	100624	101024	128903	21327	88495	83090	77629	15538	35	45	161	12
Section B	**Performing operations; transporting**	**205149**	**214850**	**229992**	**80482**	**182858**	**195670**	**213262**	**66024**	**47**	**26**	**10**	**27**
B01-B09	Separating; mixing	43231	45942	55899	15383	40066	43290	54110	13830	12	6	1	3
B21-B33	Shaping	83622	86578	88269	32869	77263	80984	83543	28765	2	1	1	1
B41-B44	Printing	7272	7462	7844	2878	5925	6442	6581	1880	1	0	0	1
B60-B68	Transporting	70440	74292	77447	29091	59175	64512	68620	21373	32	19	8	22
B81-B82	Microstructural technology; nanotechnology	584	576	533	261	429	442	408	176	0	0	0	0
Section C	**Chemistry; metallurgy**	**183652**	**172950**	**191851**	**60683**	**165645**	**157782**	**180624**	**51210**	**37**	**27**	**13**	**21**
C1-C14	Chemistry	160262	149840	169633	49235	144654	136714	160248	41331	32	24	8	18
C21-C30	Metallurgy	23287	23020	22133	11403	20909	21004	20314	9845	5	3	5	3
C40-C99	Combinatorial Technology	103	90	85	45	82	64	62	34	0	0	0	0
Section D	**Textiles; paper**	**17837**	**20045**	**20418**	**6791**	**16429**	**18740**	**19382**	**5845**	**0**	**0**	**0**	**0**
D01-D07	Textiles or flexible materials not otherwise provided for	15816	17386	18093	5777	14679	16288	17169	4991	0	0	0	0
D21-D99	Paper	2021	2659	2325	1014	1750	2452	2213	854	0	0	0	0
Section E	**Fixed constructions**	**43855**	**49763**	**49161**	**17933**	**41474**	**47856**	**47796**	**16591**	**27**	**11**	**7**	**10**
E1-E06	Building	34643	40984	40660	13373	32858	39605	39570	12371	4	3	4	2
E21-E99	Earth or rock drilling; mining	9212	8779	8501	4560	8616	8251	8226	4220	23	8	3	8
Section F	**Mechanical engineering; lighting; heating; weapons; blasting**	**91632**	**91714**	**88698**	**34820**	**78057**	**80584**	**78922**	**25972**	**13**	**21**	**8**	**12**
F1-F4	Engines or pumps	20985	21262	17977	9485	15439	16539	14012	5720	6	7	4	4
F15-F17	Engineering in general	30904	29749	26051	11800	26147	25923	22613	8508	4	6	2	4
F21-F28	Lighting; heating	38527	39174	43063	12796	35316	36646	40739	11042	3	6	2	3
F41-F99	Weapons; blasting	1216	1529	1607	739	1155	1476	1558	702	0	2	0	1
Section G	**Physics**	**188623**	**216684**	**255100**	**96079**	**161533**	**192328**	**233914**	**78694**	**39**	**29**	**9**	**38**
Section H	**Electricity**	**160035**	**183112**	**179775**	**95353**	**127132**	**153659**	**155704**	**69685**	**22**	**15**	**7**	**14**

3.2.2 IPR in China

According to WIPO's Global Innovation Index Report 2019, China ranks 14th among the 129 economies and in the top position of 34 upper mid-income nation group. The trend has shown that China firmly establishes itself as one of the innovation leaders, contributing to 24 percent of the world's R&D expenditures in 2017 (up from only 2.6 percent in 1996) and to 44 percent of all patent applications (up from 2 percent in 1997).

The industrial added value of patent intensive industries of China has reached 10.7 trillion yuan, accounted for 11.6 percent of GDP in 2018. China's effective invention patents totaled 1.86 million, effective trademarks registered at 25 million in number, computer software copyrights totaled 1.48 million by the end of 2019.

The current priorities for Chinese authorities working with Intellectual Property Rights (IPR) are enforcement of protection, utilization and international cooperation.

IPR Protection Action Plan 2020-2021 was put into force in April aiming to consolidate the legal framework and to improve administrative law enforcement and criminal justice on all sorts of violation of IPR. Three special IPR courts in Beijing, Shanghai and Guangzhou are designated to handle cases of IPR. In addition, 46 IPR protection centers are becoming comprehensive service platforms for patent application and assessments, legal assistance and IPR financing. From international community perspective, China still has a lot to do to improve its image on IPR protection globally. Chinese central authorities have lifted IPR protection up to political level since IPR infringement has challenged national innovation strategy, jeopardized the business environment and regulatory environment. However, IPR production will still be a long-term task of law enforcement.

IPR utilization outperformed in many indicators used by WIPO's Global Innovation Index Report 2019. In addition to China's top position for the numbers of patents/GDP and utility models/GDP, China's high-tech net exports share of total trade was about 28 percent, ranked first in the world. The high-tech imports accounted for 23 percent total trade, ranked 4th among all countries. As for creative products, China was in the first place both in trademark and industrial designs per GDP. The Creative goods exports has a share of 12 percent of total trade, also top-ranked according to WIPO. The transformation of national economy growth model increasingly requires high-tech contents created by indigenous innovation and through international technology cooperation. Further comprehensive policy instruments are foreseeable in those bottlenecks hinder the utilization of IPR productivity.

China is a member of WIPO and the signatory of many other IPR-related treaties. The latest example is the **China-Norway Patent Prosecution Highway (PPH) Pilot Program** which was launched on April 1, 2020. It demonstrated an improvement in IPR cooperation between the two countries.

According to the *Memorandum of Understanding on the Cooperation between China National Intellectual Property Administration (CNIPA) and Norwegian Industrial Property Office (NIPO) on the Patent Prosecution Highway on the Patent Prosecution Highway*, the China-Norway PPH pilot program launched for a duration of three years from April 1, 2020 to March 31, 2023.

After the start of the program, the applicants of NIPO can submit a PPH request to CNIPA in accordance with the Procedures to File a Request to the CNIPA (China National Intellectual Property Administration) for Patent Prosecution Highway Pilot Program between the CNIPA and the NIPO (Norwegian Industrial Property Office); and the applicants of CNIPA can submit a PPH request to NIPO in accordance with the Procedures to File a Request to the NIPO (Norwegian Industrial Property Office) for Patent Prosecution Highway Pilot Program between the NIPO and the CNIPA (China National Intellectual Property Administration).

3.3 Special market spotlight

China takes technology development seriously, especially after the trade war with the US. On 28th Aug, 2020, China MOFCOM and MOST jointly issued the new version of "The Catalog of Prohibited and Restricted Technology Export", which was originally issued in 2008. It is considered as a countermeasure towards the trade war with US. On another aspect, it reflects that China has its unique technology and are more concern in the technology development.

Scaling up the production is the mostly used way for Chinese manufacturer to develop, with an advantage for them to cut down the producing cost. On the other hand, it also brought too much similar goods into the market, with much less personalized designed products. As a result of this, their R&D work normally focus more on the cost cutting than tailor made innovations. This left some market space for Norwegian or Europe companies who has special products or solutions to the niche market both in China and in the world. For example, Norwegian company Lattix who had a special products for the Aluminum bar specially made for some position of airport, still enjoy a good market globally.

Another trend of Chinese process industry is their expansion to both upstream and downstream value chain, in order to keep a safer position in the competition, especially to those large-scale companies.

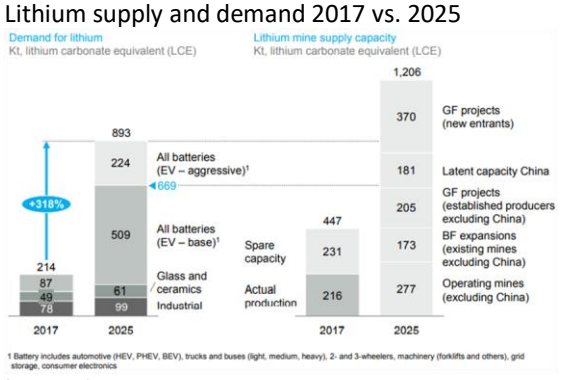
According to relevant agencies forecast, by 2050, the global demand for lithium metal will reach 40 million tons, and the current global lithium resources of up to 30 million tons of metal, but the proven mining of lithium resources into lithium metal is only 15 million tons, there is a huge gap between supply and demand. If mining technology is not qualitatively improved, the lithium crisis may even come early.

China only has 20 percent of the global Lithium reserves, which will be a challenge to its battery manufacturers in the future. Countries with key mineral resources are starting to restrain their mineral exports due to this potential crisis. For example, Indonesia as the richest country in nickel mines, has banned its nickel mineral exportation from the Jan of 2020, two years early as planned.

CATL's partner Tsingshan Steel who owns 12 million tons laterite-nickel ore, had invested 5 billion USD in local industrial park construction for deeper mineral processing, will have an advantage in supply. CATL's another partner GEM who focus on the recycling will have the advantage in supply as well.

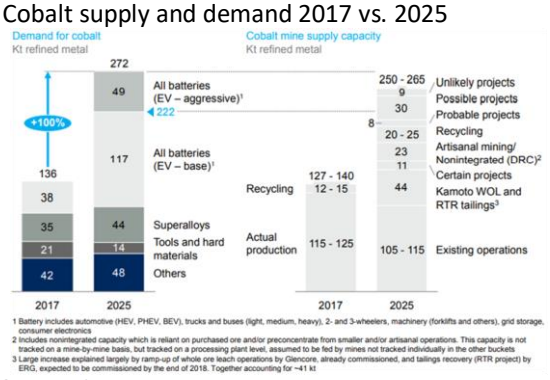
In recent years, Chinese process industry pay much more attention to R&D, as mentioned before. The investment in R&D keep on increasing. In 2019, CATL invested 2,992 million yuan in R&D, an increase of 50.28 percent year-on-year. Among its R&D teams, there are 143 PhDs and 1943 Master's degrees. As of 2019, CATL has more than 5,000 domestic and international patents, including licensed and under application, which takes the leading position in the industry. On June 24 this year, CATL announced to invest another 3.3 billion yuan for building up its 21C innovation laboratory.

Fig. 3.3-1
Lithium supply and demand 2017 vs. 2025



Source: McKinsey

Fig. 3.3-2
Cobalt supply and demand 2017 vs. 2025

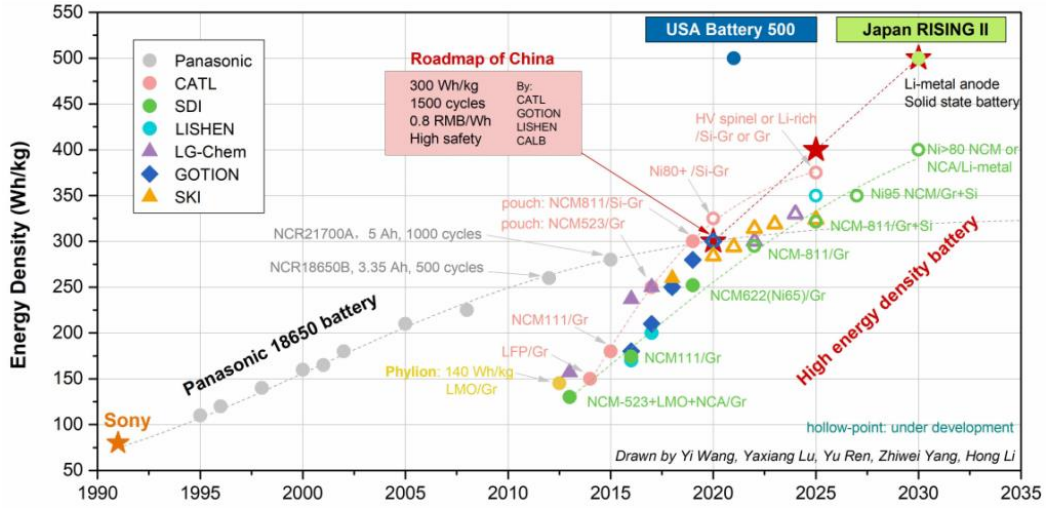


Source: McKinsey

Table 3.3 CALT Metal Global Supply Chain		
Lithium	Pilbara Minerals, Australia	
	North American Lithium Inc.(NAL)，	90%, Canada
	Tianyi Lithium 四川天宜锂业	
Nickle	North American Nickel Inc	25.38%, Canada
	IMIP, 50,000 ton /year JV with Tsingshan Steel, GEM, HANWA etc.	25%, Indonesia
Cobalt	Glencore	4-year contract with 20,000t/y
	Brump Recycling	52.88%,
Anode materials	Brump Ningde JV	9.13 billion yuan, 100,000tons/year

In June 2020, China's first official hybrid ship was successfully launched in Guangzhou, with CATL's lithium-ion battery system. Yutong pure electric bus equipped with CATL's battery, has been at an altitude of 4657 meters to 5168 meters in Everest Base Camp, successfully run for more than 1000 days. CATL and FOTON jointly delivered the HET in Beijing, as the country's first battery replacement system commercial application. CATL's extension also to the investment to EV manufacturer BYTON, and electric bicycles, charging systems as well. Even though, CATL still is facing strong competition from stakeholders of Japan, South Korea and USA.

Fig 4.2.2-3 Comparison of the gravimetric performance of different batteries for automotive applications



China's CATL is ready to produce a battery that lasts 16 years and 2 million kilometers, which will be supplied to is the Model 3 produced at Tesla's massive factory in Shanghai. CATL is developing a new type of electric vehicle battery that doesn't contain nickel or cobalt, which will also be different to its current lithium-ion-phosphate (LFP) batteries supplied to Tesla and its nickel-cobalt-manganese (NCM) batteries. BYD also get breakthrough in their Slice Lithium Phosphate battery technology.

Norwegian process industry with low carbon footprints keep their advantages. For example, Hydro has developed and marketed certified, greener aluminum products and has today two brands in this market segment: Reduxa® and Circal®. Reduxa guarantees a certified maximum level of CO_2 which is only possible with renewable energy in the aluminum production and with leading production technology through the entire value chain. Circal is a circular product based on a minimum of 75 percent post-consumer scrap.

Borregaard has one of the most advanced and sustainable bio refineries based on natural and sustainable raw materials. Borregaard produces advanced and environmentally friendly biochemicals substituting fossil-based products. Borregaard also has strong positions within ingredients and fine chemicals. Their specialization strategy aims at global niches with high entry barriers and leading

market positions. Focus on innovation is strong and 13 percent of the 2018 turnover was due to new products launched the previous 5 years.

China has the "Whole-Country-System" which can concentrate the whole country's capacity for one technology breakthrough, especially when the target technology becomes strongly demanded, sometimes the pressure also comes from media and public attentions. For example, the nib steel used in ball pen tip, was successfully produced in 2019 by the TISCO, which is also part of Baowu Steel, after several years of R&D. It was reported several years ago that China could not produce this special product and 100 percent rely on import. Although it's a niche market, the government and SOEs would like to spend resources in developing it. Another similar example is the super steel (2200 MPa, yield strength 16 percent) produced in 2017, which is highly demanded by industry, and has a huge market in China.

4. Investment and acquisitions

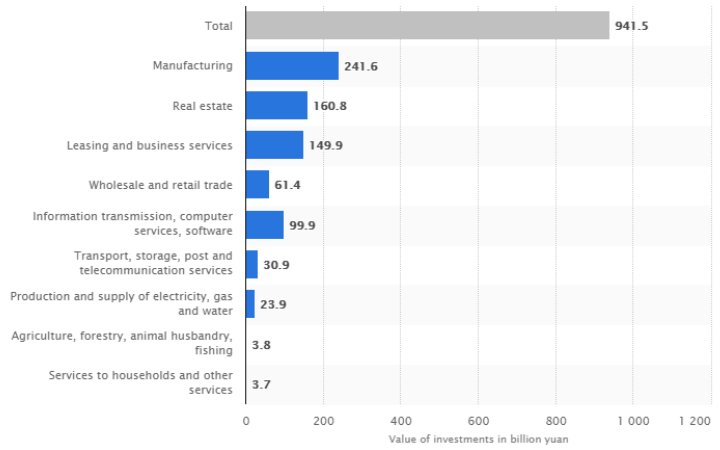
4.1 Process industry investments in China

FDI

Being the second-largest economy in the world, China is trying to transform from high-speed to high-quality growth. The consumption-driven economy features its immense market with robust demand. As China was celebrating the 40th anniversary of economic reforms in 2018, China's opening-up has entered a new era with a master plan for the economy to transform into a top innovative nation and a moderately prosperous society while mitigating rising global protectionism, even de-globalism after the outbreak of COVID-19.

In 2019, the total FDI in China is 941.5 billion yuan and the manufacturing industry is the most concentrated sector. The FDI from EU within recent years is also focused on manufacturing industries, especially in the automobile industry and industries related to it.

Fig. 4.1-1 Value of non-financial FDI in China 2019, by sector (in billion yuan)



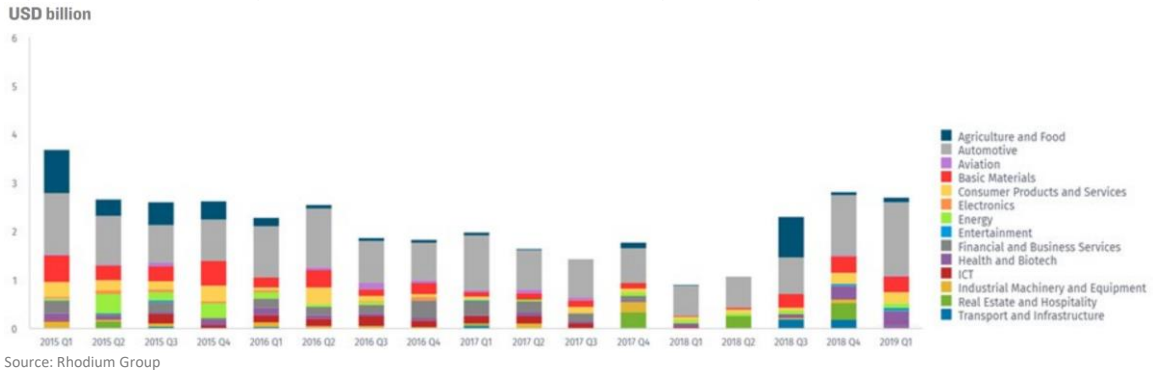
Source: IEA

Automotive and basic materials continued to account for the largest share of EU FDI in China in Q1 2019 due to ongoing projects such as Lithium Werks' battery plant in Zhejiang and BASF's $10 billion facility in Guangdong, which just opened a liaison office in March. Major new deals in the automotive sector also included Daimler's $437 million capital increase in Beijing Benz and its new joint venture with Geely.

The above data not including the Tesla's investment in Shanghai. This project made a new record in green field FDI in China for building up an EV factory (annual production of 250,000 Model 3) within 8 months. Tesla's sales in China market had increased 130.5% YoY in the first half of 2020.

With the new policy of EV and battery, the auto sector will likely continue to be an attractive field for EU FDI in China. China EV battery enterprises became important to German auto companies, with their technology, manufacturing capability and market. In April 2020, Volkswagen Group invested 9 billion yuan to become the largest shareholder in Gotion, while Daimler purchased 3 percent stake in Farasis Energy with 900 million yuan investment in July 2020.

Fig. 4.1-2 Value of Completed EU FDI Transactions in China by Industry



Source: Rhodium Group

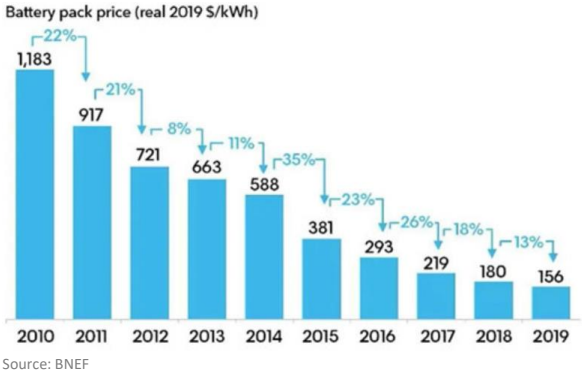
In January 2019, the largest Chinese real estate developer Evergrande Group purchased 58 percent of EV battery company CENAT with 1.06 billion yuan, and at the same month, bought the NEVS by 930 million USD, after its huge investment in Faraday Future. With about 20 billion yuan investment, Evergrande NEV has almost the whole value chain in NEV industry within 2 years.

In May 2019, South Korea's SK announced a $3.35 billion yuan investment to build their second power battery plant in China; in June, LG Chemical and Geely Automobile invested nearly $200 million in to build a joint venture, and their plant in Nanjing has been built up; in July, Samsung SDI announced the opening of an energy expansion project in Shaanxi, investing 460 million yuan; and Panasonic has already spent hundreds of millions of dollars on two new production lines at its Dalian plant. At the same time, Japanese Auto enterprise Honda also invested 3.7 billion yuan for a 1 percent stake in China CATL after its 56 GWh deal last February. According to an incomplete statistic, these four enterprises (Panasonic, SK, LG Chemical, Samsung SD) have invested more than 57 billion yuan in China power battery industry within the last two years.

After cooperated with Panasonic and acquired Maxwell, Tesla is also considering building their own battery plant in China, to support its Shanghai super plant, like Toyota, Geely and BYD.

One of the reasons for these M&As is because of the rapidly dropping of battery production cost in recent years, even faster than expected, which might brough the critical point of parity closer. According to Bloomberg New Energy Finance (BNEF), the cost of power battery has fallen to 135$/kWh in 2020, down 88% from 2010. BNEF's previous forecast of its critical point of parity with fuel vehicles is below $100/kWh by 2025. But it has lowered this level to $87/kWh afterwards. Moreover, the Chinese supply has the lowest price in the world so far.

Fig. 4.1-3 EV Battery Production Cost



Source: BNEF

Germany, the Netherlands, and France were the main European investors in China in recent years. German investments mainly consisted of new and ongoing automotive investments. The Netherlands stood out in Q1 2019 due to two sizable investment by DSM as well as ongoing investments from

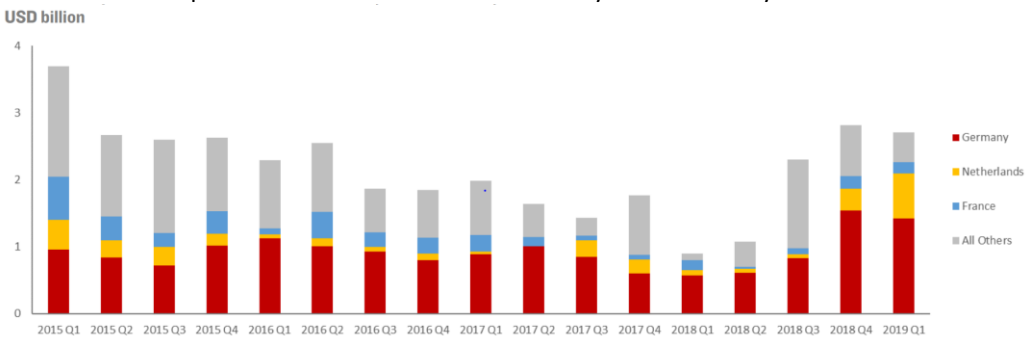
Lithium Werks and Ikea plants. Lithium Werks had purchased a battery plant locates in Changzhou China from A123 System in 2018.

Besides EDF's acquisition of solar and offshore wind projects, there were several smaller French projects that helped to push up the total: Peugeot's investment in Chinese used car company FengChe; apparel line Kitsune's China joint venture and new facility; and Indigo's new joint venture with Sunsea to develop parking structures.

The new Foreign Investment Law (FIL), which came into force on 1 January 2020, marks China's commitment to reform the inbound investment landscape. Though more detailed measures are yet to be announced, this statute represents a big step towards optimizing the business environment for foreign investors and safeguarding fair participation in the market by FIEs.

Soon after Chinese New Year and as early as 10 February 2020, while China was still battling the first wave of the pandemic crisis, the MOFCOM published the *Notice on Actively Strengthening Services to Foreign Enterprises and Attracting Investment during the COVID-19 Epidemic*. The Notice urged local governments to assist foreign companies doing business in China to mitigate and tackle challenges

Fig. 4.1-4 Value of Completed EU FDI Transactions in China by source country



Source: Rhodium Group

presented by COVID-19 as they resume normal operations after the temporary lockdown, such as labor mobility and project management. The government also gave extra support to foreign businesses through streamlining administrative procedures and offering stimulus packages to optimize the business environment.

Domestic investment

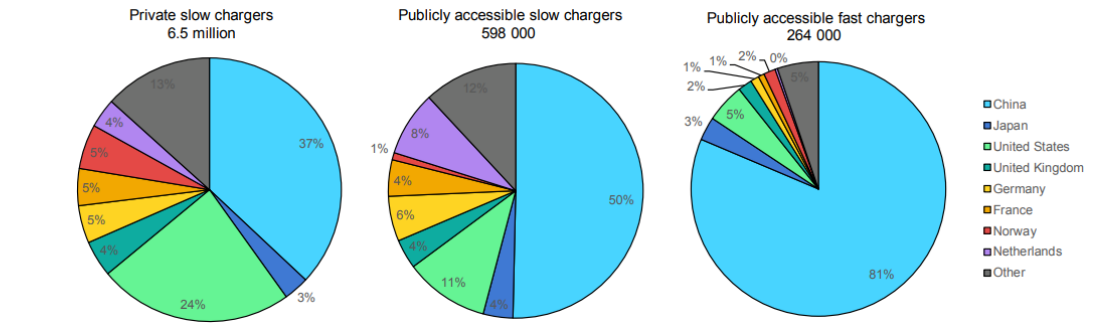
Till the end of 2019, overcapacity is still a critical challenge for Chinese process industry, although it has been emphasized by the central government for long time. Many process industry moved to the inland and west (see chapter 1.2.2), with the policy of production capacity replacement.

The situation became worse due to the global economic depression from 2019, and furthermore, the economic crisis in 2020 caused by COVID-19 and US-China trade war (see 1.4, 1.5), Chinese domestic process industry is in a difficult period. Most of these basic material suppliers were influenced by the shrinking of the market demands, especially those who relay very much on exportations. The importation of critical raw materials or core parts were also interfered either by the pandemic or by the trade war. Many suspended or closed their production, some even bankrupted, especially from the private sectors.

The central government is trying to pull up the economy by so called "internal circulation", which is to transform from invest-driven and export-driven model into consumption-driven model. It's a dilemma that if increase the income in a large scale for the preferred model, then the production cost will further increase, and the process industry will lose its competitiveness.

The other more practical way is increase investment, which was reluctantly used by the central government, for the sake of avoiding the lessons from 2009 for over capacity acceleration. The new policy for "New Infrastructure" emphasized the moment, as one important measure of the country's economic recovery. The EV charging system is one of the seven sectors of the New Infrastructure. In 2019, China is already the most accessible country in the world with its charging facilities.

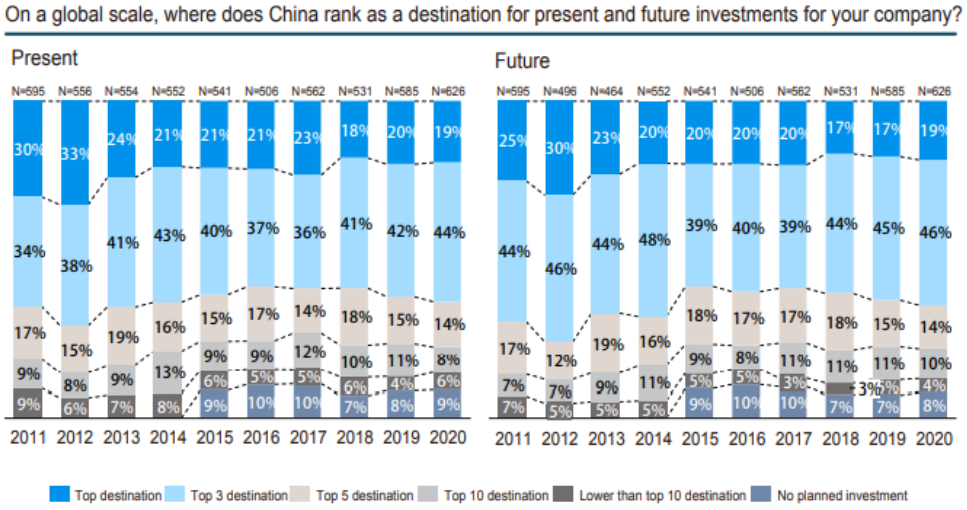
Fig 4.1-5 Private and publicly accessible chargers by country, 2019



Source: IEA

The Electric Vehicle Charging Infrastructure Development Guide (2015-2020) issued by state Council which requires 5 million charging piles to meet with the 5 million EVs on road in China by 2020. Till the end of 2019, there are about 1.2 million charging piles in China, a big gap left and with encouraging policy made this market increasingly attractive. The Chinese giant SOE State Grid has already announced that they will enlarge their business in this field. From the EUCCC's Business Confidence Survey of 2020, China still rank high for their top or top three destination for present and future investment.

Fig. 4.1-6 Majority of members identify China as a top or top three destination for present and future investments



Source: EUCCC Business Confidence Survey 2020

4.2 China's acquisitions in Europe

4.2.1 China's outbound investment in general

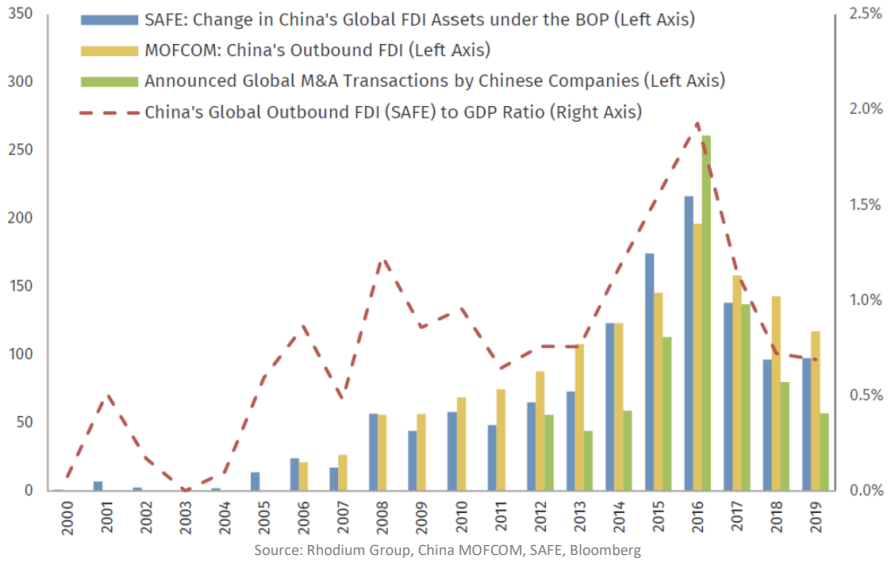
According to statistics from the China MOFCOM and SAFE (State Administration of Foreign Exchange), China's outbound investment in 2019 was 807.95 billion yuan, down 6 percent YoY (US$117.12 billion, down 9.8 percent YoY). Among them, domestic investors in China have made non-financial direct

investments to 6,535 foreign enterprises in 167 countries and regions, with a cumulative investment of 762.97 billion yuan, down 4.3 percent YoY (US$110.6 billion, down 8.2 percent YoY).

As a matter of fact, China's OFDI peaked in the year 2016, later in the year, the Chinese government strengthened policy guidance on it to slow down Chinese enterprises' overseas investment, and advised enterprises to improve their investment structure with more focus on the strategic overseas layout and global resources allocation. However, "going abroad" is still an important step in the globalization of Chinese enterprises. Since 2018, the global landscape has changed dramatically with increasing geopolitical risks. A series of uncertain factors such as the Sino-US trade dispute and Brexit are affecting Chinese enterprises' decisions on overseas investment. At the same time, it is critical for Chinese enterprises to further improve internationalization and acquire overseas investment experience and professional talents in order to "go abroad" with higher quality to achieve better investment return.

In the March of 2017, NDRC published the revised version of Measures for the Approval and Filing of Investment Projects by Enterprises, and then jointly with MOFCOM, PBC and MFA issued the Opinion About Further Guidance and Regulations the Direction of Overseas Investment.

Fig. 4.2.1-1 China's Global Outbound Investment, 2000-2019 (USD Billion)



Source: Rhodium Group, China MOFCOM, SAFE, Bloomberg

In 2018, China's outbound investment was US$ 143.04 billion, making it the world's second largest foreign investor, with its US$1.98 trillion of OFDI, which is 66.3 times higher than the year 2002, listed No. 3 behind the United States and Netherland in world OFDI country ranking.

Between 2003 and 2016, China's OFDI grew at a CAGR of 35%, with an annual year-on-year growth rate of up to 123% (2005), and even during the financial crisis, its OFDI maintained a positive growth rate. As a result, direct investment accounted for 21% of China's total overseas assets at the end of 2017, which is quite high compared to other countries. Judging from China's overseas asset structure, China's OFDI had already exceeded its FDI, thus became a net outflow of direct investment. There are also other reasons for the decline as follows:

- Decline in foreign exchange reserves, from 2014.
- Deterioration of investment access environment in developed host countries, e.g. US
- Focus more on investment quality and return
- Affection to China's overall financial security by Capital flight in the name of OFDI

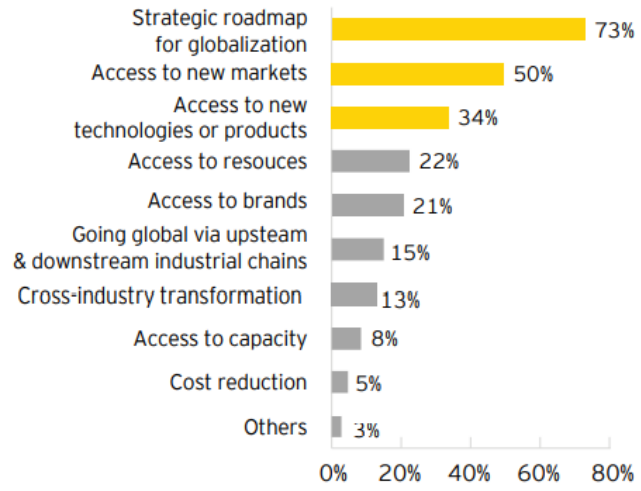
In April 2018, China State Council issued Opinions on Guiding The Healthy Development of Outbound Investment and Financing Funds jointly with NDRC, MOF, MOFCOM, PBC, CBIRC and CSRC for further control of OFDI funding.

In 2019, China's No.1 overseas M&A destination is Asia ($22.3 billion, up 19.1% YOY), accounting for nearly 30% of the total investment, mainly in TMT, financial services and real estate, hospitality and construction, although its overall M&A value decline.

The announced overseas M&As in Europe decreased significantly by 57.1% YOY to US$20.5 billion. It was the third consecutive year of decline and the lowest since 2014. Investments were mainly concentrated in sectors such as consumer products, TMT and financial services. The main investment destinations were the UK, Switzerland and Germany. After UK has confirmed to leave EU on 31 January 2020, further uncertainties will influence China's investment in Europe.

China overseas M&As in North America continued to be affected by geopolitical risks and FDI policy resistance. In 2019, the announced value of China overseas M&As in North America were US$13.5 billion, down nearly 30 percent YOY, the lowest since 2012. Key sectors were TMT (mainly in media and entertainment sector, accounting for over 60 percent of the total), mining and metals and consumer products. With the intensified US–China trade war and its negative influence, the door to the North America had been closed. Even though, Chinese companies' operation in US were obstructed, like Huawei and TIKTOK, which raised the risk sharply.

Fig. 4.2.1-2 Chinese enterprises' strategic objectives of ODI



Source: MOFCOM

According to China MOFCOM, in 2019, the total value of newly-signed China overseas EPC (Engineer, purchase, construction) contracts increased by 7.6% YOY to US$260.3 billion, EPC turnover was US$172.9 billion, up 2.3 percent YOY; It has created nearly 800,000 jobs for the host countries, more than US$ 14 billion's equipment and materials exports from China.

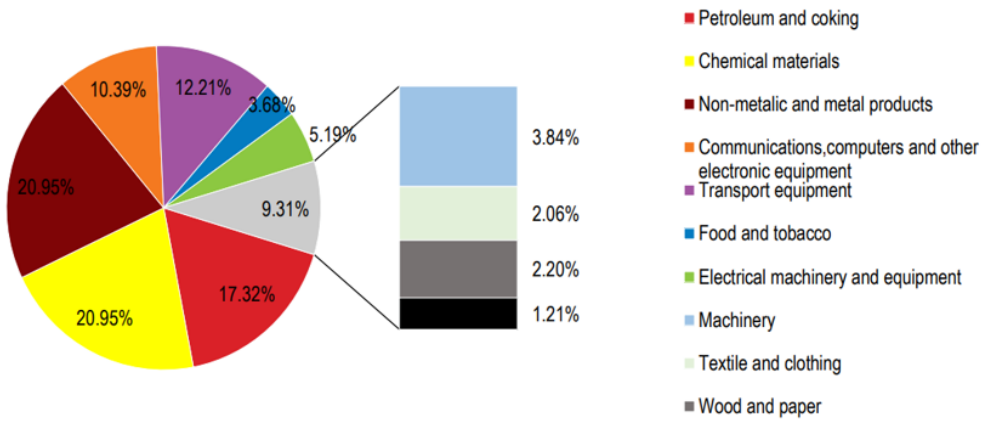
According to the survey buy EY, most of Chinese enterprises takes the "strategic globalization, access to new markets and technologies" as their goal and motivation for ODI. Some process industry's ODI focus on resources, especially those resources not rich in China, for example the Bauxite and alumina in the aluminum industry. They had to seek for the resources globally.

There are 46 Chinese enterprises that produce metallurgical grade alumina, with two joint ventures abroad, one in Jamaica with a production capacity of 1.65 million tons/year, the other in Indonesia with a production capacity of 1 million tons/year.

More than ten Chinese companies involved in the development of the bauxite mine in Guinea, including CHARCLE, Hangzhou Jinjiang Group, SANY Heavy Technology and KIMBO. Nanshan will expand its alumina in Indonesia with a new investment of 3,068 million yuan. Yantai port has accepted 100 million tons of bauxite till the end of 2019.

CITIC's Angola Aluminum Profile Plant was in operation during May 2019, with an investment 40 Million USD in the Luanda-Bengo Special Economic Zone (ZEE).

Fig. 4.2.1-3 Manufacturing ODI is concentrated in resource-based industries, 2017



Source: MOFCOM

Overseas Special Economic Zones & Industrial Parks

In 2015, China MOFCOM and CDB issued the Notice on Issues Related to Supporting the Construction and Development of Overseas Economic and Trade Cooperation Zones, to further guide and support its overseas SEZs and Trade & Industrial Parks development.

With the changing global economic and industrial landscape and the advancement of BRI construction, overseas economic and trade zones have become a platform for Chinese enterprises to invest in and build partnership overseas, especially for small and medium-sized POEs, helping them mitigate risks when investing overseas. As of September 2018, Chinese enterprises have built 113 overseas economic and trade zones in 46 countries across Asia, Europe, Africa and Latin America and achieved positive results, allowing host countries to ride on the express train of China's progress by boosting shared development and synergizing strategies. As of September 2018, the total investment in overseas economic and trade zones by Chinese enterprises has reached US$36.6 billion. In total, 4,663 companies are housed in the overseas economic and trade zones, paying tax worth US$3.1 billion and creating more than 287,000 jobs in host countries.

Fig. 4.2.1-4 China's Overseas Special Economic Zones and industrial parks

Source: Graphic

The overseas industrial parks have been developing rapidly since the BRI was launched in 2013. Most of the parks are jointly developed and promoted by Chinese and foreign governments or enterprises, which can provide stationed enterprises with relatively complete industrial infrastructure, more attractive preferential policies and business environment, and better supporting services to reduce barriers for overseas investment. Chinese enterprises can further expand business to surrounding countries and regions through the markets where the parks are located. At the same time, they can push forward the localization of technology and talent, leverage China's

advantageous industries to optimize the industrial structure of host countries, drive local economic development, and achieve mutual benefit and win-win results.

The parks spread across Asia, Europe and Africa, covering all six BRI economic corridors, and nearly 80 percent of which are in Asia with Southeast Asia taking up the highest proportion. From an industry perspective, the parks are dominated by traditional industries. Among all, the number of processing industry and manufacturing parks is the largest, accounting for more than 30 percent of the total. Cross-border cooperation in technological parks and innovative research & development center parks are still at the early stage of development.

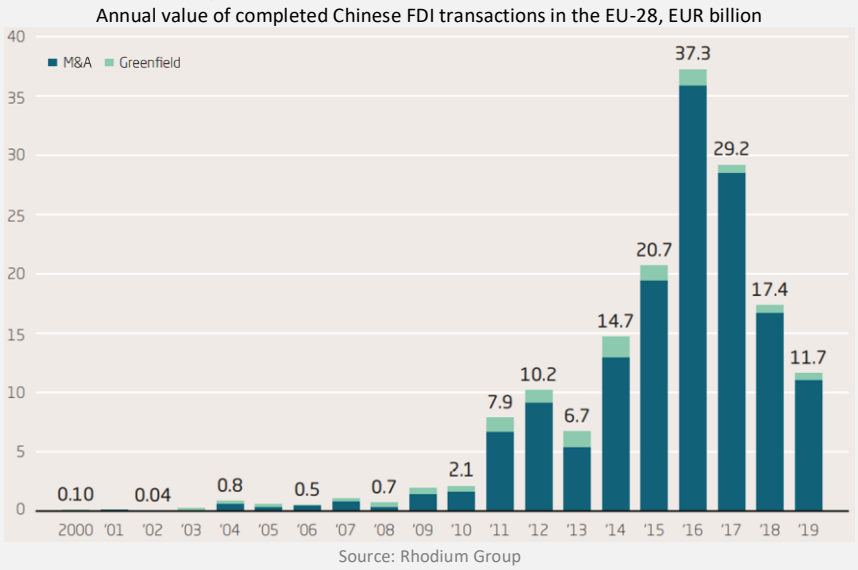
Overseas industrial parks are designed to be built in the major cities of BRI countries, with the advantages of integrating policies and resources, the parks always present strong clustering effect to attract enterprises along the industrial chain, creating 'going abroad' opportunities for Chinese enterprises. However, most of the overseas industrial parks are still in their early stage of construction and development, facing challenges like unstable external environment, lack of protective mechanisms in cooperating models and systematic planning. It is necessary to strengthen collaboration among all parties, including governments and enterprises from both China and host countries, to achieve win-win results.

4.2.2 China's M&A in Europe

As one of the world's largest economies and financial markets, Europe has already become a favored destination for Chinese investment for long time. It's obvious that if China continues its path towards more advanced levels of economic development, the country must expect a massive further increase in its outbound FDI. Some of the Chinese investors' purpose of M&A in Europe are as follows.

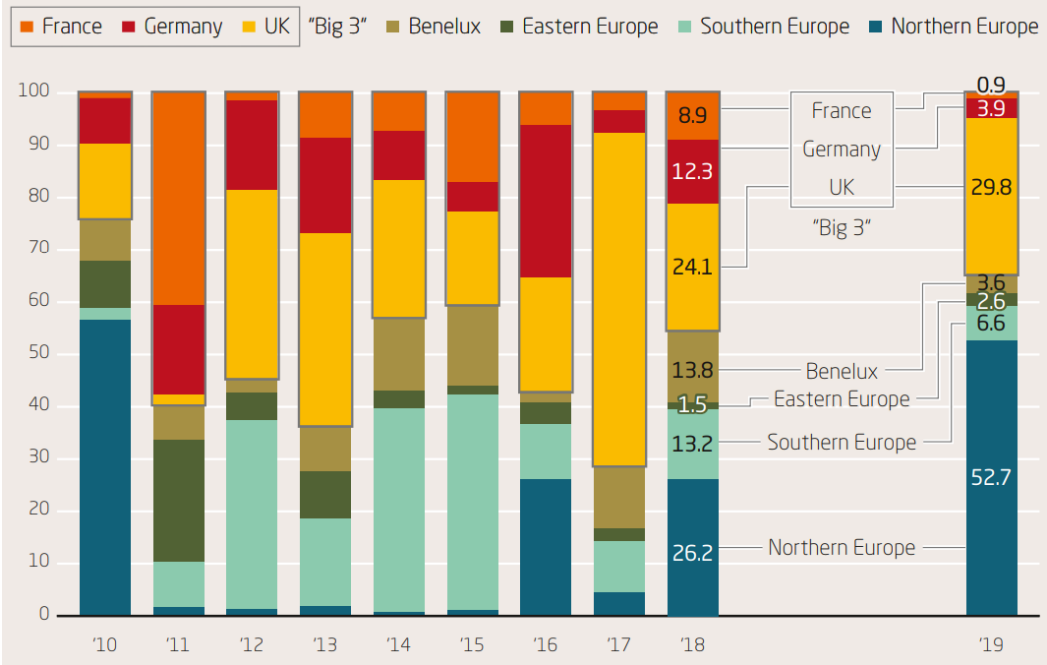
- Technology, to include established high-tech assets, emerging technologies and know-how
- Access to the European market, for Chinese goods and services or purchased European companies
- Access to third markets via European corporate networks, especially in Latin America and Africa
- Brand names to improve the marketability of Chinese products both abroad and for the Chinese domestic market
- Improve production quality by following EU standard and market demand
- R&D for products development, take Europe branch as an R&D center
- Integrated regional and global value chains in production, knowledge, transportation and service
- Sourcing

Fig. 4.2.2-1 Chinese FDI in the EU, 2000-2019



Chinese FDI in the EU also peaked in 2016, and then continued to decline in 2019. Chinese FDI transactions in the EU-28 dropped by 33 percent, from EUR 18 billion in 2018 to EUR 12 billion in 2019, bringing the total back to 2013 levels. The decline is in line with the downward trajectory of China's global outbound investment since 2016.

Fig. 4.2.2-2 Chinese FDI Chinese FDI in the EU-28 by country group 2010-2019, percentage



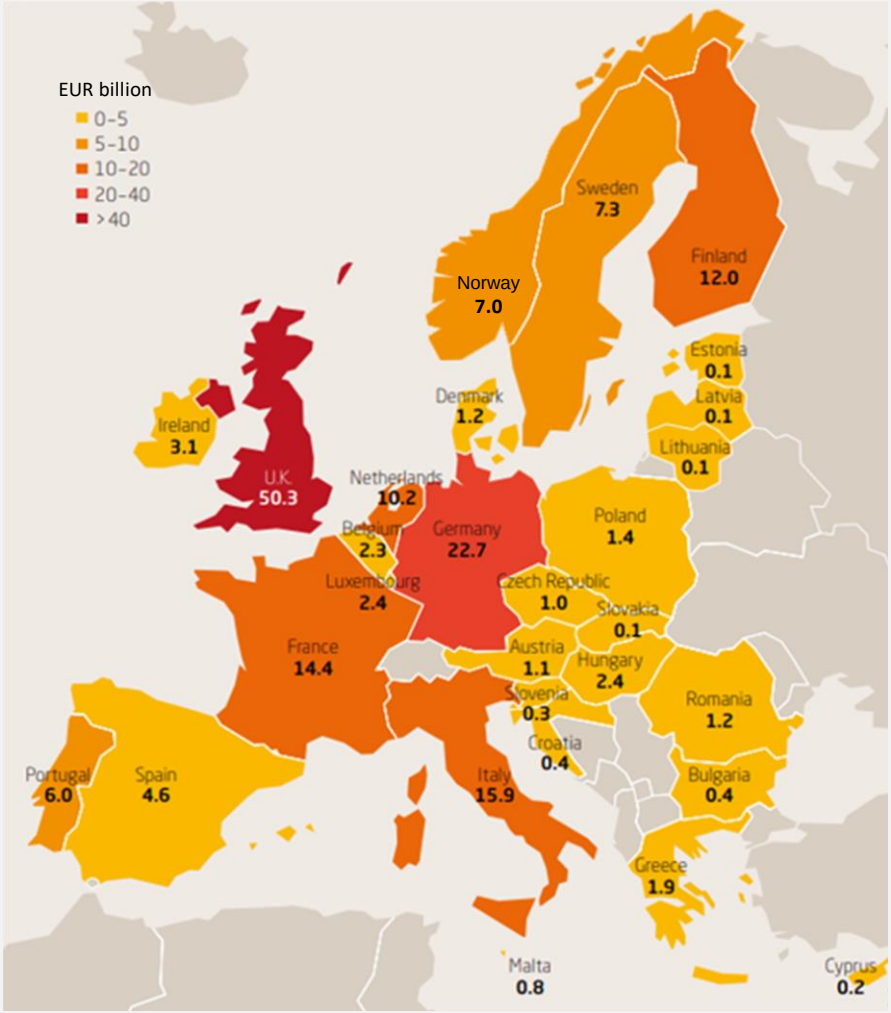
Note: The "Big 3" includes France, Germany, and the UK. "Benelux" includes Belgium, Netherlands, and Luxembourg. "Eastern Europe" includes Austria, Bulgaria, Czech Republic, Hungary, Poland, Romania, and Slovakia. "Southern Europe" includes Croatia, Cyprus, Greece, Italy, Malta, Portugal, Slovenia, and Spain. "Northern Europe" includes Estonia, Denmark, Finland, Ireland, Latvia, Lithuania, and Sweden.

Source: Rhodium Group

According to the analysis from Rhodium and Merics, in 2019, the geographic distribution of Chinese FDI in the EU changed noticeably. The share of the "Big Three" economies (UK, Germany, France), which have traditionally received the most Chinese capital, dropped to 34.6 percent of total investment in 2019, compared to 45 percent in 2018 and 71 percent in 2017. Investment into all three countries declined, though the UK held up best. The UK remained the second largest recipient of Chinese FDI by volume in 2019, mostly due to Jiangsu Shagang's acquisition of additional stakes in data center firm Global Switch (worth £1.8 billion, or EUR 2 billion) and Alibaba's $700 million investment in World First UK. The former one also topped the list for the number of single transactions. In Italy, the distinguished one is Qingdao Haier's $552 million takeover of Italian competitor Candy.

Northern Europe supplanted the "Big Three" as the top region for the first time since 2010, receiving 53 percent of all Chinese investment. This was due mainly to a few large M&A deals, including Anta's acquisition of Amer for EUR 4.6 billion (which made Finland the top recipient country for Chinese investment in 2019) and China Evergrande's investment in NEVS for EUR 830 million (making Sweden the third highest recipient country in 2019). Investment into Ireland also increased and is set to grow further as two large greenfield factories by Wuxi Biologics get underway over the next few years. Southern Europe and Benelux both saw their shares decline to less than 10 percent. Eastern Europe's share rose from 2 percent in 2018 to 3 percent in 2019, a level still well below the region's weight in the GDP of the EU (10.1 percent in 2019).

Fig 4.2.2- 3 Cumulative value of Chinese FDI transactions in the EU by country 2000-2019



ChemChina is one of most active Chinese companies in M&A in Europe, mostly in the process industry field, for the value chain integration (table 4.2.2-1).

Table 4.2 ChemChina's M&A in Europe

European company	Sector	Year	Amount (M USD), share %	Country
Adissue	Process industry	2006	400 (M EUR)	France
Rohdia	Process industry	2006	N/A	France
Elkem AS	Process industry	2010	2000	Norway
Makhteshim Agan Industries	Process industry	2011	1440	Israel
ADAMA	Process industry	2011	1400, 60%	Israel
REC	Process industry	2014	670	Norway
Perelli	Process industry	2015	7,100 (M EUR)	Italy
Krauss Maffei Group	Process industry	2016	925 (M ERU)	Germany
Mercuria	Process industry	2016	2,200, 12%	Switzerland
Syngenta	Process industry	2017	43,000	Switzerland

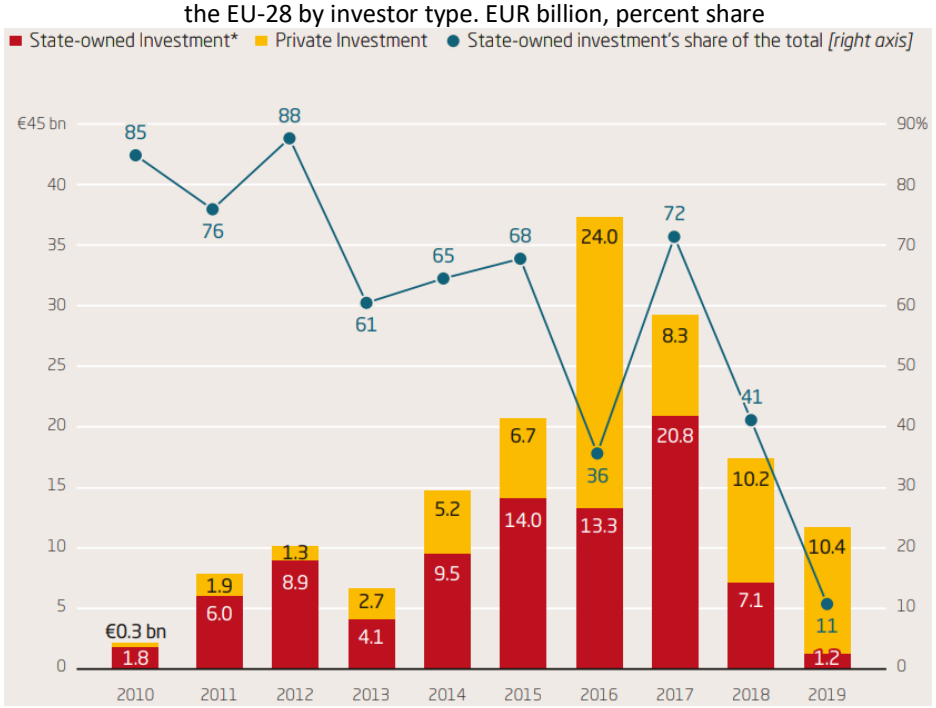
As mentioned, ChemChina is merging with SinoChem, who also had some M&A activities in Europe:

Table 4.2.2-2 Sinochem's M&A in Europe				
European company	**Sector**	**Year**	**Amount (M USD)**	**Country**
DSM NV(DSMN.AS) *	Process industry	2011	278 (50% JV)	Netherland
SIAT NV	Process industry	2012	192.56 (M EUR)35%	Belgium
Elix Polymers S.L	Process industry	2019	166.8	Spain
*Note: Bain Capital purchased all Sinochem's share in the JV in 2018.				

Investment to Romania estimated to EUR 230 million in 2019 due to several sizable acquisitions, and the establishment of CGN's new joint venture company with Cernavoda nuclear power plant which could lead to further significant greenfield investments. But influenced by the US, in June 2020, Romania cancelled the agreement they signed with CGN one month ago for this project, which values about 6 billion EURO. Meanwhile, Chinese investment in Greece was also slowed down after the country's Archaeological Council declared a large part of Piraeus port (majority owned by China's COSCO) a site of archaeological interest, rejecting investment plans to create a shopping mall, a floating ship repair dock and a luxury hotel in the area.

Before 2016, The SOEs plays a dominant role in China's M&A activities in Europe. Its proportion drops sharply from 2016, when Chinese government took measures to restrain its ODI, and in the year 2019, SOE's M&A in Europe only took 11 percent. From 2016, private sector became more active in this field. Even though some distinguished private company like VANDA was also influenced seriously by the restrain policy from the central government, which was the main reason of China's total ODI quantity drop.

Fig 4.2.2-3 State-owned investors' share of OFDI plummeted in 2019 Chinese OFDI in the EU-28 by investor type. EUR billion, percent share



Note: State-owned companies refers to firms that are at least 20 percent owned and controlled by the government or a central State-owned enterprise (SOE). Source: Rhodium Group

The influence from COVID-19 and US-China trade has also brought negative influence to Chinese M&A in Europe, although the asset price decreasing due to the above influence and the economic recession globally. Chinese companies are always seeking European companies with unique technology, but the situation becomes increasingly unpredictable with the pandemic and interference from the US.

4.2.3 China's acquisitions in Norway

China's M&A in Norway

Norway is one of the Chinese OFDI destination due to its stable governance, safe society, distinguished resources and advanced industries. China is Norway's ninth largest export market and third largest source of imports. In June 2020, the volume of Norwegian crude oil transported to China reached about 1,42 million tons, which was the ninth place on the purchasing list of China's crude oil suppliers that month. Quite a few M&A occurred in the last decade, even during 2010-2016, which was a difficult bilateral time due to the Nobel Peace Prize.

Table 4.2.3 China's M&A in Norway (2003–2019)

Year	Chinese Investor	Entity in Norway	Size of Investment in USD millions (stake)	Sector
2003	Sinochem	Atlantis	105 (100%)	Energy
2008	COSL Norwegian CNOOC	Awilco Offshore	2500 (100%)	Energy
2010	Hai Nan Air (HNA)	GTB (SinOceanic Shipping AS)	N/A, 33.33% in 2010, 90% in 2017.	Transportation
2010	Grand China Logistics (HNA)	Offshore Heavy Transport	N/A (60%, reduced to 33% in 2017)	Transportation
2011	China Bluestar, ChemChina	Elkem	2000 (100%)	Metallurgy
2014	Deltronics (Netherlands) B.V. Delta (TaiWan)	Elteck ASA	525 (100%)	Power
2015	Bluestar Elkem Investment, ChemChina	REC Solar	640 (100%)	Solar (PV)
2015	Anhui Guozhen (Owned by Sanxia Group from 2018)	Goodtech Environment AS	5.2 (100%)	Environment
2015	CIMC	Brevik Engineering	N/A （100）	Offshore Design
2016	Reignwood	Voss Water	105 (55%)	Mineral water
2016	Golden Brick Qihoo and Beijing Kunlun	Opera Software (consumer devision)	575 (100%)	Software, IT
2016	Elkem Bluestar, ChemChina	Fesil Rana Metal (Incl. share in Norkvarts)	N/A	Metallurgy
2017	ZHEFU Holding Group Co.,Ltd.	Rainpower Holding AS	7.86 (32%)	Hydro Power
2017	China Resources Holding Co. Ltd. (Consortium)	Statkraft AS	30% stake of the Dudgeon wind park off the UK coast for GBP 555 million (USD 743m/EUR 630m).	Offshore wind power
2018	Qumei Investment AS	Ekornes ASA	630（100%）	Furniture
2018	Cube Infrastructure Fund (China Everbright Group)	Boreal Holding AS	200 (100%)	Infrastructure
2019	Shanghai Bluesoul	Torgy	N/A (60%)	LNG Shipping
2019	Tencent	Forcum	134.33 (29% in 2019) 148 in 2020， N/A	Game

Post M&A operation

Some politicians and national labor union representatives have raised issues with Chinese companies taking over Norwegian firms. For instance, China Bluestar (ChemChina), which moved in to buy Elkem for a deal that was completed in 2011, triggered some debate, mainly focusing on whether Chinese owners based in a country with an authoritarian political system would be able to develop the company and take care of the Norwegian workers. After the takeover, however, the debate faded.

Elkem's Norwegian staff representatives appear regularly in the Norwegian media, speaking positively about their Chinese owners and what they have done with the company.

In December 2016, Norway–China relations were normalized, and both sides have since increased efforts to bring all parts of the bilateral relationship up to speed. There is more trading than M&A in the economic cooperation between the two countries. The sales of Norwegian salmon to China has been increasing sharply.

Construction projects

Besides M&A, there are also construction projects. In 2017 China Sichuan Road and Bridge Group (SRBG) won the contract for the construction of Beitstadsund bridge in central Norway. SRBG had already successfully bid for another construction project in Norway in 2013 (the Hålogaland bridge).

The level of overall investment from China into Norway is still moderate, especially when compared with the inflow from other countries. In the case of Norway, our overall outbound investment flows to China are still considerably larger than the inbound investments we get in return. The Norwegian Government Pension Fund Global has (as of October 2017) around USD 15 billion invested in equities in China, spread over 500 separate investments. In Hong Kong, the Fund holds around USD 7 billion, spread over around 200 separate deals. Thus, investments are clearly an issue of mutual interest and remain a significant dynamic in Norway's bilateral and international relations.

International cooperation

In 2010, Sinopec purchased 40 percent of benefit from Statoil's (Equinor) Peregrino project in Brazil, with 3.4 billion USD. China Resources is also a partner in Equinor's Dudgeon offshore wind farm in the UK.

5. Sustainable development in Chinese process industry

In a speech delivered to the UN virtual General Assembly on September 22, 2020, Chinese president Xi Jinping said for the first time that China would strive to be carbon neutral by 2060, and reiterated the pledge made in 2016 under the Paris Agreement that China's carbon emissions would peak by 2030.

5.1 Green industries development

China has made "Green Development" as one of the five guiding principles in the 13th FYP, calling for a more eco-friendly development of the economy to solve severe pollution problems. One of the key measures has been to integrate "Green Industry" and encourage consumption of "Green Products". In furtherance of these objectives, the State Council has mandated that the Certification and Accreditation Administration of the People's Republic of China (CNCA) establish a comprehensive, integrated green product certification and labelling scheme to replace the existing system.

By the end of 2019, the Green Manufacturing Action of MIIT has supported more than 360 key projects, developed more than 160 green standards, improved more than 10 percent of energy efficiency and water efficiency. It has totally certificated 1402 Green Factories, 118 Green Industrial Parks, 1097 Green Design Products, and 90 Green Supply Chain Management demonstration enterprises.

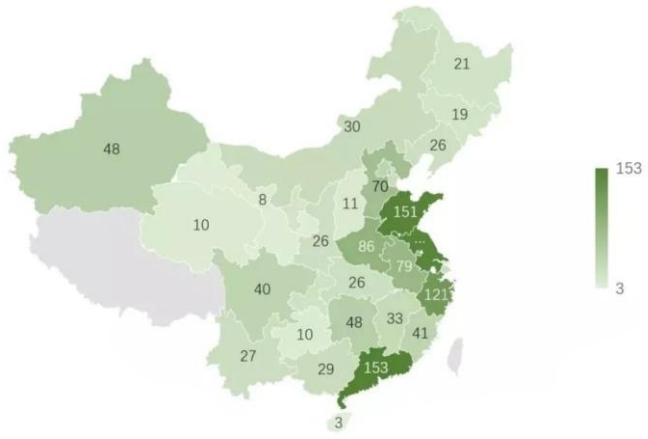
Green Factory

China's Industrial Green Development Plan (2016-2020) states that "Green Factory is according to the principles of plant intensification, innocuous raw materials, clean production, waste turn to resources, and low-carbon energy." Guide enterprises to build, transform and manage plants in accordance with the standards of green factory construction, and intensive use of the plant.", as a definition of green Factory. At the same time, to develop green factory construction standards and guidelines, in steel, non-ferrous, chemical, building materials, machinery, automotive, light industry, textiles, medicine, electronic information and other key process industries to carry out pilot demonstration.

Currently, GB/T 36132-2018 Green Factory Evaluation General Principles implemented on December 1, 2018, is the guide for certification. Therefore, the green factory is a comprehensive, systematic concept, compared with the traditional clean production, green factory is not only reflected in the production process of green and lifelong management of environmental protection, but also in the plant design, construction, operation and waste treatment and other aspects of the green concept throughout. In the index system of green factory evaluation, not only the hardware requirements of infrastructure, energy input and waste disposal are emphasized, but also the software requirements for managers and management systems are also put forward.

The standard clarifies basic terms and definitions, establishes systematic evaluation specification system and identifies general requirements of green factory assessment in accordance to the principles of plant intensification, harmless raw materials, clean production, waste recycling and low carbonization. The release of the standard will help guide companies to establish green factory, promote industries to green transformation and update and achieve green development.

Fig. 5.1-1 Green Factory in China (3rd batch)



Source: MIIT

Green Design Products

MIIT has updated the standards for Green Design Production in March 2020, a total of 381 Green Design Products were produced by certificated Green Factories, accounting for 34.7 percent of the total number of certificated Green Design Products.

In order to meet the requirements of the “Green Manufacturing System Construction 2016-2020" and facilitate green design product assessment, MIIT has issued the “Notice on Green Manufacturing System" and "Guideline on Green Manufacturing Standardization" in 2016 as a crucial part of green manufacturing strategy, the list is expected to cover over 1.000 products by 2020.

Except five national recommended standards on green design, the other 86 are developed by social associations which have been issued and published on national social association standards platform. The industrial products involved as of today are shown in Table 5.1-1.

By February 2019, MIIT has issued three batches of Green Design Products covering 726 industrial products. In August 2019, MIT released the latest updated Green Design Products standards list covering 9 industries and 91 standards.

Table 5.1-1 Eco-design standards by industry

Industries	Standards
Electronics	6
Textile	10
Steel	5
Machinery	18
Building materials	5
Light industry	22
Petrochemical	9
Telecommunications	9
Nonferrous metal	4
Others	3

Green Supply Chain

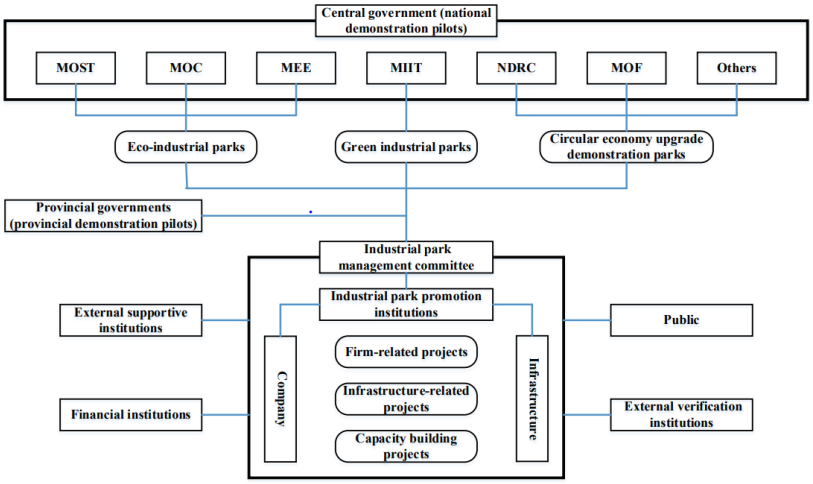
With systematic thinking about the whole supply chain in terms of the life cycle of product, Green Supply Chain (GSC) refers to the best modern management mode for enterprises. It aims at coordinated and general environmental management of the whole supply chain through close cooperation and mutual constraints among each organization and between relevant organizations in the supply chain in order to obtain environmental, economic and social benefits of supply chain with high efficiency of resource and energy, low emissions and good ecology.

In May 2017, China's National Standardization Management Committee officially issued the National Standard on Green Supply Chain Management Guidelines for green manufacturing enterprises (GB/T33635-2017), which was implemented on December 1, 2017. In 2019, the "Green Supply Chain Management Enterprise Evaluation Index System for the Electronic and Electronic Seine Industry", "Green Supply Chain Management Enterprise Evaluation Index System for Machinery Industry" and "Enterprise Evaluation Index System for Green Supply Chain Management in the Automotive Industry" were published, which detailed the requirements for the evaluation of green supply chain management in the above three industries.

Green (Ecological) Industrial Parks

The greening of the Chinese industrial sector is a key factor that will determine the success of the “ecological civilization.” Industrial parks (IPs) have played a particularly important role in industrial development in China. MEE (then the State Environment Protection Administration—SEPA) initiated the EIP Demonstration Program in the early 2000s to minimize pollution and waste generation in existing IPs and was later joined by MOST and MOC. Some sector-specific IPs—such as chemical parks in the Yangtze Delta Area and sugar-making parks in the Zhujiang Delta Area—adopted measures early on to balance economic growth and environmental sustainability. Other initiatives to green IPs were

Fig. 5.1-2 Green Factory and industrial park in China



Source: World Bank, MIIT, NDRC, MEE

adopted in parallel. This includes the Circular Economy Pilot Zones program initiated in 2001 by the MEP (now MEE) and taken over in 2005 by the NDRC, which since 2012 has jointly led it with the MOF as the Circular Transformation Industrial Parks program. In addition, the Low-Carbon IP Pilot Program was launched in 2013 by the MIIT jointly with the NDRC. The general managerial and operational structure of Chinese EIPs at the current stage is presented in Figure 5.1.

Table 5.1-2. Number and proportion of certified Eco-Industrial Parks (EIP) in China

	MEE-certified	NDRC-certified	MIIT-certified
No. of certified IPs	93	138	46 (100 by 2020)
Total no. of IPs	2,543	2,543	2,543
% of IPs certified	3.7%	5.4%	1.8% (3.9% by 2020)

Sources: NDRC, MIIT, MEE

Standards and indicators

Four different Chinese ministries have formulated relevant evaluation frameworks, focusing on upgrading of ordinary IPs into (i) green industrial parks, (ii) EIPs, and (iii) IPs in line with the circular economy principle. Standards and indicators are specifically designed to manage and guide the green development of Chinese IPs:

- Standard for National Demonstration Eco-Industrial Parks 47
- Notice on the Establishment of a Green Manufacturing System48
- Notice on Recommending Key Candidate Industrial Parks for Circular Economy Transformation in 2017
- Specification for Circular Economy Performance Evaluation of IPs 50

In 2018, the Law of Environmental Protection Tax was behind the massive factory shutdown across the nation. Next, comes the Soil Pollution and Prevention and Control Law. Consequently, this law will put a halt to the factories that impose a negative impact on its local environment. (See 2.3)

All three Chinese green standard-makers have a broad set of policy instruments in place to promote indirect compliance with the Chinese green standards, and the green transformation and development of IPs overall. The sources of incentives are various, including direct subsidies from the central government's budget; supportive fiscal policies from national, provincial, and local

governments; financing from financial institutions; and preferential tax rates and interest rates (for loans); as well as nonfinancial incentives.

Green Technology Bank

On 19 September 2016, China's Premier Li Keqiang released China's National Plan on Implementation of the 2030 Agenda for Sustainable Development, thereby suggesting a will to establish a technology bank, to reaffirm its commitment to the seventeen sustainable development goals (SDGs).

Green Technology Bank (GTB), a key initiative launched in 2016 by MOST and the Municipal Government of Shanghai, focuses on boosting green technologies and green finance to meet the goals of the 2030 Agenda for Sustainable Development and the Paris Climate Change Agreement. GTB is committed to the following aims:

1) Foster green technology innovation
2) Facilitate information flow, technology transfer and industrial application
3) Design financial mechanism and innovate financing tools for green technology
4) Engage public and private funds to support green projects

GTB is enabling its role of a technology hub and networking center because we possess the following attributes:

- Most prestigious and large-scale platform in China with tech databases, information bank, technology library and pool of experts
- Professional financial service platform for green projects
- Tech transfer platform with integrated services
- Major information platform covering and operating 7,500 substantial technology achievements

Green Development Fund

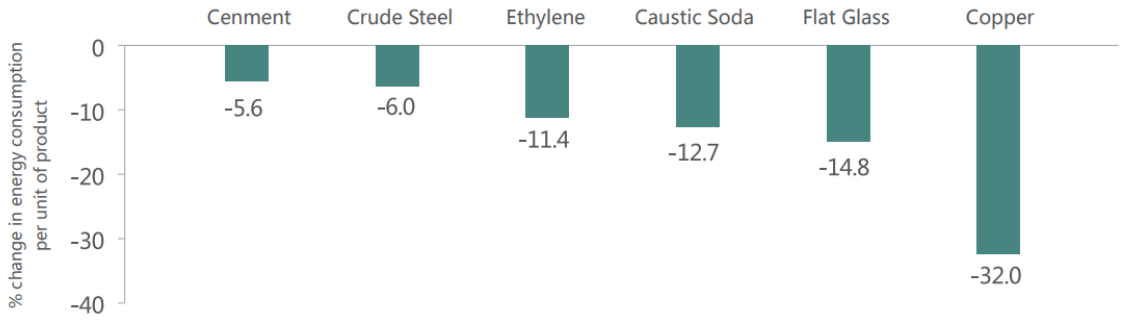
Green development funds to be established at different administrative levels are the third financial instrument for promoting the development of EIPs and industries. By the end of 2016, more than 50 green development funds have been established by various provincial and municipal governments, including Zhejiang Industrial Fund, Guangdong Environmental Protection Fund, and Xinjiang Green Industrial Fund at the provincial level, and Pu'er (Yunnan) Green Economic Development Fund, Zhangjiakou (Hebei) Green Industrial Development Fund, and Xin'anjiang (Anhui) Green Development Fund at the municipal level. As of the end of 2017, there were about 250 green funds (governmental and nongovernmental) located in all provinces across the country.

On 15 July 2020, the National Green Development Fund was established in Shanghai, jointly by 26 institutions, including the Ministry of Finance, with a registered capital of 88.5 billion yuan. Its business scope includes equity investment, project investment, investment management and investment consulting services.

5.2 Energy efficiency and renewable energy

China enacted the Energy Conservation Law in 1998. Since then, China's energy efficiency work has made significant progress domestically as well as contributions to global energy efficiency improvement. The most significant energy efficiency program in industry is called Top-10,000 Energy-Consuming Enterprises, implemented in the framework of the 12th Five-Year Plan. Within the framework of that program, the designated enterprises are required to appoint energy managers; measure and report on energy consumption; prepare energy conservation plans; and reach energy consumption reduction targets. Those 10,000 enterprises represent about two thirds of the country's total consumption and about half of the industrial demand. A Top-1,000 Energy-consuming

Fig. 5.2-1 Reduction in Chinas energy consumption per unit of product in six process industries (2010-2016)

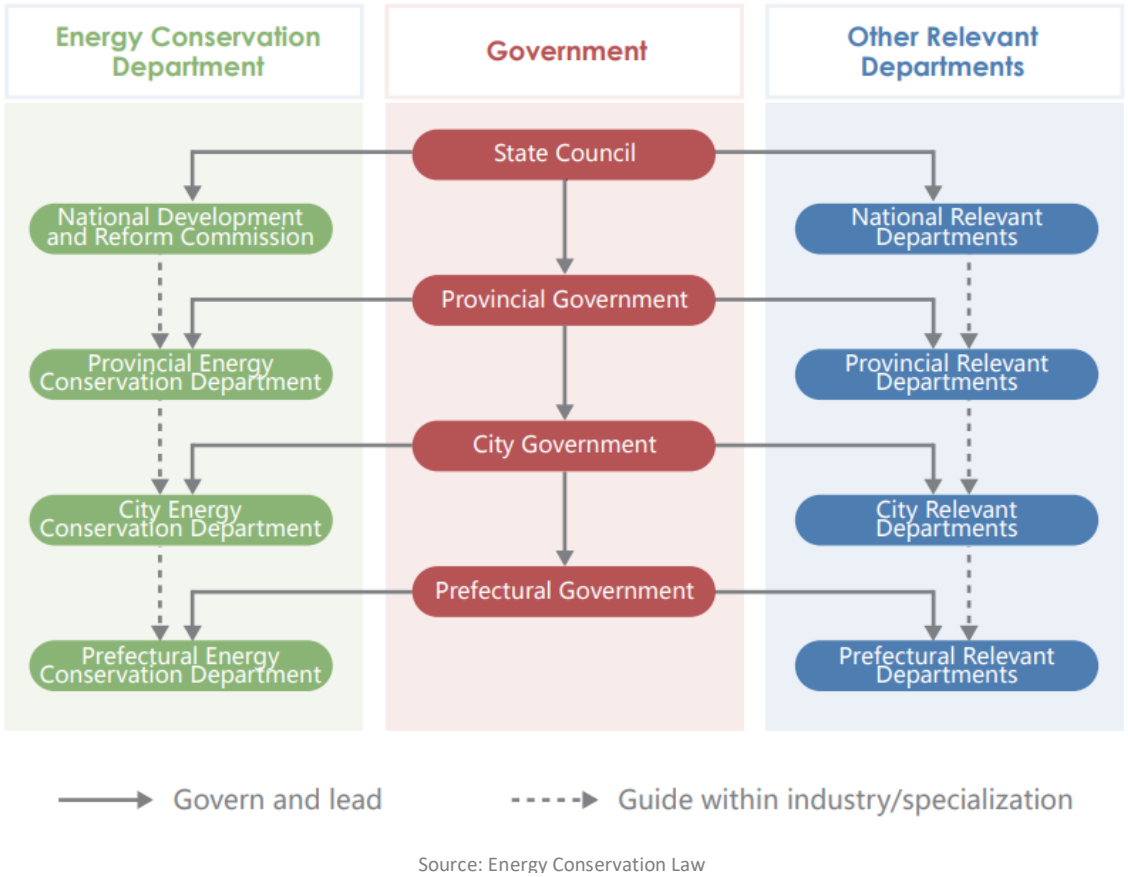


Source: Energy Efficiency China 2018

Enterprises program was implemented under the 11th Five-Year Plan and covered one third of the country's total consumption. China has set energy savings targets for energy-intensive industries, to be achieved by 2015. The target for steel producers is 25 percent, for the non-ferrous metal industry 18 percent, and for cement production 3 percent. To achieve these targets, the government phased out obsolete capacity in aluminum smelting and copper, lead and zinc refining. These targets would save China the equivalent of 7.5 Mt of standard coal.

Despite improvements in technical energy efficiency, Chinese steel production remains energy intensive, representing around 4% of global final energy use. Energy-intensive primary production routes, specifically those involving a coal-based basic oxygen furnace, are used in well over 80% of Chinese crude steel production. The use of electric arc furnaces – which are much less energy-

Fig. 5.2-2 Government Management System for Energy Conservation in China



Source: Energy Conservation Law

intensive and are fed by scrap metal – is on the rise. However, demand for steel in China far outweighs the availability of scrap metal, so higher steel demand leads to higher blast furnace use and higher coal use.

In 2007, the NDRC issued orders to retire small and inefficient plants in various industrial sub-sectors. It also announced measures to decrease the nation's kiln and boiler consumption of coal by 70 million tons: the selection of high-quality coal; the renovation of medium-sized and small boilers and kilns with advanced techniques such as circulating fluidized bed (CFB) and pulverized coal firing; and the establishment of a scientific management and operation system.

In January 2017, the state council issued the "13th FYP for Energy Conservation and Emission Reduction", and made clear the goal of by 2020, the energy consumption of China's 10,000 yuan of GDP will decrease by 15 percent compared with 2015, and the total energy consumption will be controlled within 5 billion tons of standard coal, and the total emissions of major pollutants decreased by 10-15 percent.

The 13th FYP for Energy Development aims to develop the energy sector such that by 2020:

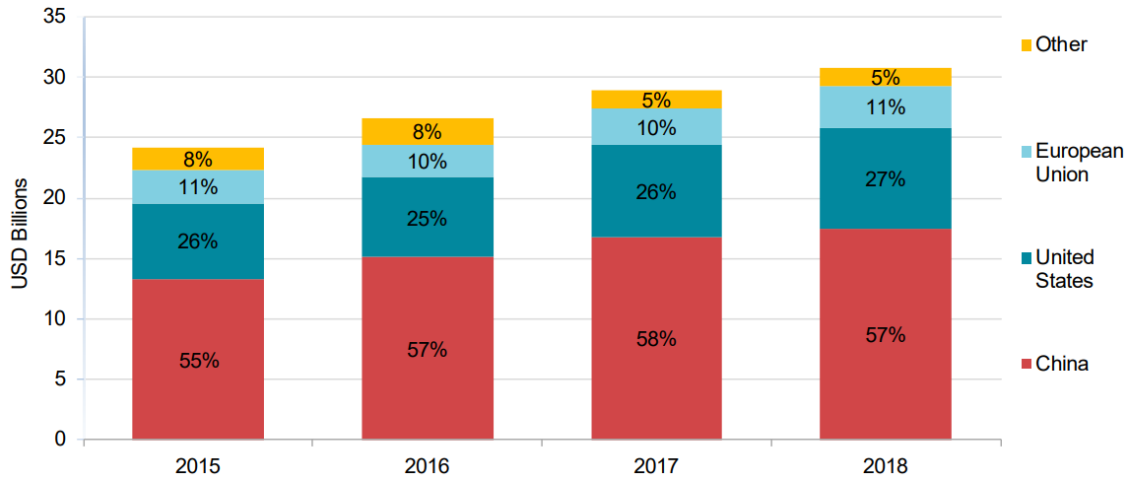
- Total energy consumption is capped at 5 Gtce.
- The proportion of non-fossil energy in total energy consumption is increased to above 15 percent.
- The existing installed capacity of coal-fired power is capped at 1.1 TW.
- Energy consumption per unit of GDP is reduced by 15 percent relative to 2015.
- CO_2 emissions per unit of GDP are reduced by 18 percent compared with 2015.

Energy service companies

ESCOs (Energy Service Companies) are key enablers of investments in energy efficiency, because they deliver efficiency projects based on long-term contracts tied to energy performance. ESCOs may finance initial project costs directly or with the involvement of a third party, while the customer is not required to make upfront capital expenditure. This contracting structure is critical to the success of ESCO financing. since upfront costs for efficiency upgrades often present a barrier to investment, and long-term contracts allow ESCOs to deliver more comprehensive energy efficiency improvements.

The IEA tracks key trends and developments in the global ESCO market, which grew to USD 30.9 billion in 2018, from USD 28.6 billion in 2017. China continues to dominate the global ESCO market. Policy makers seeking to increase investments in efficiency through ESCOs can draw on lessons from both

Fig. 5.2-3 Global ESCO market growth 2015-18



Source: IEA

emerging and developed economies. ESCO associations, for example, have been established in several countries. They are vital sources of information for policy makers and help to raise awareness among financial institutions. They connect ESCO representatives with customers and/or public officials, and support the development of important tools, for example standardized contracts or protocols for measuring and verifying efficiency savings. Governments have also promoted ESCO markets by inviting ESCOs to bid for performance contracts to retrofit public buildings, for example. Additional measures that have been effectively deployed in several countries include ESCO project databases and other information tools, and capacity building such as training for public officials tasked with developing complex calls for ESCO project tenders.

Waste Heat Recovery (WHR)

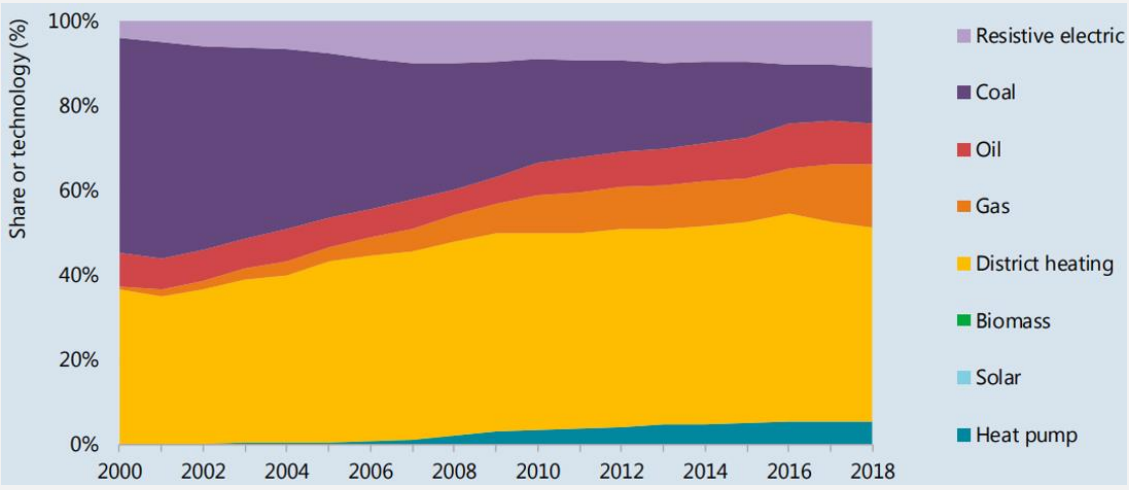
From 2009, China starts to implement waste heat recovery technology into process industries. First from cement industry, then soon spreading into chemical and metallurgical industries. By the end of 2019, most of the steel plants and ferroalloy plants have installed the WHR projects. The heat recovered mostly would be reused into electricity generation or the process of industries where heat is needed. Norwegian company Norsk Energi had involved in many WHR projects in ferroalloy industry of China, with technical consultation.

In recent years, some cities in north China explored the use of recycled industrial waste heat for urban heating and achieved remarkable results. The cost of using industrial waste heat is much lower compared to heating based on coal and natural gas, with investments being both economically and technically feasible. The Waste Heat Project Implementation Plan for Residential Heating, issued in October 2015, proposed to reduce coal-fired heating by more than 2 billion ㎡ and reduce the raw coal for heating by more than 50 Mt through switching to waste heat sources by 2020.

Heating

Chinese homes switch to more efficient heating Householders in China have historically relied on coal to heat their homes. Since 2000, heating systems in Chinese homes have moved dramatically away from coal. This transition is driven partly by migration from rural areas to cities where there are more likely to be district heating systems. However, since December 2017, and as part of the overall pollution control budget, subsidies have been introduced for cities to replace coal heating systems with natural gas or electric heating systems. CNY 25 billion (USD 3.76 billion13) has been provided in 35 cities (IEA, 2019). Furthermore, district heating systems that were predominantly coal-based boilers and cogeneration are moving towards cleaner fuels. For example, urban areas in Beijing are now entirely fueled by four large gas co-generation plants.

Fig 5.2-4 Technology fuel mix for heating in China



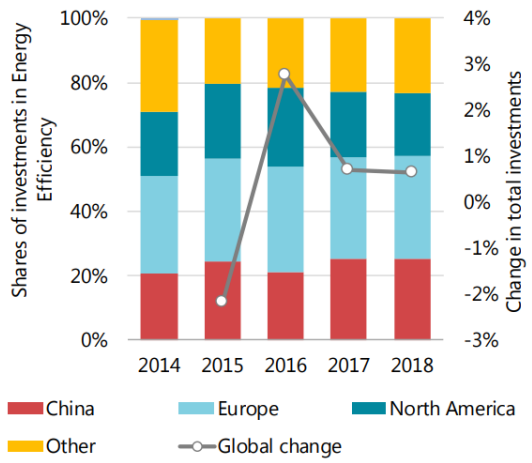
Source: IEA (2019) Energy technology perspective

In 2018, according to the MEE, 4.8 million households changed from coal to cleaner energy sources like gas and electricity, 20 percent more than in 2017. This trend is expected to continue in the near future: the Natural gas heating development targets for 2017–2021 (NDRC, 2017) includes a target of converting 12 million households from coal-fired to gas-fired boilers, representing an incremental increase in gas demand of 9 billion cubic meters by 2021.

Energy Supply and Consumption Revolution Strategy (2016-2030)

The Energy Supply and Consumption Revolution Strategy (2016-2030) is outlines the comprehensive strategic deployment of China's energy revolution over a longer timeframe of 15 years, which has important practical significance. The Strategy considers the fact that China's energy development enters into a new domain, transitioning from total quantity expansion to quality improvement. The Strategy reflects the need to respect the constraints of limited resources and the environment's carrying capacity, requiring the setting and achievement of long-term sustainable development goals.

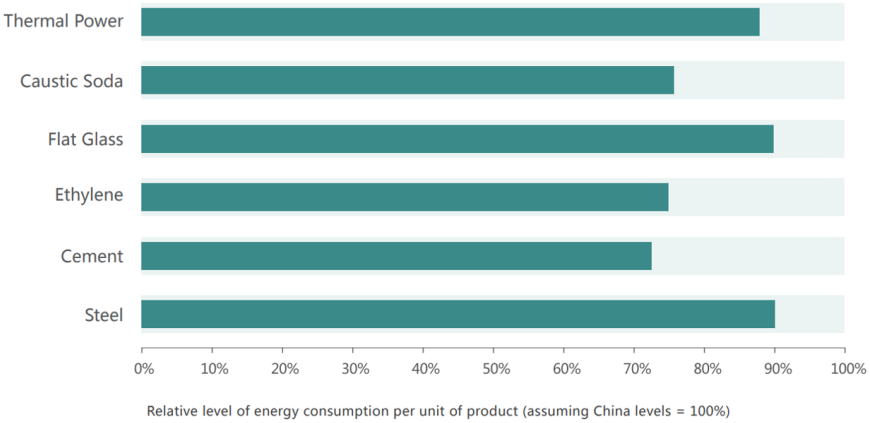
Fig. 5.2-5 Energy efficiency investment by region, 2014-18



Source: IEA

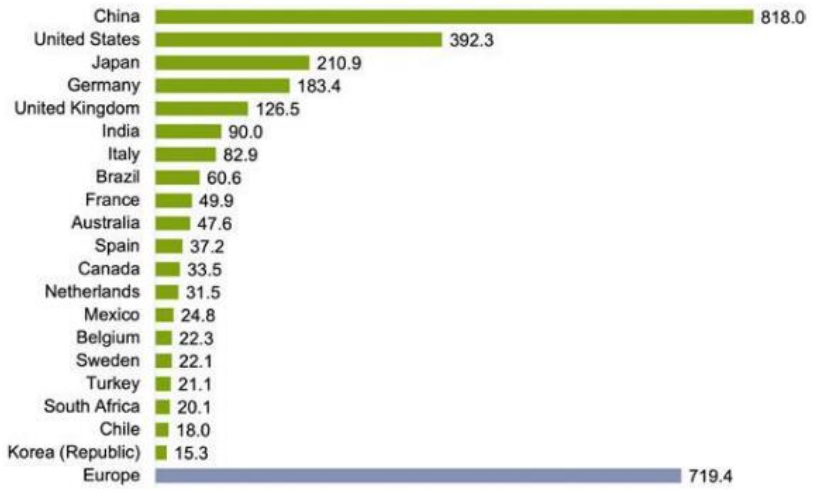
The 13th FYP for Energy Development (2016-2020), released ahead of this strategy, proposed to implement 'Dual Control' both on total energy consumption and energy intensity by 2020. Building on this basis, the Strategy proposes further energy revolution goals to be achieved by 2030. From 2021 to 2030, the use of renewable energy, natural gas and nuclear energy is expected to grow, and the consumption of high-carbon fossil energy is expected to greatly reduce. By 2030, China expects that the total energy consumption will be capped at 6 Gtce, non-fossil energy and natural gas will account for about 20 percent and 15 percent of total energy consumption respectively, and new energy demand will mainly rely on clean and sustainable energy. CO_2 emissions will peak around 2030 though China will strive to ensure they peak as soon as possible while CO_2 emissions per unit of GDP will reduce in the range of 60-65 percent compared with 2005. The energy consumption per unit of GDP will reach the current global average while the energy efficiency performance levels of China's main industrial products will be among the most advanced in the world.

Fig. 5.2-6 China typical process industry energy consumption per unit of products relative to international advanced levels



Source: China Energy Efficiency Report

Fig. 5.2-7 Renewable energy capacity investment, 2010-2019 (top 20 markets, billion dollars)



Source: UNEP, Frankfurt School-UNEP Centre, Bloomberg NEF

Subsidy to Renewable Energy

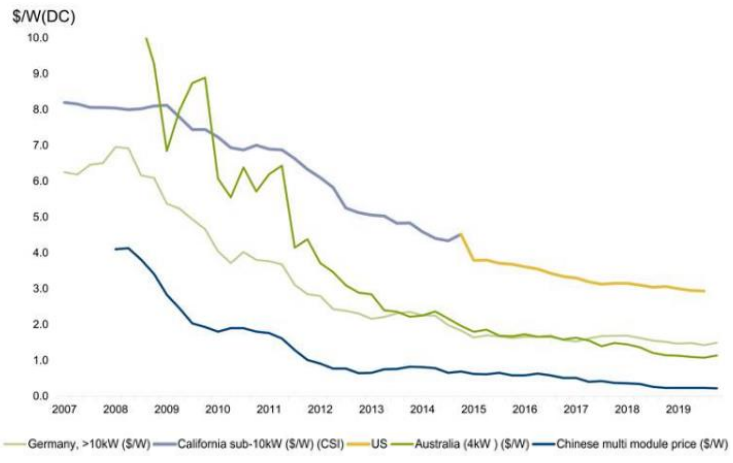
In 2009 China MOF, MOST and NEA jointly issued the "Notice of Subsidy to Golden Sun Demonstrative Projects" for subsidy to solar project. There are many similar policies to subsidize other renewable energies such as wind, biomass, tide & wave, geothermal and hydrogen. With the great support policy China has made the largest investment in the world in the renewable energy during the last decade.

The subsidy from Chinese government is keeping on reducing. In some region, the grid purchase price to solar electricity is close to the level of coal fired power plant, as a result to its scaling effect of solar industry. China brought online 30 GW of solar PV capacity in 2019, down from 44 GW in 2018. The NEA was trying to use reducing subsidy as a functional tool to control the overcapacity in Chinese PV industry, and other renewable industry as well.

China plans to make a 50 percent cut in the 2020 subsidies budget for new solar capacity and completely remove support for new offshore wind farms to ease the financial burden on its budget.

It was reported that the NEA will allocate CNY 1.5 billion (USD 214.7m/EUR 190.1m) for subsidizing new photovoltaic (PV) projects, of which CNY 1 billion will go for large-scale projects awarded through auctions. The remaining CNY 500 million will be set aside for distributed generation (DG) schemes. The total envisaged subsidy amount in the solar segment is 50 percent lower than the one in 2019. In addition to cancelling support for new offshore wind farms in 2020, the country is also considering ending the subsidies for onshore wind projects in 2021, according to the report.

Fig. 5.2-8 Small PV system cost in Germany, USA and Australia, and trend in Chinese module prices (USD/watt)



Source: UNEP, Frankfurt School-UNEP Centre, Bloomberg NEF

PV production costs have fallen by 82 percent over the past decade, mainly due to technological advances, industry scale and supply chains. From a national perspective, the world's major photovoltaic power generation countries in 2019 cumulative installed capacity of the top three are: China, Japan, the United States, the total installed capacity of photovoltaic power generation is 327452MW, accounting for 56.4 percent of the world, of which China accounted for 35.3 percent of the global share.

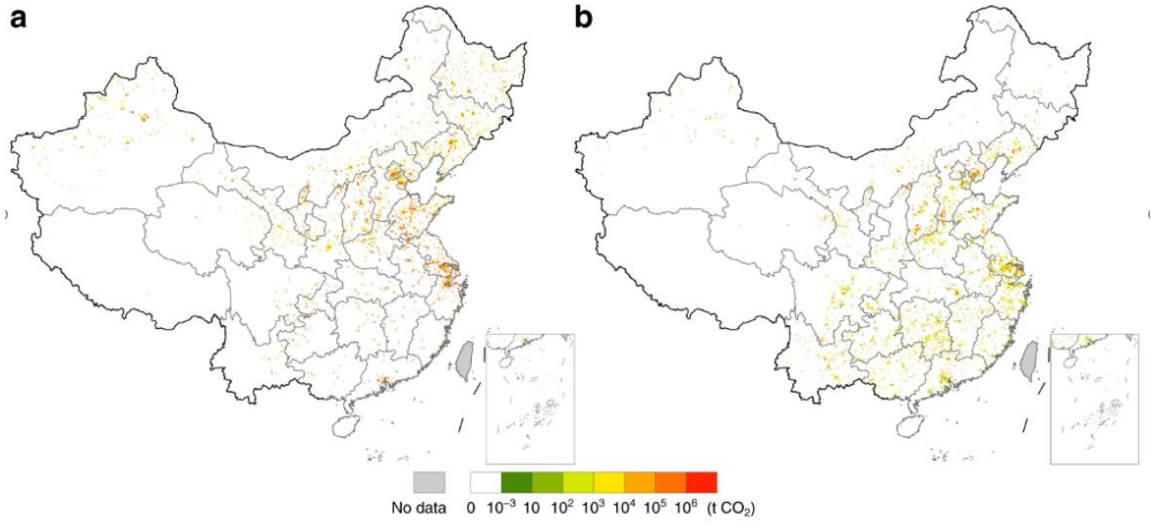
5.3 Emission reduction

China became the world's largest carbon emitter since 2006, now accounts for 27 per cent of global annual emissions. China has made great efforts in reducing the GHG emissions, both I process industry and other sectors. Most notably, emissions of SO_X and NOx peaked in 2006 and 2011 respectively, while some water pollutants such as ammonia nitrogen have been declining since the early 2000s. Most of the reduction of SO_X and NOx emissions was achieved in the energy production sector, while emissions from manufacturing remained relatively stable. Given the high rates of GDP growth in China over the last 10-15 years, even relative decoupling (of other pollutants) will continue to intensify environmental pressures.

Per capita carbon emission intensities have grown rapidly in China since 2000, the amount of carbon emitted per person in China is also increasing but at a lower level and a slower growth rate than production-based per capita carbon emissions. This pattern is in contrast with OECD countries and is most likely linked with China's specialization in more energy-intensive production and the high volume of exported goods with high carbon footprints. Although there is still a lot of debate over carbon emissions embodied in international trade, China has played an irreplaceable role in the international division of labor along global value chains and has made a substantial contribution to promoting the integration of the world economy.

The energy and carbon intensities of the Chinese economy have been considerably reduced since 1990, due to the combination of multiple factors, including the high growth rates of GDP, structural changes within the economy as well as technological advancements. However, China still generates lower economic value (in terms of GDP) per unit of carbon emitted and per unit of energy consumed than

Fig. 5.3-1 Export driven carbon footprint hotspots in two different sectors in China



a shows the carbon footprint hotspots driven by export in production and supply of electricity, steam, gas, and water sector, and **b** shows the carbon footprint hotspots driven by export in smelting and processing of metals sector.

Source: Mapping global carbon footprint China

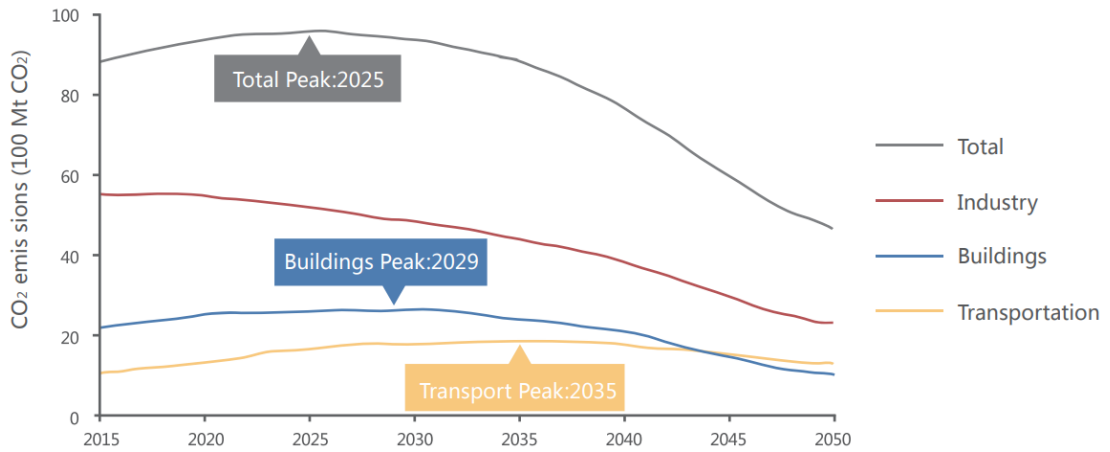
the OECD countries. This indicates untapped opportunities for efficiency gains. Improvements in energy intensity since 1990 have been accompanied by development and use of cleaner fuels and renewable energy sources. The mix of renewables in primary energy supply has diversified, with solar, wind and hydropower increasing more than ten-fold during 1990-2014, while traditional use of biomass for cooking and heating, which can exert significant pressures on human health and ecosystems, considerably reduced. In terms of electricity generation, the use of hydropower increased eight-fold during the same period, while the use of solar energy has been growing exponentially since 2010. Nevertheless, coal continues to dominate the country's energy supply and power generation.

The reduction in the total emission of some air pollutants, pollution levels remain high and represent a risk for the environment, the people and their quality of life. This is particularly the case for emissions of fine particulates (PM 2.5) and 18 some other air pollutants where continued high levels of exposure have in significant impacts on human health and high social costs.

The use of environmentally related taxes in China has grown and the share in total tax revenue has increased significantly in the past 15 years (See chapter 2.2). The tax base is dominated by transport and energy. Recent efforts have also been made to phase out inefficient fossil fuel subsidies and to move towards more market-based pricing of energy and resources.

Due to the electrification and decarbonization process, the industrial energy-related CO_2 emission will be keeping dropping in two scenarios during the scenario period. And the combination all energy saving measures in Stated Polices scenario can help significantly reducing China's future industrial CO_2 emissions from the current 2854 million tons to 977 million tons by 2050, and the deepened measures in Below 2°C scenario can help further reducing CO_2 emissions by as much as 24 percent to 736 million tons in 2050.

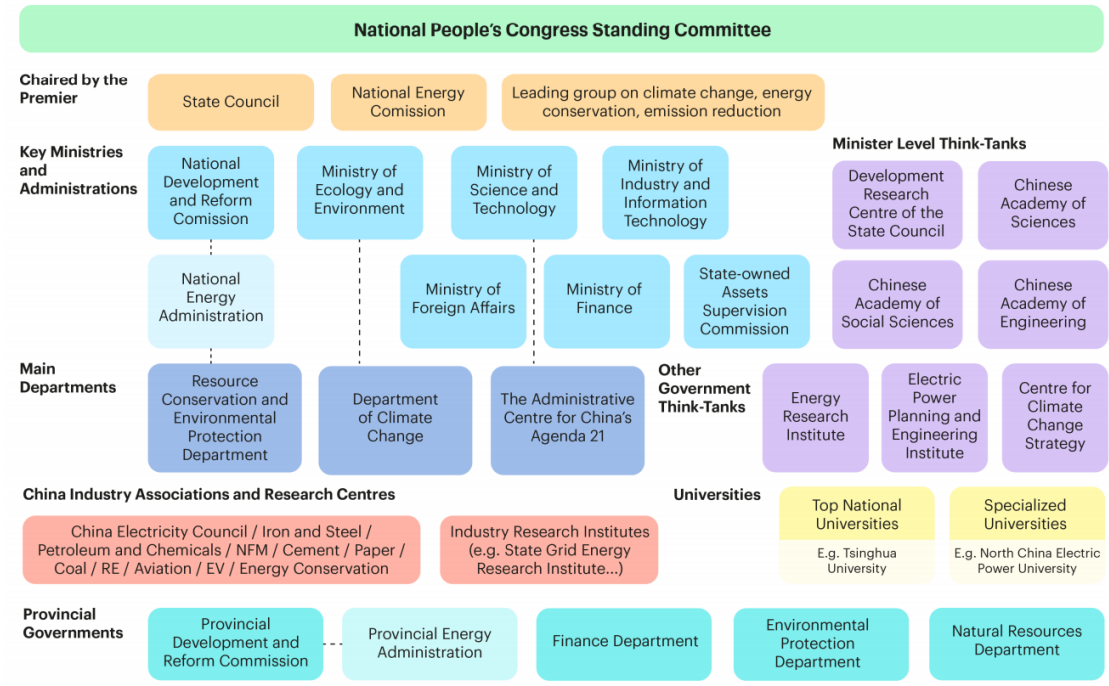
Fig. 5.3-2 Energy-related CO2 emission curves under the Reinventing Fire scenario (2015-2050)



Source: ERI, LBNL, RMI. 2016. Reinventing Fire: A Roadmap for China's Revolution of the Consumption and Production of Energy to 2050, Executive Summary

Stricter energy and environmental policies to offer new opportunities for ESCOs in recent years, the Chinese government has issued more and tougher energy and environmental regulations to curb pollution and restructure industries. Through the promulgation of a series of environmental policies such as the Environmental Protection Planning for the 13th FYP Period, the creation of the ecological protection red lines, the Blue Sky national air quality campaign, and establishment of environmental surveillance, China's energy conservation and emissions reduction work have moved towards pragmatic implementation. Some non-compliant enterprises have been forced to close. Energy-intensive industries such as iron and steel, chemicals, building materials, and non-ferrous metals, as well as emission-intensive cities, are under great pressure to make significant improvement.

Fig. 5.3-3 Overview of major climate and energy policy organizations of China



Source: IEA

Although China has made remarkable progress, the country needs to step up its effort in order to achieve the 2020 and longer-term environmental quality improvement and energy efficiency goals. However, targeting end-of-pipe solutions to meet long-term environmental and energy goals is not only costly, but also constrained by technology. In contrast, energy efficiency improvement can provide a solution that addresses the problems from its source, thus reducing the use of polluting fossil fuels while lowering energy costs. Undoubtedly, tougher environmental and energy regulations will create tremendous market opportunities for ESCOs. For example, a number of ESCOs have seized the opportunity created by tougher regulations to reduce NOx emissions in Beijing, Tianjin, and Xi'an among other cities, to retrofit industrial boilers, replace equipment, and install smart combustion control solutions to minimize the amount of NOx generated. In addition, the Chinese government has put in place the "double control" policy to control both energy consumption and intensity. The policy breaks the national target of energy consumption into the provincial targets and allocates the targets to sectors as well. This requires implementation of major energy efficiency and environmental protection programs. Further, to more effectively cut carbon emissions, the Chinese government officially launched a national carbon trading market in 2017, which at the current stage caps only emissions from the power generation sector. The energy and emission caps will increase operational costs of enterprises and create intrinsic motivation for energy users to either conserve energy or improve energy efficiency. This will no doubt create abundant opportunities for ESCOs to expand their EPC business.

China's efforts to reduce carbon intensity are not just a matter of fulfilling the Paris Agreement's commitment to reduce carbon intensity by 40 to 45 percent between 2005 and 2020 (the target was achieved by the end of 2017), but also intended to address domestic problems, including air quality. It's PM 2.5 concentration, an air pollution indicator, was 3.7 times the OECD average in 2016, according to the World Bank. The situation is much serious in the large industrial cities where population concentrated.

Targets

- 2016-2020: Reduction in carbon emissions per unit GDP by 18 percent compared to 2015 level (13th FYP)
- By 2020: 40-45 percent reductions in carbon intensity compared to 2005 levels (voluntary commitment under the Copenhagen Accord of 2009)
- By 2030: Peak CO_2 emissions around 2030, with best efforts to peak earlier; China also has committed to lowering CO_2 emissions per unit of GDP by 60-65 percent from 2005 levels (NDC)
- By 2030: Carbon neutral

CO_2 is not the only greenhouse gas (GHG) to worry about. Other gases like methane, nitrous oxide and hydrofluorocarbons (HFCs) can have a much more powerful effect in heating our atmosphere.

Table 5.3 China's Pledges and Targets

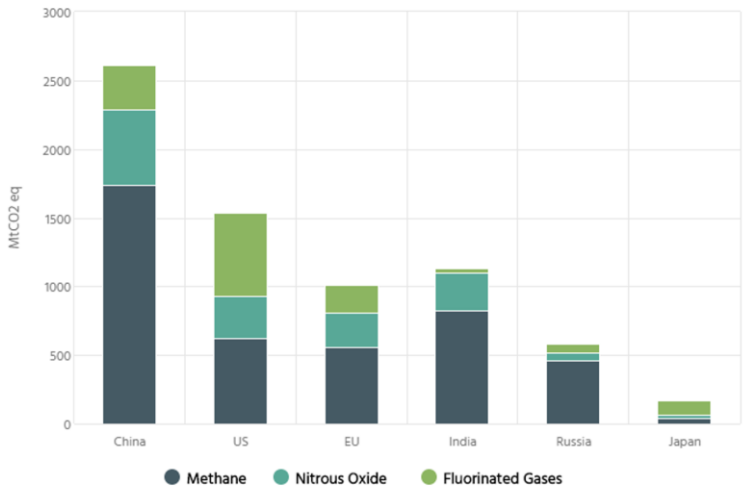
Agreement	Targets	Target Date
Copenhagen Accord	Carbon intensity reduction of 40% to 45% below 2005 levels	2020
	Increase the non-fossil fuel share of energy supply to 15%	
Paris Agreement	Peak CO2 emissions	2030
	Carbon intensity reduction of 60% to 65% below 2005 levels	
	Increase the non-fossil fuel share of energy supply to 20%	

Source: The Climate Action Tracker

In 2014, China emitted 2 gigatons of non-CO_2 greenhouse gases, which accounted for 16 percent of the country's GHG emissions. To put that in perspective, China's non-CO_2 emissions alone have a warming impact greater than all greenhouse gas emissions from Japan or Brazil. If China's non-CO_2 emissions were a country, they would be the 7th largest emitter of total GHGs in the world. According to WRI research, policies China has recently put in place to cut non-CO_2 emissions puts the country on track to avoid the 3.5 gigatons of CO_2 equivalent (CO_2e) between 2015 and 2030, compared to policies in 2015. Analysis says that if China takes more cost-effective actions to tackle sources of non-CO_2 emissions it could avoid an additional 3 gigatons of CO_2e in that same time period.

The 14th Five-Year Plan (2021-25), with the post-Covid-19 stimulus response, will be critical for the success of China's clean energy transition.

Fig. 5.3-4 Non-CO2 Emission for Selected Countries (2018)



Source: PBL Netherlands Environmental Assessment Agency

5.4 CCUS in China

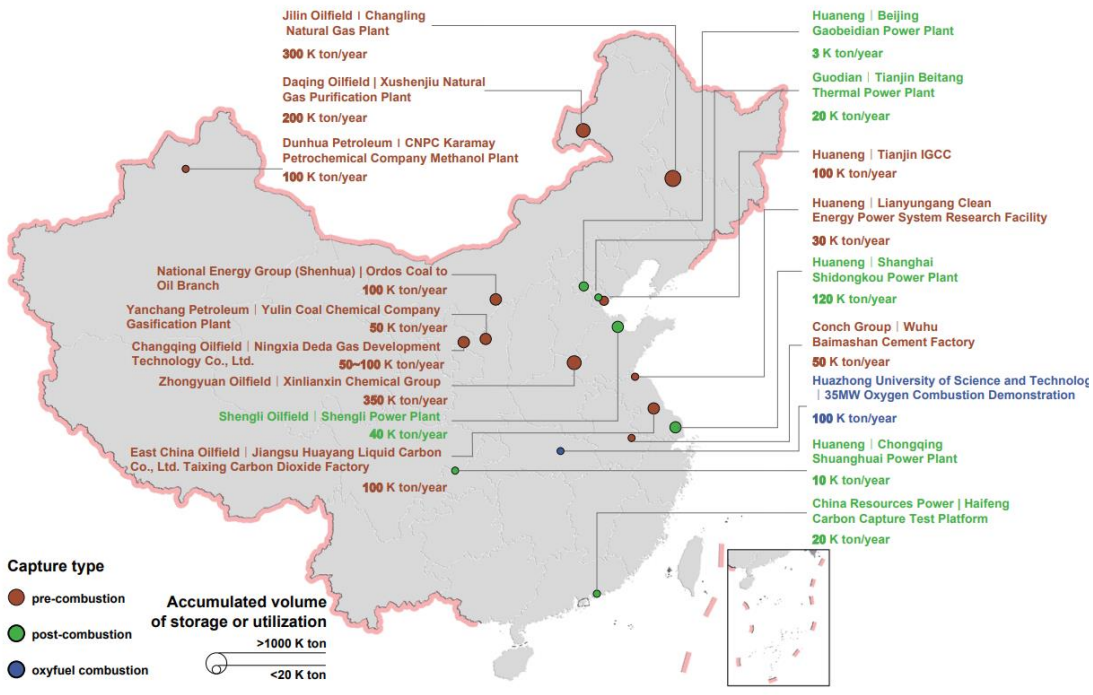
5.4.1 CCUS projects in China

As the world largest greenhouse gas emission country, China has made a solemn commitment to achieve carbon emissions peak by 2030. However, China's coal-based energy structure cannot be changed in a short term. CCUS, as an effective technology with great potential to realize low-carbon use of fossil energy, has attracted wide attention in recent years.

There are various CCUS technologies demonstrated in China, including CO_2 storage in deep saline aquifers, CO_2-enhanced oil recovery (CO_2-EOR), and displacement of coalbed methane by CO_2. These projects provide valuable experience and data for the future development of CCUS in China and the rest of the world. As of the end of 2019, China had launched a total of 26 capture, utilization & storage demonstration projects (in different stages, see chapter 2). The cumulative volume of geologically stored CO_2 in all CCUS projects is approximately 2 million tons.

The CO_2 capture projects of China are mainly concentrated in the coal chemical industry, followed by the thermal power industry. Geological utilization and storage projects are mainly focused on enhancing oil recovery. China's CO_2 capture technology is relatively mature, and several core technologies in geological utilization and storage have made major breakthroughs. CO_2-EOR has entered the initial stage of commercial application. The economic cost is a major hurdle for the development of CCUS in China. CO_2 capture consumes the most energy and is the most expensive in the entire CCUS process, including capture, transportation, utilization, and storage. Currently in China, the capture cost for the low-concentration CO_2 is 300-900 CNY/ton, and the transportation cost by tanker is about 0.9-1.4 CNY/(ton/km). The cost of flooding and storage technology varies greatly depending on the technical details, reservoir conditions, gas source, and source-sink distance. CO_2-EOR can effectively compensate the cost of CCUS. At the level of 70 USD per barrel of crude oil, the cost of CO_2-EOR can be balanced in China.

Fig. 5.4.1-1 CCUS projects in China



Source: MOST Roadmap for Carbon Capture, Utilization and storage Technology in China (2019)

China's policy scheme has several advantages compared to those of western countries, for example the stabilization of national long-term development plans regardless of the alternation of parties with different positions and ideologies, and high efficiency as well as promptly effective responses to emerging challenges and opportunities. This represents that if the central government expresses a strong passion for CCUS for climate reasons, it will be researched, planned, tested and deployed expeditiously.

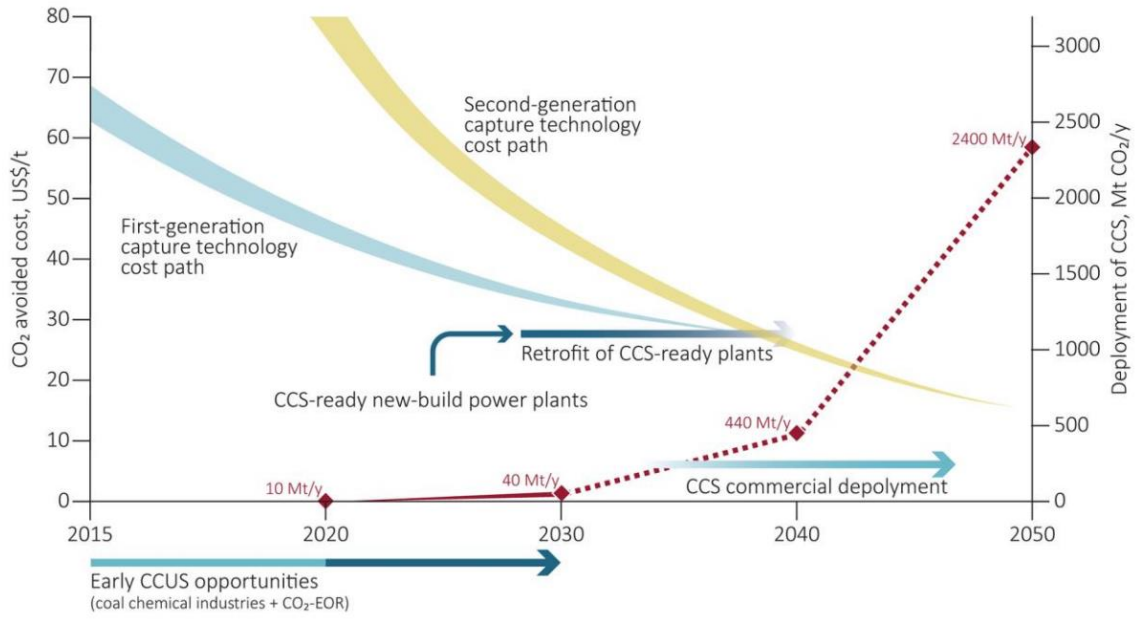
In October 2016, the State Council of China issued the 13th Five Year Plan with The Work Program on Controlling Greenhouse Gas Emissions Proposes in the coal-based industry and oil & gas exploration. The industry carries out large-scale demonstration projects of carbon capture, utilization and storage in the country. Many projects had been developed before that period with the academic study programs, international cooperation and funding from domestic or abroad.

5.4.2 China roadmaps for CCUS

The Ministry of Ecology and Environment of the People's Republic of China (MEE), and Ministry of the Science and Technology of the People's Republic of China (MOST) currently drive China's comprehensive CCS program. The Department of Climate Change of MEE which was moved from NDRC (National Development Reformation Committee) in 2018, is the main responsible office from the Chinese central government, in corresponding with the international climate change agreements and actions, such as Paris Agreement.

Starting in 2012, the Department of Climate Change of the NDRC carried out the Project for elaborating the Roadmap for Carbon Capture and Storage (CCS) Demonstration and Deployment in China with the support of the Asian Development Bank (ADB). In the absence of a national plan for CCS demonstration and deployment, the Roadmap was developed to outline technical, legal, policy, financial and public engagement solutions that need to be implemented to move CCS from early demonstration projects to full-scale commercialization. The Roadmap worked out by both domestic and international experts, informs decision makers on a scientific basis about China's readiness to use this innovative technology as well as about the urgency to expand its deployment at a rapid scale to meet priority emission reduction targets in the short, medium and long-term. It is a practical

Fig. 5.4.2-1 China Road Map for CCUS



The NDRC and Asian Development Bank roadmap for CCS deployment in China (ADB, 2015)

document as it recommends specific actions during the period of the 13th Five Year Plan (2016-2020), and beyond 2020, as part of a phased approach to implement CCS in the context of this country.

China has launched many commendable initiatives with an effort to peak out its carbon dioxide (CO_2) emissions by 2030. Its current policy suite prioritizes accelerated energy efficiency improvement, rapid deployment of renewable energy, and larger share of low-carbon, low-emission natural gas and nuclear in the mix. But coal, which has underpinned the PRC's rapid economic growth over the past quarter of a century, is still expected to supply more than two-thirds of its energy needs compared to the global average of 24 percent. Coal is not only the most carbon intensive fossil fuel causing the largest increase in CO_2 emissions but is also the main contributor to the poor air quality prevalent over a large part of China.

The "new normal" economic growth paradigm in the PRC with greater emphasis on quality of growth with environmental friendliness has brought renewed attention on continued use of coal in the business as usual case. Nonetheless, large new capacity of coal-based power generation and industrial plants is still expected to meet incremental energy demand for the next 20–25 years. These new plants are expected to be most efficient and low emission at par with the best available technology in the world. But they will still cause an increase in absolute CO_2 emissions. Thus, the need to urgently demonstrate and timely deploy carbon capture and storage (CCS), the only near-commercial technology currently available to cut up to 90 percent of CO_2 emissions from coal-based plants, becomes an urgent policy imperative for the country.

Key Policy Actions to Implement the CCS Roadmap	**Key Policy Actions to Implement the CCS Roadmap**
2021-2030 • Second-generation CCUS targets announced. • More market-based incentives for coal–chemical projects introduced, such as carbon tax, CO2 emission caps, etc. • Incentive program for coal-fired power plants introduced. • Comprehensive CCS regulatory framework put in place. **Beyond 2030** • Economic and regulatory incentives for CCUS deployment in coal-fired power generation sector strengthened.	**2021-2030** • Largest contribution of second-generation technologies to the cost reduction in coal-fired power plants. • Commercial deployment in coal–chemical industry and demonstration phase for wider CCS application. **Beyond 2030** • Capture cost reduction and carbon price reach a level to trigger wider application of CCS.

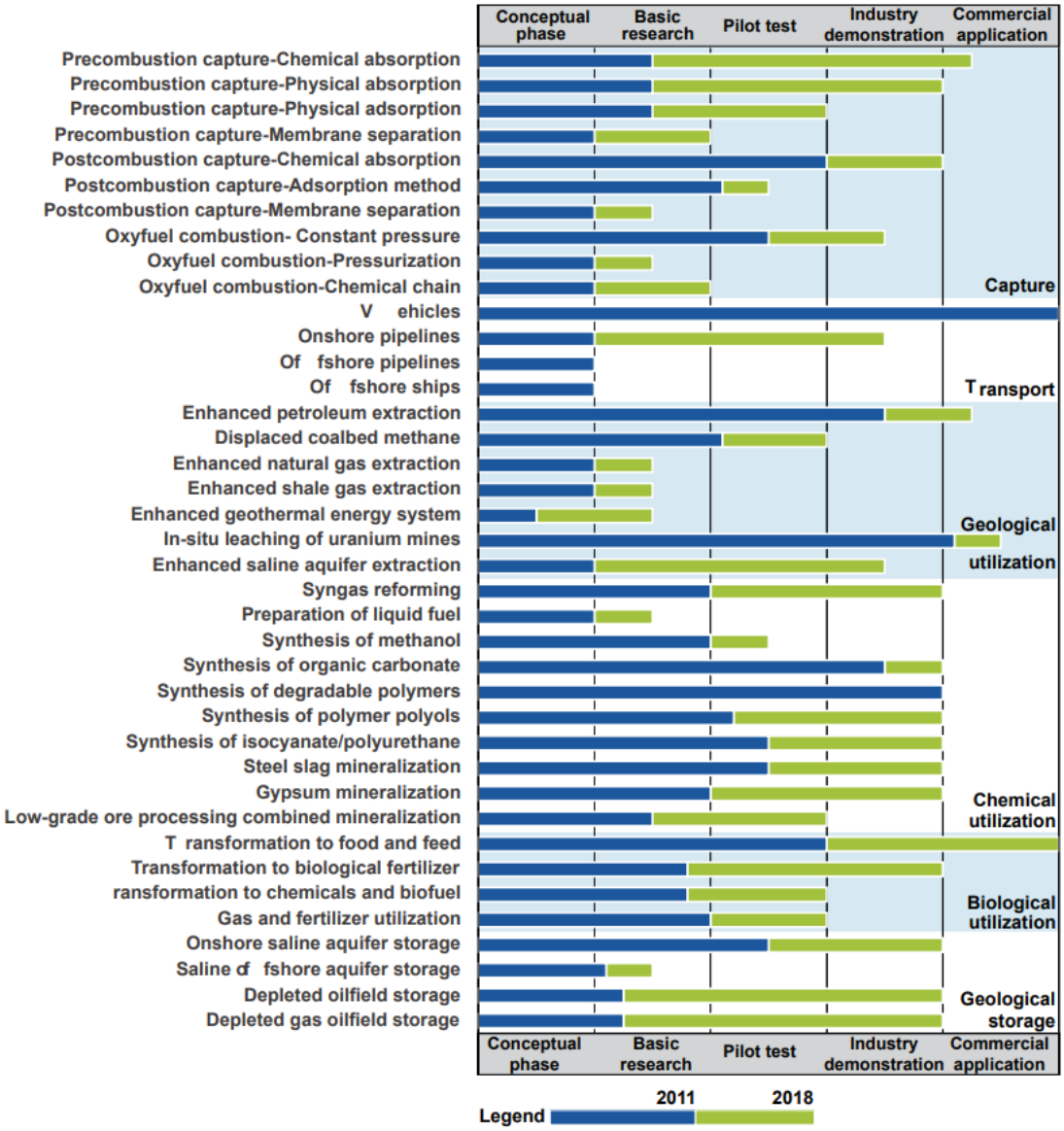
- The Projected CCS Deployment Path The CCS deployment level attained is highly uncertain and will depend on (i) the degree of cost reduction achieved; (ii) the costs of CCS relative to alternative low-carbon technologies, including nuclear and renewables; and (iii) gain in capture efficiencies.
- The projected CCS deployment path will lead to a cumulative avoidance of CO2 emissions of (i) 10–20 MtCO2 by 2020, (ii) 160 MtCO2 by 2030, and (iii) 15 GtCO2 by 2050.

5.4.3 Technological development situation

China has achieved great progress in the CCUS technological development, during the last two decades. Remarkable achievements have been made in macro planning, technology research and development, promotion and application, and international cooperation regarding CCUS.

Both China's government authorities and Chinese CCUS stakeholders are very eager and open to cooperate with the world, especially in technology development. The cooperation can be academic joint research or industrial project construction.

Fig. 5.4.3-1 Schematic diagram of CCUS technology development stage in China



Source: Roadmap for Carbon Capture, Utilization and storage Technology in China (2019)

5.5 ETS in China

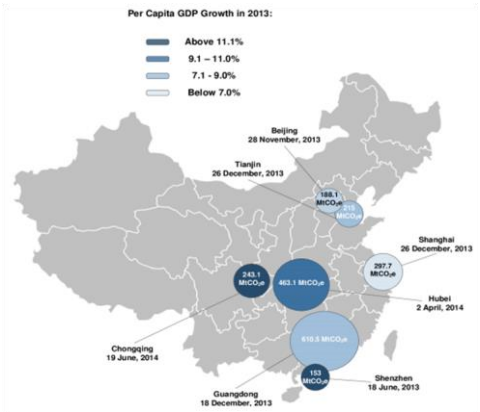
Before the ETS initiation, China already benefited by several years of experience from the Clean Development Mechanism (CDM) through which it became familiar with the market-based mechanism to reduce emissions.

As a result of China's 12th Five Year Plan (2011-2015), which lays out plans to "gradually develop a carbon trading market", China's ETS（Emission Trading System）was initiated from the year 2011, with the announcement from NDRC to build up seven pilot ETS as follows: Beijing, Tianjin, Shanghai, Shenzhen, Chongqing cities, Hubei and Guangdong province. Later, approved by the NDRC, Sichuan and Fujian provinces also build up their own ETS voluntarily.

After several years of preparation, all online trading was launched during 2013-2014. By the end of 2017, the cumulative quantity of seven pilot carbon markets in China exceeded 200 million tons, with a cumulative turnover of more than 4.7 billion yuan. Each pilot has its own unique design that considers local circumstances and the respective economic profile. The purpose of the pilot ETS practice was to encourage the cities and provinces to test different design options and explore best practices. The pilot ETS differ in scope, allocation methods, MRV provisions and price levels among others.

The Shanghai United Assets and Equity Exchange (UAE) is in charge of the founding of China ETS, with the support from Shanghai Environment and Energy Exchange. An evaluation meeting was held in Shanghai on 24 April of 2020.

Fig. 5.5-1 Pilot ETS in China



China has announced seven pilot ETS in China as follows, Beijing, Tianjin, Shanghai, Shenzhen, Chongqing cities, Hubei and Guangdong province.

MEE also continued to improve the establishment of plans for a national registry and a trading system, as well as the development of a national enterprise GHG direct reporting system. In March 2020, the MEE published a draft of the 'Interim Regulation on Carbon Emission Trading' for public consultation, marking progress towards the adoption of ETS implementing legislation. The experiences from the pilot ETS informed the establishment and implementation of the national ETS and the pilots themselves will eventually be merged into the national ETS.

Building on its experience of successfully piloting carbon markets in seven regions, China launched its national ETS politically in December 2017. This launch was a goal set in 2015 at China's highest political level, which was reaffirmed by its NDC under the Paris Agreement and the '13th Five-Year Work Plan for Greenhouse Gas Emission Control.' The provisions for the launch and incremental development of the ETS are laid out in the Work Plan for Construction of the National Emissions Trading System (Power Sector) (Work Plan), approved by the State Council in late 2017.

Table 5.5-1 Comparison of the key design features of the regional ETS pilots

	Beijing	Chongqing	Guangdong	Hubei	Shanghai	Shenzhen	Tianjin
GHG target							
Total cap (Mt CO_2e)	46 (2016)	100.4 (2016)	422 (2017)	257 (2017)	156 (2017)	31.45 (2015)	160-170(2013)
Scope							
Sectoral coverage							
Electricity	✔	✔	✔	✔	✔	✔	✔
Water supply					✔	✔	
Manufacturing	✔	✔	✔	✔	✔	✔	✔
Services	✔				✔		
Aviation			✔		✔		
Other Transportation	✔				✔	✔	
Direct and indirect emissions	✔	✔	✔	✔	✔	✔	✔
GHG Coverage							
CO_2 only	✔		✔	✔	✔	✔	✔
CO_2, CH_4, N_2O, HFC, PFC, SF_6		✔					
Thresholds							
t CO_2e / year	5,000	20,000	20,000		20,000*	3,000	20,000
metric tonnes of coal equivalent			10,000	10,000	10,000**		
Share of total emissions	~ 45%	~ 40%	~ 60%	~ 35%	~ 57%	~ 40%	~55%
Number of entities	582 (2016)	237 (2016)	296 (2017)	344 (2017)	298 (2017)	824 (2016)	109 (2017)
Allocation							
Free allocation	✔	✔	✔	✔	✔	✔	✔
Grandfathering	✔	✔	✔	✔	✔	✔	✔
Benchmarking	✔		✔	✔	✔	✔	✔
Auctioning			✔	✔	✔	✔	
Flexibility							
Banking	✔	✔	✔	✔	✔	✔	✔
Borrowing							
Offset (CCER) limit as a share of	✔	✔	✔	✔	✔	✔	✔
annual allocation	5%			10%	1%		
annual compliance obligation		8%	10%			10%	10%
Provisions for price management	✔	✔	✔	✔	✔	✔	✔
MRV							
Annual reporting	✔	✔	✔	✔	✔	✔	✔
Third party verification	✔	✔	✔	✔	✔	✔	✔
Compliance							
Financial penalities	✔	✔	✔	✔	✔	✔	
Disqualified from financial support		✔		✔	✔	✔	✔

Note: The thresholds in t CO_2e / year and metric tonnes of coal equivalent only refer to the new entrants in power and industrial sectors since 2015; and the rest with 50% of the thresholds. They are not holding regular auctionings of a certain share of allowances, as part of the allocation process.

Source: ICAP (2018b), Pang and Duan (2015), Zhang et al. (2017), Zhang (2015), Zhang et al. (2014).

The Work Plan foresees a three-phase roadmap for the development of the ETS:

- First Phase: will focus on the development of market infrastructures (roughly one year)
- Second Phase: foresees simulation trading (roughly another year)
- Third Phase: will be the deepening and expanding phase with allowances spot trading for compliance purposes (roughly starting from 2020).

A gradual transition of the Chinese pilots is foreseen by the Work Plan. In the short term, the existing ETS pilots are expected to operate in parallel to the national market, covering the non-power sectors. Over the medium to long term, they are expected to be integrated into the national market once it is fully operational.

From 2018, MEE had taken the responsibility as the authority for China ETS instead of NDRC. In addition, the government continued to advance the work on reporting and verification of the 2018

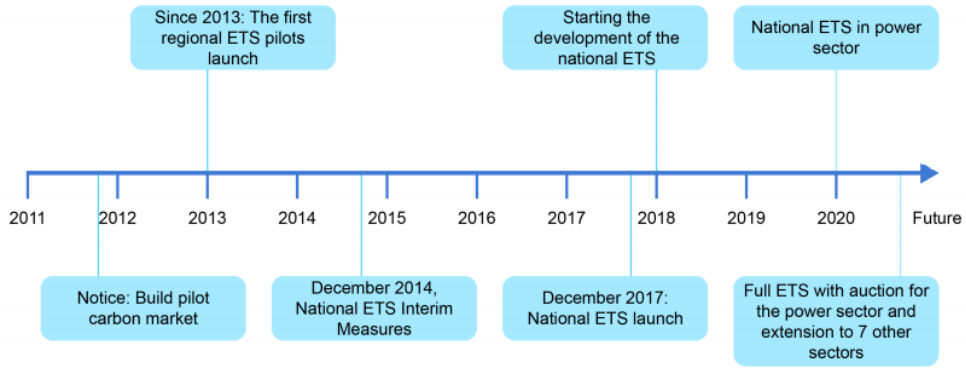
emissions data from eight emission-intensive sectors of the economy as follows: petrochemical, chemical, building materials, steel, nonferrous metals, paper, and domestic aviation. There is no specific timeline for this expansion.

Table 5.5-2 Status of National ETS (Sep 2019)

	Current status	Future trends
Policy	National ETS Development Plan released. Three phases of national ETS clarified: foundational work, simulation trading, deepening and expanding. Interim Administrative Measures on Emission Trading (Draft for Comment) released by MEE.	Detailed implementation plan of National ETS needs to be clarified further. Interim Administrative Measures on Emission Trading and the supporting administrative rules needs to be released.
Coverage	Only power generation sector will be covered initially.	Other sectors inc. once conditions met: petrochemicals, chemicals, building materials, iron and steel, nonferrous metals, papermaking, and aviation.
Allowance allocation	Trial Allocation Plan for National Power Sector ETS released; Draft allocation plans for cement and electrolytic aluminium have been formulated, and trial calculation conducted.	Release formal allowance allocation plan. Conduct allowance allocation according to the results of trial calculation.
Monitoring, reporting & verification (MRV)	MEE issued notification to start carbon emission monitoring plans, reporting and verification among 8 industrial sectors. Most provinces/cities have started the MRV work as required and are supposed to finish by end of May.	The authority of National ETS will work with relevant departments to formulate administrative measures on reporting and verifiers, improve guidelines and technical standards of GHG calculation and reporting.
Compliance	Interim Administrative Measures on Emission Trading (Draft for Comment) identifies responsibilities and penalties for emitters, verifiers and traders.	Specified legal responsibilities and compliance mechanism needs to be clarified further in the formal regulation.
Supporting systems	Plan for developing registry, trading, settlement and reporting systems has been confirmed. Plans for national registry system and trading system have been formulated; data collection is under development.	Registry will be located and managed in Hubei; Trading platform will be located and managed in Shanghai. After the plans of two systems confirmed, the development and implementation will be promoted.
Offsets	The administrative measures on CCERs are still under revision.	CCERs will be included in national ETS once conditions are met.
Transition plan of pilots	Power sector entities in regional markets to be incorporated into national ETS. Pilots continue to operate and will transition to national ETS once conditions are met.	The detailed transition plan is still being researched.

Source: China Carbon Forum, 2019 CHINA CARBON PRICING SURVEY

Fig. 5.5-2 China ETS milestones

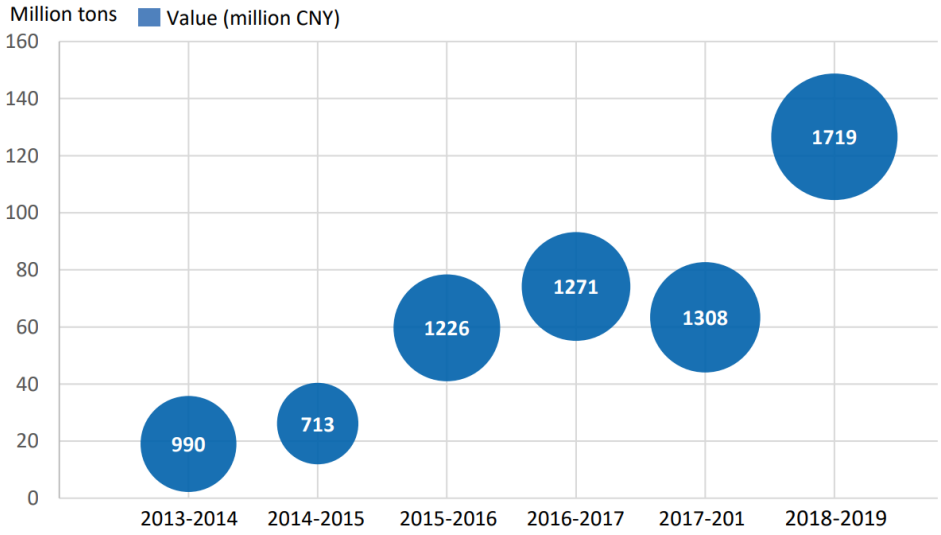


Source: IEA

MEE also continued to improve the establishment of plans for a national registry and a trading system, as well as the development of a national enterprise GHG direct reporting system. In March, the MEE published a draft of the 'Interim Regulation on Carbon Emission Trading' for public consultation, marking progress towards the adoption of ETS implementing legislation.

In 2019, MEE also conducted a China-ETS Allowance Allocation and Management Training Series in more than 15 cities. The aim of the training was to enhance the capacity and readiness of various stakeholders for the national ETS. Further, MEE released the information regarding the allocation plan through the 'Implementation plan of carbon emission allowance allocation for key emitters in power generation industry (including captive power plant and co-generation) in 2019 (trial version).' The training plan was used in capacity-building activities and further tested the rationality and operability of the benchmarks for the power sector. Looking to the future, the main tasks of national ETS development are legislating national ETS regulations, accelerating the development of market infrastructure, promoting reporting, carrying out verification and carbon management for key enterprises, and strengthening capacity-building activities. In the end of 2019, MEE issued the " Notice on the Work Related to the 2019 Carbon Emissions Reporting and Verification and the Submission of the List of Key Emission Units in the Power Generation Sector" for emission data reporting in the above mentioned eight industries. The simulation trading in the power sector is expected to start in 2020.

Fig. 5.5-3 Trading volume and value of primary and secondary market in pilots (million tons/CNY)



Source: China Carbon Forum, 2019 CHINA CARBON PRICING SURVEY

The national ETS will initially cover coal- and gas-fired power plants. Allowances to emit CO_2 (also known as permits) will be allocated based on each plant's generation output, with specific benchmarks for fuel and technology.

China started the implementation phase of the national ETS in 2017 to limit and reduce CO_2 emissions in a cost-effective manner. The ETS could become a major climate policy tool to help China realize its Nationally Determined Contribution (NDC) to the Paris Agreement on climate change and its long-term low-carbon strategy. The first compliance period is expected to start in 2020.

Influence from EU

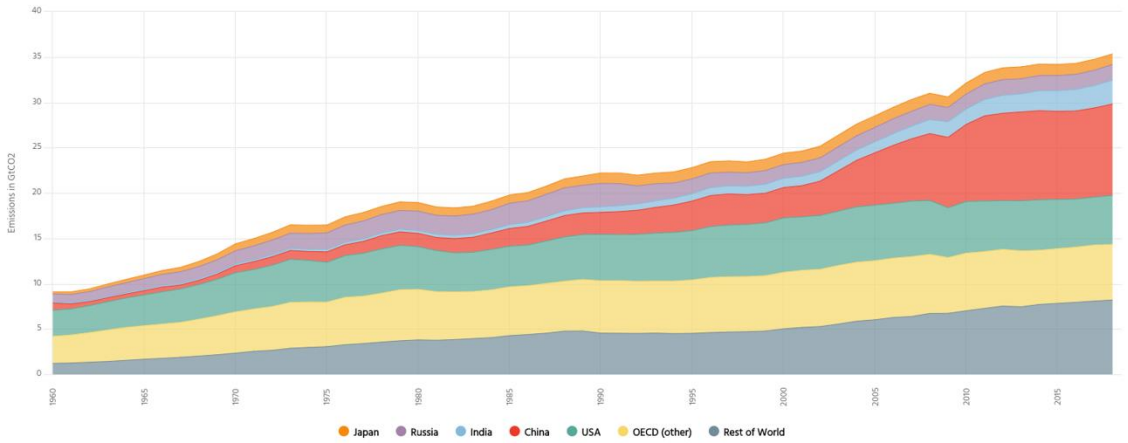
China take EU as a world pioneer in tackling with global climate change issues. From CDM to ETS, China was trying to keep up with EU's step, and promote its domestic policy against GHG emissions. However, in 2011, when EU was trying to implement carbon tax in its international aviation, China was one of the 28 countries strongly against it. But China EU finally shelve it.

Recently, carbon border tax is one of several mechanisms that the European Commission is considering as part of the European Green Deal, a bold initiative to cut greenhouse gas emissions in the EU by 50 percent over the next decade—compared with the current target of 40 percent—and make Europe the world's first climate-neutral continent. The president of the European Commission, Ursula von der Leyen, has recently called the European Green Deal a key element of the region's post-COVID-19 economic recovery.

The European Commission's consideration for tax the carbon emissions attributed to imported goods, which could create competitive advantages for foreign companies with small greenhouse gas footprints—and have financial repercussions for other exporters, adding to the financial strain caused by the COVID-19 crisis. Process industrial sectors such as basic metals, chemical products, and paper products, while less dependent on trade, would be directly affected because of their high carbon intensity. In terms of commodity steel, Chinese and Ukrainian process industries, which mostly produce steel using blast furnaces and basic oxygen furnaces, would be hit much harder, on average, than those of Canada and South Korea, where a greater portion of steel comes from mills using cleaner electric arc furnaces.

Companies in nations with their own ETS, such as Australia, Canada, and Japan, has the advantage that may be exempt if their governments negotiate new trade pacts with the EU or update existing ones.

Fig. 5.5-4 Global Carbon Dioxide Emissions



Source: Global Carbon Atlas

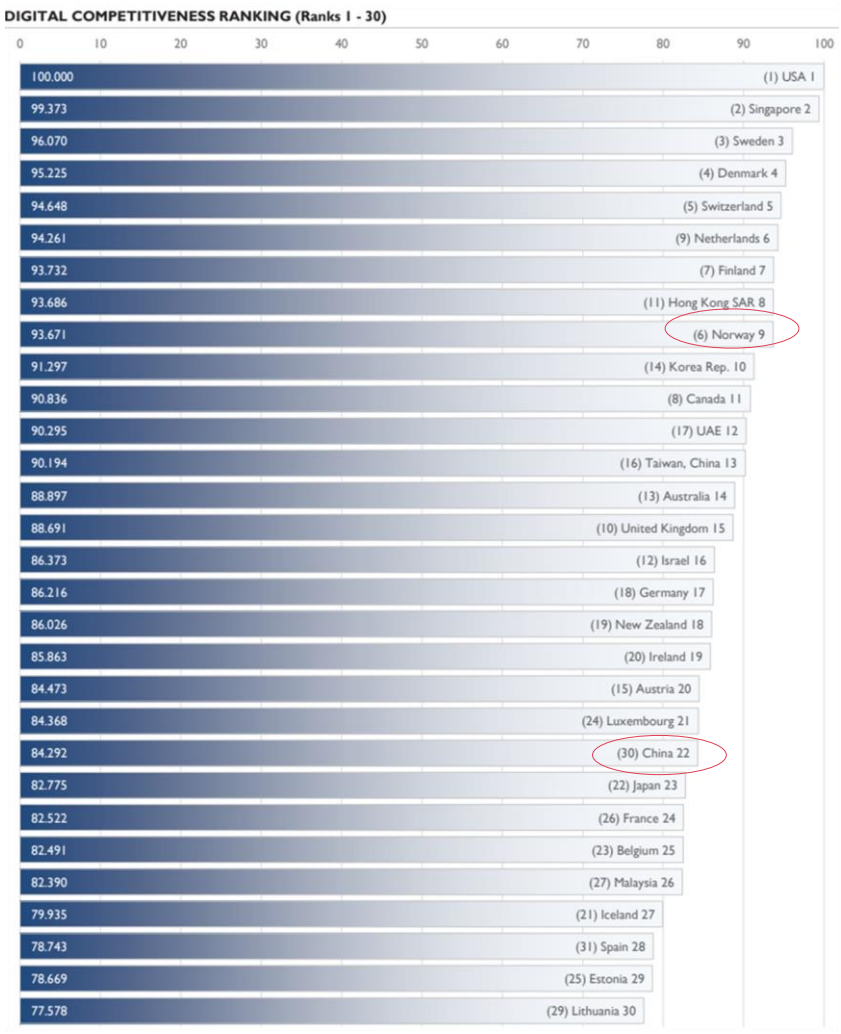
5.6 Digitalization

5.6.1 Digitalization in China

Digital Economy

At the end of 2019, China's mobile Internet users reached 1.319 billion, accounting for 32.17 percent of the total size of the global Internet users, much more than the EU and the USA combined. There are 5.44 million 4G base stations in China, accounting for more than half of the total number of 4G base stations in the world, with its mobile net flow reached 122 billion GB, an increase of 71.6 percent from 2018. The New Infrastructure Program of China, which takes 5G as one of its seven focused sectors, will bring great opportunities for stakeholders in the industry and push forward the Chinese digitalization. Although China's digital economy has expanded rapidly in recent years, the average digitalization of the economy remains lower than in advanced economies, which ranked No. 22 in World Digitalization Competitiveness by IMD (Norway listed No. 9, and Hongkong No. 8).

Fig. 5.6.1-1 World Digital Competitiveness Ranking



Source: IMD World Digital Competitiveness Ranking 2019

China is one of the world's largest investors and adopters of digital technologies home to one-third of the world's unicorns. China has the scale to drive rapid commercialization of digital business models and has the advantage of a large home market of consumers who are young and eager to embrace digital in all its forms. Three aggressive, giant internet companies with global reach—Baidu, Alibaba,

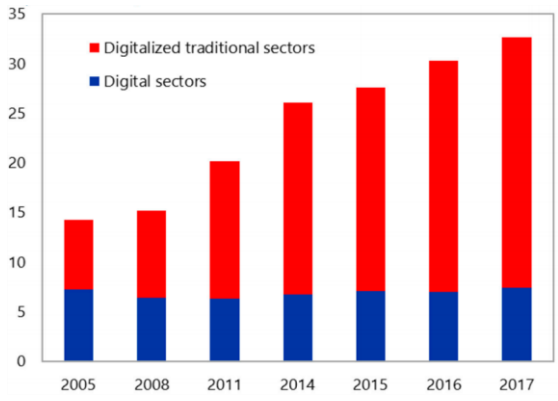
and Tencent (So called “BAT”, recently Byte Dance, owner of Tiktok has the trend to replace Baidu) with the rising of as they are collectively known—are creating a multifaceted and multi-industry digital ecosystem that touches every aspect of consumers’ lives. All BATs are developing driverless technologies, especially Baidu’s Apollo System which lauched a pilot Robotaxi at the Daxing District of Beijing in Sep 2020. Other digital innovators such as Xiaomi, NetEase and Ping An are also building their own ecosystems.

The government is actively encouraging digital innovation and entrepreneurship by giving companies room to experiment and offering support as an investor, developer, and consumer of new technologies. China’s digital transformation is already having a profound impact on its own economy and is likely to have an increasing influence on the worldwide digital landscape. China’s digital globalization is only just getting started and is gathering momentum. Through mergers and acquisitions (M&A), investment, the export of new business models, and technology partnerships, China could set the world’s digital frontier in the coming decades.

China's digital economy reached 22.6 trillion yuan in 2016, about 30.3 percent of GDP. In 2019, its value added of the national digital economy reached 35.8 trillion yuan, ranking second in the world after US. By 2030, the figure is forecasted to reach 77 percent of GDP, which means more than 153 trillion of GDP will come from the digital economy.

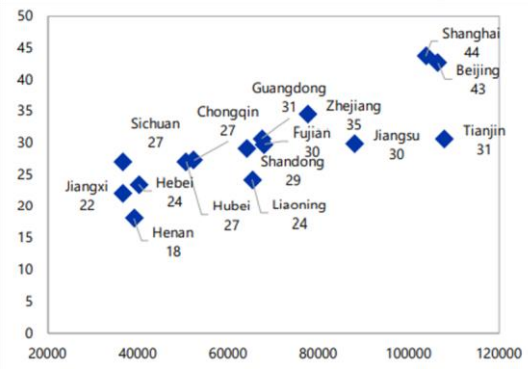
The COVID-19 accelerated Chinese digitalization in a way. Many worked from home during the pandemic, did online meetings and changed working from obligation to motivation. The annual Canton Fair (China Import and Export Fair), which is the largest export expo in China from 1957, had to be carried out online in June 2020.

Fig. 5.6.1-2 China Digital Economy Development (in percent of GDP)



Source: China Academy of Information and Communication Technology

Fig 5.6.1-3 China Digitalization Across Provinces (Share of digital economy as percent of GDP, GDP per capita in yuan)



Source: China Academy of Information and Communication Technology

E-commerce

As the world’s largest e-commerce market - accounting for over 40 percent of the global e-commerce transactions' value (from less than 1 percent about a decade ago), China’s e-commerce transactions amounted to 34.81 trillion yuan in 2019, which has occupied the top spot in the global e-commerce market for many years.

The penetration of e-commerce (in percent of total retail sales) stands now at 15 percent, compared to 10 percent in the U.S. The numbers presented here are averaged across all Chinese provinces, including e.g. rural China, while in more advanced parts of the economy, the indices suggest much higher level of digitalization.

The market competition in China e-commerce is very stiff, with giant dealers like Alibaba (T-mall, Taobao), JD, Pingduoduo, Meituan etc., as one of the reasons for Amazon withdraw from China in 2020, and e-bay many years ago.

In 2019, China's e-commerce employments have reached 51.2565 million, an increase of 8.29 percent from 2018. Not only B2C or C2C models, B2B deals are also rising, with some process industries sourcing or selling for bulk goods through internet.

Sharing economy

China has become a world leader in a number of services, particularly those internet-based that can be easily digitalized, such as e-commerce, online payments and online car hailing, the sharing economy emerged in this stream.

The sharing economy accounted for about 6 percent of China's GDP in 2017 and the target is 10 percent in 2020 and 20 percent in 2025. The major area is financing, followed by daily services, production capacity, transport, knowledge and skills, accommodation and medical services. In 2017, 10 percent of newly created employment (1.3 million) was in the sharing economy and employed 7.2 million people. Didi Chuxing, an online car hailing company alone provided work opportunities for nearly 4 million laid off workers in addition to 1.3 million unemployed and 1.8 million former soldiers. Regulations in shared services should catch up with the development of the industry to ensure safe use and provide for potential environmental and other consequences.

This new model of economy subverting the process industry in a way. For example, one of the city bike sharing companies (Mobike) used to give an one million bikes production order to a Chinese bicycle plant, a huge quantity that they can never imagine before. The design was jointly made but had to follow the Mobike's consideration and brand. The final product without any logo or brand name from the manufacturer. These huge orders with bullwhip effect brough deep influence to the upstream process industries like metals and parts. If the same thing happens in vehicle industries, it will change the game more significantly.

Fintech

The value of China's consumption-related mobile payments by individuals totaled 790 billion USD in 2016 already, 11 times that of the U.S. Related to the growth of this sizable market, the processing capacity of one of China's largest mobile payments providers is roughly 3 times faster than of U.S. counterparts.

In 2019, non-bank payment institutions made 719.998 billion online payments, amounting to 249.88 trillion yuan, an increase of 35.69 percent and 20.10 percent year-on-year, respectively.

The volume of online payment transactions of China reached 249.88 trillion yuan in 2019, and the penetration rate of mobile payments was among the leading in the world.

The volume of mobile payment business grew relatively quickly in recent years. In 2019, China's banks handled 223.388 billion e-payments, amounting to 260.704 trillion yuan. Among them, the online payment business 78.185 billion, amounting to 213.484 trillion yuan, an increase of 37.14 percent and 0.40 percent YoY, and the mobile payment business 101.431 billion, amounting to 347.11 trillion yuan, up 67.57 percent and 25.13 percent year-on-year, respectively, and 176 million telephone payments, amounting to 9.67 trillion yuan, up 11.12 percent and 25.94 percent year-on-year, respectively.

Cash payment disappears very quickly, only aged people go to banks and use cash. For the people living in cities, there're no need to bring cash anymore because mobile payment has covered almost everywhere in the city.

DC/EP

Developed from 2014, China's national digital currency DCEP (Digital Currency Electronic Payment), built with blockchain and cryptographic technology, might become the world's first central bank sovereign digital currency. Its back-end infrastructure has already been completed, and will be internally tested in Beijing, Shenzhen, Suzhou and XiongAn New Area, as well as in some application scenarios in Winter Olympic of 2022. Along with some local hotels, unmanned supermarkets, postal lockers, bakeries, bookstores, and gyms, foreign firms such as Starbucks, McDonald's, and Subway have been announced as companies that will participate in testing of DCEP.

This revolutionary cryptocurrency is not only to increase the circulation of the RMB and its international reach, but also trying to reshape its current cross border payment system, due to the risk of over reliance on Inter-Bank Payments System (CIPS), CHIPS (Clearing House Interbank Payments System) and SWIFT (Society for Worldwide Interbank Financial Telecommunication).

The digital economy is becoming an important engine of the economic development, especially in the underdeveloped provinces, which is expected to push the regional development differences narrower. The digital economic index of each province is roughly the same as their GDP distribution, but it is not a simple positive correlation, and there are significant differences in the level of digital economic development and economic scale in some areas. For example, Guizhou Province's GDP in 2018 achieved 1.48 trillion yuan, accounting for 1.6 percent of the country's total, while the total digital economy index of 27.4, ranking 17th in the country, much higher than the 25th ranking of GDP.

5.6.2 Digitalization in process industry

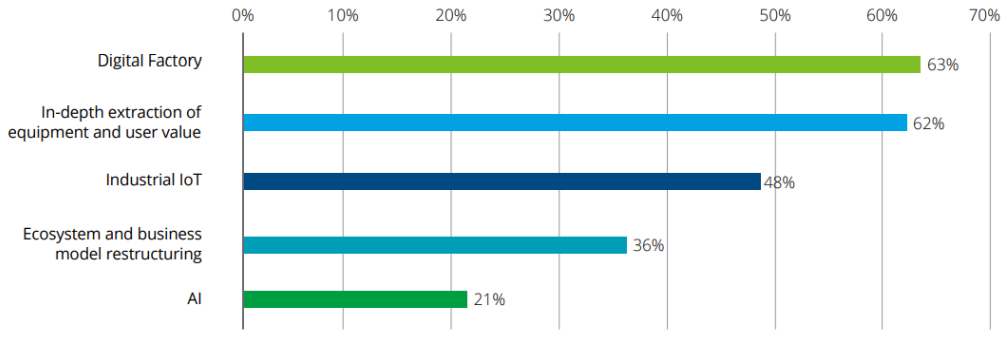
China has the most active digital-investment and start-up ecosystems in the world, especially in big data, AI, and fintech. Such digitalization transformation will continue to reshape the Chinese economy by improving efficiency, boosting productivity, and upgrading industries.

Smart manufacturing

Driven by a series of favorable policies such as the ''Intelligent Manufacturing Development Plan (2016–2020)'' and MIC 2025 the smart manufacturing industry in China is well positioned to accelerate its growth in the future. The revenue of smart manufacturing industry rose from CNY 838.4 billion in 2012 to CNY 1,450.0 billion in 2016, representing a CAGR of 14.7 percent, and is expected to grow to CNY 3,668.4 billion in 2021 at a CAGR of 20.4 percent from 2016 to 2021.

According to the ''Intelligent Manufacturing Development Plan (2016–2020)'', the smart manufacturing industry will develop at least 60 major technologies by 2020, among which the development of smart testing and assembling is one of the eight key major technologies that will be emphasized in this period. As precision 3D testing and precision machining represent a key technology

Fig. 5.6.2-1 Focus of smart manufacturing deployment



Source: Deloittte smart manufacturing enterprise survey 2018

breakthrough, the precision 3D testing and precision machining solutions market has a promising future as smart manufacturing continues to grow in application.

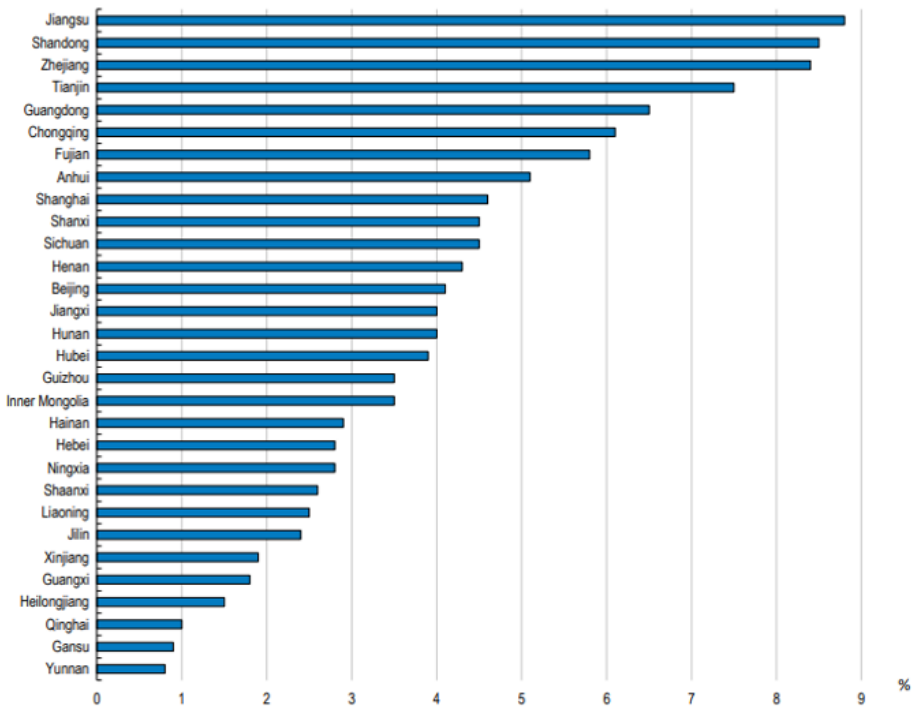
In 2018, 78.1 percent of large-scale steel companies in China adopted digital control systems in key production procedures, which was 28.7 percentage points higher than the national average, and 19.9 percent of them were ready to realize smart manufacturing, 12.9 percentage points higher than the national average, according to a recent report from China Industrial Control Systems Cyber Emergency Response Team and the Contemporary Service Alliance for Integration of Informatization and Industrialization.

Currently, a lot of state-owned companies, such as China Baowu Steel Group, are taking the lead in adoption of smart manufacturing, because they are more willing to invest in related equipment and technologies to increase productivity and reduce carbon emissions, in pursuit of high-quality development as a positive response to the national agenda. The private sector is also now more willing to spend money on smart manufacturing upgrades, because they have become aware of the ample returns on such investment, as smart technologies will bring about higher efficiency, lower costs and increased profitability. It is estimated that the domestic smart manufacturing market will exceed 220 billion yuan (US$ 31.78 billion) by 2020.

Since 2015, the MIIT has announced four batches of pilot smart manufacturing projects nationwide, nine steel projects, and two Aluminum alloy projects from CHALCO had been selected. China has already built up more than 200 digital smart factories. Digital Factory is the first consideration in Chinese smart manufacturing deployment.

So far, China has formed four major smart manufacturing clusters, including the Yangtze River Delta, the Bohai Rim, the Pearl River Delta and the Midwest region. In addition to regional clusters, China

Fig. 5.6.2-2 China regional smart manufacturing development (The share of smart manufacturing firms in total)



Note: A manufacturer is "smart" if over 50% of its key processes are digitalised, management and control and production and sales are integrated, is in the process of upgrading integration or introducing path-breaking innovation.

Source: China Info 100, China Digital Economy Development Report 2018

has more than 40 robotics-focused industrial parks throughout the country. Robotics-focused industrial parks benefit from government resources and incentives to promote the industry.

Big data

Big data developed very quickly in China, but more rapidly on the market and service sectors than in the industrial sectors. In many Chinese city municipalities, a new department called "Big Data Bureau" had been founded up, normally under the local IIT Committee system, in responsible of collecting, managing the developing of big data, which is considered as a kind of new valuable resource of the society. Digital city, e-government and City Brain practice were also introduced into these cities.

In May 2020, MIIT issued the document "Guidelines for the Development of Industrial Big Data", which will significantly promote the industrial big data development in the future. Digital platform will play an important role in it.

Digital platform

Digital platforms in the manufacturing sector are considered crucial to upgrade industry, improve productivity, optimize resource allocation and increase employment. With MIIT's document of "Guiding Opinions on Developing the industrial internet by Deepening "Internet+ Advanced Manufacturing'", they set goals for the year 2020, which include: one leading global digital industrial platform, 10 cross-sectoral platforms, the first cohort of company-level platforms to promote corporate digitalization (数字化), connectedness (网络化) and "smartification" (智能化).

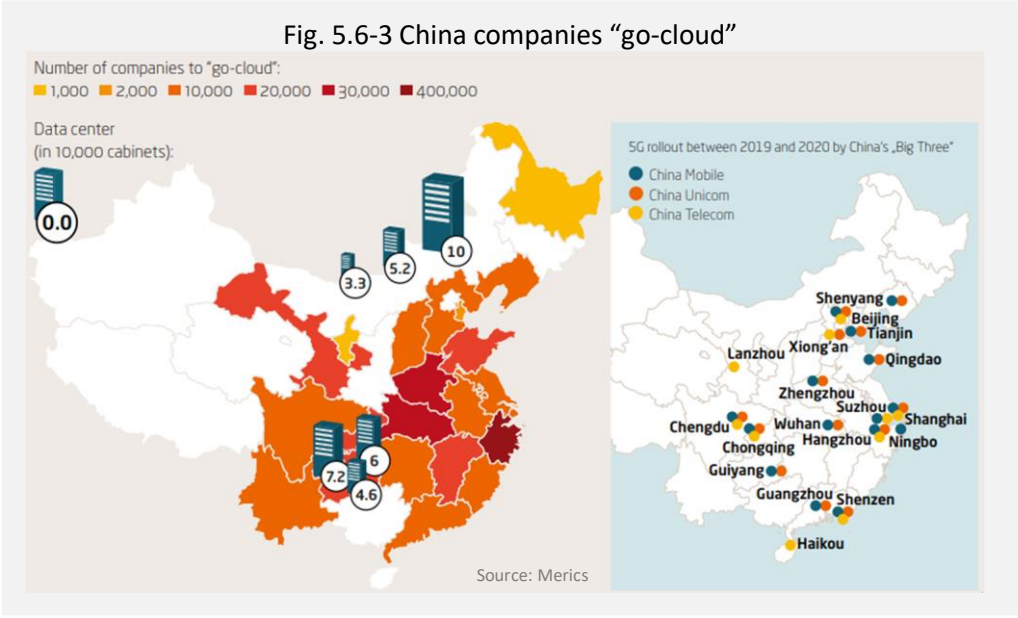
China's promotion of the digital platform economy sits within an ecosystem of major policy initiatives, Internet+, Made in China 2025 and China Standards 2035, an effort to standardize cutting-edge technologies, e.g. AI, cloud computing, IoT and big data. The digital platform drive combines corporate initiatives from China's internet giants with the state-led push to integrate traditional industries using advanced information and communication technology (ICT).

In June 2019, the State-Owned Assets Supervision and Administration Commission (SASAC) unveiled the Industrial Internet Convergence Platform for Centrally Administered State-owned Enterprises. The platform exists to promote resource sharing and overall industrial upgrading. It was carried out by 289 SOEs, with China Aerospace Science and Industry Corporation (CASIC) as the lead developer.

Cloud technology

Chinese governments have set specific targets for the number of companies "to go cloud" (上云).

Fig. 5.6-3 China companies "go-cloud"



The most ambitious provinces are not located in the comparatively well-developed coastal region of China, but notably further inland (e.g. Henan, Hubei, Chongqing and Guizhou). The regional push for cloud-connected companies seems to align with current efforts to build large data centers in Guizhou province and parts of Sichuan. In contrast, China's 5G development, a key enabler of the digital industrial platforms, centers on big cities in coastal areas.
With the help of Huawei, Alibaba, the MIIT and several research institutes, Petrochemical Yingke (Sinopec Group) launched the ProMACE industrial cloud platform to support digital transformation in China's petrochemical industry.

Robot

According to the International Federation of Robotics (IFR), China has had the most industrial robots in operation globally since 2016. By 2020, China is expected to produce 150,000 industrial robot units and have 950,300 industrial robots in operation.

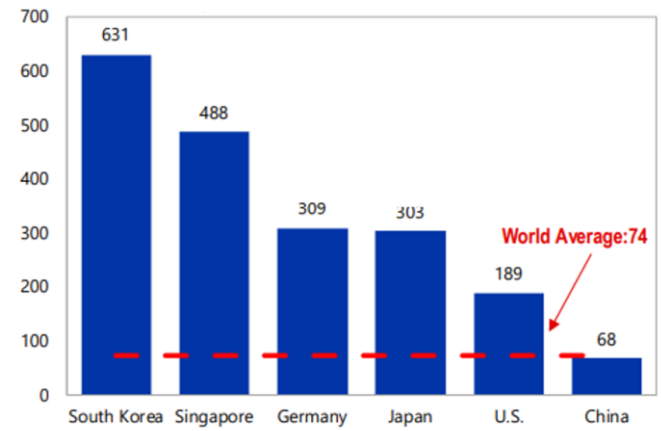
by the end of 2017, there were over 6,500 companies relating to robotics. Major Chinese robotics players include SIASUN and DJI Innovations. The main applications of industrial robots in China are in the following sectors: automobile manufacturing, electrical and electronics, rubber plastics, metallurgy, food, chemical engineering, and medicine and cosmetics. 50 percent of industrial robots are used in automobile manufacturing, of which more than 50 percent are welding robots.

In 2016, MIIT launched the Robotics Industry Development Plan (2016-2020) to promote robot applications to a wider range of fields and to attract foreign investment, aiming to make 100,000 industrial robots produced by domestic technology annually by 2020. China's industrial robot market was worth an estimated US$ 4.22 billion in 2017. By 2020, it is expected to reach US$ 5.89 billion.

Although China has had the most industrial robots in operation globally since 2016, its robot density is below the global average, with only 68 units per 10,000 workers. Furthermore, most of the demand for robots in China is from international firms, and domestic producers are reliant on foreign technology.

Digitalization will likely result in industrial job losses going forward, but the overall impact on employment is likely to be contained. China's current robot intensity in the industrial sector is 5 percent, compared to 18 percent in the U.S. and 60 percent in Korea. Automation will continue replacing low-skilled workers as China goes through industrial upgrading. Yet China is well placed to handle such shocks, as the shift towards the services sector is expected to create millions of new jobs. If industrial workers could be trained and work in services, overall employment would remain robust, despite an expected slowdown in employment growth rate to below 0.1 percent. In addition, the shrinking working age population will limit labor supply, and contribute to a tight labor market.

Fig 5.6.2-4 Major Economy Robotic Density (number of installed industrial robots per 10,000 employees in Manufacturing industry), 2016

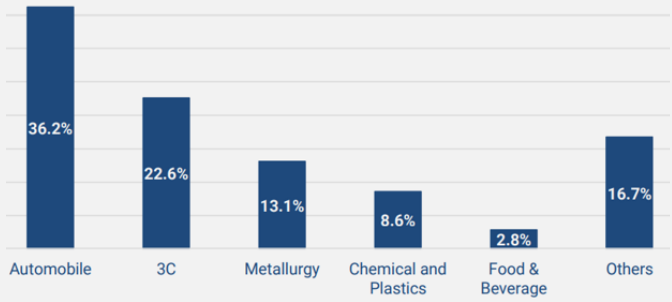


Source: International Federation of Robotics

Most market demand of robots in China is for industrial robots. Service robots show good potential in China's market since many families accept household robots. Service robots operate semi- or fully autonomously, to perform services useful to the well-being of humans, they usually include household/domestic robots, medical service robots and public service robots. There are also specialized robots, which are purpose-built for a specific task, such as working in high-risk environment. They generally include military robots, emergency rescue robots, etc.

Industrial robots used for manufacturing include welding robots, transport robots, palletizers, packaging robots, painting robots, cutting robots, and more. China is the largest market in the world for industrial robots. Along with the economic growth and currency appreciation in China, the production costs have increased significantly. High labor costs encourage factories to seek cheaper substitutions; and industrial robots are no doubt their primary choice. Productivity Cooperation between industrial robots and workers can yield unprecedented productivity. High efficiency brought by machines optimizes the manufacturing procedure, leading to an automated production line. Precision and quality modern industrial products face increasingly strict requirements for precision and quality. However, such high expectations can be hardly met by human workers. For instance, cleaning technology brought by industrial robots is critical to product purity for buyers in the chemical industry.

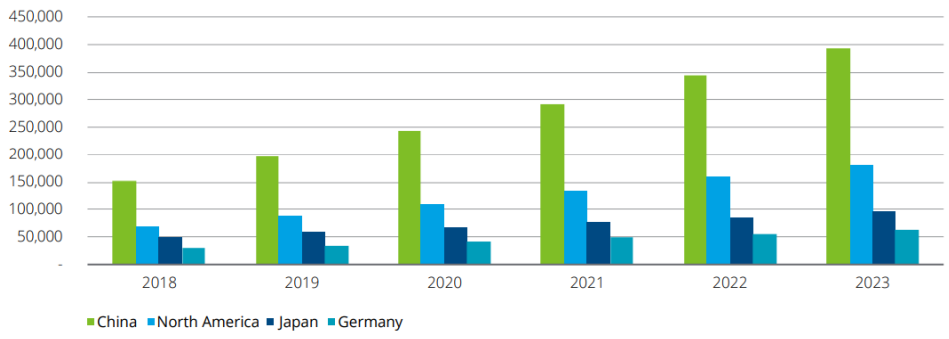
Fig 5.6.2-5 Main Buyer of Industrial Robots in China (2018)



Source: The AI ecosystem in China 2020

To remain globally competitive, Chinese manufacturers must continue to boost productivity and flexibility, and move up the industrial value chain with higher-tech, innovative products. In large manufacturing companies in several industries in the Pearl River Delta, for example, in addition to rising wages, their major concerns relate primarily to challenges in meeting fast-changing downstream demand. The companies' antiquated demand-planning systems and old, inflexible production lines left them with high inventories and low return on investment. The southern Chinese manufacturers said they see investment in Industry 4.0 manufacturing technologies, with smart robots and advanced planning systems, as an opportunity to improve flexibility and productivity.

Fig. 5.6.2-6 Industrial robot sales in major global markets



Source: IFR, Deloitte Research

5.7 Circular economy

5.7.1. Policy, plan and mandates

The top leaders of China have long been calling for circular economy at the political level. As early as in 2005, the State Council has given opinions on the development of circular economy with focus on improving energy efficiency in the production of energy, ferrous and non-ferrous, non-metal minerals etc. Utilization of recycled copper, aluminum and lead were specially targeted. In addition, industrial waste recycling, municipal solid waste handling, water saving in agriculture and industry are also been pointed out as focuses with specific goals.

The *Master Plan of Industry Transformation and Upgrading* promulgated by the State Council in the end of 2011 has provided general guidelines for prioritized tasks, directions of technology innovation and specific goals.

In 2013, the State Council issued a national development strategy for circular economy and action plan which further emphasized its importance in developing China's national economy.

The national strategy of developing circular economy has been materialized in industry policies for all the process industries such as coal production, power generation, iron and steel, non-ferrous metals, petroleum and petrochemical industry, chemical industry, building materials, pulp and paper, food production and textile etc.

Circular economy development in the process industry boils down to comprehensive technology solutions in energy and water saving, reduction of raw materials, recycling and reclamation mechanism as well as phasing out outdated capacity.

Industrial parks are important vehicles of implementing circular economy solutions. Demonstration projects of upgrading industrial parks based on circular economy concept are initiated and financed to showcase the social and economic advantages of adopting circular economy in regional development plans.

To support the development of circular economy nationwide, A special funding from central government budget are allocated to finance key projects, technology demonstration and promotion, capacity building and other relevant programs to facilitate the implementation of circular economy solutions in respective industries. The funding is mainly used in following aspects:

- "Urban mines" project-recycling and reclamation of iron and steel, non-ferrous metals, precious metals, plastic and rubber, glass etc. from scrapped and used products
- Bio-wastes reclamation and decontamination
- Demonstration projects of transformation of industrial parks using circular economy solutions
- Re-producing projects focusing on technologies, collecting systems and industrialization and promoting of re-produced products
- Demonstration and promotion of clean production technologies
- Capacity building programs (policy-making studies, standards, promotion and mobilizing, information system that facilitate the circular economy administrations, methodologies of assessment and verifications)

In addition to the special funding support, the government also prioritized the financing support to circular economy solutions on resource reduction, recycling and reclamation. Commercial banks, equity funds and other financial institutions are encouraged to offer supportive financial services to enterprises engaging in circular economy. Preferential policies and practices include loans, bonds, funds and IPO arrangements.

Circular economy projects with foreign loans are welcomed. The government is active in supporting projects applying and using loans from International financial institutions and foreign governments. The support in applying Clean Development Mechanism (CDM) projects are also prioritized.

5.7.2. Laws and regulations

To safeguard the national strategy of developing circular economy, China's central government has made a handful of laws concerning environment protection, clean production and circular economy development since a two decades ago. Many of these laws and regulations were subject to revision and amendment to suit the rapid social and economic development of China. The legal framework supporting circular economy in China has been well established.

- **Circular Economy Promotion Law of the People's Republic of China**
  (Order No. 16 of the President of the People's Republic of China)
  Effective October 26, 2018. Revised based on the previous law promulgated in 2008.
- **Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste**
  (Order No. 43 of the President of the People's Republic of China)
  Effective September 1, 2020. Revised and amended based on the previous law promulgated in 1995, 2004, 2013 and 2015
- **Environmental Protection Law of the People's Republic of China**
  (Order No. 9 of the President of the People's Republic of China)
  Effective January 1, 2015. Revised based on the previous law promulgated in 1989.
- **Marine Environment Protection Law of the People's Republic of China**
  (Order No. 81 of the President of the People's Republic of China)
  Effective November 5, 2017. Revised and amended based on the previous law promulgated in 1982, 1999, 2013, 2016 and 2017
- **Law of the People's Republic of China on Promotion of Clean Production**
  (Order No. 54 of the President of the People's Republic of China)
  Effective July 1, 2012. Revised based on the previous law promulgated in 2002
- **Law of the People's Republic of China on Prevention and Control of Water Pollution**
  (Order No. 70 of the President of the People's Republic of China)
  Effective January 1, 2018. Revised and amended based on the previous law promulgated in 1984, 1996 and 2008
- **Law of the People's Republic of China on Energy Conservation**
  (Order No. 16 of the President of the People's Republic of China)
  Effective October 26, 2018. Revised and amended based on the previous law promulgated in 1997, 2007 and 2016
- **Renewable Energy Law of the People's Republic of China**
  (Order No. 23 of the President of the People's Republic of China)
  Effective April 1, 2010. Revised from the previous law promulgated in 2005
- **Law of the People's Republic of China on Environmental Impact Assessment**
  (Order No. 24 of the President of the People's Republic of China)
  Effective December 29, 2018. Revised from the previous law promulgated in 2002, 2016
- **Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution**
  (Order No. 16 of the President of the People's Republic of China)
  Effective October 26, 2018. Revised from the previous law promulgated in 1987, 1995, 2000 and 2015
- **Mineral Resources Law of the People's Republic of China**
  (Order No. 36 of the President of the People's Republic of China)
  Effective Date: September 1, 2009. Revised and amended based on the previous law promulgated in 1986 and 1996.

6. Made in China 2025

6.1 Made in China 2025

The background

The Chinese State Council promulgated the masterplan of Made in China 2025 [Guo Fa (2015]No. 28] on August 5, 2015 which was effective on the same day. It is the first Ten-Year Action Plan for implementing China's strategy of becoming the world superpower of manufacturing.

Through the rapid development for several decades, the scale of manufacturing industry in China has leaped to the first place in the world, formed an independent and complete industrial system covering extensive fields, and become the important foundation for supporting the economic and social development of China.

The constant technological innovation has greatly raised the comprehensive competitiveness of the manufacturing industry in China. The technology breakthroughs in several key areas has strengthened Chinese companies' international competitiveness in recent years. These areas include manned spaceflight and deep-sea vehicle, large aircraft, the Beidou satellite navigation system, super-computing, high-speed train, million-kilowatt power generation system, deep-sea oil drilling etc.

However, Chinese authorities saw that the manufacturing industry is still in the early phase of modern industrialization. The capability for independent innovation is still rather weak and many core technologies and high-end equipment have high dependence on foreign suppliers. Comparing with advanced industrial countries in the world, Chinese products are not high in grade and lack of world-famous brands. The efficiency of utilization of resources and energies is low and there are prominent problems of environmental pollution. The industrial structure is not rational and the development of high-end equipment manufacturing lags. The digitalization and its integration with industrialization is insufficiently in depth. Internationalization of the manufacturing industry is not high enough and enterprises lack sufficient capacity for global operation. Chinese policy makers tried to confront these challenges of manufacturing industry with a comprehensive and strategical masterplan of Made in China 2025 which interlinked various industrial policies. The optimal goal is turning China into a "manufacturing superpower."

The strategic objectives

Made in China 2025 is strongly inspired by Germany's Industry 4.0 strategy initially and is a top-down strategy for China's economic and industrial modernization. It integrates a great number of previously largely uncoordinated efforts to promote smart manufacturing. On this basis, the long-term plan looks far into the future, boldly and ambitiously outlining China's technological development path until 2049, with 2025 merely representing an intermediary step. (Merics report: Made in China 2025)

Step 1: Striving to enter the manufacturing powerhouse in ten years. By 2020, industrialization shall be basically realized, the status of a manufacturing power shall be further solidified, and the level of information technology in manufacturing industry shall be greatly raised. A batch of key and core technologies in key fields shall be grasped, the competitiveness of advantageous fields shall be further enhanced, and the quality of products shall be greatly improved. Significant progress shall be made in the digital, networked and intelligent manufacturing. There shall be obvious decrease in the energy consumption, material consumption and pollutant discharge per unit of industrial added value in major industries.

By 2025, the overall quality of manufacturing industry shall be greatly raised, the innovation capacity shall be obviously increased, overall labor productivity shall be greatly raised and the integration of industrialization and informatization shall reach a new stage. The energy consumption, material consumption and pollutant discharge per unit of industrial added value in major industries shall reach the world's advanced level. A batch of multi-national companies and industrial clusters with strong

international competitiveness shall be formed and the status in the global industrial division of labor and the value chain shall be raised obviously (Table 6.1-1).

Step 2: By 2035, the manufacturing industry in China shall reach the intermediate level of the world's manufacturing powerhouse as a whole. Innovation capacity shall be greatly raised, there shall be significant breakthrough in the development of major fields, the overall competitiveness shall be enhanced obviously, the capability for guiding the global innovation in advantageous industries shall be formed and industrialization shall be realized as a whole.

Step 3: By the 100th anniversary of new China, the status of China as a manufacturing power shall be further solidified and it shall rank among the top of the world's manufacturing powerhouse in terms of comprehensive strength. The main sectors of manufacturing industry shall have the innovation-leading capability and obvious competition advantage and the world's leading technology and industry systems shall be established.

Table 6.1-1 The main targets of Made in China 2025

Category	Indicators	2013	2015	2020	2025
Innovation Capacity	Share of R&D spending of operating revenue[1] (in %)	0.88	0.95	1.26	1.68
	Invention patents per 100 million CNY total revenue[2](item)	0.36	0.44	0.70	1.10
Quality efficiency	Quality competitiveness index[3]	83.1	83.5	84.5	85.5
	Increase of rate of added value (in % compared to 2015)	-	-	+2	+4
	Productivity growth (in %, annual average)	-	-	About 7.5	About 6.5
integration of industrialization and informatization (digitalization)	Broadband internet penetration[4](%)	37	50	70	82
	Use of digital design tools in R&D[5] (penetration in %)	52	58	72	84
	Use of numerical control machines in key production process (penetration in %)	27	33	50	64
Environmental protection and Green development	Decrease in industrial energy intensity (in % compared to 2015)	-	-	-18	-34
	Decrease in CO_2 emission intensity (in % compared to 2015)	-	-	-22	-40
	Decrease in water usage intensity (in % compared to 2015)	-	-	-23	-41
	Reuse of solid industrial waste (in % of total waste)	62	65	73	79

Notes:
1. This indicator is set for "manufacturing enterprises above designed scale"-a term used in national statistical system which refers to companies with annual turnover above 20 million yuan.
2. This indicator is calculated as the number of the effective patents divided by the revenues from main business activities. It is also set for companies with revenue of 20 million yuan or above.
3. The index is an accumulated indicator based on data from 250,000 enterprises. It is to reflect the overall quality level of the manufacturing industry in China and is based on the 12 specific indicators covering the quality level and development capacity.
4. Broadband internet penetration is represented by the figure of fixed broadband penetration of families which is calculated as: Fixed broadband internet family users/Number of the families.
5. It is set for companies with annual turnover above 20 million yuan and is calculated as: Number of the enterprises use digital design tools in R&D/total number of the enterprises. (relevant data is derived from 30,000 sample enterprises).

Source: Notice of the State Council on Made in China 2025

Key technologies targeted by Made in China 2025

Above goals apply in particular to ten high-tech industries such as the automotive industry and energy equipment. Besides smart manufacturing, Made in China 2025 also includes provisions on innovation in manufacturing, product quality management and sustainable production.

Strategic priorities

Made in China 2025 emphases indigenous innovations and overall industrial development in the process of upgrading its manufacturing industry. Nine strategic priorities were set as guidelines and some with measurable targets.

1) **Innovation capacity of manufacturing industry on the national level:**
   a) To establish 15 manufacturing innovation centers (industrial technology research bases) by 2020.
   b) To increase the number to around 40 by 2025.
2) **In-depth integration of informatization and industrialization:**
   a) By 2020, great improvements of smart production are expected. For pilot and demonstration projects in the key areas of manufacturing industry, the target is to achieve 30 percent less operation cost, 30 percent shortened production cycle of products and 30 percent lowered rate of defective products.
   b) By 2025, 50 percent comparison targets were set in operating costs, production cycle and rate of defective products.
3) **Basic capabilities of the industry:**
   a) The "Four Basic" bottlenecks: basic parts and components, basic technological process, basic materials and basic industrial technologies.
   b) By 2020, achieving self-sufficiency of 40 percent core basic parts and components and key basic materials.
   c) By 2025, achieving self-sufficiency of 70 percent core basic parts and components and key basic materials.
4) **Product quality and brand building.**
5) **Promoting green manufacturing:**
   a) By 2020, 1000 green demonstration factories and 100 green demonstration parks established; energy consumption in some heavy chemical industries shall show inflection point; the emission intensity of main pollutants in key industries decrease by 20 percent.
   b) By 2025, the green manufacturing system shall be basically established; energy consumption of main products of manufacturing industry comparable with global advanced level.
6) **Breakthrough in key technological areas (Table 6.2-2).**
7) **Structural adjustment of manufacturing industry.**
8) **Service-oriented manufacturing and service providers for manufacturers.**
9) **Internationalization of manufacturing industry.**

Table 6.1-2 Key technologies targeted by Made in China 2025	
1.	New generation information technology
2.	High-end computerized machines and robots
3.	Space and aviation
4.	Maritime equipment and high-tech ships
5.	Advanced railway transportation equipment
6.	New energy and energy-saving vehicles
7.	Energy equipment
8.	Agricultural machines
9.	New materials
10.	Biopharma and high-tech medical devices

6.2 The 13th Five-Year Plan (2016-2020)

China's national Five-Year Plans (FYP) are a series of social and economic development initiatives issued by the central government of China. The first FYP was started from 1953 to 1957. Planning is a key characteristic of socialist economies, and one plan established for the entire country normally contains detailed economic development guidelines for all its regions. Starting the 11th FYP (2006-2010), this master program is considered more like a guideline instead of plan in the sense of "planning economy". However, the Party still plays a leading role in establishing the foundations and principles of Chinese communism, mapping strategies for economic development, setting growth targets, and launching reforms.

The national FYPs are published by the National People's Congress (NPC), the highest state organ of power in China. The national FYPs are masterplans of economy and social development with a time interval of five years. Major national development goals and targets (indicators, refer to Table 6.2-1) were set either as "mandatory" or "non-binding" depending on their nature

These indicators are not necessarily consistent through the making of all the FYPs in the past decades. Many of those were fine-tuned, modified or removed to reflect the key principles of the up-coming, forward-looking national strategies, seeing from the perspective of NPC-the top legislative body of China. Some new measurable targets were set up in the 13th FYP comparing with the 12th FYP indicating new and detailed priorities in the time period of 2016-2020.

National innovation, energy-saving and environment protection, social equality and poverty alleviation were highlighted priorities with specific goals to achieve by the end of 13th FYP (in the year if 2020, refer to Table 6.2-2).

Guided by the national 13th FYP, central government bodies in charge of various social and economic development plans are entitled to issue their specific 13th FYPs within their respective responsibilities. Many of these FYPs were jointed made and published by several ministries and authorized organizations under the State Council due to shared (or overlapped) responsibilities of them. An incomplete list of these FYPs is shown below (Table 6.2-3).

Local government bodies at provincial, municipality or county levels will make more specific FYPs with reginal priorities in accordance with the national FYP for the specific industrial sectors or mandates. Local conditions such as resources, infrastructure, industry clusters, level of education of the labor force, regional environment challenges etc. must be considered in the making of local FYPs. Most developed regions of China will make ambitious plans based on local development conditions in which, seeing from the eyes of less developed parts of China, the plans were far beyond reach. Regional differences of social and economic development result in different priorities and implementation plans of the "rich" and "poor" authorities. Yet the local level 13th FYPs must be coordinated in accordance with the principles of the national 13th FYP.

Shanghai municipal government's 13th FYP on the "Transformation and Upgrading of Manufacturing Industry" issued on June 30, 2016 has shown its ambition of pioneering in industry innovation and digitalization in China and keeping up its leading positions in most advanced R&D fields critical to the process industry. Nine sectors of the Shanghai manufacturing industry were prioritized. They are:

1) Next generation information technology (including integrated circuits (IC), next-generation network (NGN, 5G, VR&AR etc), automotive electronics, new display technologies, satellite applications and positioning & tracking services, software)
2) Smart production equipment (industry internet, AI, industry big data, robot, high-end CNC and specialized processing equipment, additive manufacturing (3D printing), sensor control etc.)
3) Biomedicine and high-end medical devices

4) New energy and intelligent vehicles based on Internet of Things (IoT), inter-connecting technology, fuel cell technology and electric control systems
5) Aerospace industry
6) Offshore engineering equipment
7) High-end energy production equipment (nuclear power, gas power system, smart grid, distributed power systems, highly efficient clean coal power generation, wind power and solar power system etc.)
8) New materials (graphene, a new generation of biomedical materials, special optical fiber materials, 3D printing materials, high-temperature superconducting material, artificial crystals, functional ceramics, silicon carbide (SiC), gallium nitride (GaN), high-power laser glass, organic chemical materials, ultra-high-strength automotive steel, high-grade silicon steel, large-size circuit-grade silicon and silicon wafers, modified plastics, rare earths permanent magnet materials and other new materials with certain basic and scale advantages)
9) Energy saving and environment protection sector

As the process industry concerned generally, the industry organizations and large state-owned enterprises will have to make detailed implementation FYPs in order to contribute to the realization of the regional and national FYPs with various tasks, following the guidelines of central and local authorities. Energy-saving, emission control, innovation, green production are the key words in the industry policies implemented aiming to achieve respective and inter-related indicators of the national 13th FYP.

Table 6.2-1 Main goals and targets of the National 13th FYP for Economy and Social Development

Indicators	**12th FYP goals, by 2015**	**12th FYP achieved by 2015**	**13th FYP goals, by 2020**
Economic development			
GDP (trillion yuan) and growth rate	7%, annually	67.7%, average annual increase of 7.8%	>92.7, with average annual increase above 6.5%
Ratio of added value of tertiary industry	47%	50.5%	56%
Urbanization rate	51.5%	56.1%	60%
Science, Technology and Education			
9-year compulsory education completion rate	93%	93%	-
High school enrollment rate	87%	87%	-
R&D expenditure/GDP ratio	2.2%	2.1%	-
No. of invention patents per 10,000 people	**3.3**	**6.3**	**12**
Resource and Environment			
Farmland maintained bn. Chinese *mu* (=1/15 ha)	1.818	1.865	1.865
Water reduced per industry added value	-30%	-35%	A new indicator, water usage reduction per 10000 GDP is introduced. The target: -23%
Irrigation water coefficient	0.53	0.532	
Ratio of consumption of non-fossil fuels in primary energy	**11.4%**	**12%**	**15%**
Reduced energy consumption per GDP	**-16%**	**-18.2%**	**-15%**

Reduced CO_2 emission per GDP	**-17%**	**-20%**	**-18%**
Reduction rate of total main pollutants: **COD** **SO_2** **Ammonia** **NOx**	 **-8%** **-8%** **-10%** **-10%**	 **-12.9%** **-18%** **-13%** **-18.6%**	 **-10%** **-15%** **-10%** **-15%**
Forest Growth: -Coverage rate -Forest stock (bn m^3)	 21.66% 14.3	 21.66% 15.1	 23.04% 16.5
Livelihood and well-being of the people			
Urban residents' average disposable income (CNY)	>7%, annually	>7.7%, annually	>6.5%, annually for all residents (urban and rural)
Rural residents' average net income (CNY)	>7%, annually	>9.6%, annually	
Urban registered unemployment rate	<5%, annually	4.05%, annually	-
Urban new jobs accumulated	45 million	64 million	>50 million
Urban residents with basic pension scheme	357 million	377 million	90% for all nationals
Three basic social medical insurance penetration	3%	>3%	-
Government subsidized housing for urban low-income residents (number of apartment)	36 million	40 million	-
Total population (bn)	<1.39	1.375	-
Average life expectancy	74.5 years	76.34 years	77 years

Table 6.2-2 Additional indicators in the National 13th FYP

Indicators	**Status of 2015**	**13th FYP goals, by 2020**
Economic development		
Overall productivity (10,000 yuan/person)	8.7	>12%
Driving forces of Innovation (formal category of science, technology and education)		
R&D expenditure intensity	2.1%	2.5%
Contribution of science & technology advancement	55.3%	60%
Internet penetration: -Fixed broadband(household) -Mobile broadband subscribers	 40% 57%	 70% 85%
Resource and environment		
Additional land usage for construction (million Chinese *mu*, equals 1/15 ha.)	-	<32.56
Air quality-percentage of index with good and fine in major cities	76.7%	>80%
Air quality-decreased density of PM2.5 in major cities which did not reach the standards	-	-18% (decrease of 18%)
Surface water quality-Percentage of Level III and better	66%	>70%
Surface water quality-Percentage of Level V and worse	9.7%	<5%

Livelihood and well-being of the people		
Average years of education of labor force	10.23	10.8
Number of people in rural areas supported by poverty alleviation program	-	55.75 million
Re-build housing of urban run-down areas (number of apartments)	-	20 million

Table 6.2-3 Some examples of 13th FYPs aiming for special fields and tasks

The 13th FYP for specific fields	Date of issue	Issued by (org. abbrev. shown in Table 6.2-4.)
National Basic Research Programs	May 31, 2017	MOST, MOE, CAS, NSFC
National Science, Technology and Innovation Programs	July 28, 2016	The State Council
National Key Science and Technology Infrastructure Programs	Dec. 23, 2016	NDRC, MOE, MOST, MOF, CAS, CAE, NSFC, SASTIND, EDD-CMC
National Strategic and Emerging Industries Development Programs	Nov. 29, 2016	The State Council
National Informationization (digitalization) Program	Dec. 15, 2016	The State Council
National Intellectual Property Protection and Utilization Program	Dec. 30, 2016	The State Council
National ecological environment protection plan	Nov. 24, 2016	The State Council
Working plan for Greenhouse Gas Emission Control	Oct. 27, 2016	The State Council
Comprehensive working plan for Energy-saving and Emission Control	Dec. 20, 2016	The State Council
Science and Technology Program for climate Change	Apr. 27, 2017	MOST, MEE, CMA
Coordinating and carrying out 165 major engineering projects in 13th FYP period	Apr. 18, 2017	NDRC
National Energy Development Plan	Dec. 26, 2016	NDRC, NEA
Renewable Energy Development Plan	Dec. 10, 2016	NDRC
Innovation Plan for energy sector	Dec. 30, 2016	NDRC

Table 6.2-4 Major central government bodies involved in FYPs

Abbreviations	Chinese Government bodies and authorized organizations by the State Council	Websites
NPC	The National People's Congress	http://www.npc.gov.cn/
	The State Council	http://english.www.gov.cn/
MOE	Ministry of Education	http://www.moe.gov.cn/
MOST	Ministry of Science and Technology	http://www.most.gov.cn/
CAS	Chinese Academy of Science	http://english.cas.cn/
NSFC	National Natural Science Foundation of China	http://www.nsfc.gov.cn/english/site_1/index.html
NDRC	National Development and Reform Commission	https://en.ndrc.gov.cn/
CAE	Chinese Academy of Engineering	http://en.cae.cn/en/
MOF	Ministry of Finance	http://www.mof.gov.cn/index.htm
SASTIND	State Administration of Science, Technology and Industry for National Defense	http://www.sastind.gov.cn/
EDD-CMC/MOD	Equipment Development Dept. of Central Military Commission/Ministry of National Defense	http://eng.mod.gov.cn/
NEA	National Energy Administration	http://www.nea.gov.cn/

MEE	Ministry of Ecology and Environment	http://english.mee.gov.cn/
CMA	China Meteorological Administration	http://www.cma.gov.cn/

6.3. From Made in China to Create in China

In 2015, the Chinese central government announced two actional plans, i.e. “Made in China 2025” and “Internet+” in the government work report. “Made in China 2025” aimed to upgrade manufacturing industries towards more market-oriented and higher value-adding driving force for the long-term economy growth. While “Internet+” is considered mostly relevant to the tertiary industry and some emerging business sectors such as software and e-commerce.

According to the 2020 Statistical Report on Internet Development in China by China Internet Network Information Center (CNNIC), the Internet infrastructure and Internet penetration have provided solid foundation for advanced applications such as e-banking, online shopping and payments, travel booking, food ordering, car-hailing etc. Public and social services are greatly improved with the popularity of APPs for education, music and literature as well as searching engine services powered by artificial intelligence, voice and facial recognition technologies etc.

Table 6.3-1 Main indicators extracted from China Internet Development Statistic Report 2020

Total internet users	904 million
Internet Penetration	65%
Access internet with fixed line bandwidth above 100Mbps	85%
User internet access with mobile phone	99%
Users access internet with PC and laptop	78%
Average online time per week	30 hours
Time spent on instant messaging APPs	15%
Percentage of .cn domain names	44%
Percentage of .com domain names	29%
Number of websites in China	4.97 million
Number of APPs in Chinese market	3.67 million
APPs available in Apple store (China)	1.5 million
Share of e-commerce APPs in all stores	11%

Source: China Internet Development Statistic Report 2020

According to MIIT at the latest press conference in September, China has implemented more than 500,000 5G base stations, connected with more than 100 million 5G terminal devices covering applications in industries, education and medical services.

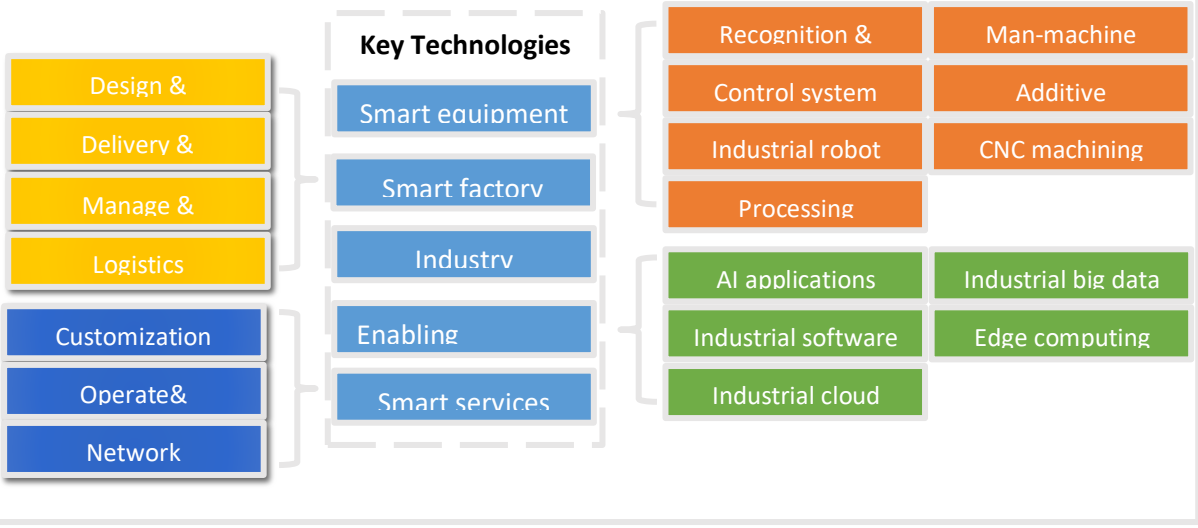
While internet applications impacting on the social life of the general public such as means of acquisition of information and various services, the manufacturing industries have not fully utilized the potential of the improved ICT infrastructure and the new technologies such as big data and machine learning. “Internet+” is the master plan to foster the utilization of the innovations of the “new economy” in order to re-shape the traditional industries by taking the advantages of ICT platforms and the Internet-based business models.

The concept of the convergence of “Made in China 2025” and “Internet+” formulates a road map of China’s economy development pattern from “Made in China” to “Create in China”.

To the great extent, the competitiveness of Chinese manufacturing industry relies on the scale of economy and relative low costs. Imbalanced market mechanism, environment constrains and

disappearing demographic dividend have forced Chinese policy makers to seek solutions of transforming the large but not strong manufacturing industry in order to consolidate the market position in the world.

Fig. 6.3-1 Key technologies



Chinese government has planned to achieve the goal as a strong industrialized nation within 30 years. The ultimate goal is to become a competitive supplier of industrial products as other western countries in the first tier by 2045. “Made in China 2025” is the action plan of the first 10 years (2016-2025) targeting on digitalization, smart production and utilization of resources derived from the internet economy. “Internet+” action plan is supportive to “Made in China 2025” by integrating the manufacturing industry with ICT infrastructures and innovative business models.

Mobile network, cloud computing, big data, Internet of Things will become strong tools when integrating with industrial processes by adding values to traditional business model and forging new competitiveness.

MIIT is one of the key stakeholders in charge of setting up guidelines and implementation plans. In MIIT’s development plan of smart production (2016-2020), key tasks and objectives were made to guide the industry organizations and manufacturing enterprises to gradually materialize the ambitious goal of “Create in China.”

- Breakthroughs in key technologies and critical equipment
  - Fundamental technologies commonly used in smart production sector
  - Core system support software
  - Equipment and machinery R&D for mass productions
- Completed standards for smart production
  - Standardization of smart production system
  - Industrial internet establishment for manufacturing industry
  - Establishing information safety mechanism
- Eco-system formulation;
  - Support the growth of large, competitive system integration suppliers;
  - Establish the talent pool for smart production development;
- Digitalization in key sectors
  - Digitalization in enterprises’ R&D activities
  - Computerized control systems in critical processes
  - Digital workshop and digital factory

The above identified key areas for improvement and upgrading are inter-related with those key technology sectors defined in Made in China 2025. The core concept is to embed digital technologies into traditional manufacture industry in order to improve efficiency and product quality as well as to step in advanced production of more value-added products.

In the government top-level design to safeguard the realization of the action plan of “Create in China,” R&D and innovation are highlighted as the main driving force. The focuses are set on establishing innovation centers for manufacture industries, filling the gaps between basic research and industrial applications and building up common service platforms.

Financial supports are prioritized for national key technology development projects and critical equipment for the manufacturing industry. Preferential tax policies are applied to enterprises engaging in major R&D projects. Import tax deduction or exemption are offered to enterprises when import key components, parts and raw materials which are vital to the success of these R&D projects.

Diversified investments such as industry development funds, venture capitals, equity funds are encouraged by policies to finance the innovation of the manufacturing industry especially SME players.

International cooperation is also encouraged in many areas such as industry standard formulation, intellectual property rights transaction, foreign investment in R&D and talent training facilities, smart production pilot projects etc. Outbound investments such as mergers and acquisitions, equity investment for international R&D and innovation capacities are encouraged options for Chinese manufacturing industry.

China’s vision to become a moderately developed country by the middle of this century is achievable relying on prerequisites of social stability, improvements of public governance, science and technology advancement, innovation and education system and last but not the least, favorable international environment.

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