PROSESS21

Process Industry in China

Future developement and government regulation

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Condensed report

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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

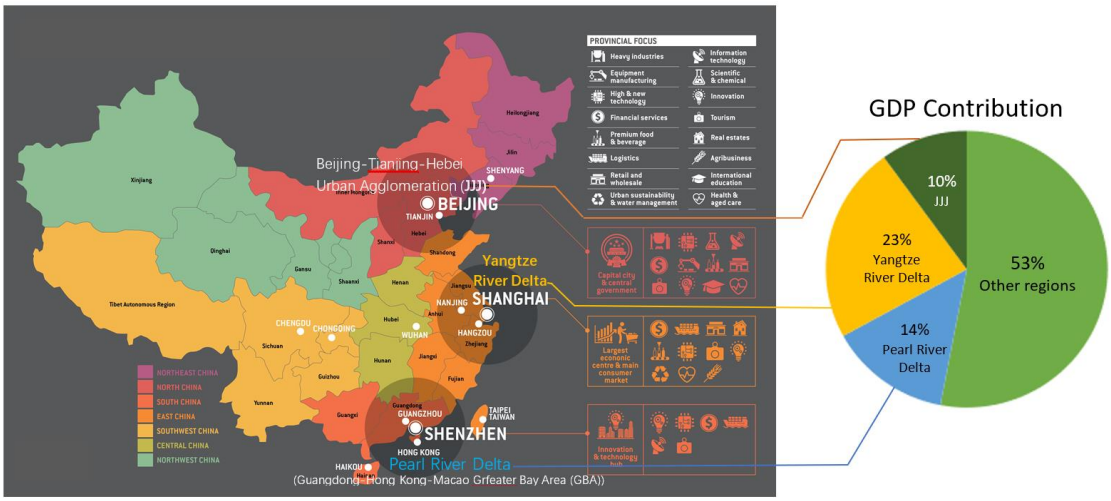
BRI	*Belt and Road Initiative*
CAE	*Chinese Academy of Engineering*
CAI EU	*China Comprehensive Agreement on Investment*
CAS	*Chinese Academy of Sciences*
CBIRC	*China Banking and Insurance Regulatory Commission*
CIIF	*Circuit Industry Investment Fund*
CAGR	*Compound Annual Growth Rate*
CNPC	*China National 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

1.1 Chinese Process Industry brief introduction

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 which the process industry is an important part. Many Chinese process industries rely on import raw materials and export market. In the period of 2013-2017, 21 percent of global mining and quarrying imports went to China vs 7 percent during 2003-2007. China is one of the largest manufacturers and exporters of electronics and textiles in the world.

Fig. 1.1-2 China Economic Focus Map



Source: NSB, IN analysis

The location of Chinese process industry, in many cases, depends on raw material and energy supply, human resources and cost, as well as convenience for transportation. In recent years, the support from local government becomes more and more important due to the pollution control policy. Many Chinese process industries selected to base in three regions: Beijing-Tianjing-Hebei (JJJ), Yangtze river Delta and Great Bay Area for a better international connection and talent human resources. However, the center of Chinese manufacturing gravity is moving to inland, accelerated with the relocation policy from the central government, who is promoting this trend, in order to pull up the economy in the western of China, and reduce the pollution form costal area. NDRC recently published the inquiring draft of "Encourage Catalogue of Industries for the Western China", and more active policy can be expected in the near future. At the other end of the country, the North-East part of China (Heilongjiang, Liaoning and Jilin provinces) where traditional heavy industrial locates, is struggling for their economic development, with population shrinking from their smaller cities and rural areas, now fell into the Rust Belt of this country.

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 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. In recent years, SASAC has been continuously reforming the Central SOEs by strategic integrating.

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. The profit and cost space left by SOEs in different process industries were usually the motivation of private enterprises' decision for entering into the business fields, which as one of reason of production overcapacity.

China's overcapacity problem is a complex issue lasted for fairly long time, which has significant influence on its economy and to the world. The scale of overcapacity in China's process industries such as steel, aluminum and cement highlight the severity of the problem, and became worse after the global financial crisis in 2009. 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. Chinese government issued a series of policy and regulation to control the overcapacity situation, but not succeeded obviously. In the end of 2019, China crude steel production has reached 996.34 million tons, 8.3 percent growth from 2018, and was predicted to over one billion tons in 2020, but the production utilization rate still below 80%.

1.2 Some of the relevant process industries' development

With the rapid development of manufacturing and huge population, China grows into a large market with tremendous import and export. For example, 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, 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. The re-melted aluminum imported 62,000 tons, more or less the same quantity of exports, which is 67,000 tons.

In many process industrial sectors, China has achieved as the largest manufacturer globally. Till the end of 2019, there are about 82 large 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. Since 2015, China had overtaken Japan as the world's largest supplier of EV batteries, with an output of nearly 71 GWh in 2019, up 9.4 percent year-on-year and slowing from 2018. However, China EV and battery industries are also haunted by overcapacity problems, like in many other process industries. 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 unit within 2020, with about 400 billion yuan investment. In the end of 2019, the EV battery manufacturing capacity in China was over 100 GWH.

In recent years, the investments in energy conservation and emission reduction technology has accelerated in China Process industries, as well as in the high-end materials development and equipment upgrading.

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 a result of the relocation policy, the total primary aluminum capacity been transferred into Yunnan province has reached 6.15 million tons/year in the end of 2019, 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 etc. The center gravity of process industry is moving into inland. Another trend of Chinese process industry is their expansion to both upstream and downstream of the value chain, in order to keep a safer position in the competition. Those large companies have the advantage to reduce their operation cost in the whole value chain management.

1.3 Cooperation with Norway

The bilateral co-operations between the two governments of Norway and China have been specially focusing on the climate change and environment protection issues. Norway has been contributing both in capacity building as well as in financial supports to the Chinese counterparts in projects such as hazardous chemical pollutants analysis, emission trade scheme pilots and capacity building projects. The cooperation projects generated satisfactory outcomes which, to some extent, have influenced environmental protection policies and contributed to the technical solutions for China's environment challenges. Recent and ongoing cooperation fields include establishing national ETS registry system, managing hazardous and industrial wastes from cement kilns and capacity building to reduce mercury pollution, just to mention a few examples.

The business to business co-operations in relation to the process industry in the past decades reflected the mutual needs and common interests of industry players of Norway and China. Norwegian exports of advanced manufacturing equipment, processing design and control systems and high value-added end products have entered high-end markets which are usually dominated by suppliers from OECD countries.

Norwegian players and their partners are actively promoting their products and solutions in China, which include but not limit to the following companies: Elkem (microsilica), BecoTek (brass bearing cage), Johnson-Metall (copper alloy parts), Yara (fertilizers and other chemicals), Borregaard (various fine chemicals), Lattix (aluminum alloy frangible structures for passive safety systems), Jotun (painting and coating solutions for buildings and maritime applications), Hydro (aluminum doors & windows), Hycast (metal casting system), Tomra (municipal solid waste handling systems and ocean plastic pollution control projects), Cambi (sludge treatment system for waste water treatment both for industrial and municipal applications), Neo Monitors (laser-based gas analyzer for real-time monitoring systems applied to steel industry and environmental protection projects).

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

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

Higher tariff caused some production cost increasement to Chinese process industry, thus is changing the situation of the global competition. The prohibition towards technology export to China had influenced the upgrading of Chinese process industry, but also stimulated the Chinese investment in R&D.

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 2019, China MOFCOM also issued regulations for unreliable entity list, aimed at foreign companies endanger its national sovereignty, security or development interests, as a countermeasure against the United States.

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 the influence will be transferred to the whole supply chain globally, 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.

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. Many Chinese process industry are seeking to transfer their export from US to Europe, as well as import more from Europe. Actually, it is fairly difficult for this year because EU's economy was also impacted seriously by the pandemic and is struggling for recovery.

The export to US market is becoming increasingly difficult for Chinse manufacturing industry, 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 became very 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 its huge domestic demand. The drop of oversea orders in the first half of 2020, made worse by the pandemic situation, brough a sharp drop to Chinese process industries, especially to those rely on export, or suppliers to export industries.

China's oversea M&A and OFDI dropped sharply too in 2020, which has reached the lowest level in the past ten years. Chinese process industry who is facing the challenge from the trade-war and COVID-19, concentrated more on keeping normal operation instead of expansion.

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 economy is recovering rapidly.

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.

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. In dealing with it, China is try to explore and develop its domestic market with the "internal circulation", but soon was replaced by the "dual circulation" concept, which means to develop both domestic and oversea market, due to its reliance to international demand.

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

The direct influence of COVID-19 on Chinese 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. 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. The COVID-19 had great impact to China process industries' supply chain, raw material import and product export, as well as human resources and market demand both form domestic and global.

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. 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. The situation has gradually eased with China's strict control of its epidemic, and by June 2020, the supply had almost returned to normal.

On the other hand, the COVID-19 greatly promoted E-commerce in China and accelerated the digitalization in Chinese government and process industries.

2. Government influence on China's process industry

2.1 Policies and regulations

The Chinese governmental regulation to process industry penetrated in all aspects, 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 2018, China has started the implementation of "Negative List for Foreign Investment Access" instead of former complex approving system. This is a significant reformation from governmental management 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. 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.

The Catalogue for Guiding Industry Restructuring (2019 edition) not only outline prohibitive regulations, but also require 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.

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, for example in Special Economic Zones or Free Trade Zones, comprehensive promotion will only occur after successful experiences had been proved.

There are 18 FTZs established in China till the end of 2019. 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, with the No. 16 round of FTA in Wuhan in September, was expected to be signed by the end of 2020. With the influence from pandemic and US trade war, China will be more open to the world, especially to Europe. The negotiation of EU-China Comprehensive Agreement on Investment has been accelerated.

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 seven fields: 5G networks, AI. Data Centers, NEV charging stations, Inter-city transportation and inner-city rail systems, Ultra-high voltage transmission Grids.

2.2 Tax

Enterprises operating in Chinese process industry may apply up to 17 kinds of taxes. Corporate Income tax (CIT) and Value-added Tax (VAT) are the major taxes with the general rates of 25% and 17% respectively. CIT preference may apply to government certified high-and-new technology enterprises and government encouraged activities such as CSR and environment friendly investments. Geographical locations and legal registration in special administrative zones (such as Free-trade Zones) may also a criteria for tax authorities to decide on tax deduction or exemptions of CIT. Lower VAT rate applies to companies engaging in sectors of utilities, publications, agricultural materials as well as general service industries. VAT refund scheme is offered to companies who export goods with exceptions of those items regulated by the state.

For manufacturing industry, a handful other taxes on properties are added up to the total operating cost. These taxes include: Urban and town land use tax, Farmland occupancy tax, Land appreciation tax, Urban maintenance and construction tax, Resource tax, House property tax, Motor vehicle and vessel taxes, Tax for vehicle purchase etc. The rate of these types of taxes were adjusted over time by revised laws and regulations. Considerations on regional differences and industry development priorities by the government are reflected in the tax rates and/or deduction and exemption policies.

Individual income tax (IIT) has been amended quite frequently since its initial roll-out in 1980. IIT adjustments can be interpreted as the result of average social income growth, increased gaps between low and high income taxpayers and gradually implemented social insurance welfare scheme covering the whole industrial workforces. Employers of manufacturing industry have experienced fast increase of labor costs due to their obligations enforced by the Labor law, IIT law and Social Insurance Law. Norwegian companies established in China can benefit from the bilateral agreement on IIT to avoid double taxation and tax evasion.

Custom duties are often a major cost factor for process industry. Most-favored-nation (MFN) rates (ranging from 1%-10%) apply for importing Norway originated products of the process industry. Export rebate scheme is offered to Chinese exporters of products which are encouraged for exporting. However, Export tax (ranging from 20%-40%) on a few specific resource-related and high energy intensive products are applied to many products in the process industry. The policymakers aimed to leverage on the export of these products with multiple goals.

Environmental Protection Tax was a new tax introduced in 2018, to replace the previous administrative fee on pollution discharges. The tax meant to encourage voluntary emission reduction on the enterprise level and its effectiveness will have to be reviewed from the mid and long-term perspective.

Companies running manufacturing business in different locations of China are subject to different overall tax burden. Local authorities are given the power to decide on actual rates on property and resources-related taxes, based on local social and economic development status and industry policies.

2.3 Human resources

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 process industry development.

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.

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. China is stepping into an aging society with the fading out of demographics dividend. The education level of labors in Chinese process industry is quite low, in comparing with advanced countries per capita. In China process industry, average salary variates dramatically due to the employee's education, position, experience, capability etc., and changes a lot in different regions or sectors, also varies greatly if it's including income tax, health insurance, housing provident fund and enterprise annuity etc. or not.

2.4 Corporate Social Responsibility

CSR in Chinese process industry is becoming more and more important, especially from 2006, when it was included in Chinese Corporate Law. The quantity of CSR reports from Chinese process industrial enterprises has increased remarkably in recent years, especially in the developed coast areas.

Process industry enterprises, especially large SOEs, publish their CSR report annually. In recent years, the enterprises with oversea investment are more eager to have their CRS report, in order to review and balance their economic profit with public benefit.
Example: CSR Report of LONGi

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

New requirements has been issued that, by 2020, will mandate all listed companies and bond issuers to disclose ESG report. Some Process industry enterprises turned to ESG report instead of CSR report, some even have both.

Example: Environmental, Social and Governance Report of CHALCO.

2.5 Logistics

Riding the country's economic expansion, China's transport and logistic industry has grown impressively in recent years. China as the world's largest logistics market, with huge investment in its infrastructure annually, following the Medium and Long-term Planning on Logistics Development (2014-2020). 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" model from 2008 in against the financial crisis.

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. The average cost of railway transportation in China is much lower than the road by trucks. Keep close distance with a railway station for goods is always a critical factor to be considered for the location of Chinese process industries.

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 and will play an important role in the EU-China transportation in the future.

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. 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. 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. China is among the few major vehicle markets that have enacted mandatory efficiency (or GHG) standards for heavy-duty vehicles, which has the highest contribution to GHG emissions in logistic industry.

2.6 Power generation

In 2019, China generated 7.5 trillion KWh electricity power, more than 5 times of that of 20 years ago. (1.38tr KWh in 2000)

Investments in electricity production dominated the total investments made in the energy production sector. The ratio is ranging from 56% (in 2011) to 75% (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).

Coal is still the dominant energy source driving the massive manufacturing industry as well as China's economy growth. It's composition to the total energy product maintained at around 70% in the past twenty years from 2000. Crude oil's contribution to the total reduced 10% in the same period. Hydropower, nuclear power, solar and especially wind power combined has seen tremendous increase to 18.8% by 2019.

Thermal power plants are the main contributors of electric power generation of China, totaled at 5.2 trillion KWh in 2019, accounted for 72% of total power generation of the year. Meanwhile China has made significant investments in developing renewable energies with exciting achievements.

In the 13th FYP, the goal of total renewable power generation capacity is set at 680 million KW, with electricity production of 1.9 trillion KWh, accounting for 27% of total power generated in 2020. The target of total non-fossil fuel's share in the primary energy consumption was set at 15% by 2020 and 20% by 2030.

Hydro power generation has been growing steadily with its contribution share maintained around 17% in the past twenty years. In 2019, hydro power contributed 17,4% of the total power generated of the year.

Wind power took off starting 2008 from 0% to 4.5% of the total power generation in 2017. The latest statistical data has shown that wind power has more than 5% share of total power generation in 2019. According to the 13th FYP of Wind Power Development (2016-2020), the wind power capacity will reach 210 million KW by the end of 2020.

Solar power shall provide 110 million KW by the end of 2020. The solar power generated in 2015 was merely 42 million KW. The state-ran Renewable Energy Development Fund provided subsidy to support renewable power generation primarily for wind and solar power projects.

Looking from the demand side, China's GDP grew 9 times from 2000 to 2019, the total energy consumption increased 3.3 times in the same period. China's total industry sector took over 65%-70% energy consumption of the whole society in the period of 2000-2017. The manufacturing industry consumed around 55% of the total energy in the same period. The most energy intensive sectors in the manufacturing industry are in the process industry include smelting and pressing of ferrous and non-ferrous metals, process of petroleum, chemicals and metals etc.

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

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.

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. The central government took important steps to strengthen environmental policies and legislation. The 11th, 12th and 13th Five Year Plans have progressively integrated more ambitious environmental policy objectives. Series of measures had been taken in water, air, soil and waste control, especially towards process industry. From water resources protection to water treatment; From air particulate control, to deSOx and deNOx; From industrial hazardous waste control to mineral tails and slags etc. The pressure from the government is increasingly high to China process industries, consequently increased the cost of their operation. PM

2.5 is a hot issue in Chinese cities' air quality control, and lots of process industries had to move from big cities to the North-western area of the country due to strict pollution control regulations.

China is a country lack of water resources. Water conservation and water treatment is critically important to process industry. Abundant water supply is an indispensable condition in process industry project approvement.

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". The garbage treatment is a very potential market in China, Norwegian companies such as Cambi and Tomra have made successful achievements in this field.

The Work Plan on "Zero-waste City" Pilot Program was initiated by Chinese government in 2018, in the purpose of 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.

For a long period, the government was trying to reduce to use coal as primary energy, especially the bulk coal usage in rural areas. Technology of smelting waste reuse in process industry is encouraged by the authority. Stricter standards had been issued to control the process industrial pollution. With the promotive policies, China became the largest manufacturer for NEV and power battery, as another measure to reduce the usage of fossil energy.

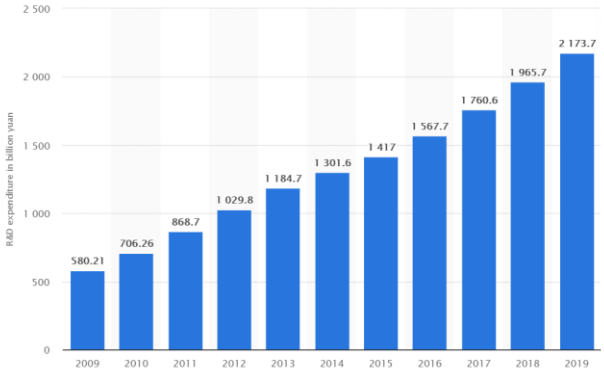
3. R&D development and improvement of patent

3.1 R&D development 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.

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. The statistic shows internal R&D spending in 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.

Fig 3.1 Internal R&D spending in China from 2009 to 2019 *(in billion yuan)*



China also lacks well-established linkages between businesses and universities, which significantly limits knowledge transfers. More than 70 per cent of the investment in R&D 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.

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. 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, NEV, wind and solar PV, artificial intelligence and some parts of advanced manufacturing and robotic (drones).

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. Many postdoctoral Workstations in enterprises were built up which can strengthen the link between academy and process industry.

In Chinese process industry, the R&D resources were spent much more on optimization of existing productions, such as cost reduction, upgrade of equipment, improvement of energy efficiency etc. , than fundamental innovation of products, since to reduce production cost is always welcomed by plant owners. In recent years, many 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 by the universities, enterprises and government, for a win-win situation.

3.2 Patent and IPR in China

According to World Intellectual Property Organization (WIPO), China's 58,990 patent applications filed under PCT (Patent Cooperation Treaty) in 2019, surpassing 57,840 applications from USA and became the country with most applications in the world. In 1999, WIPO only received 276 applications from China.

The majority of Chinese patent applications were 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. Statistics from 2010-2018 shown that the total patents granted in IPC section C-Chemistry and Metallurgy accounted 13%-23% among all eight IPC sections. The other sections with high percentages are section G- Physics and Section H-Electricity, accounting for 15%-25% of all sections.

The high concentration of patents in IPC sections related to process industry coincide with the Chinese industry sectors encouraged by the government to strengthen the implementation of IPR strategies. This means that more R&D resources are allocated to these sectors aiming to create more home-grown intellectual properties which are mostly needed to improve the technologies and commercial applications in these sectors. In which, a lot are related to the process industry such as, metal processing machinery; mining, metallurgy and material handling equipment; metal surface treatment and thermal treating equipment; basic chemicals; fertilizer; synthetic materials; batteries; special fine chemicals; chemical processing equipment; environment protection and waste treatment solutions etc.

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

The IPR Protection Action Plan 2020-2021 was put into force in April 2020 aiming to consolidate the legal framework and to improve the law enforcement and criminal justice on IPR violation. Three special IPR courts in Beijing, Shanghai and Guangzhou are designated to handle IPR-related cases. In addition, 46 IPR protection centers were established across China as 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 enforcing law and order in business practice.

China and Norway have signed an MOU on China-Norway Patent Prosecution Highway (PPH) pilot program in April 2020. It is a milestone of IPR cooperation between the two countries. Norwegian and Chinese companies will benefit from this program when seeking resolutions of IPR-related issues effectively.

3.3 Special market spotlight

China takes technology development much more seriously after the trade war with the US. In recent years, Chinese process industry paid high attention to R&D, with an increasing investment annually. Achievements have been made in the R&D of NEVs and power batteries, for example by BYD and CATL.

Scaling up the production to reduce the cost is the mostly used method for Chinese process industry to develop. On the other hand, it also brought too much similar products into the market, with much less specially designed products. As a result, their R&D work normally focus more on the production cost cutting than tailor made products' innovations. This left some market space for Norwegian or Europe companies who own special products or solutions to the niche market both in China and in the world. For example, Norwegian company Lattix who produces a kind of unique Aluminum bar specially made for some position of airport, still enjoys a good market in China.

Norwegian process industry with low carbon footprints still keep their advantages as well. For example, Hydro's greener aluminum and circular products, and Borregaard's bio-refineries based on natural and sustainable raw materials, have the unique position in the industry, benefited by their specialization strategy aims at global niches with high entry barriers and leading market positions.

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, after several years of R&D. It was criticized by the media several years ago that China could not produce this special steel and 100 percent rely on import. Although it's a niche market, the SOEs would like to spend resources in developing it.

4. Investment and acquisitions

4.1 Process industry investments in China

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.

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. Germany, the Netherlands, and France were the main European investors in China in recent years.

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 has the possibility to decrease its competitiveness.

The other more practical way is to increase investment, which was reluctantly used by the central government, for the sake of avoiding the lessons from 2009 for over capacity acceleration. 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.

4.2 China’s acquisitions in Europe

According to statistics from the China MOFCOM and SAFE, China's outbound investment in 2019 was 807.95 billion yuan, down 6 percent YoY (US$117.12 billion, down 9.8 percent YoY). 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 war are affecting Chinese enterprises' decisions on overseas investment.

Overseas economic and trade zones as well as industrial parks 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 with total investment of 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.

As one of the world’s largest economies and financial markets, Europe has already become a favored destination for Chinese investment for long time. The main investment destinations were the UK, Switzerland and Germany.

Chinese FDI in the EU also peaked in 2016, and then continued to decline till 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. 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).

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.

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 number 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

5. Sustainable development in Chinese process industry

5.1 Green industries development

China has made the "Green Development" as one of the five guiding principles in the 13th Five Year Plan, calling for an 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, policies, standard and certification system had been issued and implemented in recent years for Green Factory, Green Design Product, Green Supply Chain and Green (Ecological) Industrial Park.

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.

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, turn waste into resources, and low-carbon energy." Guide process industrial enterprises to build, transform and manage plants in accordance with the standards of green factory construction, and intensive use of the plant. 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.

Green Technology Bank (GTB), and Green Development Fund have been established for technical and financial support to the green transformation.

5.2 Energy efficiency and renewable energy

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 area. These process industries were given a cap for their production capacity limitation. They have so 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 control, waste control and water treatment 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”.

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 waste heat recovery projects. The heat recovered mostly would be reused into electricity generation or the process of industries where heat is needed, some heat also supplied to city district heating system. Norwegian company Norsk Energi had involved in many WHR projects in ferroalloy industry of China, with technical consultation.

ESCOs are key enablers of investments in energy efficiency, because they deliver efficiency projects based on long-term contracts tied to energy performance. EPC model were promoted by the government, with favorable policy.

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.

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. China brought online 30 GW of solar PV capacity in 2019, down from 44 GW in 2018. With the great support policy, China has made the largest investment in the world in the renewable energy field during the last decade.

The subsidy from Chinese government to renewable energy 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 PV industry. 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.

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 in process industry and other sectors. Most notably, emissions of SO_2 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_2 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.

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.

In last decade, Chinese process industries focus more on energy efficiency and renewable energy, than the emission control, because the former one can reduce their operation cost while GHG reduction needs extra investments. Chinese government is considering to issue new policies and subsidies to guide process industry in taking more measures for emission reduction, in order to keep the target of peak CO_2 emissions by 2030 and realize carbon neutral in 2060. 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 and emission reduction.

5.4 CCUS in China

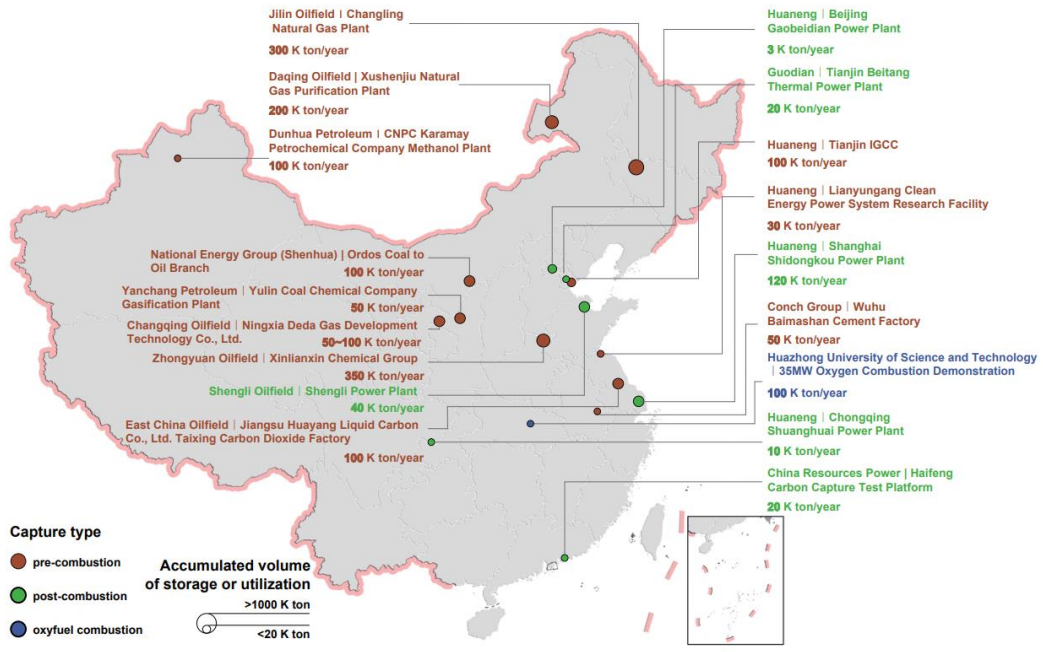
As the world largest greenhouse gas emission country, China has made a solemn commitment of emission reduction. However, China's coal-based energy structure cannot be changed in a short term. CCUS, as an effective technology with great potential to realize low-carbon use of fossil energy, has attracted 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). 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 (EOR). 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.

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.

Fig. 5.4 CCUS projects in China



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

MEE and MOST currently drive China's comprehensive CCS program. 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. To reach the target of Carbon Neutral by 2060, CCUS is an inevitable measure to be taken by Chinese government and process industries.

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. The European Green Deal will also bring significant change to Chinese ETS, and process industry as well.

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 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.

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, which is expected to start in 2020.

5.6 Digitalization

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.

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.

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. 16 in World Digitalization Competitiveness by IMD in 2020 (Norway listed No. 9, and Hongkong No. 8).

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 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. New business model like sharing economy developed quickly in China and bring many changes to the supply chain of process industry with the bullwhip effect.

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. 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.

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.

Driven by a series of favorable policies, the revenue of smart manufacturing industry in China is expected to grow to CNY 3,668.4 billion in 2021 at a CAGR of 20.4 percent from 2016 to 2021. China has already built up more than 200 digital smart factories. Digital Factory is the first consideration in Chinese smart manufacturing deployment. Process industries are encouraged to "Go to Cloud", and connect to big data resources and AI technology. In 2018, 78.1 percent of large-scale steel companies in China adopted digital control systems in key production procedures.

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 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. There is huge potential in the process industry due to the increasing human resources cost and strict HSE requirement. 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. Fifty percent of industrial robots are used in automobile manufacturing, of which more than half are welding robots.

In many Chinese city municipalities, new department called "Big Data Bureau" had been founded up, normally under the local IIT Committee system. Big data platform were also built up in many process industries, with the promotion of "Internet+" policy. The implementation of 5G technology with AI will change the landscape of Chinese process industry in the future.

5.7 Circular economy

The top leaders of China have long been calling for circular economy development at the political level. As early as in 2005, the State Council made guidelines on the development of circular economy with focus on improving energy efficiency in the sectors of 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 national strategy of developing circular economy has been materialized in industry policies for all the process industries such as coal production, power generation, iron & steel, non-ferrous metals, petroleum and petrochemical industry, chemical industry, building materials, pulp & paper, food production and textile industry.

Circular economy development practices in the process industry boiled down to comprehensive technology solutions in energy and water saving, reduction of raw materials, recycling and reclamation mechanism as well as phasing out outdated production capacity.

Economic Developing Zones and 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 program of the central government budget are allocated to finance key production projects, technology demonstration and promotion projects, capacity building and other relevant programs to facilitate the implementation of circular economy solutions in respective industries. The funding is mainly used in following areas.

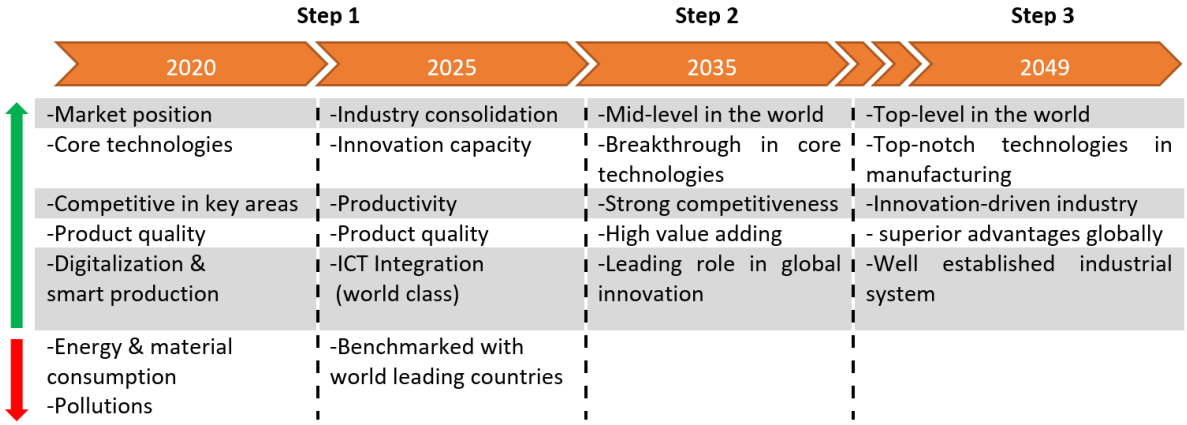
- "Urban mines" project-recycling and reclamation of iron & steel, non-ferrous metals, precious metals, plastic & rubber, glass etc. from scrapped and used products;
- Bio-wastes reclamation and decontamination;
- Demonstration projects of transformation of industrial parks using circular economy solutions;
- 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-supporting studies, standard formulating, technology promoting, information system that facilitate the circular economy administrations, methodologies of assessment and verifications);

To safeguard the national strategy of developing circular economy, Chinese central government has made a handful of laws concerning environment protection, clean production and circular economy development since two decades ago. Many of these laws and regulations were subject to revision and amendment to suit for the rapid social and economic development of China. The legal framework supporting circular economy in China has been well established. Among those, the governing law was the Circular Economy Promotion Law, further enforced with laws on environmental protection; pollution control on air, water and solid waste; clean production and mineral resources.

6. Made in China 2025

6.1 Made in China 2025

In August 2015, the State Council promulgated the masterplan of Made in China 2025(MIC 2025) which interlinked multi-dimensional industrial development policies for the manufacturing industry. MIC 2025 is strongly inspired by Germany's Industry 4.0 strategy initially and is a top-down strategy for China's economic and industrial development. It integrates a great number of previously largely uncoordinated efforts to modernize the manufacturing industry. On this basis, the long-term plan looks far into the future, ambitiously outlining China's technological development roadmap in three steps until 2049 (100 year of the foundation of P.R. China), with 2025 merely representing an intermediary step.



China owns world largest manufacturing capacity with complete supply chain covering extensive product fields. Manufacturing industry is the important foundation supporting the economic and social development of China. Technology advancements in a few sectors such as super-computing, high-speed train and satellite navigation systems showed potentials of Chinese capabilities of manufacturing hi-tech products and competing in global market.

However, the manufacturing industry in general is still weak in core technologies and innovation capacity. High-end equipment and materials have high dependence on foreign suppliers. Chinese products are not high in grade and lack of brand recognition in global market. Energy efficiency of the industry is low and there are prominent problems of pollutions. The digitalization is in the early phase and Chinese enterprises lack capacity for global operation. In the MIC 2025 masterplan, specific and measurable targets were set in four key areas of manufacturing industry, which are: Innovation capacity, quality efficiency, digitalization and sustainable development.

MIC 2025 emphases indigenous innovations and overall industrial development in the process of upgrading its manufacturing industry. Nine strategic priorities were set with measurable targets in innovation capacity; digitalization; fundamental materials, components and processing technologies;

branding; green production; industry system re-shaping; professional services; internationalization; and technological breakthrough in ten areas.

1. New generation information technology	6. New energy and energy-saving vehicles
2. High-end computerized machines and robots	7. Energy equipment
3. Space and aviation	8. Agricultural machines
4. Maritime equipment and high-tech ships	9. New materials
5. Advanced railway transportation equipment	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. FYPs played a leading role in establishing the foundations and principles of Chinese communism, mapping strategies for economic development, setting growth targets, and launching reforms.

In the 13th FYP (2016-2020), innovation, energy-saving and environment protection, social equality and poverty alleviation are highlighted priorities with specific goals. Main goals of 13th FYP include:

GDP(trillion yuan):	over 92.7	Average annual GDP growth rate:	over 6.7%
Added value of tertiary industry:	56%	Urbanization rate:	60%
Invention patents ratio:	1.2 ‰	Non-fossil fuels in energy mix:	15%
Energy consumption reduced per GDP*:	15%	Water usage reduced*:	23%
CO_2 emission deduction per GDP*:	18%	Main pollutants deduction* (COD, NOx etc.):	10-15%

**The corresponding figures are the total amount accumulated in the five-year interval*.

Guided by the national 13th FYP, central government bodies in charge of various social and economic development plans are entitled to issue 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 (and sometimes, overlapped) responsibilities.

Local government bodies at provincial, municipality or county levels also make regional specific FYPs with priorities in accordance with the national 13th FYP for the specific industrial sectors or mandates. Due to huge differences of local conditions such as natural resources, infrastructure, scale and level of industries, education of the labor force, regional environment challenges etc., regional 13th FYPs are often quite different in scopes and goals but they must be coordinated and follow the principles of the national 13th FYP.

As the process industry concerned, 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 13th FYPs. Energy-saving, emission control, innovation, green production are the priorities of the industry policies aiming to achieve respective and often inter-related indicators of the national 13th FYP.

The upcoming 14th FYP (2021-2025) is in the process of drafting and internal discussions. Considering the consequences of global spreading of coronavirus and US-China trade war, the policy makers will have to trade-off long-term economic development targets and short-term realist goals.

Economists and think tanks in China are rolling out their analysis on the key elements of the 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.

6.3 From Made in China to Create in China

In the same year of the launching of MIC2025, China also rolled out an action plan of "Internet+". MIC 2025 aimed to upgrade manufacturing industries towards more market-oriented and higher value-adding driving force for the long-term economy growth, while "Internet+" was initially considered mostly relevant to the tertiary industry and some emerging business sectors such as software and e-commerce.

Various Internet applications have deep impacts on the social life of the general public such as means of acquisition of information and social services in recent year. On the other hand, China's industry sectors 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.

To the great extent, the competitiveness of current 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.

"Internet+" action plan is supportive to MIC 2025 by integrating the manufacturing industry with ICT infrastructures and innovative business models. Solutions based on mobile network, cloud computing, big data, Internet of Things are powerful tools to integrate with the manufacturing processes and add values to the traditional business model and to forge stronger competitiveness.

The concept of the convergence of MIC 2025 and "Internet+" formulates a road map of China's economy development pattern from "Made in China" to "Create in China". As one of the first-step implementations, smart production is prioritized with specific technical areas for improvements.

- Key technologies and critical equipment combining hardware and software and R&D capacity;
- Completed standards for smart production including fields of industrial internet and information safety;
- Eco-system formulation including strong system integrators and talent pool establishment;
- Digitalization in key sectors such as R&D, computerized control systems and digital factory;

These areas are inter-related with the key technology sectors defined in MIC 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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