THE 16TH CMIA

THE 16TH ANNUAL MEETING OF THE CHONGQING MAYOR'S
INTERNATIONAL ECONOMIC ADVISORY COUNCIL

重庆市市长国际经济顾问团会议
第十六届年会

Penetrating Insights

CONTENTS

Synergetic Development, Strategically Building a Sustainable Industrial System in the Region

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This article serves as the theme report of Corning Corporation at the annual Chongqing Mayor's International Economic Advisory Group Meeting. It is based on the theme of "*Good Tale of Two Cities, Building Chengdu-Chongqing Economic Circle*", combining with Corning's recent development experience in Chengdu, Chongqing and other western regions, and the study of strategic industries such as display and new materials. This article specifically focuses on Chongqing's industrial characteristics and comprehensive advantages in the economic circle, and studies the domestic and international experiences of the synergetic development in urban economic circles, and provides suggestions for Chongqing's establishment and promotion of the Chengdu-Chongqing economic circle, as well as the development of a modern industrial system.

Part I - Corning's western strategy - from glass sales, to the overall development of the display industry chain, and to the evolution of innovation strategies. Starting as a material supplier, Corning has been continuously investing in Chongqing, from a post processing plant, a logistics center, and now a melting furnace, as well as other facilities for new materials, such as Corning Gorilla Glass for consumer electronic products, and innovative automotive glass. Corning's development experience in Chongqing well demonstrates the practice of building a sustainable industry in the Chengdu-Chongqing region.

Part II - Synergy and integration - building a strategic industrial system. This part studies international experiences and urban circle development theory, as well as the development elements of the Chengdu-Chongqing economic circle. Based on the characteristics of regional industrial structure, we propose to pay attention to rational division of resources, optimized layout of investment, and collaboration and integration, so as to establish an internationally competitive industrial system.

Part III – Bridgehead of the west - make full use of Chongqing's advantages, strengthen its status as a transportation hub, and build a bridgehead for the economic development of the western region. As the gateway to the west, Chongqing shall continue to leverage the advantages of the Yangtze River Golden Waterway, the combined transportation system of rivers and railways, and

the comprehensive bonded zone to create a two-city integrated system and achieve the optimal use of resources.

Part IV – Strengthen and expand – from the strategic height of the Chengdu-Chongqing Economic Circle, to further develop the business environment for foreign investment, so as to attract Corning to continue to expand and strengthen the display industry chain, drive more innovations with new materials, and continue to invest in the western region.

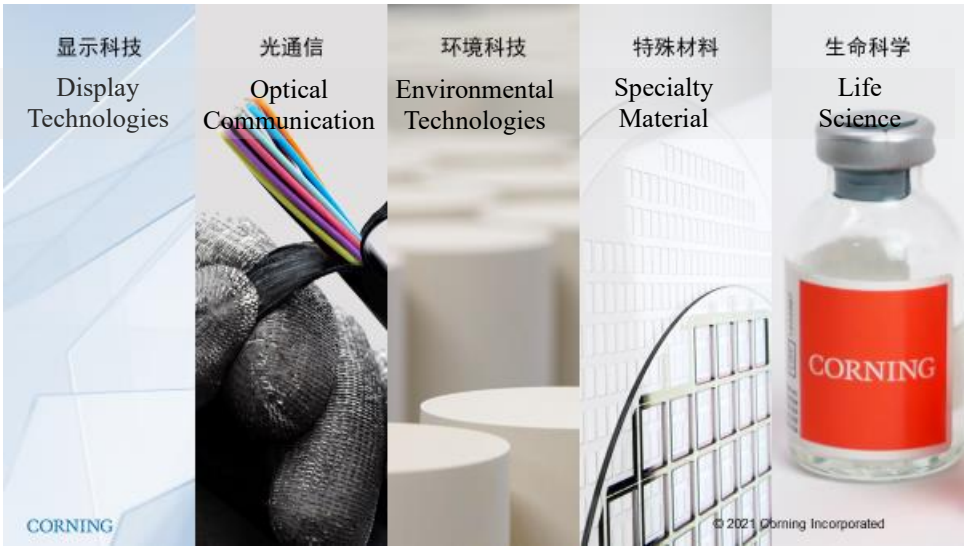
Corning is with full of confidence in Chongqing's government at all levels in the vision of building a two-city economic circle and building a strategic highland in the west. we look forward to further strengthening cooperation and guiding the rapid development of the industry.

Part I - Corning's western strategy

Corning is a leader in diversified material sciences

Corning Incorporated (NYSE: GLW) was founded in 1851 and is headquartered in Corning, New York, USA. It is a global leader in materials science and process innovation. Corning is ranked 277th on the 2020 Fortune 500 list.

Corning's diversified portfolio



Corning has used its technical expertise in specialty glass, ceramic materials and optical physics to develop a diversified business portfolio. Its products have established the market leading position in display technology, optical communications, mobile consumer electronics, automotive applications, and life sciences. Corning has a series of industry-leading technologies and processes, including precision glass for advanced displays; Gorilla cover glass for consumer electronics; optical fiber, wireless communication technology and connectivity solutions for communication networks; trusted products for drug discovery and packaging; as well as air purification technology for cars and trucks.

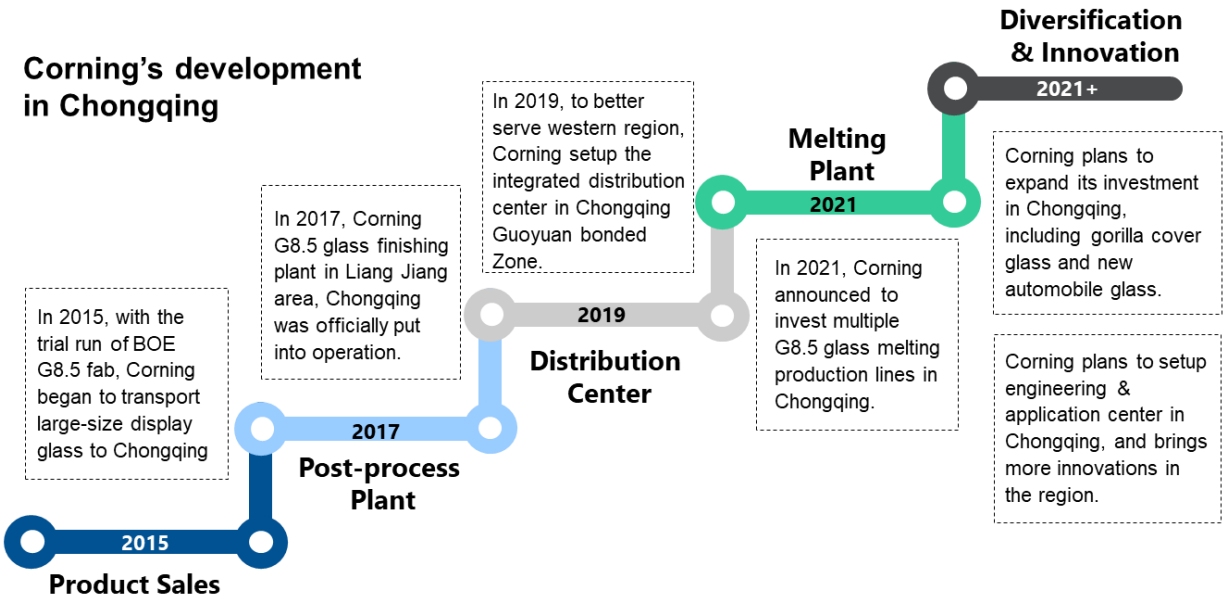
Along with China’s reform and opening-up, Corning began to actively participate in China’s development as early as 1980. At present, the total investment in mainland China has exceeded 8 billion U.S. dollars. There are more than 20 factories located throughout the country, and the total number of employees has exceeded 5,000. people.

Corning Display’s development in Chongqing and the west region

The relationship between Corning and Chongqing began with Corning Display Technology, which mainly provides LCD and OLED glass substrates for LCD screens of TVs, laptops, desktop computers, portable electronics and communication equipment. With its unique fusion process and

innovation capabilities, Corning has always been in a leading position in the industry. As early as 2015, as the BOE Chongqing was officially put into operation, Corning Display Technology decided to invest in Chongqing to establish a Gen 8.6 LCD glass substrate production plant. The plant occupies an area of 130,000 square meters and is designed in accordance with Corning's standard post-process production line. Since its commissioning in 2017, the business has grown rapidly and has quickly become the bridgehead of Corning's western strategy.

Taking advantage of Chongqing as the excellent transportation hub in west, Corning transports large size display glass full sheet from Japan, South Korea and Taiwan, China to Chongqing, and then distribute them to customers in the west region after processing at the Chongqing plant. Corning has been using a variety of transportation methods including waterways, railways, highways, and aviation, including multimodal transportation, to ensure the balance of quality, cost, and delivery.



Chongqing's strategic significance as Corning's operation hub in the central and western regions has been strengthened, with the completion of glass processing facilities in Chengdu, Xianyang, Mianyang and other places. In 2019, Corning, as the first batch of users in the Guoyuan Free Trade Zone, built a logistics and warehousing center in Chongqing, which greatly enhanced the overall inventory turnover. This logistics hub takes advantage of Chongqing's multi-model transportation capabilities, which includes Yangtze River shipping, water and rail, water and land models, better serving Corning's customers in the central and western regions.

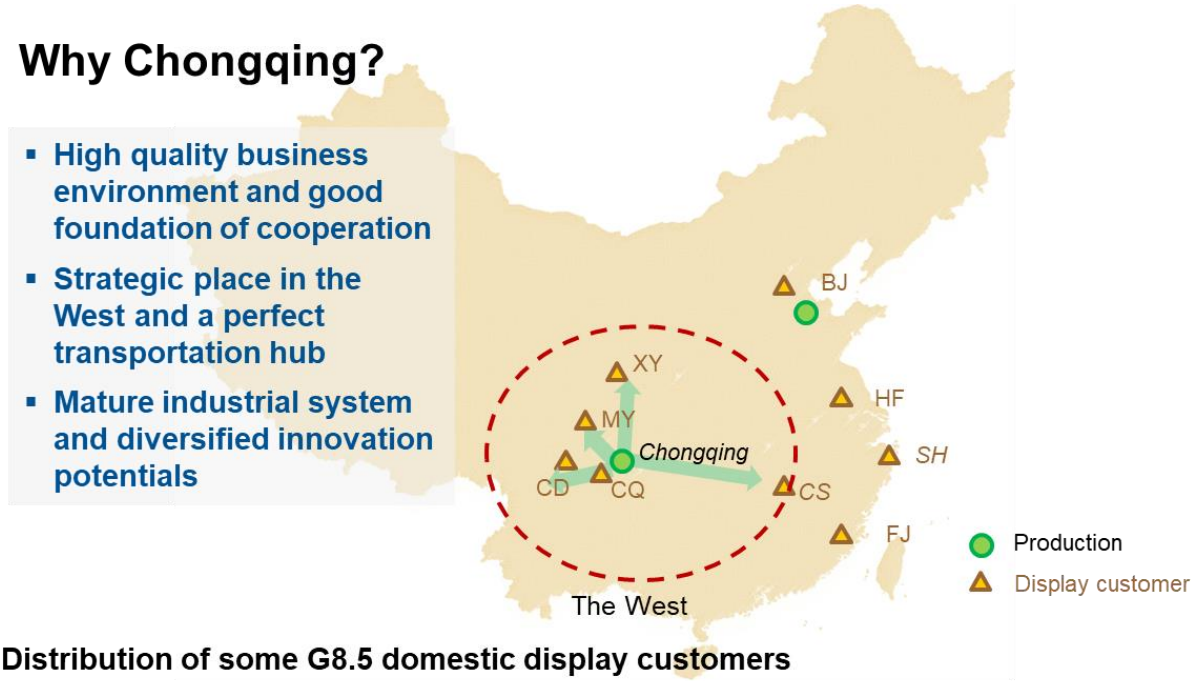
With this logistics hub, Chongqing's strategic position in the central and western regions has become more prominent, and it has become an inevitable choice to continue to expand display

value chain. This year, Corning announced the plan to invest multiple Gen 8.5 large-size glass melting production lines in Chongqing in next three years, and the first line will be put into operation by the end of 2022. From front-end melting and forming, to post cutting and edging processing, and to the warehousing and logistics center, Corning Display has brought to Chongqing the entire industrial chain of world leading electronic glass technologies. Based in Chongqing and radiating to the west, Corning has realized the first step of its western strategy.

Corning's vision in the west with Chongqing as its core

It is no accident that Corning chose Chongqing as the center of its western strategy. First of all, we have established a good partnership with the Chongqing government since 2014. With the operation of the Chongqing factory, we have received strong support from local governments at all levels. From infrastructure construction, handover and operation support, Chongqing's speed and Chongqing consciousness are reflected everywhere. Secondly, Chongqing has established an excellent business environment for foreign businesses, keeping promises, efficient communication, and service priority. Through years of cooperation, the fit between Corning and Chongqing governments is also gradually improving.

More importantly, Chongqing has become an important strategic place for western development. The concept of "Chengdu-Chongqing Economic Circle" is put forward and promoted. It has risen to the national strategic level, and the economic potential is huge. Chongqing has also established industrial clusters based on display, information technology and automobiles, and the driving effect is even more obvious. All this strengthens Corning's strategic decision to base itself in Chongqing and radiate the west.



Distribution of some G8.5 domestic display customers

Corning's western strategy will not be limited to this. On the one hand, we will continue to expand the display industry chain. Apart from the investment in glass melting production lines, we will also actively promote to expand in upstream raw material industry to make the industrial chain layout more complete. At the same time, relying on the Chongqing-Chengdu region's transportation hub positioning and industrial structure, Corning will continue the construction of the logistics center, procurement center and operation and maintenance center, so as to lay a solid foundation to optimize the overall industrial system.

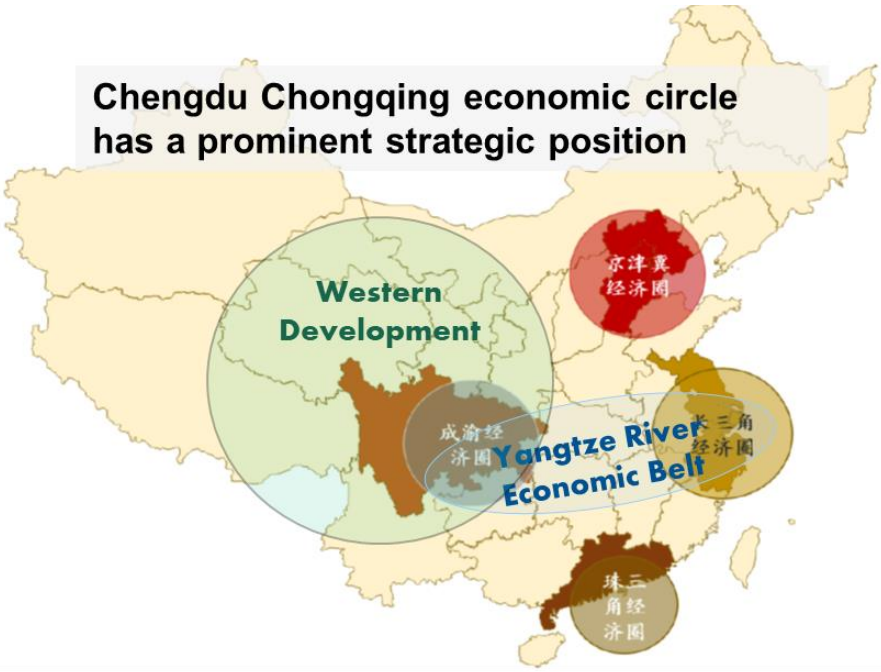
On the other hand, due to the successful experience of Corning Display, we hope to continue to develop Corning's advanced and diversified industrial system in the Chengdu-Chongqing area. Corning plans to expand investment in Chongqing with Gorilla cover glass and Corning automotive glass, one for consumer electronics and one for automotive innovations. We are confident that there will be more possibilities, combining Corning's diversified industrial system and R&D advantages, as well as the Chengdu-Chongqing Economic Circle's vision to build an internationally competitive advanced manufacturing cluster.

This year is the third time that our company has delivered a keynote report on the Chongqing Mayor's International Economic Conference. We will also put forward some strategic views and suggestions on the opportunities and challenges of the theme of "*Good Tales of Two Cities, Building Chengdu-Chongqing Economic Circle*".

Part II: Synergy and integration, to build a strategic industrial system

In January 2020, the central government put forward for the first time "promoting the construction of the Chengdu-Chongqing economic circle". It aims to make the Chengdu-Chongqing region an important economic center nationwide, a center for technological innovation, a new highland for reform and opening-up, and a high-quality livable place to promote high-quality development. At the same time, it also clarified the focus of construction of the "Chengdu-Chongqing Economic Circle": strengthening the transportation infrastructure, accelerating the modern industrial systems, enhancing the capacity for collaborative innovation and development, optimizing the spatial layout of the country, strengthening ecological environment protection, promoting systematic innovation, and sharing of public services.

The proposal of this new concept setup the "Chengdu-Chongqing Economic Circle" to a national strategic level. The Chengdu-Chongqing Economic Circle gradually rises to the same strategic level as the Beijing-Tianjin-Hebei, Yangtze River Delta, Guangdong-Hong Kong-Macao national economic circles. The "fourth pole" is also beginning to take shape.



Meanwhile, the Chengdu-Chongqing Economic Circle is also well positioned in the two national development strategies, the Yangtze River Economic Belt and the Western Development. On the one hand, the Chengdu-Chongqing Economic Circle is an important part of the development of the Yangtze River Economic Belt. It forms the "three poles" of the Yangtze River Economic Belt development together with the Yangtze River Delta centered in Shanghai and the middle reaches of the Yangtze River centered in Wuhan.

On the other hand, the Chengdu-Chongqing Economic Circle is also an important platform for the development of the western region. According to the "Guiding Opinions of the Central Committee of the Communist Party of China and the State Council on Promoting the Development of the Western Region in the New Era to Form a New Pattern" in May 2020, the synergetic development of Chengdu-Chongqing region and Guan Zhong Plain with Xi'an as the center will create a core engine to the development of the western region.

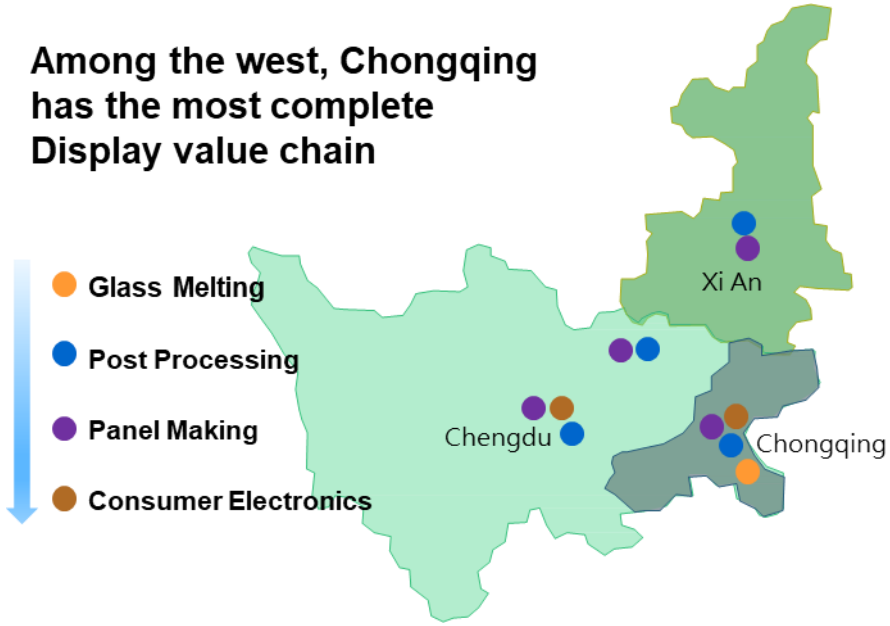
Compared with the other three major urban agglomerations, the Chengdu-Chongqing region has huge development potential. From the economic perspective, its economic volume and urbanization rate are second to none in the western region. In recent years, GDP growth has been higher than the national level, and population growth and consumption have also led the country. It has the ability to become a driver of high-quality development in the country. It will be an important growth pole and a new source of power. In our view, the Chengdu-Chongqing economic circle will have more opportunities to plan a unified and optimized layout, carry out synergetic development and establish a sustainable industrial system.

The Industrial Structure of Chengdu-Chongqing Economic Circle

In order to better build the technological innovation industry system, it is necessary to have a certain understanding of the current situation and development of the industrial structure of Chengdu and Chongqing. Although the industrial focus of Sichuan and Chongqing is different, the industrial structure of the two regions is still relatively similar. Both cities rely heavily on electronics manufacturing, Sichuan Province as a whole tends to light industry, and Chongqing's heavy industry is more powerful. The strategic industries are also similar, focusing on biomedicine, new materials and environmental protection.

Compared with Chengdu, Chongqing’s secondary industry has an absolute advantage in terms of output value and is an important advanced manufacturing center in the country. This is consistent with the local vigorous plan to develop manufacturing clusters such as automobile and motorcycle, equipment, and materials. In recent years, with the trends of industrial transformation and upgrading, Chongqing has gradually integrated the electronic information industry with its traditional manufacturing industry. The electronic manufacturing industry has replaced automobiles and has become the main driving force for the growth of industrial output value. The equipment manufacturing, advanced materials, and biomedical industries all have grown to strong economies of scale. At the same time, as an important waterway transportation hub in the west, the integrated development of Chongqing's modern logistics network makes it possible for even higher output value in the transportation, storage and postal industries.

Take the display industry chain as an example, both Chengdu and Chongqing have established relatively complete consumer electronics manufacturing industries. Chongqing has ranked first in global notebook computer output for six consecutive years. Since 2005, as BOE and other panel companies have settled down, a number of large-size panel manufacturing and glass processing production bases have been established in the west. Chongqing, with its advantages in manufacturing and the Yangtze River waterway, is more suitable to expand the display value chain to upstream glass melting and to downstream distribution center. Meanwhile, a complete industrial chain will further promote the development of more diversified innovative businesses in Chongqing. Chengdu and Chongqing will make overall plans and develop an industrial system suitable for their own characteristics accordingly, and thus form an industrial cluster with international competitiveness.



Therefore, how to further focus on the construction of the "two-city economic circle", give full play to the core advantages of the western region, and strategically develop innovative industries has become a hot topic.

International advanced experience for the reference

The pioneer of modern urban agglomeration studies is the French scholar Jean Gottmann. After investigating the urbanization of North America, he published "Megalopolis: The Urbanization of the Northeastern Seaboard of the United States" in 1957, which explored its spatial growth model and proposed a new concept of urban agglomeration. His views have been widely acknowledged. Since then, with the deepening of economic globalization, the development pattern of regional integration in urban agglomerations has gradually formed.

The so-called regional integration means that though regional development needs core cities to provide development impetus, it relies on industrial clusters to build an overall industrial development layout. The development of globalization and urbanization has accelerated the free circulation and allocation of resources, and has also intensified competition between cities and even between countries. How urban agglomerations can allocate resources more efficiently, benefit from the advantages of industrial agglomeration, and improve overall development capabilities are not only important for promoting coordinated regional development, but also for the improvement of national competitiveness.

Gottmann believes that the important signs of the maturity of urban agglomerations are the reasonable division of urban functions and the development of cooperation between core cities. Only cooperative competition can reflect the overall strength of urban agglomerations, and cooperation is the key to regional competitive advantage. This requires the innovations in systems and policies to enable governments at all levels to achieve ideal cooperation in broader areas, and thus jointly improve the competitiveness of urban agglomerations.

The northeastern coast area of the United States where Corning is located can be an example. The whole area has developed into a complete urban system, with each city having its own unique functions. Boston is a center of knowledge, technology, and politics; New York is a commercial and financial center; Philadelphia is a manufacturing center; Baltimore is an important seaport; Washington DC is not only a political and administrative center, but also a place that carries historical and cultural heritage. Therefore, the functional structure of the city circle is very clear, and it also drives the overall development of other areas in the region. Although the cities within the urban agglomeration are closely integrated with each other, they are reasonably separated geographically. Each city has its own production, lifestyle, and ecological model.

With the deepening of globalization, urban agglomerations need to actively participate in global competition. Internationalization and modernization are the inevitable trends in the development of urban agglomerations in the country. Strengthening internal connections, breaking the division within the group, effectively allocating economic factors, sharing infrastructure, and establishing a cross-regional cooperation mechanism are the inherent requirements for the development of urban agglomerations.

The core of the development of urban agglomerations is to have internationally competitive industrial clusters. It is through the development of these industrial clusters that urban agglomerations influence and control the development of the surrounding areas. Industrial clusters with competitive advantages are the inherent requirements for the sustainable and healthy development of the regional economy, and they are constantly enhancing the competitiveness of the urban agglomeration. Therefore, in order to achieve sustainable growth for urban agglomerations, it is necessary to conduct a comparative study within and outside the city clusters, and to create a unique industrial development model and a reasonable and efficient industrial structure.

Rationalized division, Optimized investment, Collaborative integration, Clustered industrialization

Hereby, we put forward the following suggestions, regarding the construction of an integrated industrial cluster in the Chengdu-Chongqing Economic Circle. They have been combined with Corning's experience in the display, consumer electronics and new materials industries.

(1) ***Optimize the regional industrial layout and guide the overall development of the industry.*** This refers to optimize the industrial structure layout in Chengdu, Chongqing and its surrounding areas from a macro perspective, and strengthen the coordinated development of various industries in the urban agglomerations; in terms of industrial form, to rationally deploy strategic emerging industries and new service industries based on characteristics of basic industries in each city; and in terms of industrial layout, to break the administrative division restrictions, adopt and form a multi-level, networked industrial spatial layout system. For example, it requires a cross-region overall planning in the Display industry. Chongqing can rely on its strong upstream heavy industry and downstream logistics advantages to broaden supply chains for other western regions such as Chengdu, Mianyang and Xianyang. Within the economic circle, we can optimize through macro-control, avoid duplication of investment, thereby form a comprehensive industrial chain in the west.

(2) ***Establish an industrial cooperation mechanism to complement and coordinate development.*** On the one hand, it is to strengthen macro-control and establish a mechanism to

enhance coordination and dialogue between cities in the urban agglomeration, and thus to break the inter-regional blockade; on the other hand, the cities in the urban agglomeration need to work together to create coordinated industrial development. For example, in the field of electronics manufacturing, Chengdu and Chongqing, as the core cities, can coordinate the establishment of a cross-regional cooperation mechanism. Chongqing can leverage its advantages in electronic components, Internet of Things, and big data intelligence to integrate resources, deepen cooperation, and improve efficiency.

(3) Emphasize both software and hardware, integrate "four chains" to achieve high-quality development. The synergetic development of the electronic information industry requires Chengdu and Chongqing to leverage their existing advantages in both software services and hardware facilities. It also requires to further integrate the industry production chain, element supply chain, product value chain, technological innovation chain, so that the Chengdu-Chongqing region can jointly build a China's leading intelligent manufacturing and innovation center. Corning's development in Chongqing has once again proved that through the development of the industrial chain can bring more possibilities. We also expect Chongqing to take the lead in supporting the glass upstream element supply chain, thereby driving more diversified and cross-industry technological innovations.

(4) Create a new force by developing the industrial agglomeration. Industrial agglomeration is the trend in the development of urban agglomerations. The development of Chengdu-Chongqing urban agglomerations must stand on the development of industrial clusters. It is to enhance the interactive effects between urban agglomerations and industrial clusters, strengthen industrial agglomeration and resource integration, and thus to build trillion scale industrial clusters. Focused on automobile, electronics manufacturing, and information industry, the Chengdu-Chongqing economic circle can build the industry cluster systems with complementary advantages and distinctive features. And it will further integrate into the development of the Yangtze River Economic Belt.

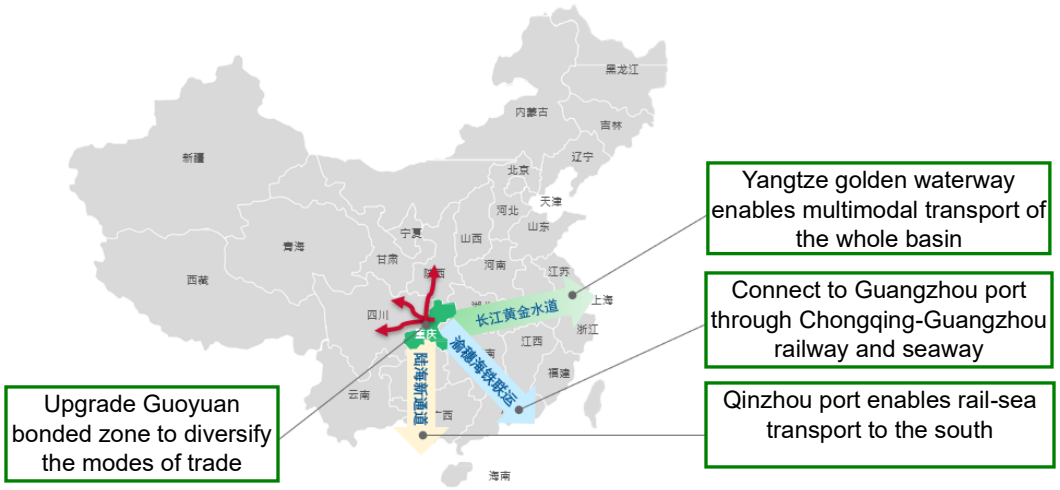
Part III: Build a bridgehead for the western economic circle by strengthen the transportation hub

International transportation hub and multimodal transport

The advantages of the good location with developed and convenient transportations are the essential basis for the full development of urban agglomeration. With the introduction of the major strategy of "Chengdu Chongqing Economic Circle", the transportation integration pattern in the region has gradually taken shape. In the main framework of the national transportation network, Chengdu Chongqing area includes Beijing Tianjin Hebei Chengdu Chongqing main axis, Yangtze

River Delta Chengdu Chongqing main axis, Guangdong, Hong Kong, Macao Chengdu Chongqing main axis, western land and sea corridor, Chengdu Chongqing Kunming corridor, Sichuan Tibet corridor, Xiamen Chengdu corridor, etc. Among them, the golden waterway of the Yangtze River, the new south-bound land-sea channel and the Chongqing-Guangdong sea-rail combined transports are of great significance to Corning. As a glass manufacturer, Corning is very sensitive to the operational efficiency of logistics, transportation and warehousing, which has also been the focus of our company in the past two years. In recent years, with the completion of bonded warehouses in Guoyuan, Chongqing, Corning has also opened routes through the Yangtze River waterway, the land-sea channel of Qinzhou Port, and the sea-rail combined transportation of Guangzhou Port. We have witnessed Chongqing's efforts and achievements in building an international transportation hub. And the importance of Chongqing, as the core of Corning's western operations center, has also been solidified.

"Multimodal transport" boosts supply chain construction of Chongqing



This year, considering the needs of the display industry, we will still pay attention to the following points. (1) Take advantage of the capacity of the golden waterway, build Chongqing as the distribution center in west; (2) Vigorously develop the multi-model public transportation, with railway connected and the highway complemented; (3) Upgrade the Guoyuan bonded area, and thus improve the industrial structure.

Upgrade multi-model channels and optimize strategic cooperation

Open to Europe and reach the sea, Chongqing aims to create a strategic highland for inland opening. The Chengdu-Chongqing Economic Circle is located at the junction of the "Belt and Road" and the Yangtze River Economic Belt. It has outstanding geographical advantages.

First, the huge transportation capacity of Yangtze River Golden Waterway makes it suitable for enterprises to build Chongqing as the logistics center. As the western gateway of the Golden Waterway, Chongqing has natural transportation advantages. Compared with highway and railway transportation, sea-river combined transportation has a large carrying capacity and obvious cost advantages. Corning has also successively built multiple production nodes in Hefei, Chongqing, and Wuhan along this waterway, and has positioned Chongqing as a warehousing and distribution center in the west.

Secondly, as an international transportation hub, Chongqing needs to further promote the multi-model transportations, with railway, highway, water, and aviation, and to expand access to western China and Southeast Asia. At present, Chengdu and Chongqing have initially formed a variety of logistics models for the western land and sea corridors. And now efforts are being made to form a sea-river-rail-road multi-model transport, with railways connecting Chengdu and Chongqing, and highways as supplements. In order to build a logistics and operation center in Chongqing, Corning is also working hard to build the sea-rail combined channels from Shanghai, Ningbo, Guangzhou and Qinzhou Port to Chongqing. Especially for the needs of large-size and ultra-thin electronic glass transportation and storage, it is even more necessary to work with governments at all levels to further strengthen international capacity cooperation and development with other regions in Asia.

Third, the Chengdu-Chongqing region can actively integrate resources between the two places, enhance the status of logistics centers, improve logistics operation efficiencies, and thus jointly build an inland international logistics hub. Corning also expects to accelerate the upgrading of Chongqing Guoyuan Class B Free Trade Zone to the comprehensive Free Trade Zone. It can support an integrated industrial structure covering warehousing, logistics, trading, processing, as well as research and development. We believe this can further open the international market and integrate into the global industrial chain, value chain, and supply chain. The effectively integrated the industry, channel and port resources will also enable Chongqing to optimize resources and maximize the benefits.

Finally, during the epidemic, we have also seen that it has strategic values in establishing a transportation hub in Chengdu, Chongqing and the west China. The sudden epidemic in 2020 has completely changed the global logistics landscape. Restricted by international transportation capacity, cargo is frequently pressed into ports, and shipping costs are very high. For a global company like Corning, it is even more necessary to plan and establish multiple operational logistics centers. Chongqing will be the first choice of Corning and other multinational companies, due to its strategic location advantages, a complete multimodal transport system, and its highly adapted policy environment.

Part IV: Strengthen business environment, continue to expand

Continue to optimize the business environment

In recent years, foreign trade developed very well in Chengdu and Chongqing region, with imports and exports showing a rapid growth trend. High-tech products such as electronic manufacturing products are the main import and export commodities. Meanwhile, with the opening of China-Europe express trains, the deepening of the “Belt and Road” initiative, the implementation of the land-sea strategy, the overall improvement of the business environment, and the formal implementation of the Foreign Investment Law, Chongqing and other central and western regions have also become important targets for foreign investment. In 2020, during the epidemic, the actual use of foreign capital in Chongqing reached 10.3 billion U.S. dollars, of which 2.1 billion were foreign direct investment. The city has newly added 287 foreign-invested enterprises, a year-on-year increase of 28.7%.

In June 2020, the Chongqing Municipal Commission of Commerce issued the "Chongqing City's Measures for Further Utilization of Foreign Capital". In January this year, Sichuan Province issued the "Jointly Building an Inland International Logistics Hub Center". Both cities proposed to further enhance the opening up, investment promotion, and service guarantees for foreign investors. Chengdu-Chongqing economic circle aims to attract more foreign investment, by expanding the scale, optimize the structure, and improve the quality of foreign investments, and thus cultivate new advantages with cooperation and competition.

The Chengdu-Chongqing Economic Circle has both strategic positioning and supporting policies. It can be predicted that this will further assist, promote and build the western inland open highland in the fields of high tech, trade, logistics, and finance.

Corning's vision

As an innovative leader in material industry, Corning is confident in the further development of the Chengdu-Chongqing Economic Circle and is willing to bring more industry experience and innovative ideas here. Looking back on Corning’s history in Chongqing, from initial product coverage, to the investments in glass processing plants, logistics centers, and advanced melting furnaces, Corning China continued to invest in Chongqing to expand and strengthen the display industry chain. Corning's development history in Chongqing can also be seen as a demonstration of the sustainable foreign investment in the west.

The further development of the Chengdu-Chongqing Economic Circle results in more opportunities and possibilities. As an advanced materials company with more than 100 years of innovative genes, Corning is willing to bring more material innovations to the west. In addition to

The signing ceremony of Corning Display Glass Upstream Melting Production in Chongqing

Display technology, Corning is planning to further expand investment, including Gorilla cover glass for consumer electronics products and automotive glass for new automotive innovations.

Invest in China, root in China, and give back to China. Corning sees the infinite possibilities of Chongqing and the western region. We believe that Corning, as a good corporate citizen of Chongqing, can witness the synergetic development of the Chengdu-Chongqing economic circle, and witness the rise of a world-class economic, industrial, and innovation center in the near future.

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Suggestions and Prospects of Developing Modern Industrial System

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Contents

Chapter One The Industry Status Analysis of the Chengdu-Chongqing Area

1. Multiple Strengths Overall and Solid Development Base

In October, 2020, the Political Bureau of the Communist Party of China Central Committee deliberated on the *Planning Outline for the Construction of Chengdu-Chongqing Economic Circle*, which provided a grand blueprint for the development of the Chengdu-Chongqing area. Meanwhile, the considerable economic volume, strong industry foundation, and rich scientific reserve of the Chengdu-Chongqing area also serve as a solid base to support it to become "an important growth pole and new engine that powers the quality development across the country".

1.1 Positive Long-term Economic Growth Trend with the Opportunity of National Strategy

From the initial "Chengdu-Chongqing Economic Corridor", "Chengdu-Chongqing Economic Zone", and then "Chengdu-Chongqing City Cluster", to the current "Chengdu-Chongqing Twin City Economic Circle", the nation's top-level design pays an increasing attention on the development of Chengdu-Chongqing area, significantly elevating its strategic position from "the pivot of western development" to "the fourth pole of China's economic development". Following the national strategic opportunity, there are continuous positive policies and increased national support. The economy of the Chengdu-Chongqing area greets a long-term positive development period.

In recent years, the growth rate of national economy has slowed down. However, the economy of the Chengdu-Chongqing area has still maintained a relatively rapid growth. In 2020, the overall GDP of the Chengdu-Chongqing Economic Circle reached 6830 billion yuan, taking up 6.72% of the national GDP. Within the area, Chongqing and Chengdu are two national central cities whose economic volume reached 2,500 and 1,770 billion yuan, growing at the rate of 5.92% and 4.14% respectively. The overall growth rate of the Chengdu-Chongqing Economic Circle in 2020 stood at 4.62%, which was higher than the national figure (2.3%[1]). From the long-term perspective, the growth rate of Chongqing's economy has taken the lead nationwide for years and Chengdu has achieved the growth rate of over 8% for many consecutive quarters since 2017. The overall economic growth rate of the economic circle is impressive with a strong upward momentum.

Meanwhile, in the very special year of 2020, affected by the major public health event, the Covid-19 pandemic, the national economy in the first quarter went down by 6.8%, yet the figures in Chongqing and Chengdu only dipped by 6.5% and 3%[2] respectively. They suffered a lower degree of impact than the national average, showing relatively strong anti-pressure ability and economic resilience. With the great impetus provided by the national-level policy of economic

[1] Source of data: Wind
[2] Source of data: Wind

development, the Chengdu-Chongqing Economic Circle is expected to usher in unprecedented development in the future.

1.2 Coordinated Development of Industries with Gradually Strong Industrial Base

Through many years of exploration and development, the Chengdu-Chongqing area has built a comparatively solid industrial base. Firstly, there are quite a lot of traditional competitive industries in this area. As one of China's main grain-producing areas, Chengdu and Chongqing have a long history in agriculture. It plays a strategic role in China's basic grain production and its distinctive agricultural products of livestock and poultry, fruits and vegetables and silkworm also have a significant position in China. The Chengdu-Chongqing area also enjoys great advantage in the food and beverage. The iconic products in this area such as tea and white wine not only have distinctive local characteristics and historical profundity, but are also abundant in resources. In 2019, the total value of output in agriculture, forestry, animal husbandry and fishery in the Chengdu-Chongqing Economic Circle reached 878.5 billion yuan, 12%[3] of the nation, and its compound growth rate between 2010-2019 reached 12%, maintaining a high-speed growth.

Next, the Chengdu-Chongqing area has a good industrial base. Currently, it has basically formed an industrial system in which leading industries include electronics and information, equipment manufacturing, automobile and motorcycle production, biopharma, energy and chemical, and aeronautics and aerospace. Among them, the output volume and value of industries in electronics and information, automobile and motorcycle production, and equipment manufacture are at the forefront of the nation, with a strong competitive advantage. In 2020, the scale of the electronics and information industry in Chengdu and Chongqing totaled more than 1.7 trillion yuan, ranking among the highest in the country, with revenue from the manufacturing industry of electronics and information products above designated scale up 30.7% year-on-year. Microcomputer production volume in both cities together accounts for about 40% of the country's total, and in the manufacture of integrated circuits, production has nearly quadrupled[4] from 2014 to 2020. In addition, Chengdu and Chongqing are traditional automobile and motorcycle manufacturing centres. In 2020, the two cities produced about 2 million vehicles, accounting for an average of 10% of the country's output in the past 10 years, forming a relatively strong comparative advantage.

Moreover, the Chengdu-Chongqing area is building western financial centre in recent years. According to the ranking shown in the *China Financial Centre Index* (issue twelve), published in December 2020, Chengdu and Chongqing stood at 6th and 8th place respectively, making the top

[3] Source of data: Wind
[4] Source of data: Wind, Chongqing Bureau of Statistics, Chengdu Bureau of Statistics

10 of the regional financial centres, taking a significant lead over other western cities. In 2020, the financial sector added value of Chengdu and Chongqing were 221.28 and 211.48 billion yuan[5] respectively, ranking 5th and 6th in the country. Compared with other western provinces, the development of the financial industry in the Chengdu-Chongqing area takes a strong lead.

Meanwhile, the Chengdu-Chongqing area is also actively laying out plans for emerging industries. Currently, in the field of new energy, Chongqing actively plans the construction of wind power equipment industry base, and photovoltaic research and development (R&D) production base; Chengdu proposes to speed up R&D of the new energy. In the biological medicine area, Chongqing and Chengdu both encourages innovative biopharmaceuticals, and Chongqing has also put forward the development requirements of strengthening the national biopharmaceutical industry base. With policy support and scientific and technological cooperation, the development of emerging strategic industries will further promote the landing of R&D projects in the twin-city economic circle in Chengdu-Chongqing area, and it will in turn stimulate scientific R&D, playing a key role in the construction of "economic development center" and "science and technology innovation center".

1.3 Abundant University R&D Resources with High-level Talent Reserve

According to the latest statistics of the Ministry of Education, there are 200 general colleges and universities in the Chengdu-Chongqing area, of which 79 are undergraduate colleges and universities, and 55 are in Chengdu or Chongqing. There are 3 "first-class universities", and 7 colleges and universities with "first-class disciplines" in this area, which almost all concentrated in Chengdu and Chongqing. In May 2020, led by Sichuan University and Chongqing University, “University Alliance of the Chengdu-Chongqing Economic Circle” was formed with the collaboration of other 18 universities, which aims to cooperate in talent cultivation, team development, scientific research, discipline construction, social services, international cooperation, public resource sharing and co-construction, and system development, so as to provide scientific and technological support and intellectual support for the construction of the twin-city economic circle in the Chengdu-Chongqing region. On the basis of the high quality of local university resources, the national scientific research support is gradually spreading. By the end of 2020, the Chengdu-Chongqing region has 22 national key laboratories, 26 national engineering and technology research centers, and a number of other state-level scientific research institutions such as China Nuclear Power Research Institute, Southwest Electronic Technology Research Institute, Southwest Communications Research Institute, etc.

In addition, the Chengdu-Chongqing region has a wealth of high-level talent reserves. Since

[5] Source of data: Wind

2008, Chengdu and Chongqing have gradually entered the stage of population reflux, in which the proportion of intellectuals has increased significantly. By the end of 2018, the number of scientists and engineers in Sichuan Province and Chongqing has reached 519,000 and 218,000 respectively, and the number of high-level talents has been increasing steadily year by year[6].

1.4 Located in the Western Hinterland with Obvious Location Advantage

The Chengdu-Chongqing area is located in the intersection of the "Belt and Road", the Yangtze River Economic Corridor, and the New International Land-Sea Channel. Inwards, the Chengdu-Chongqing area can be connected to the Yangtze River Delta region through Yangtze River waterway and the railway and highway along the river, with the location advantage of connecting the east and west, and connecting the north and south. It is the potential region to build a new development pattern and expand domestic demand. Outwards, it can connect with Europe through the China-Europe Freight Train, and Southeast Asia through the New International Land-Sea Channel to achievement development momentum. The region can become an important spatial support for the integration of domestic and international resources and communication between domestic and international dual cycles, with a broad market size and huge development potential.

But on the whole, Chengdu-Chongqing Economic Circle still has certain gaps and weaknesses compared with the world-class city clusters. Meanwhile, with the further development of the new round of scientific and technological revolution and industrial revolution, and the global economic challenges brought by the coronavirus pandemic, along with the re-arrangement of the global industrial chain, supply chain and value chain, the industrial development of the Chengdu-Chongqing region is also facing many challenges.

2. Grasp the Opportunity of Internal Circulation, and Upgrade Industries

2.1 Prominent "Horizontal" Homogenization Competition

In horizontal comparison, although Chengdu and Chongqing have continued to promote industrial cooperation and gradually reduce administrative barriers in recent years, the dominant industrial layout of cities in the twin-city economic circle is still more convergent overall, and the overlap of major categories of local competitive industries is still relatively high. The homogenization competition among cities is very prominent. Internal competition for high-quality resources happens from time to time and there has not yet formed a cross-regional coordinated industrial development model, which delays the overall industrial upgrading.

As of 2018, using the main business income of industrial enterprises above the scale as indicators, Sichuan and Chongqing have comparative advantages in 19 and 12 industries in China,

[6] Source of data: Wind

including 9 overlapping ones, namely, railway ship aerospace and other transport equipment manufacturing industry, computer communication and other electronic equipment manufacturing industry, gas production and supply industry, non-metallic mining industry, printing and recording media reproduction industry, non-metallic mineral products industry, pharmaceutical manufacturing industry, water production and supply industry, general equipment manufacturing industry. They account for 47% and 75% of competitive industries in Sichuan and Chongqing, respectively, and are structurally convergent in the subdivisions of integrated circuits, smart terminals, and new displays, etc.

According to the statistical table of output value of industries above scale (categorized by industry) in the Chongqing and Sichuan Statistical Yearbooks, 34 of the major industrial output values were identified as basic data, and the industrial division of labor in 16 cities in the twin-city economic circle was quantitatively analyzed by similar coefficients of industrial structure $SimCoef = \sum X_i n X_j n / \sqrt{\sum X_{in}^2 \sum X_{jn}^2}$, the results of which are shown in Table 1. The similar coefficient of industrial structure between cities in the economic circle is greater than 0.8, more than 76% is over 0.9, and the industrial overlap ratio is relatively high.

	Chongqing	Chengdu	Nanchong	Deyang	Mianyang	Meishan	Ziyang	Suining	Leshan	Ya'an	Zigong	Luzhou	Neijiang	Yibin	Dazhou	Guang'an
Chongqing	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chengdu	**0.96**	1.00		-	-	-	-	-	-	-	-	-	-	-	-	-
Nanchong	**0.94**	**0.94**	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-
Deyang	**0.96**	**0.94**	**0.98**	1.00	-	-	-	-	-	-	-	-	-	-	-	-
Mianyang	**0.95**	**0.97**	**0.99**	**0.98**	1.00	-	-	-	-	-	-	-	-	-	-	-
Meishan	**0.96**	**0.92**	**0.97**	**0.99**	**0.96**	1.00	-	-	-	-	-	-	-	-	-	-
Ziyang	**0.93**	**0.94**	**0.97**	**0.97**	**0.97**	**0.95**	1.00	-	-	-	-	-	-	-	-	-
Suining	**0.95**	**0.94**	**0.98**	**0.97**	**0.97**	**0.96**	**0.99**	1.00	-	-	-	-	-	-	-	-
Leshan	0.88	0.86	**0.91**	**0.94**	**0.91**	**0.93**	**0.96**	**0.93**	1.00	-	-	-	-	-	-	-
Ya'an	**0.97**	**0.91**	**0.90**	**0.92**	**0.92**	**0.94**	0.89	**0.92**	0.89	1.00	-	-	-	-	-	-
Zigong	**0.96**	**0.97**	**0.98**	**0.97**	**0.98**	**0.96**	**0.96**	**0.97**	**0.91**	**0.94**	1.00	-	-	-	-	-
Luzhou	**0.94**	**0.92**	**0.94**	**0.90**	**0.93**	**0.90**	**0.91**	**0.95**	0.81	**0.91**	**0.93**	1.00	-	-	-	-
Neijiang	**0.94**	**0.91**	**0.97**	**0.97**	**0.96**	**0.95**	**0.97**	**0.98**	**0.94**	**0.91**	**0.95**	**0.94**	1.00	-	-	-
Yibin	0.88	0.88	**0.94**	**0.95**	**0.94**	**0.94**	**0.93**	**0.92**	**0.93**	**0.90**	**0.95**	0.86	**0.94**	1.00	-	-
Dazhou	0.89	0.85	**0.90**	**0.93**	**0.93**	**0.92**	**0.93**	**0.92**	**0.98**	**0.93**	**0.92**	0.85	**0.95**	**0.95**	1.00	-
Guang'an	**0.96**	**0.94**	**0.97**	**0.97**	**0.97**	**0.97**	**0.98**	**0.99**	**0.95**	**0.95**	**0.97**	**0.95**	**0.98**	**0.94**	**0.96**	1.00

Table 1: Similar coefficients of urban industrial structure in the Chengdu-Chongqing area

The industrial convergence phenomenon of Chengdu and Chongqing, the core cities in Chengyu's economic circle, is more obvious. When comparing Chongqing's "6+1" pillar industries with Chengdu's featured competitive industries, they show a high degree of overlap. Centered industries including electronics information, automobile, equipment manufacturing, petrochemical, etc. Taking the electronics information industry as an example, both cities regard it as the first leading industry and important growth points for economy, both made development plans for the chip design, wafer manufacturing, and packaging testing in the field of integrated circuit, and

produce glass substrates, LCD panels, display modules in the new display field.

Chongqing "6+1" Pillar Industries	Featured Industries in Chengdu
Electronics Information Industry	Electronics Information Products Manufacturing Industry
Equipment Manufacturing Industry	Mechanical Industry
Automobile Motor Industry	Automobile Industry
Petroleum & Natural Gas Chemical Industry	Petroleum & Chemical Industry
Energy Industry	
Material Industry	Construction Material Industry
	Metallurgical Industry
Consumer Products Industry	Light Industry
	Food and beverage and tobacco Industry

Table 2: Pillar Industries in Chengdu and Chongqing

2.2 Low Synergy in "Vertical" Development, Aggregation at Low End of Value Chain

In vertical comparison, the industrial development of most cities in the Chengdu-Chongqing Economic Circle is concentrated in the low value-added stages of the industrial chain, such as production and manufacturing, processing and assembly, etc. The product structure is relatively low and at the middle and low-end of the global value chain. Although some industries have their own advantages, the overall synergy is relatively low.

The lack of R&D and industrial coordination makes the traditional industries in the Chengdu-Chongqing region face crucial problems in the process of transformation and upgrading, such as the mismatch between R&D and market demand, and the inability of maximizing the value of industry.

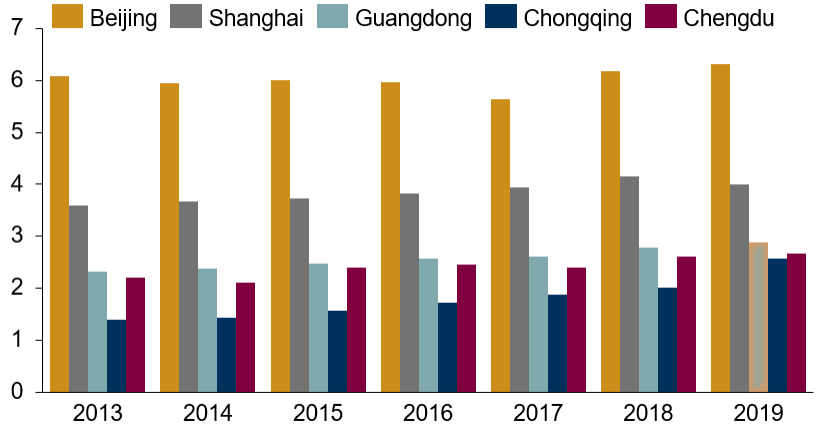
Take the semiconductor industry for example. Chengdu has a great industry base, with the market size of its integrated circuit industry leaping to the fifth in the country. Chongqing has also become the first choice of factory investment for many integrated circuit enterprises. However, industries in the Chengdu-Chongqing region mostly focus on back-end of the semiconductor production line such as OEM (original equipment manufacturing), sealing and testing, etc. In 2020, the market size of IC design in the Chengdu-Chongqing region only accounted for 5% of the semiconductor industry, well below the national average of 40%.

Meanwhile, the backwardness of R&D leads to the disconnection between R&D and the

production end, which makes the process of upgrading difficult for the manufacturing industry in the Chengdu-Chongqing region. There are more than 100 IC design companies, and a vast majority of them engage in the R&D of power IC. They have a relatively low integration with other industries like automobile manufacturing and equipment manufacturing industries in the Chengdu-Chongqing region. On the one hand, the market results of R&D transformation cannot land locally to bring industrial overlaying effect. While on the other hand the local manufacturing industry lacks the impetus for R&D, which makes industrial upgrading difficult.

Leading companies that directly face the market with more patience and more comprehensive mechanism are more pertinent in their R&D, and are more likely to convert R&D results into business results. In the Chengdu-Chongqing area, the lack of R&D directly led to inadequate development of leading enterprises in the area, unable to grasp the overall industrial power of discourse.

At the same time, although the R&D investment in Chengdu and Chongqing is increasing, but compared with other three core cities, Beijing, Shanghai and Guangzhou, there is still a certain gap. In 2019, the R&D investment in Chongqing and Chengdu is 23.91 and 45.25 billion yuan respectively. The intensity of R&D investment (R&D investment/GDP) is 2.56% and 2.66% respectively[7]. In the process of overall industrial expansion, the problem of "big but not strong, big but not excellent" is rather prominent, and there is still a lack of industry leaders with absolute leading edge and core competitiveness.



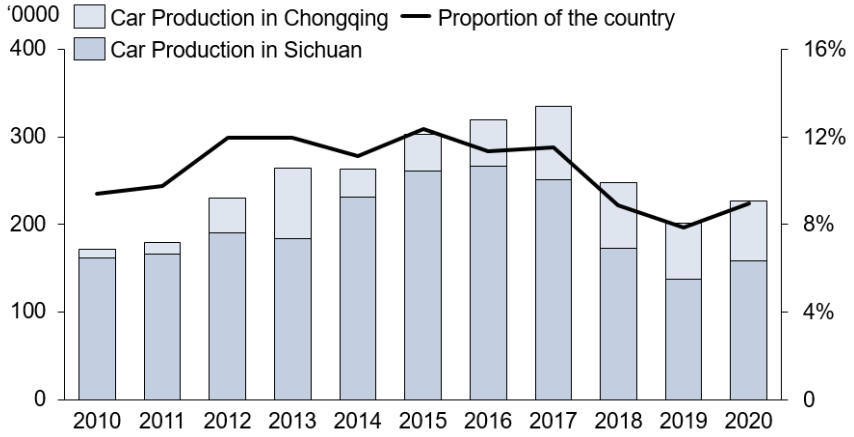
Graph 1: Comparison of R&D Investment Intensity with Three Core Cities (R&D Investment / GDP)

From the other aspect, the fact that the development of producer service industry lags behind has led to the gradual emergence of “degradation of high-end industry to the low-end” in some competitive industries. The development of producer service industry in the Chengdu-Chongqing

[7] Source of data: Chinese Academy of Science and Technology for Development; Wind

area started late, and the problem of system imperfection is rather prominent. Some producer services are still in their infancy such as industrial design, information services, science and technology services, energy conservation and environmental protection services, and supply chain management, etc. Services including productive leasing, vocational education and training are still weak. The relevant norms in financial services, Internet platforms, e-commerce and other fields are incomplete. Chongqing and Chengdu have not even released specialized statistics of value added of productive services as other eastern provinces like Guangdong and Jiangsu did.

Taking the automobile industry for example, China's current number of vehicles in operation has reached over 200 million, and the demand for passenger cars is gradually becoming saturated. The large reduction of the main market consumption, coupled with the development of urban transportation system, the improvement of the railway network and the motor vehicle limit policy, leads to the overall downturn in the automotive industry. Therefore, the automotive finance, Internet of vehicles, automotive add-on services and other fast-growing emerging industries are becoming an indispensable part of the development of the industry, and the lack of this part in the Chengdu-Chongqing region has gradually weaken the impetus of its huge industrial chain of vehicle manufacturing for the economic development.



Graph 2: Car Production Volume in Sichuan and Chongqing8

3. Pandemic Presents Challenges and Harbors Opportunities

The pandemic in 2020 brought certain impact on the Chengdu-Chongqing region. In the first quarter of 2020, the automobile and energy industries suffered from a considerable negative impact with a sharp downturn in trade volume, in which the car production volume went down 42% year-on-year. The value added of the energy industry above the scale decreased by 30% year-on-year. Industries such as textiles and clothing, chemicals, machinery, precision instrument and office

[8] Source of data: Wind

equipment also suffered setbacks. Commodities like fuels, mineral ores, metals, food and agricultural raw materials fell even more badly by a record amount.

However, at the same time, the outbreak has also brought new opportunities for the development of the Chengdu-Chongqing region.

As the situation in China improves, while the overseas outbreak continues to escalate, international logistics are seriously affected. Under the circumstance of hindered global sea transportation and air transportation, the China-Europe Railway Express has played an important role in maintaining the stability of global industrial chain and supply chain. By the end of 2020, the cumulative number of China-Europe Railway Expresses that departure from Chengdu and Chongqing reached 14,000, accounting for more than 40% of the total number of China-Europe Railway Express[9]. Moreover, Chengdu and Chongqing are also important initiators, promoters and operators of the new land-sea channel in the west as the fastest access to the sea in the western region. By March 2021, the destination of the new land-sea channel in the west has expanded to 264 ports in 96 countries and regions around the world[10], and has achieved rapid development against the trend during the outbreak. Relying on the location advantages of connecting the East and the West and linking the north and the south, the total import and export value of Chengdu and Chongqing in 2020 increased by 22.9% and 12.5% year-on-year, reversing the trend during the epidemic and reaching a record high. Chengdu even appeared as a dark horse that raced into the country's top ten foreign trade cities, with the import and export growth rate ranking first nationwide in 2020.

The outbreak has also led to an accelerated adjustment of the international division of labor system and economic order, and the global supply chain has re-positioned China as an important strategic location. Thanks to China’s effective measures on pandemic control, domestic production and logistics transportation have been largely restored, and the supply of industrial chain has recovered rapidly. However, the situation in the international trade market is not yet stable, and the pandemic has widened the development gap in all regions of the world. Due to the rising cost of trade caused by logistics restrictions, the contraction of trade financing in developing economies, and the decline in purchasing power of export-oriented economies, some foreign companies have moved back, and some industries has relocated, and production orders from the manufacturing industry of apparels and textiles and automobiles have returned to mainland China in large numbers. According to the survey by McKinsey in 2021, no buyers planned to increase purchase from China in the next five years before the outbreak, while 13% of purchasing executives are expected to increase their share of purchases from China after the outbreak. Among the reasons

[9] Source of data: Xinhua News Agency
[10] Source of data: Xinhua News Agency

for order flow-back, China's strong value chain integration capabilities play a key role as a raw material supplier.

As the most densely populated area in the west with the strongest industrial base and the most extensive market space, coupled with the advantage of operating cost lower than that in the eastern region, the Chengdu-Chongqing area has great advantages in the process of the global industrial chain returning to China. The economic scale of the Chengdu-Chongqing region has been among the best in the country, and its electronic information industry and automobile manufacturing industry have become important industrial centers in China. At the same time, it has three international logistics channels, i.e. the China-Europe Railway Express, the western new land-sea channel rail-sea transport line, the Yangtze River Golden Waterway, which connects the Central Asia, South Asia, Southeast Asia, Europe and western China, the Yangtze River Economic Belt and other domestic and foreign markets closely. The basis of developing the pan-Asian and pan-European supply chain configuration center has already been in place.

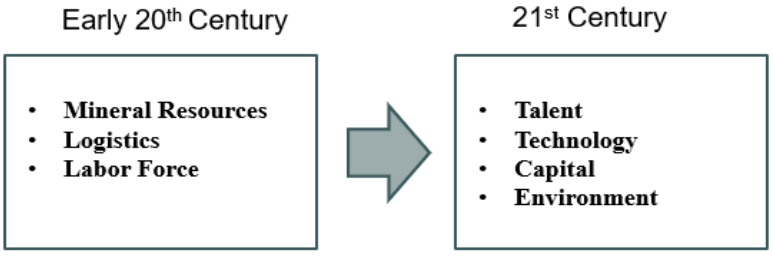
When the global manufacturing industry puts the spotlight back on China, the construction of industrial clusters in Chengdu-Chongqing Economic Circle should elevate its positioning to the height of the division of labor in the global industrial chain, seize the opportunity of the industrial chain returning to China, and further undertake the global industrial division of labor by using its location advantages to maximize the regional economic scale effect and synergy effect.

4. Co-build the Modern Industrial System, Nurture Advanced Manufacturing Clusters

The formation of the Chengdu-Chongqing Twin-City Economic Circle is not only conducive to accelerating the development of the western region, but also conducive to improving the quality of development of the whole country, which has extraordinary strategic significance. However, the Chengdu-Chongqing region still faces internal and external challenges such as similar industrial structure, low value added, the lack of R&D innovation mentioned above. How should the Chengdu-Chongqing region efficiently carry out industrial coordination and cultivate leading industrial clusters in the whole country?

Mike Porter, the proposer of the concept "industrial cluster" believes that the emergence of the original industrial cluster mainly depends on natural resources, logistics level and human resources. When a region possesses these three resource elements, it will naturally form an industrial cluster based on local natural resources; for example, the Detroit automotive industry cluster in the early last century is a typical initial industrial cluster. With the continuous development of science and technology, digitalization, robotics and other emerging technologies have shattered the industry's dependence on labor, and "data and technology" have replaced traditional natural resources to become a new element of global competition. Nowadays, the

necessary factors for building an industrial cluster have become “talent, technology, capital and environment”.



Graph 3: Change of Competitive Elements for Industrial Clusters

Then how to construct an advanced industrial cluster? The U.S. Competitiveness Selection Committee has proposed the following definitions for advanced industrial clusters.

1) Basic elements for industrial clusters: gathering of enterprise universities, rich human resources, and a comprehensive supply chain in the surrounding.
2) Developmental elements for industrial clusters: perfect innovation mechanism, including investment in basic research, preferential policies on R&D, involvement of venture capital, reserve of scientific research personnel, protection of intellectual property rights, and open and concise system of international investment and trade

Based on above definitions, it can be seen that the manufacturing industry in the Chengdu-Chongqing area already has the basic elements of industrial clusters, and further strengthening the developmental elements can lay a solid foundation for cultivating advanced manufacturing industrial cluster.

Through the benchmarking analysis of the advanced international experiences, this paper will make suggestions on how to perfect the development factors of industrial clusters from the perspectives of "cooperation mechanism of cross-regional industrial clusters", "talent cultivation and financial support" and "positioning of the role of the government in industrial cultivation", so as to help the Chengdu-Chongqing region form a joint force at an early stage and become a new driving force for the high-quality development of China's economy.

Chapter Two International Experiences of City Clusters with Different Power Sources for Reference

1. Oresund: A Model of Collaboration in Cross-border Industrial Clusters

The Oresund Region is a cross-border area between Denmark and Sweden, including the Danish capital Copenhagen and 13 administrative regions such as Malmo and Lund in southern

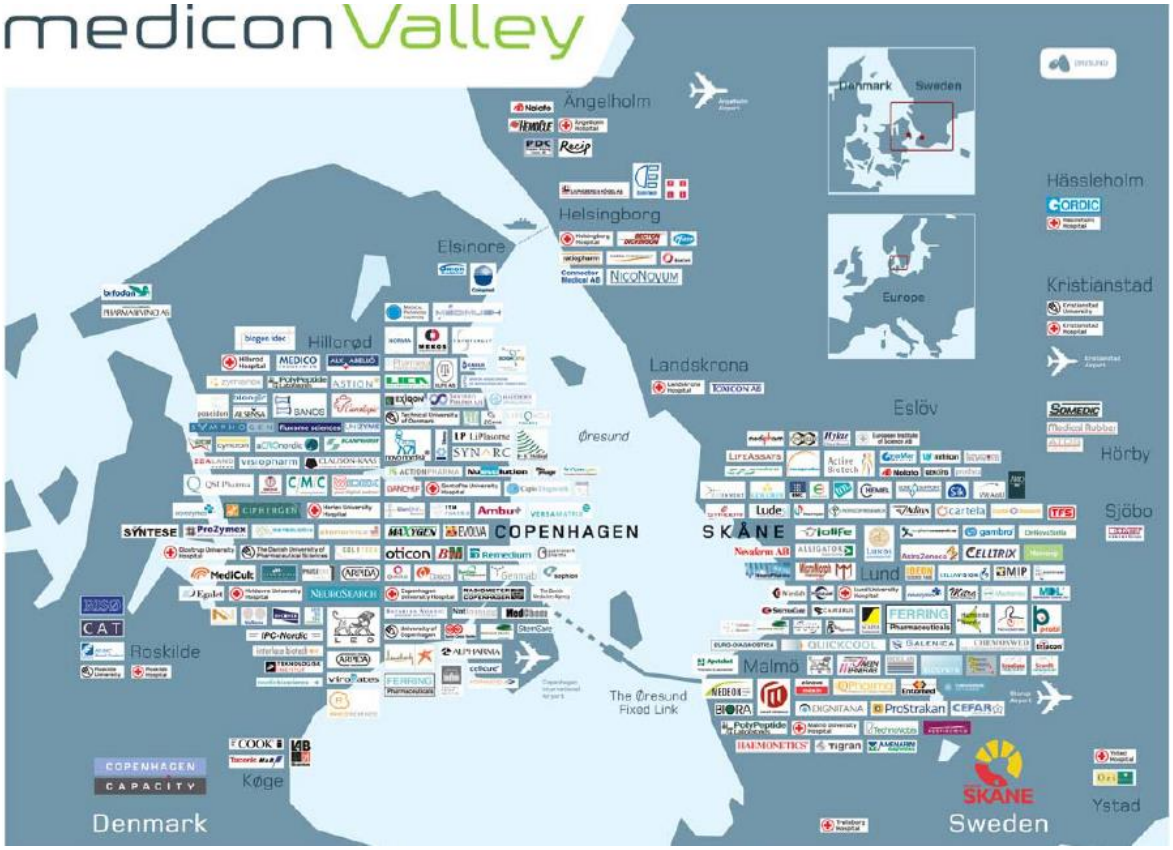
Sweden. The region, which spans both countries, is a world-renowned biopharmaceutical industry cluster with a GDP equal to about 29% of the combined GDP of the two countries. It is home to 3 million people, representing 22% of the population of both countries. It has nearly 350 pharmaceutical-related enterprises and employs nearly 30,000 people, including 4,000 research and technical personnel; and 26% of newly founded businesses in both countries are registered in this region each year. The two countries have built a collaborative industrial ecosystem in the region, creating open and cooperative business mechanisms, which is considered as "the best in cross-border regional cooperation" by the Organization for Economic Co-operation and Development (OECD).

In the 1980s, relying on local university resources, the Oresund region created new pharmaceutical and IT industrial clusters in the process of the transfer of traditional heavy industry to the Asian region. But at that time Denmark and Sweden on both sides of the Strait were at their respective stages of development. After the 1990s, local industries in both countries had a more urgent need to expand and attract talent. To this end, after the deliberation of the two countries' investment promotion agencies, the region was officially named as "Oresund", and began to work together to build a bio-industry cluster.

When building the industrial cluster in the region, the two countries have made the following coordination: 1) construct the infrastructure facilities and frame supporting tax mechanisms 2) establish self-governing committees to plan regional strategies with independent indicators 3) cross-border industry-government-research coordination.

Through the measures above, the two governments have strengthened the exchange of talents, funds and business in the Oresund region, ensuring the coordination and continuity of regional

development.



Graph 4: Layout of the Oresund Medicon Valley

1.1 Bridge Over the Oresund Strait, Expedite Economic Exchanges

In the early stages of the development of industrial clusters, in order to promote cross-border movement of people in the Oresund region and economic exchanges between the two places, the two countries spent 400 million euros in 2000 to build a 12-kilometre cross-sea railway road dual-use bridge. The bridge has shortened the traffic time between the two places to 35 minutes, which greatly shortened the traffic distance, reduced the costs of logistics and transportation, and provided great convenience for the personnel exchange and logistics communication between two places. Today, 70,000 people travel to and from the bridge every day for cross-border business activities.

Additionally, apart from building and perfecting the hardware facilities like transport networks, the governments of two countries also put forward special tax system for cross-border workers to ensure the movement of people within the region. For instance, Danish residents

working in Sweden can apply for a relatively low tax rate of 25%[11], which greatly promotes the interaction of technicians from both countries. Meanwhile, in order to facilitate the daily lives of cross-border workers, the Danish Government has also taken the lead in setting up a special platform for cross-border workers to provide information in regulations, social security, taxation, etc.

1.2 Establish Independent Evaluation System, Promote Collaborative Development

After completing the construction of infrastructure, two governments built a separate management system independent of the management system of the two countries, in order to avoid the inconsistency of the policies in two countries that may result in the unsustainable development strategy of the region and to ensure coordinated development.

First of all, representatives of two countries founded the Oresund Committee in the region, which is responsible for promoting the overall development of the local industrial cluster. Committee members are composed of people from the municipal, county, and other administrative units. Aiming at achieving win-win cooperation between two places, the Committee guarantees the interests of the Oresund region before national parliaments meetings of Denmark and Sweden, and lobby on behalf of the Oresund region at the national and international levels.

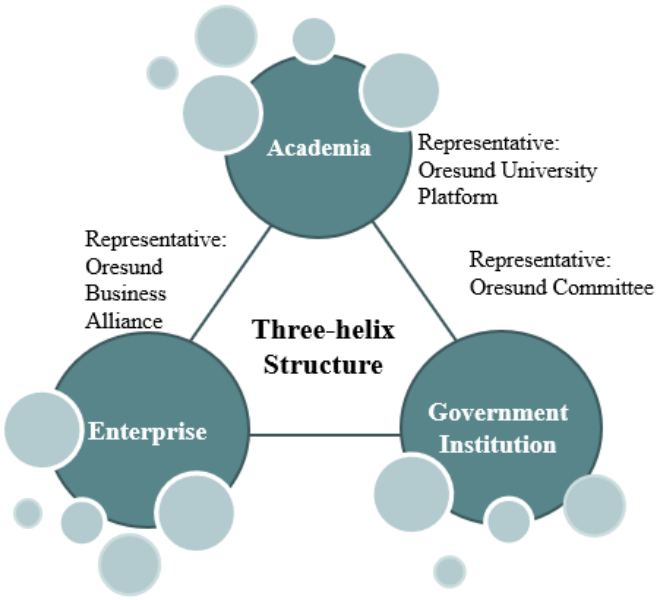
Second, the two governments worked together to establish a regional database, which evaluated Oresund as a whole and provided independent evaluation criteria. The Oresund database, co-established by the two governments, provides basic data of the Oresund region and publishes the Oresund Integration Index to assess the degree of integration in the five areas of labour market, transport communication, housing market, business, and culture. Founded in 2002, the non-profit Danish-Swedish association Oresund Institution, based on these data, provides research reports about the Oresund region for governments and businesses, etc. Based on these indicators, the Oresund Committee will also be responsible for developing a master plan that provides direction for the policies of the two governments in the Oresund region and ensures consistency of the regional policy and coordination of development between the two countries, to achieve the long-term healthy development of the industrial cluster.

1.3 Industry-Academics-Government Integration of Advantageous Resources, Collaboration for Regional Prosperity

The cooperation in the Oresund region is characterized by "multi-level" and "diversity", and the cooperation between government agencies, enterprises, and academic institutions of the two countries constitutes a three-helix structure. It can make the communication and cooperation

[11] Source of data: Bakertilly Tilly (Taxation consulting firm of Oresund)

between the subjects more efficient, and provide nutritious environment for project financing, the investment on scientific research and the transformation of the innovation results.



Graph 5: Three-helix Structure for Oresund

At the academic research level, in order to support Oresund's scientific innovation capabilities, Denmark and Sweden jointly build cutting-edge scientific research institutions and equipment in biological and medical areas, such as large-scale research and development facilities like split neutron sources and synchronous accelerated nuclear radiation laboratories, which can also reduce the cost and risk of individual investment while enhancing the scientific research capabilities of the Oresund region. In addition, the "Oresund University Platform" has been established in universities to enhance exchanges and cooperation among academia, integrating 150,000 students, 12,000 researchers, 14 historic universities, 5 science parks and 29 hospitals in the Oresund region.

At the corporate level, life sciences, pharmaceutical-related enterprises are attracted by policies and a strong academic atmosphere has created an industrial convergence in the Oresund region. To strengthen collaboration between pharmaceutical companies and academia, the Medical Valley Alliance was established in 1997 and it has more than 300 members to date, including 47 biotechnology companies, 58 contract production and research organizations, 6 universities for all biomedical research and a number of commercial and investment institutions. Forming an efficient communication platform through the alliance creates a cooperative, innovative and win-win atmosphere and improves Oresund's "brand effect" and its ability to attract investment.

2. Silicon Valley in San Francisco: Industrial Clusters Driven by Talent and Capital

The San Francisco Bay Area is the second largest metropolitan area in California, one of the

world's most important high-tech research and development centers, and the most important financial center on the West Coast of the United States. In 2019, the GDP of the San Francisco Bay Area is about $0.89 trillion, ranking 17th among the world's major economies, equivalent to the Netherlands' total. Major cities in the Bay Area include San Francisco on the San Francisco Peninsula, Oakland in the east and San Jose in the south, and Silicon Valley, the world's leading high-tech research and development base in the south. As the world's pioneer and development center of high-tech innovation, Silicon Valley brings together many world-renowned high-tech enterprises in electronics and computer industry, and thousands of high-tech company headquarters. Despite the continued growth of other high-tech regions in the United States and around the world, Silicon Valley maintains its global position with its core competencies.

Graph 6: Map of Some Technology Companies in Silicon Valley

Silicon Valley is developed from the former Stanford Industrial Park, founded in 1951 under the effort of a former vice-chancellor of Stanford University, which was the world's first highly integrated university industrial zone. There are 34 public universities, 49 private universities, and five national research laboratories in the San Francisco Bay Area, which together form an academic center in the Western United States. Surrounding the Stanford University and the University of California, Berkeley, it is also home to more than 3,000 high-tech industries and many research and development institutions that nurture top talent in high-tech, business administration, and more around the world.

Silicon Valley's rise is not simply based on the creation of industrial parks, incubators or the establishment of technology transfer offices, but built upon first-class universities, first-rate researchers and start-ups as the core to ensure that the region can continue to attract talent and gather capital, leading the global development of science and technology, through the system support of a complete set of "innovation incentives, commercial transfer applications, intellectual property protection and financial support".

2.1 Talent Cultivation and Industrial Development Under the Innovation Incentive Mechanism

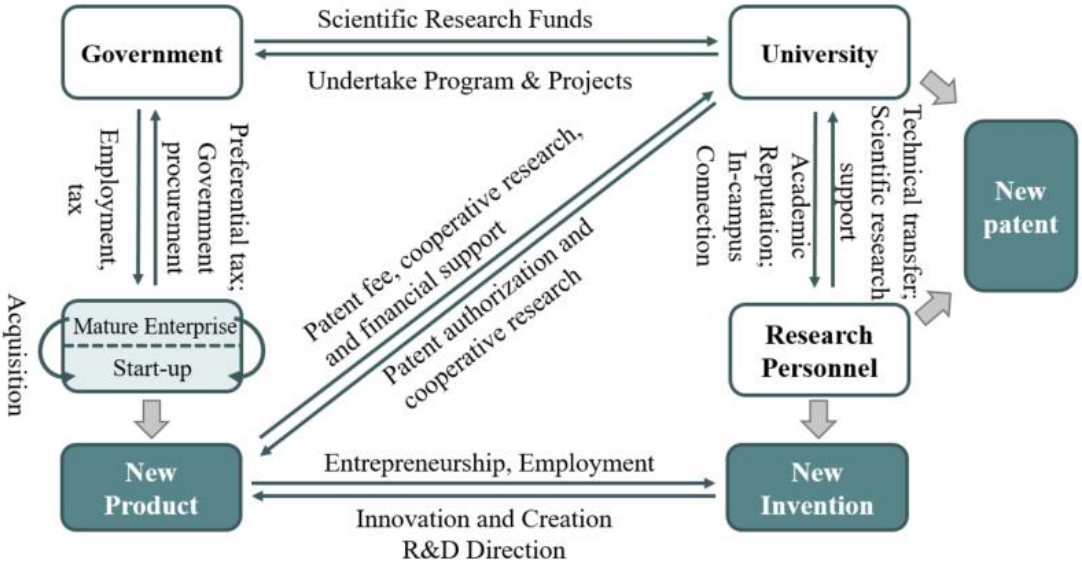
Silicon Valley makes sure that entrepreneurs are willing to implement their own business ideas here through the policy support of "innovation incentives, commercial transfer applications, and intellectual property transfer", while helping universities and institutions in the Silicon Valley continue to have opportunities to conduct R&D on cutting-edge technology and provide talent and technology reserves for the development of industry.

Silicon Valley has an independent special legal system. For instance, it can provide a range of free legal services for start-ups located in Silicon Valley, including new company registrations, drafting investment letters of intent, providing legal forms, and so on. At the same time, the U.S. government passed policies and bills that allow colleges and universities to grant patents for scientific research results to enterprises in the form of exclusive licenses or non-exclusive licenses, greatly reducing the time cost of converting technology patents into technology products to enter the market, and achieving a win-win situation for universities and Bay Area enterprises.

In terms of innovation incentives, the California government is actively pursuing the U.S. Government's Small Business Innovation Research (SBIR) program to help innovative companies gain business opportunities and commercialize technology. The SBIR system requires state governments to entrust a percentage of their projects to small and medium-sized businesses for the funding plans that are over $100 million when they make research and development investment in the public sector (aerospace, health, defense, energy). The commission of such projects needs to go through three phases. The first is based on the technology and feasibility reports of SMEs, at a certain cost (US$ 100,000) paid by the government. In the second phase, better projects are selected from the first-phase enterprises and project execution investment ($750,000) are made, and after the completion of the first two phases of the investment, the project can commercialize and SMEs can provide goods and services to the public market. This mechanism allows innovative enterprises to obtain initial funds in the early stages of start-up, and government procurement provides enterprises with opportunities of industrial application to help them improve their products and services. This makes it easier for companies to gain attention from venture capital firms after getting their products on the market. At the same time, the research achievements of universities, research institutions and other government research and development institutions can

be effectively transferred, and ultimately help train more local technical personnel to achieve the technical talent reserve.

In addition to its talent pool, Silicon Valley has also reduced the potential losses of the brain drain through policies. The California law, for example, prohibits the non-compete clause in employment contracts, meaning that a position with the confidentiality requirement will not be subject to limitation of not able to continue in the same industry for several years after leaving office. This law can facilitate the horizontal flow of talent between companies in Silicon Valley and help prosper the entire Silicon Valley talent system. Meanwhile, Silicon Valley supports school students and faculty to work on research inventions and entrepreneurial projects, allowing students on-campus to invest in invention and the faculty to engage in venture capital investment while they are on school leave. Stanford University, for example, offers rental benefits to startups and even office space for start-ups with the rent as little as $1.



Graph 7: Stanford University and Silicon Valley's Model of Industry and Research

2.2 Fully Usage of Market Funds, Intellectual Property Transfer Accelerates Investment Returns

The development of Silicon Valley cannot be achieved without the support of financial markets. A well-developed technology financial system and a constantly improving innovation system are key drivers for Silicon Valley to maintain its competitive edge. The San Francisco Bay Area has developed a technology finance industry driven by Silicon Valley as its industrial chain, as well as a complete investment system consisting of angel investment, venture capital and private

equity.

The help that capital market provides for industrial clusters, not only limits to the funds for enterprise development, but more importantly supports rapid improvement of industrial value. Due to the profit-driven nature of venture capitalists and angel investors' investments, they can be more professional in selecting investment targets and can effectively identify the most promising enterprises in the development of the industry. And in order to maximize the benefits, investors will inject a lot of resources to help enterprises improve management, expand sales, and ultimately realize the rapid improvement of enterprise value. They accelerate the transformation of scientific and technological achievements into productivity, and push the rapid expansion of high-tech enterprises from small to large, from weak to strong, thus promoting the vitality and prosperity of the entire economy.

As a result, from an early stage, Silicon Valley has developed a number of policies to attract capitals to invest here. Taking the reference of the California government's policy, in order to attract capital investment, the government mainly introduced the following policies.

Lower tax rates and increase investors' profit opportunities. Back in 1978, the California government enacted a tax bill that cut the capital gains tax rate from 49.5 percent to 28 percent, dramatically boosting the return on successful investments and allowing large amounts of capital to quickly enter Silicon Valley. In 1987, the California government cut the tax on research and development earnings from 49 percent to 25 percent, making more investors willing to invest in start-ups, not just more established ones.

Financial innovation, activate capital markets to increase financing channels for small and medium-sized enterprises. In 1979, California's government loosened restrictions on pension funds, allowing huge pension funds to enter the field of venture capital, which made Silicon Valley's venture capital market expand rapidly from $600 million to $3 billion that year. In 1981, the California government also provided financing channels and tax incentives for companies within the state, including SME loan guarantee programs, research and development tax subsidies, and eligible research and development spending could receive 15 percent of the annual research over-expenditure (50 percent of the current year's research costs at minimum) or 24 percent of the basic research expenditure paid to third-party organizations.

Comprehensive property rights trading platform to ensure the high return and high utilization of capital. California is the world's first region to introduce equity incentives, and around the appearance of the incentive system, with active transaction tax policies, California helps investors achieve arbitrage through the M. A, OTC, IPOs and other property rights transactions, which promotes the high yield and high turnover rate of market capital. According to statistics, in

2020, about 40% of venture capital funds across the United States went to start-ups in Silicon Valley. In the same year, IPOs from Silicon Valley rose 117 percent, and the market value of companies in Silicon Valley and San Francisco climbed 37 percent overall to $10.5 trillion[12]. While many parts of the country are attracting more start-ups, Silicon Valley has yet to see a clear rival.

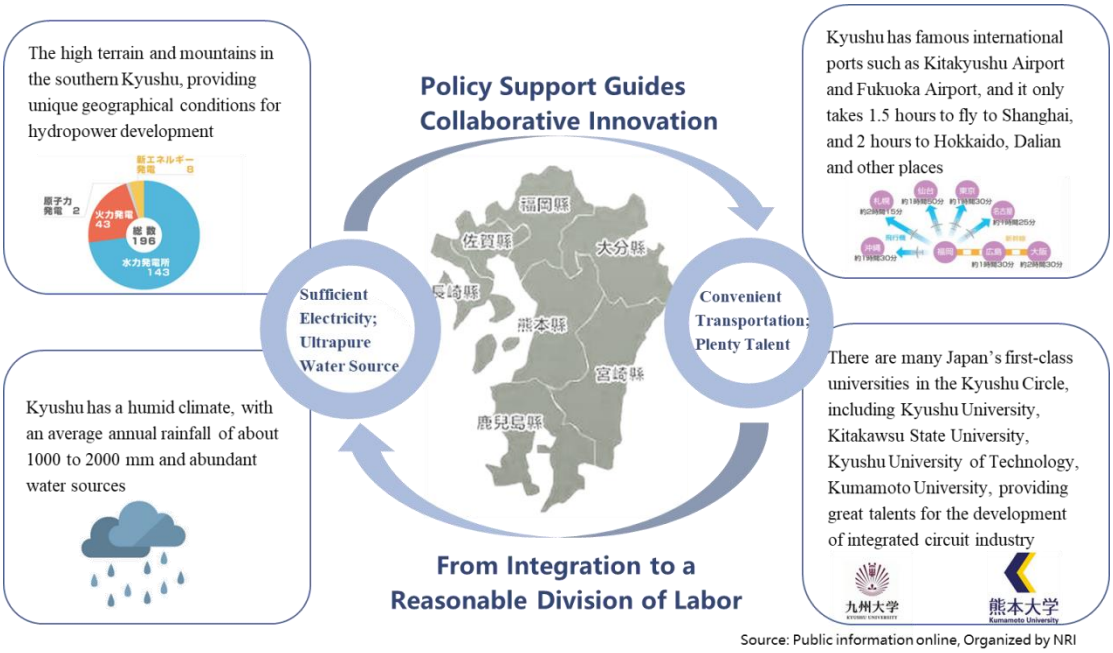
3. Kyushu Japan: A World-class Government-driven Semiconductor Industry Cluster

3.1 Underwent Twists and Turns in Development, Achieve Reborn through Industrial Upgrading

As Japan's third largest island, Kyushu's semiconductor industry has become one of the eight major chip industry centers in the world since the 1960s, having an important position in the global industrial chain. Kyushu now gathers more than 200 of the world's top semiconductor equipment manufacturers and component manufacturers, forming an industrial chain with the whole process from upstream raw material supply to midstream design-manufacturing-packaging-testing. Many well-known companies have production bases here including Sony, Toshiba, Hitachi, Mitsubishi, Fujitsu, Xinyue Chemical Industry, Tokyo Electronics, etc., whose semiconductor production volume accounts for about 40% of Japan's total.

Historically, Kyushu has been Japan's gateway to the Asian continent, with its excellent transportation network, abundant water resources and labor force. It shares many natural and geographical advantages with the Chengdu-Chongqing region. Kyushu's superior conditions has attracted many semiconductor enterprises to set up factories here since 1965. By 1985, Kyushu's production volume of the integrated circuit accounted for 44% of Japan's total, making it the world's second-largest cutting-edge technology industry cluster after Silicon Valley.

[12]Source of Data: Silicon Valley Index

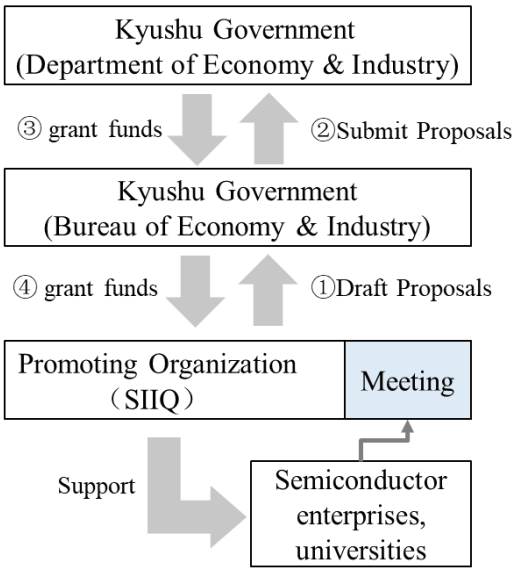


Graph 8: Kyushu and Chengdu-Chongqing Share Similar Regional Advantages in Semi-conductor Industry Development

However, after the collapse of bubble economy in 1995, some large semiconductor enterprises gradually transferred production plants overseas in order to reduce cost. Meanwhile, most of R&D institutions and personnel of key enterprises are still mainly concentrated in Tokyo and other major cities, and Kyushu semiconductor industry gradually become a shell with only production and assembly-oriented small and medium-sized enterprises, which was disconnected with and design and R&D. It was even described as "mindless Silicon Valley." In order to revitalize Kyushu's semiconductor industry and thus reshape the semiconductor economy of Japan as a whole, the Japanese government has adjusted its regional industrial policy, actively introducing research and development centers and chip design enterprises through the cultivation of high-tech industrial clusters, and promoting regional economic revitalization through industrial transformation and upgrading, and eventually developing the region into a world-class semiconductor industry cluster.

3.2 Government-led Upgrading of Industrial Clusters with a Significant Guiding Role

The Japanese government launched the *Industrial Cluster Plan* in 2001 and provided a lot of financial support, including one of the key industrial cluster projects, for which the Kyushu government formulated the "Silicon Island Industrial Cluster Plan". And the government led the establishment of a promotion organization to promote the upgrading of semiconductor industry clusters.



Graph 9: The Promotion System of the Industrial Cluster Upgrading Plan in Kyushu

The whole plan is divided into three phases for execution. Phase one, from 2001 to 2006, is the initial stage of industrial cluster. The main responsibility of government in this stage is to develop the necessary basic conditions that the industrial upgrading needs, including setting up promotion system, opening up channels of industry-academia-government communication, and perfect infrastructure. In 2002, the Kyushu government led the establishment of the Kyushu Semiconductor & Electronics Technology Innovation Association (SIIQ), whose members are heavyweights of local governments, enterprises and universities, etc., and it is generally chaired by managers of large enterprises in rotation. Its primary role is to build a communication platform for industry, academia and the government, to promote the virtuous circle of knowledge creation and industrial vitality, and to coordinate the resources of all parties and continuously promote the upgrading of industrial clusters in Kyushu. Secondly, in November 2004, the Fukuoka LSI (large-scale integrated circuit) Integrated Research and Development Center was established, which aimed at training semiconductor professionals, promoting semiconductor-related research and development, cultivating a number of start-ups, with Fukuoka's geographical advantages connecting with China, Hong Kong, Taiwan, India, and Singapore, to build the "Fukuoka Sea Silicon Belt." So far, the promotion system of semiconductor industry upgrading and the core research and development system have been established.

2006-2010 is the second phase, which is the growing stage of industrial clusters. At this stage, the government's main responsibility is to make full use of the existing system to link the industry with domestic and foreign resources, forming Kyushu brand. SIIQ collected more than 2,500 commercial prototypes from 21 universities in Kyushu during this period and selected 70 projects

with higher commercial possibilities to introduce to the relevant companies[13]; implemented the *Core Manufacturing Talent Development Program for Production and Academic Cooperation* in 2005, which involves enterprises and universities, with the aim of training professionals who are familiar with the design, production and the entire technical flow of semiconductor industry; explore advanced semi-conductor technology, expand the global market and take the opportunity to promote the brand of Kyushu semiconductor industry cluster through holding international conferences, and exhibitions to facilitate the alliances between local enterprises, research and development institutions and oversea enterprises

The third stage, 2011-2020, is the period of independent development of industrial clusters, when the government gradually withdraws, allowing the financial independence and self-development of industry clusters, while further promoting the formation of industry-academia-government cooperation networks. SIIQ, as the main promoting organization for industrial upgrading, has relied mainly on government funding for its operations since its inception. And this grant gradually declined as the industrial cluster matured. By 2010, the government stopped funding altogether. Replying on the membership fee system introduced in 2007, SIIQ gradually changed from a government-based organization to a civil society organization, and continued to accompany the growth of Kyushu industrial clusters.

Overall, the Japanese government plays an important role in the upgrading of Kyushu's semiconductor industry. The central government mainly formulates the overall framework and financial supports at the top-level, while the local government actively exerts its subjective initiative to participate in the upgrading of industrial clusters. In the early stage and the growth stage of industrial clusters development, the government built a good network and channels of industry-academia-government cooperation and improved the industrial innovation ability and technological transformation capacity of scientific research institutions, laying a solid foundation for the independent development of the industry. At the same time, the government did not interfere excessively in the development of industry, instead taking the position of providing guidance and support from the beginning to the end and also timely minimized government interference as the industry matures, allowing enterprises and technical institutions to promote industrial development and to ensure the direction and efficiency of industrialization.

Chapter Three Pathways of Building a Modern Industrial System

1. Deepen the Industrial Base and Build a World-class Industrial Cluster

1.1 Deepen the Coordination and Cooperation to Accelerate the Construction of Integrated

[13] Source of Data: SIIQ

Development Mechanism

The Chengdu-Chongqing Economic Circle belongs to Chongqing and Sichuan province. We should gradually weaken local protection, remove administrative barriers, and speed up the construction of a unified, open and orderly coordination mechanism of integrated development. In the first half of 2021, the cooperation mechanism has begun to bear fruit, with 248 bilateral cooperation agreements signed, 13 co-designed plans (programs) proceeded and 10 functional platforms for regional cooperation planned[14]. In the next step, more should be done to accelerate policy landing, deepen coordination and collaboration, and facilitate project advancement from many angles.

At the provincial and municipal levels, multi-level promotion mechanisms can be established to formulate specific action plans and special promotion programs and to implement main strategies and tasks identified in major development plans. We suggest to form a coordination mechanism aimed at coordinating industry development in the Chengdu-Chongqing region, to jointly set up a work group for the promotion of industrial coordination and development in the twin-city economic circle of Chengdu-Chongqing region, and to study such matters as industrial planning layout, promotion of major industrial projects, and integrated construction of industrial support services. At the same time, we can also explore the establishment of projects that separate research and production in the twin-city economic circle and the GDP score and tax sharing mechanism between the export region of industrial transfer projects and the region that undertakes the projects. In the economic circle, the enterprises value-added sharing and statistical methods shall be discussed and nailed down for industrial transfer, which allows different cooperative cities to share the GDP indicators in proportion for industrial transfer projects. The new value-added tax and income tax brought by cross-provincial, cross-city cooperative projects, the local part can be shared among cooperative cities proportionally.

At the regional level of the Chengdu-Chongqing area, the coordinated promotion mechanism of economic centers and science and technology innovation centers can be set up on the basis of the working mechanisms established so far, so as to further study and promote the major issues in the construction and development of economic centers and science and technology innovation centers. Meanwhile, it is necessary to strengthen the professional support for the development of the twin-city economic circle in Chengdu-Chongqing region, to establish an expert advisory committee for the research and study of the relevant major strategies and policy issues in order to support better decision-making, so as to better play as a role model for the "integrated development" of key areas. In addition, the economic circle can promote the accreditation of high-tech enterprises, double software accredited enterprises and other enterprise qualifications in the

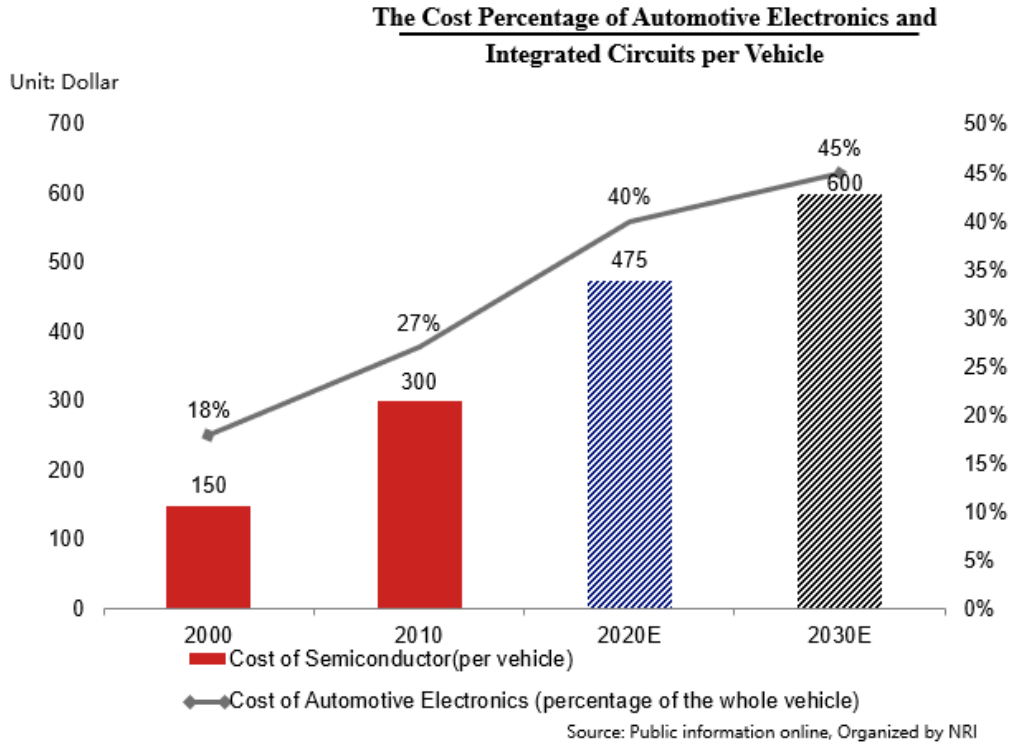
[14] Source of Data: National Development and Reform Commission

Chengdu-Chongqing region and achieve mutual recognition for enterprises within the twin-city economic circle to enjoy the same preferential policies. A unified preferential policy for investment can be implemented within the twin-city economic circle. The economic circle can also jointly set up a fund for industrial co-development, and jointly build a special fund for industrial development to support industrial transfer, undertaking and structural upgrading.

1.2 Integrate Advantageous Resources and Promote World2-class Industrial Clusters in Key Industries

Industrial upgrading is the key to the high-quality development of cities. The Chengdu-Chongqing region can integrate advantageous resources on the basis of the existing traditional competitive industries to push the existing main industries forward in forming world-class industrial clusters. And the most suitable industries for pioneering industrial clusters in the Chengdu-Chongqing region should be the electronic information industry and automobile and motorcycle industry. As mentioned above, the total size of the electronic information industry in Chengdu and Chongqing exceeds 1.7 trillion yuan in 2020, and the output of microelectronic computers in the two places account for about 40% of the country's total. In addition, the car production volume of Chengdu and Chongqing accounted for about 10% of the national output, and the two industries have formed a strong industrial base and industrial support in Chengdu, Chongqing and surrounding areas. At the same time, with the development of AI and 5G technologies, now the automotive industry's electronic transformation is also accelerating, and the

integration of the two industries themselves is also increasing.



Graph 10: Increasing Proportion of Automotive Electronics in Manufacturing Cost

Chengdu and Chongqing should rely on the existing industrial base and connect the universities and scientific research institutions of the two places to carry out the overall upgrading of industrial clusters. Making full use of the geographical advantages and logistics advantages, the Chengdu-Chongqing region stands a great chance of establishing a high value-added industrial cluster with a comprehensive industrial chain.

In the field of electronic information industry, we can utilize the existing research and development technology base in Chengdu region and the rich downstream application base of Chongqing region to further strengthen the alliance. Using rich scientific research resources, smart manufacturing and electronic information industry clusters can be built to jointly work on key technology development and high-end product manufacturing applications in the fields of core devices, integrated circuits, information security, etc., promoting the coordinated development of the two places to co-build the artificial intelligence industry highland in the west. At present, Chengdu has signed a number of major projects that focus on advanced computing, high-end packaging and testing, next-generation display technology and other fields, including the whole industry chain project of the Hygon server chip, high-end semiconductor technology R&D and manufacturing center project, Micro-LED advanced display technology R&D and industrialization

verification project, etc. Chongqing has signed a series of major projects in the field of integrated circuit manufacturing, technical platform, next-generation display technology and so on, including China Resources Microelectronics 12-inch power semiconductor wafer manufacturing project, CUMEC (United Microelectronics Center), BOE Technology 6 generation AMOLED panel project. Meanwhile, the China Electronics Corporation will also join the game. Two partners will focus on two directions — digital economy and the construction of modern digital cities, and carry out in-depth cooperation in the construction of the Southwest Information Technology Application and Innovation Industrial Demonstration Center, software industry park, southwest R&D center and data center of the modern digital city, and so on.

When co-building the industrial park and docking industries, we should also encourage large groups and enterprises to participate in the supply chain investment, accelerate the introduction of major projects and industry leaders, and promote the large-scale industrial development. And we should attract and gather resources worldwide in order to create a world-class electronic information industry cluster through the lead of first-tier enterprises and major projects in upgrading the industrial chain and value chain to a high-end version.

Whilst the development of the electronics industry, in the field of automobile and motorcycle industry, advantages of resources in the Chengdu-Chongqing region should be integrated to build a leading nationwide and important worldwide automotive research and development base. Currently, there are altogether 45 automotive enterprises and more than 1600 auto parts enterprises above scale in the Chengdu-Chongqing region with annual output of nearly 3 million vehicles, and annual output value of more than 600 billion yuan. In the first half of 2021, the auto industry in the two cities grew strongly, with the value added of Chongqing's auto industry increasing by 25.3% year-on-year and Sichuan's by 18.4%. Therefore, on this basis, we can strengthen and promote in-depth cooperation in the automobile and motorcycle industry in aspects of vehicle R&D and design, key components support, construction of testing service platform and others, strengthening and perfecting the automobile motorcycle industry and its supporting industries to jointly build a world-class automotive industry research and development and manufacturing base. Since 2020, the coordinated development of the automotive industry initiatives has continued: the establishment of Chengdu-Chongqing Automobile Industry Alliance, and the launch of the online supply and demand information platform of the automobile industry chain in the twin-city Chengdu-Chongqing economic circle. In 2021, "Sichuan-Chongqing Automobile Industry Chain Supply-side Collaborative Work Programme" was issued, to introduce a batch of leading enterprises and projects for enhancing the industrial chain from all aspects, to further improve the components procurement proportion of vehicle enterprises in the Chengdu-Chongqing region, and to effectively develop the vehicle and components production enterprises in this region into a

world-class industrial cluster.

At the same time, the cross-field innovation integration demonstration zone of the automotive industry can be built, focusing on collaborative innovation in intelligent network, anthropomorphic driving, hydrogen-fueled vehicles, distributed driving, automotive wire control, automotive big data and other fields to build a world-class automotive industry base. In 2020, the China Automotive Research Intelligent Connected Automobile Test Base was officially completed in Chongqing, which became the first "national intelligent connected vehicles pilot area" in the west that would complement the R&D weak link of intelligent connected vehicles in Chongqing. It could form a complete production cycle for intelligent connected vehicles from research and development to testing, and then mass production, promoting the transformation, upgrading and great leap forward of Chongqing automotive industry. Meanwhile, Chengdu also attaches great importance to the development of the green intelligent connected automobile industry, aiming at accelerate the construction of the green intelligent connected automobile industry ecosystem. At present, Chongqing already has such research and development leaders like China Automotive Engineering Research Institute Co., Ltd. Chengdu has gradually attracted Huawei, WM Motor, Siemens and other institutions with outstanding research and development capabilities. In the face of such a new high-tech field as the intelligent connected automobile, mutual integration and cooperation between the two cities will lay a solid foundation for creating a world-class automotive industry cluster in the region.

2. Soften the Industrial Structure and Promote Efficient Industrial Integration

2.1 Strengthen Industry-Academia-Research Cooperation and Improve Regional Innovation Capabilities

After years of accumulation, the Chengdu-Chongqing region has already gathered a strong strength in the basic industry capacity. However, the two cities are still weak in the high value-added aspects of the industry. Industrial softening and upgrading are the common demand of the two places. The Chengdu-Chongqing region needs to vigorously build a comprehensive innovation and entrepreneurial service system that shares resource and coordinate services, so that enterprises could truly become the main body of innovation, and promote the close integration of technology and industry. Moreover, in the forefront research of industrial development, we should select key areas such as electronic information, equipment manufacturing and other technology-intensive areas to enhance the innovation application capacity of the Chengdu-Chongqing economic zone through the long-term continuous cultivation of high-tech industries.

The Chengdu-Chongqing Economic Zone can promote the deep integration of innovation among enterprises, universities and research institutions based on the advantages of numerous research institutions and universities in this region and the objective conditions of innovation-led

trend in central China, and accelerate the transformation and application of cutting-edge technology. In addition, it is necessary to gain a deeper understanding of the technological innovation system in scientific research institutions and universities, in order to provide them with more financial assistance, which could promote the rapid rise of high-tech industries, facilitating the development of key industries in the Chengdu-Chongqing Economic Zone.

Silicon Valley's virtuous circle system of industry and research enables small and medium-sized enterprises to grow rapidly and become the driving force of industrial upgrading. Therefore, the Sichuan-Chongqing economic zone can also smooth the supply and demand pathways for research institutions, universities, and enterprises, to accelerate the process of commercialization and value-added of technological innovation. In addition, we will further promote the construction of the Chengdu-Chongqing National Science and Technology Achievement Transformation Demonstration Zone, focusing on the actual demand for scientific and technological innovation in the economic and social development of Chengdu-Chongqing Economic Zone, especially during the supply-side structural reform. Efforts should be made to break regional restrictions on sharing of the scientific and technological achievements, realize the cross-regional transfer and open sharing of innovative resources, and enhance the strength of the two places in the high value-added sector of industry.

2.2 Promote the Coordinated Development of Talents and Increase Financial Support

In recent years, the pattern of talent flow has gradually begun to change. Since 2008, Chengdu-Chongqing has gradually entered the stage of population reflux. Under the circumstance, the Chengdu-Chongqing area should plan the introduction, flow and allocation of human capital from a holistic perspective and develop a new pattern of coordinated development of talents.

Taking the case of San Francisco Silicon Valley for reference, in the new era of cross-regional talent development, more policies and measures can be introduced to attract high-level talent, for scientific research personnel, university engineering talent, key industry talent, financial market talent, etc. and to enhance the interaction of the industry and talent and improve the level of human resources development. At the same time, a full-cycle development plan for talents can be implemented in the Chengdu-Chongqing district to promote the rational distribution of talent resources, and an integrated policy framework can be designed to promote the coordinated development of talent. In addition, Chengdu-Chongqing region should also create an ecological environment of talent, an open and livable place to attract more domestic and foreign talent, providing a solid foundation for the development of Chengdu-Chongqing economic circle.

The increased support of funds is also crucial on the basis of talent reserve for the Chengdu-Chongqing economic circle. Referring to the case of San Francisco Silicon Valley, its active

venture capital policy has been helping start-up high-tech enterprises to grow rapidly and massively, and the support of preferential policies such as finance and taxation has also played an important role in the transformation of innovative technologies. The financial sector should focus on the problem of the lack of independent innovation ability in manufacturing industry, try to strengthen medium and long-term financial support for technological innovation and technological transformation and upgrading in manufacturing industry, actively expand diversified financing channels for small and medium-sized manufacturing enterprises, and promote structural adjustment and transformation and upgrading of manufacturing industry. At the same time, we should deepen the credit loan policy on the value of intellectual property rights between the two places, jointly promote the implementation of the policy, and accelerate the transformation of scientific research achievements between the two places. Additionally, the role of equity financing should not be neglected. We should accelerate the listing process of high-tech enterprises in small and medium-sized board, Growth Enterprises Market, and other capital markets, consolidating the long-term capital strength and accelerating the development of industries in the Chengdu-Chongqing region.

Promote the Integrated Development of Advanced Manufacturing and Modern Service Industries in Chengdu-Chongqing Twin-City Economic Circle to Drive China-EU Economic Cooperation

Dr. Chenhong Huang
Global Executive Vice President, SAP SE and President, SAP Greater China

Nowadays, China is faced with complex changes in both internal development conditions and external environment. Internationally, the world is undergoing unprecedented changes of the century. The COVID-19 pandemic accelerated the profound landscape changes in global economy, science and technology, culture, security and politics. The world is entering into an era of transformation. Domestically, due to the timely and effective prevention and control of the COVID-19 pandemic, China's economy sees a continuous rebound, with GDP growth of 2.3%YoY in 2020, making it the only major economy to achieve positive growth in the world.

According to the report of the 19th CPC National Congress, China's economy has entered a new phase of transitioning from high-speed growth to high-quality development, and it is in the pivotal process of transforming the development pattern, optimizing the economic structure and upgrading the growth drivers. The principal contradiction facing Chinese society has evolved significantly into the contradiction between unbalanced and inadequate development and the people's ever-growing needs for a better life. High-quality development has undoubtedly become the long-term theme of China's economic and social development, the essence of which is a long-term task driven by both reform in growth drivers and reform in efficiency. The reform in growth drivers is to take the digital economy as the new engine of development, while the reform in efficiency is to take the digital transformation as the new mode of development.

In the first year of the 14th Five-Year Plan, China starts a new journey towards a modern socialist country. The 2021 Government Work Report clearly proposed to accelerate digital development, create new advantages of digital economy, collaboratively promote digital industrialization and industrial digital transformation, accelerate the pace of digital society construction, improve the level of digital government construction, and build a digital China during the period of the 14th Five-Year Plan.

The 14th Five-Year Plan is a critical five-year for Chongqing to solidly promote high-quality development, open up a new era and write a new chapter for economic catch-up. Led by the Long-Range Objectives Through the Year 2035, Chongqing has set the guidelines for development under the 14th Five-Year Plan. Firstly, thoroughly implement the important instructions given by General Secretary Xi Jinping to Chongqing, to create a favorable political ecology, to adhere to the Two

Points positioning, Two Places & Two High goals, and to leverage its Three Roles to promote the construction of Chengdu-Chongqing Twin City Economic Circle. Secondly, accurately grasp opportunities in the new development stage, deeply practice the new development concept, actively integrate into the new development pattern, and effectively take on the new development mission. Thirdly, adhering to the general keynote of making steady progress, integrate development and security by taking high-quality development as the theme, deepening the supply-side structural reform as the main line, reform and innovation as the fundamental driving force, and meeting the growing needs of the people for a better life as the ultimate goal. Fourthly, accelerate the construction of a modern economic system, promote the modernization of the governance system and governance capacity, achieve steady and sustainable economic growth and maintain a stable and harmonious society, thus ensuring a good start for the new journey towards a modern socialist country.

On this basis, Chongqing has established 11 major strategic tasks under the 14th Five-Year Plan, including: 1) adhering to innovation-driven development, accelerate the construction of a sci-tech innovation center of national influence; 2) deeply promote the construction of the Chengdu-Chongqing Twin City Economic Circle, and continue to release the spatial layout optimization effect of One District Two Clusters; 3) strengthen the modern industrial system, and strive to promote the optimization and upgrading of the economic system; 4) relying on the strong domestic market, deeply integrate into the new development pattern and take on new roles; 5) promote the integrated development of urban and rural areas, and coordinate the revitalization of rural areas and upgrading of urban areas; 6) comprehensively deepen reform from a higher starting point, and build a high-level socialist market economic system; 7) implement a higher level of openness, and accelerate the construction of an open high ground in Inland China; 8) prosper the development of cultural undertakings and cultural industries, and accelerate the construction of a strong cultural city; 9) adhering to green development with ecological priority, accelerate the construction of a city with beautiful natural scenery; 10) improve the level of social construction, and strive to create a life of high quality; 11) integrate development and security to keep the bottom line of safe development. In the above 11 major strategic tasks, the first four tasks related to economic construction, are undoubtedly an important basis for achieving high-quality development in Chongqing.

SAP has been known as the management guru behind the Fortune 500 and its customers cover 92% of the Forbes Global 2000. As a leader in digital transformation, SAP can play an active and important role in the circular development of Chengdu-Chongqing Twin Cities in China, and is also the bridge connecting the domestic and international circular development. In this regard, it’s important for Chongqing to make full use of advanced digital technology with software as the core, focus on the integrated development of advanced manufacturing and modern service industries,

collaborate with Chengdu to develop the innovation path of service-oriented manufacturing, seek for innovation-driven development and industrial upgrading, and realize digital industrialization and industrial digital transformation, in order to realize long-term stable and high-quality development in the future.

Part I. Servitization of Manufacturing is a Feasible Direction in Breaking the Bottleneck for Industrial Transformation and Upgrading

Service innovation in manufacturing industry refers to improving the services in products with the value-added service activities throughout the industry chain from raw materials to final services, thus improving the satisfaction of customers and ultimately increasing the value of products.

I. Servitization of Manufacturing is the Inevitable Result of Economic Development, Consumption Upgrading and Technology-Driven Development

The new economic model or production mode of manufacturing through service innovation can be called service-oriented manufacturing, which is the combined outcome of three major factors: economic transformation, consumption upgrading and technological progress.

The servicification wave of the global economy. (1) Developed countries have completed the transformation from a manufacturing-based economy to a service-based economy, and manufacturing and service industries have become more closely linked. (2) The worldwide industrial transfer has realized a new geographical division of economy in different regions, making services, especially productive services, the medium to connect the geographical division of economy among regions. (3) Along with the worldwide industrial transfer, manufacturing enterprises in developed countries gradually transformed from production and processing with low profit and competitiveness to highly profitable design, R&D, marketing, consulting and other service activities. For example, 90% of the revenue of General Electric (GE) comes from service activities, which makes GE the master of the value chain, controlling the layout of the global value chain and benefit distribution.

The change in consumer demand. With the advent of digital economy, the concerns of customer consumption shift gradually from product quality, product life and functionality to the overall satisfaction brought by the value behind the product, resulting in an increasingly higher proportion of the services attached to products in customer consumption. As a result, customer consumption becomes more diversified and demanding, from product function and quality to appearance, shape, color, texture, popularity, cultural attributes, etc. Market competition is no longer only product-based competition among manufacturers, but more competition based on

customer perception of services, covering consultation, decision-making, purchase, feedback, after-sales, recycling and other links. The provision of services has become the most important competitive link in this era, as well as the largest source of profit for manufacturers.

Decrease in society-wide transaction costs. The development of digital technology brings a significant change that the original information cost limiting enterprise scale and expansion has dropped significantly. The development of information technologies has laid the foundation for larger scale of social division of labor and production. With real-time information transmission systems, modern enterprises can make worldwide deployment per resource endowments and comparative advantages, and realize management in a global context with lower communication costs. And this sets the prerequisite for separation in manufacturing links and full integration with services. Only with the technical support, can the industrial chain extend and separate in time-space dimensions, can the separated industrial links be effectively coupled by service activities and can the further upgrading of manufacturing become a reality.

II. Servitization of Manufacturing is a Strategic Path to Transform the Economic Development Mode and Achieve Industrial Upgrading

Service-oriented manufacturing integrates the secondary and tertiary industries, and plays an important role to enhance the industrial value chain, improve total factor productivity and increase the added value of products. The increase in service factor inputs and outputs and development of manufacturing-based services and service-oriented manufacturing can create a new business model for integrated development of manufacturing and services, thus extending and enhancing the industrial value chain.

In terms of the way of value output, service-oriented manufacturing is more than production and sales. Services will account for an increasing proportion of output, thereby creating greater added value for users. In terms of production organization and business model, the servitization transformation of manufacturing industry requires updating the concept, reconstructing the production organization form, changing the innovation paradigm, adapting to the characteristics of the new era, and developing the ability of service innovation. In terms of industrial integration, the development of service-oriented manufacturing will lead to a deep integration of manufacturing and service industries, extensive collaboration among different players, optimization of industrial structure, and innovation of industrial form, creating a new landscape.

Generally, the manufacturing companies are transforming into 4 kinds of service companies: (1) manufacturing-service companies: the manufacturing companies that have just started their sales and service activities; (2) service-manufacturing companies: the companies that still produce products, but are gradually transitioning to services and maintaining a balance between production

and services; (3) from manufacturing to service companies: companies that used to produce products but are no longer engaged in similar production activities and have gradually moved into the creation of knowledge products; (4) virtual production companies: companies that are no longer engaged in any manufacturing processes. Specifically, the virtual production companies use advanced information and network technologies to provide users with innovative value-added services such as customized services, product lifecycle management services, turnkey services and system solutions on the basis of production and products, in order to enhance value creation capabilities and build new competitive advantages. As the ratio of services provided by manufacturing companies, more value will be created for customers.

Currently, the world has entered the era of service economy. Servitization and intelligence are the growing trend of global manufacturing industry. About 1/3 of the value added in the global trade of finished goods comes from the service industry. In developed economies, the ratio of service inputs to manufacturing inputs is generally more than 30%, and the ratio of service revenue in manufacturing enterprises is also over 30%. The world's advanced manufacturing companies have made the transition from mere production to a comprehensive provision of valuable service to customers. Whether from a macro or micro perspective, the service economy has become a fundamental trend in the global economy and will have a profound impact on the economies involved in global competition.

After 40 years of reform and opening up, China has made great strides in economic development. However, in the past, China's economy has been primarily driven by the rapid growth of manufacturing, which is the outcome of the Chinese economic situation and global economy’s shifting center of gravity in a specific period of time. On one hand, the development of manufacturing industry has greatly improved the overall competitiveness and comprehensive strength of China's economy. On the other hand, the low-level, energy-consuming scaled expansion has also caused a large number of social problems, such as low labor returns and high energy and resource consumption. With the intensification of various unfavorable factors at home and abroad today, the development of China's manufacturing industry has encountered new bottlenecks. China's economy and manufacturing industry are in urgent need of transformation.

Both domestic and international influences have provided a new opportunity for the transformation of China's manufacturing industry. With the advantages of relatively sound industrial system, abundant low-end knowledge elements and huge domestic market capacity, the upgrading of manufacturing industry through servitization has a good foundation and can be realized with low cost, thus it is more suitable for China's new economic normal.

Therefore, China should make good use of such advantages, cultivate and grow service subjects, incrementally realize the servitization of manufacturing industry, improve the manufacturing industry chain, and finally lead and create new demand with high-quality supply. This is a feasible path for China to address global uncertainty and realize the transformation and upgrading of manufacturing industry. At the same time, it can also provide strong support for accelerating the construction of a new development pattern, with the "internal circulation" as the core and mutual promotion of the Domestic-International Dual Circulation.

Part II. Innovation and Empowerment by Servitization of Manufacturing Industry under the 14th Five-Year New Pattern, Fueling Future Development of Chongqing

Looking ahead to 2035, Chongqing will build a strong, distinctive Chengdu-Chongqing Twin City Economic Circle, becoming an active growth pole and strong power source with international influence, and making its way into the ranks of modern international cities. The comprehensive economic strength and sci-tech strength will be significantly improved, the total economic volume and per capita disposable income of residents will be more than doubled compared with 2020, and the per capita gross regional product will exceed USD 20,000. Starting from the three dimensions of industrial foundation, realization path and co-creation, Chongqing will accelerate the integration and development of advanced manufacturing and service industries. Undoubtedly, a new pattern of high-quality development will be built in Chongqing and its goal of 2035 will be achieved during the 14th Five-Year Plan period.

I. Chengdu-Chongqing Twin City Synergy is the Regional Basis for the Servitization of Manufacturing in Chongqing

On March 25, 2016, the Political Bureau of the CPC Central Committee launched the Outline of the Yangtze River Economic Belt Development Plan, which proposed to make the Yangtze River an important support for the development and opening up of the western part of the country, and to build cities along the river, including Chengdu, Chongqing, Wuhan, Changsha and Nanchang, into open economic high grounds in Inland China. At the same time, a new development pattern of "One Axis, Two Wings, Three Poles, and Multiple Points" has been established for the Yangtze River Economic Belt. "Three Poles" refers to the three city clusters including the Yangtze River Delta, the middle reaches of the Yangtze River and Chengdu-Chongqing cities. It aims to give full play to the radiation role of the central cities in order to build the three growth poles of the Yangtze River Economic Belt.

At the sixth meeting of the Central Committee for Financial and Economic Affairs held on Jan. 3, 2020, General Secretary Xi Jinping stressed promoting the construction of the Chengdu-

Chongqing Twin City Economic Circle, creating an important growth pole for high-quality development in the west, and making the Chengdu-Chongqing region an important economic center with national influence, a center for sci-tech innovation, a new high ground for reform and opening up, and a pleasant place to live with high quality of life. This is both a major opportunity and a heavy responsibility. It's a historical mission to be accomplished by Chongqing Municipality and Sichuan Province.

On May 27, 2021, Sichuan Provincial Party and Government Delegation visited Chongqing and the third meeting of Chongqing-Sichuan Party and Government Joint Conference for promoting the construction of Chengdu-Chongqing Twin City Economic Circle was held in Yongchuan District. The meeting aimed to study and implement the important speech of General Secretary Xi Jinping on promoting the construction of Chengdu-Chongqing Twin City Economic Circle and jointly study the key work in further achieving the goal.

As Chen Min'er, Secretary of the Communist Party of China (CPC) Chongqing Municipal Committee, pointed out at the meeting, 2021 marks the 100th anniversary of the founding of the CPC, the first year of the 14th Five-Year Plan, and the beginning of the execution of the Planning Outline for the Construction of Chengdu-Chongqing Twin-City Economic Circle. It is necessary to accomplish a collaboration chain of various industries, focusing on key industries such as automobiles and electronic information, as well as strengthen the supporting facilities of leading corporations, deepen the collaboration of crucial parks, and build a modern industrial system with efficient division of labor, dislocation in development, orderly competition, and mutual integration.

Peng Qinghua, Secretary of the CPC Sichuan Provincial Committee and Director of the Standing Committee of Sichuan Provincial People's Congress, mentioned that efforts should be made to build industrial clusters with distinctive capabilities. The joint effort should also aim to enhance the industry chain, build a strong innovation chain, and upgrade the value chain based on the industrial collaboration method of detailed division of labor in large-scale industries. It is to build a better industrial system and to create more world-class industrial clusters.

Chongqing and Chengdu are large cities with relatively intensive and developed economies in western China. Historically, the two places had strong economic ties. Many small and medium-sized cities around the regions already have the early form of an intensive industrial development zone, especially along the Chengdu-Chongqing Railway and the Chengdu-Chongqing Expressway. It will be a strategic opportunity for the opening and development of Chongqing and Chengdu in the new era of the Yangtze River Economic Belt development to make full use of the favourable travel conditions between Chengdu and Chongqing, strengthen the close collaboration of cities

along the route, give full play to the leading role of the two places, and build an advantageous area for economic development.

As far as it is concerned, Chongqing is located at the strategic junction of the Belt and Road Initiative and the Yangtze River Economic Belt. It is a high ground for inland cities in China to open up to the outside world. As China's old industrial zone and modern manufacturing base, Chongqing has a solid foundation in producing and manufacturing. Not only that it started relatively early in the production and manufacture of intelligent devices, but it also has a good starting point for the development of automobile, electronic information, and equipment manufacturing. It is the world's largest laptop production base and China's largest automobile production base.

However, in recent years, Chongqing's manufacturing industry has faced tremendous pressure for transformation and upgrades under the influence of various unfavourable external environmental factors, such as the global economic downturn and the China-US trade war. Under these circumstances, in November 2017, the 3rd Plenary Session of the 5th CPC Chongqing Municipal Committee proposed to implement an innovation-driven development strategy action plan led by intelligence, using the development of the digital economy as the city’s carrot on a stick for promoting high-quality growth and creating a high-quality life. It, however, requires the city to make efforts to promote the coordinated development of digital industrialization and industrial digitalization. These efforts have been further clarified by three specified measures. The first is to implement detailed policies to achieve the whole industrial chain coverage, full data chain integration, and full innovation chain network of the digital economy through supporting industrial policies. The second is to build an industrial system, with Liangjiang Digital Economy Industrial Park taking the lead to create city-wide digital industrialization and industrial digital integration development system. Last but not least, it is to innovate the methods of development and take multiple measures to accelerate the efficient transformation of frontier technology in the field of the digital economy and economic momentum.

Suppose we must distinguish between a transformation and an upgrade of the industrial structure. In that case, transformation is mainly used to describe the transition from one type of industry-led structure to another. In contrast, upgrade describes the transition from a structure dominated by low value-added industries (or industry links) to a structure dominated by high value-added industries (or industry links). Therefore, while confirming the advancement of China’s industrial structure, we also need to pay attention to the risk of the absence of upgrades in transformed industrial structure, which means that the essence of high added value is still generally missing.

For the previous five years, under the implementation of the 13th Five-Year Plan, Chongqing has simultaneously adopted multiple strategies, aiming to achieve the transformation and upgrading of traditional manufacturing, out of the concerns for the lack of upgrades in transformed industries. The shift from production manufacturing to service-oriented manufacturing is precisely one of the core ideas put forward in the 14th Five-Year Plan. It requires Chengdu and Chongqing to leverage their location advantages and collaborate to find answers.

II. High grounds and multiple measures for the transformation of Chongqing's manufacturing industry to a service-oriented industry

On July 26, 2016, the Ministry of Industry and Information Technology, the National Development and Reform Commission, and the Chinese Academy of Engineering jointly issued the Special Action Plan for the Development of Service-oriented Manufacturing (hereinafter referred to as Action Plan), which is an important guide for the transformation and upgrading of the manufacturing industry in China. It is believed that service-oriented manufacturing is an emerging industry that integrates manufacturing and service. The Action Plan builds an action framework for service-oriented manufacturing development around value creation activities, including design services, manufacturing efficiency, customer value, and service model innovation. The action framework covers over ten aspects, including design, manufacturing, value delivery, system integration, financial support, and new technology applications. It is a multi-level and all-rounded method to develop service-oriented manufacturing.

The development of service-oriented manufacturing is a revolutionary concept in the business model. It needs the support of macroeconomic policies and the leading corporations in essential industries to give play to their brand and technology advantages, actively promoting the transformation to service-oriented industries. Specifically, attention should be paid to the following five directions.

To begin with, it is important **to cultivate the concept of industrial integration and development, so as to build an integrated industrial policy system.** Nowadays, it is common for the industries to integrate to develop, especially since the emergence of a large number of new business models under the advancement of a new generation of information technology. Both industrial policies and government departments need to adapt to this trend of industry integration. As for the development of service-oriented manufacturing, it is necessary to establish an integrated industrial policy system to eliminate the policy differences between the service industry and the manufacturing industry in terms of taxation, finance, technology, and factor prices to reduce transaction costs. Since China has been protecting the interests of corporations but disregarded consumers' rights and interests for a long time, the corporations rely on one-time sale products for profit instead of giving attention to the value of products to consumers. Therefore, those involved

should strengthen the protection over consumer rights and interests, forcing companies to establish long-term cooperative relationships with the consumers.

Next is **to strengthen the development concept and integration of information and industrialization to enhance information technology supportability.** Information technology is the binding agent for the integration of the service industry and the manufacturing industry. For service-oriented manufacturing, a low-latency, high-reliability, wide-coverage, and safer industrial internet system is the hardware infrastructure; whereas cost-effective, highly reliable information-based software systems and industrial big data application services that combine the entire process of consumption, design, production, sales, and service are the software infrastructures. No matter hardware or software infrastructures, they need to be accelerated for development. At the same time, open sharing of manufacturing resources, manufacturing abilities, and logistics distribution can be achieved through the publicization of cloud manufacturing services to support the cross-industries alliance of manufacturing companies, internet companies, and information technology service companies.

Following on is **to establish the concept of industrial ecology and strengthen the construction of manufacturing-as-a-service platforms.** The key to the development of industrial innovation depends on whether it has a healthy ecosystem. The development of service-oriented manufacturing is a reconstruction of the original industrial chain, corporations need to re-evaluate and determine their value and status in the new ecology.

In order to encourage the development of service-oriented manufacturing, on the one hand, the government should focus on manufacturing service needs. For example, establishing public productive service platforms such as innovative design, logistics services, quality inspection and certification, marketing, supply chain management; cultivating productive service industry systems in the field of research and development, laws, financial engineering, information, consulting, design, leasing, and logistics; improving the industrial structure, and strengthening the construction of supportabilities in the manufacturing industry. On the other hand, the government should also work on strengthening the construction of information network service platforms; actively building internationally advanced outsourcing service industry platforms, such as big data platforms, cloud computing platforms, and e-commerce platforms; studying the industrial network architectures to accelerate the formulation of collaborative manufacturing technology standards for industrial network platforms and service specifications between the upstream and downstream of the industrial chain.

Both meeting the manufacturing service needs and building information network service platforms combined can introduce a future with the new generation of intelligent industrial parks,

which can utilize industrial network technology and combine industrial features to independently plan and build industrial network platforms to help corporations shorten the time to respond to users' demands, as well as achieve a more agile and efficient collaboration within the organization. This will not only improve the synergy efficiency within the corporation, but will also further break down information barriers between corporations, thereby achieving efficient synergy between upstream and downstream corporations in the industrial chain, and those that joined the industrial network platform will have stronger competitiveness in the market.

Something else to consider is **to lay the foundation of the customer-first concept and seek a fundamental breakthrough in industries and business models.** The integrated and in-depth fulfilment of consumers' potential needs is one of the important sources of efficiency for service-oriented manufacturing. It taps consumers' needs, implements service-oriented manufacturing action plans in leading industries, and innovates personalized and professional service-oriented manufacturing models.

From the perspective of typical cases and development trends of the service-oriented manufacturing industry, China's current service-oriented manufacturing development focuses on industries such as the equipment manufacturing industry, large domestic electronic appliances manufacturing industry, consumer electronics manufacturing industry, and apparel as well as furniture manufacturing industries. At the same time, it can also focus on the service models such as those that provide customers with professional supply chain financing service and construction machinery financial leasing; those that provide customers with overall solutions including self-produced main equipment, complete sets of equipment, project contracting, professional maintenance and transformation services, and professional remote comprehensive status management; and those that tailor a one-step, comprehensive supply chain solution for every client.

Finally, it is **to institute a people-oriented education and continuously improve the education system.** Knowledge-intensive and technology-intensive industries like the product-service systems and overall solutions are mainly developed by relying on high technology and modern business methods and organizational forms. In the process of introducing services into manufacturing corporations, suppliers are required not only to have an in-depth understanding of the characteristics of their products and equipment, process flow, production layout, and project management but also to be proficient in modern service concepts and service models.

At the same time, due to the intangibility, synchronization, heterogeneity, and non-storability of services, employees need to have good teamwork and customer service awareness and good communication and practical skills. However, China's current education system still trains professionals for manufacturing or service industries, and the higher learning institutions are yet

to set up majors for service-oriented manufacturing. The current talent training model and curriculum design are out of touch with the development needs of service-oriented manufacturing. Therefore, it is necessary to adjust the development focus and curriculum of higher education and vocational education, develop training institutes, and provide suitable talents to develop service-oriented manufacturing.

Part III The complementing advantages of China-EU accelerate the servitization of Chongqing's manufacturing industry

At present, strengthening China-EU cooperation has become one of China's priorities to perform foreign economic and trade cooperation amid the global turmoil. China's digital economy has been rapidly developing in recent years. At the same time, the European Union has introduced the Digital Single Market strategy, complementing the advantages of China's economy. As the global digital economy continues to develop, China-EU cooperation will have more new opportunities for expansion.

China's digital economy is entering a stage of innovative and liberal development in this day and age. For instance, the scale of China's digital economy is showing a rapid development trend. As shown by the figures in the research conducted by a relevant institution, China's digital economy's added value has reached CNY 39.2 trillion in 2020, accounting for 38.6% of GDP, which has increased by 2.4% compared with the same period last year. In addition, local governments value the development of the digital economy. The growth rate of the digital economy in Guizhou, Chongqing, and Fujian have exceeded 15%. China's online retail has also been ranked first in the world for eight consecutive years. In 2020 alone, online retail sales have reached CNY 11.76 trillion, and the number of online shopping users has reached 782 million people, accounting for 79.1% of the total netizens.

On top of that, nearly 90% of the population have utilized online payment, and the pilot digital currency process is currently the world's leading. China has also successfully built the world's most extensive 5G network, with more than 1,100 projects that bring 5G network and industrial network jointly into play, and more than 32,000 5G network base stations serving the industrial network. Following that, an emerging business model is booming, with online video users reaching 927 million people, accounting for 93.7% of the total netizens. Lastly, the industrial internet has become a new way to transform into the digital industry, which has entered a new phase of practical application. The industrial internet covers almost every field and value chain of the industry, playing an important role in networked collaboration, intelligent production, service-oriented extension, and digital management, helping to accelerate the development of new digital business models.

The digital economy in the European countries has also been developing rapidly in recent years compared with China, unlocking many achievements. Generally speaking, the achievements can be summarized into the following categories. The first is the accelerated development of core digital technologies, targeting investment in core digital technologies such as the Internet of Things, cloud computing, artificial intelligence, 5G network, and high-performance computing to reduce dependence on foreign technologies and ensure Europe's leading position in technological innovation. Next is the constantly improving digital infrastructure. The EU's 2030 Digital Compass proposes to build a safe, high-performance, and sustainable digital infrastructure, including the production of Europe's first quantum computer, cutting-edge and sustainable semiconductors, including processors, which account for at least 20% of the world's total output value, all EU households have Gigabit connections and 5G network coverage in densely populated areas.

Apart from that is the significantly improved digital public services. According to statistics from the EU Statistics Bureau, the EU's e-commerce retail sales accounted for an increasing proportion of the total retail sales. EU citizens make at least one online shopping per year, accounting for 63% of the total, of which 22% are cross-border shopping. Then, is the large scale of digital trade, which is the main source of global exports. Lastly, it is the complete digital legal and regulation system, and the continuously strengthened cyber security supervision and digital intellectual property protection. In March 2019, the Directive on Copyright in the Digital Single Market was published, and it further strengthens the protection of the legitimate rights and interests of content creators in the digital environment, promoting the legal dissemination and utilization of digital works.

As the China-EU economic and trade relationship steadily builds, there is an increasing need for China-EU to strengthen exchanges and cooperation in the field of the digital economy, in which the two sides share great commonalities and complementarities, and both are interested in further deepening cooperation. Looking forward to the future, China-EU can perform deeper cooperation in the field of network innovation entrepreneurship and create more outstanding cooperation in the digital economy. The two parties can also collaborate in strengthening network popularization, using the implementation of the Belt and Road Initiative as an opportunity to strengthen strategic alignment and collaborate in the research and development of a new generation of information technology to jointly stimulate economic growth.

Combining the Going Global strategy and the approaches of bringing in foreign investment, Chengdu and Chongqing — especially Chongqing, being the international hub of the Belt and Road Initiation — can conduct industrial division of labour and collaboration with the countries along the Belt and Road route to develop regional markets. Together, the innovation and

development of the international economic cooperation model can find a wider range of collaboration and empowerment partners for the servitization of the manufacturing industry. During the implementation of the 13th Five-Year Plan, Chongqing has coordinated economic and trade exchanges with 224 countries and regions around the world, and has successively established 12 international cooperation industrial parks with Germany, Italy, and the UK. In addition, Chongqing has also introduced five internationally renowned brands, six large OEMs, and more than 900 component manufacturers, forming a world-class electronic information industry cluster. There are 279 of the world's top 500 companies in Chongqing alone, and it will surely become the leading example for China-EU cooperation during the implementation of the 14th Five-Year Plan.

2021 marks the 100th anniversary of the founding of the CPC, the first year of the 14th Five-Year Plan, and the beginning of a critical period of achieving socialist modernization from a relatively well-off society. At the same time, it is also a year of accelerated fission driven by technology. On the one hand, under the guidance of policies such as the Domestic-International Dual Circulation strategy and the New Infrastructure Creation concept, there are breakthroughs in the application of new technologies such as the industrial internet and artificial intelligence with 5G network as the core supply, and the trend of supply chain moving towards full-link intelligent integration. It has created numerous development opportunities for the market and drives the steady development of the industry. On the other hand, the sudden COVID-19 pandemic has accelerated the arrival of corporations and industries' demands for digital transformation, network construction, and data security governance systems, putting forward more agile requirements and tests for the corporation's own strength.

In the face of the new era brought by the 14th Five-Year Plan, SAP, as the initiator of German Industry 4.0 and the world's largest commercial software service company, will take the initiative to participate as an enabler of digital transformation and new infrastructure, and a leader in the industrial internet. SAP will also use the new-found position of an entrant because of the Dual Circulation strategy to seize the historic opportunity to support the Chinese government, industries, and corporations bridge the digital divide and promote the digital transformation and upgrading of the industries.

It is a critical year for Chongqing, and SAP hopes to connect and collaborate with more representative and growing companies in various industries in Chongqing to aid them to achieve high-quality development through successful digital transformation. At the same time, under the premise of maintaining Sino-German cooperation and China-EU cooperation, SAP wishes to utilize the advantages of digital technology and services as well as talents to help the servitization process of Chongqing's industrial development. The company also hopes that by participating in the construction of Chongqing Intelligent Metro, Chongqing Intelligent Transit, ports, and other

logistics, it can contribute to the development of the city, helping Chongqing to achieve high-quality and innovative city life as soon as possible.

Good tales of two cities Building Chengdu-Chongqing Economic Circle: Opportunities and Challenges

Ben Keswick
Executive Chairman, JARDINE MATHESON

Executive Summary

- This paper examines some of the recent developments in the construction of the Chengdu-Chongqing Economic Circle (CCEC) and outlines aspects of the investment and business experience of the Jardine Matheson Group as a basis for suggestions on improving the business environment and creating a distinctive international consumption destination in the CCEC.

- The 2021 CMIA meeting comes at a crucial time for the global economy, with many challenges from the pandemic and wider geopolitical trends. The continued growth of China's economy demonstrates its resilience and offers new opportunities at a time of unprecedented change.

- The CCEC will play a key role in China's future economic development, as the fourth major urban cluster and a fast-growing part of the national economy. It has become better connected across China and to international markets, and significant measures have been taken to enhance coordination and integration across the CCEC.

- The experience of the Jardine Matheson Group in the CCEC reflects some of the important trends in the region: the 'dual core' structure of the CCEC based on Chongqing and Chengdu, the gradual spread of economic activity and development to districts outside these urban cores, and the overall growth in prosperity in the region.

- Further policy priorities for the CCEC can focus on strengthening the radiation effect of the vibrant economies of the two core cities, Chongqing and Chengdu; continued investment in infrastructure and connectivity and in urban development in second tier and satellite cities in the region; and the continued development of local tourism in districts outside the two urban cores, including the belt between Chongqing and Chengdu, where levels of consumption are currently relatively low, but where there is space for this area to become a common 'back garden' for both cities.

- The business environment across the CCEC can be further improved by aligning regulations in the different areas of the CCEC, promoting greater transparency and consistency in the

application of government policy, and instituting enhanced consultation with local and foreign businesses in the region. Chongqing can continue the work it has developed over the last two decades to open up to foreign investment and facilitate business and other travel to Chongqing (consistent with the need to manage the pandemic).

- Underlying the approach should be a high-level commitment to joint planning and integrated management of development across the CCEC. Much progress has been made since the last meeting of the CMIA, and we look forward to contributing to taking the development of the CCEC to another level.

Introduction

The theme of this year's CMIA meeting is the opportunities and challenges in building CCEC. This paper examines some of the recent developments in the construction of the CCEC and outlines aspects of the investment and business experience of the Jardine Matheson Group as a basis for suggestions on improving the business environment and creating a distinctive international consumption destination in the CCEC.

The CMIA meeting comes at a crucial time for the global economy. More than 18 months after the Covid-19 pandemic first erupted, it is still going to take some time before the global economy finds a new normal. Further, the pandemic has accelerated some of the disruptive trends in the global economy, such as e-commerce and more intensive use of technology, especially across service industries. Recent years have also seen a turn to a more confrontational China policy on the part of the United States, at a time when relative political and economic power between the East and West has been shifting, and China continues to cement its position as a major regional and global power, moving towards the centre of world affairs. In sum, we are witnessing a period of change not seen for a long time.

As people in China celebrate the 100th anniversary of the founding of the Communist Party of China (CPC), this is an important time to look to the future as well as learn from the past. While the global economy suffered a severe shock to growth levels in 2020, China's economy performed better than other major economies, growing 2.3%. In Q2 2021 GDP growth was 7.9% y/y, with GDP up 11.4% from Q2 2019, an annualized growth rate of 5.5%. This has demonstrated the resilience of China's economy and people, and the business potential here.

Meanwhile, the pandemic has highlighted the importance of sustainable and balanced economic development, and the need to focus on improvement of people's livelihoods. We have paid attention to the shifts to a new development pattern that have been promoted in China over recent years, in particular the idea of 'dual circulation' which looks to promote domestic economic

circulation and integrate it with international economic engagement. In this context, Chongqing and southwest China will play an important role, including through the construction of the CCEC.

For the Jardine Matheson Group, while the global changes bring uncertainty, the trends in China's economy create many opportunities to build on existing businesses and explore new ones. As a group, we have been investing in Chongqing for close to two decades, over which time our commitment has grown in scale and spread across Chongqing and Chengdu as well as other parts of China. We are confident that the greater coordination and integration between Chongqing and Chengdu and their surrounding areas which is envisaged by the CCEC will create new opportunities for businesses under the Jardine Matheson Group to develop and grow alongside the economies and peoples of this vibrant part of China.

The importance of the Chengdu-Chongqing Economic Circle

In remarks delivered at a meeting of the Central Financial and Economic Affairs Commission on 3 January 2020, president Xi Jinping called for the construction of the CCEC as an important growth pole for high quality economic development in western China. Since then, we have taken note of a number of developments in the construction of the CCEC which suggest that this initiative has a promising future.

First, this area of China is a significant part of the national economy, accounting for 6.6% of total GDP, and constituting the fourth most important urban cluster after those in the Yangtze River Delta, the Guangdong-Hong Kong-Macao Greater Bay Area, and the Beijing-Tianjin-Hebei region (see Table 1 for comparative data). It is home to around 100 million people. The greater significance of the CCEC lies in its position within western and inland China. The CCEC's GDP of RMB6.5 trillion (2019) accounts for about one third of the economy of the 12 provinces in western China, or almost half of the five provinces in southwest China (Yunnan, Guizhou, Guangxi, in addition to Chongqing and Sichuan).

The CCEC has also been the site of impressive economic growth in recent years. In 2019 (before the pandemic), the GDP growth rate in the CCEC was 13.8%, compared to an average of 11.0% for Chongqing and Sichuan combined, 6.7% for western Chinese as a whole, and a 6.3% national growth rate for mainland China. The CCEC is therefore already acting as a major driver of growth in western China, and its future is crucial to the prospects for China's western regions and therefore for the attainment of national goals over the coming years.

Second, the CCEC has become more connected to the national and global economies over recent years. Geographically, it sits in the western part of the Yangtze River Economic Belt (YREB), an agglomeration of 11 provinces lying along the Yangtze River which account for over

40% of China's GDP. The growing integration of the YREB, including through the development of transport linkages along the river (land, water and high-speed rail), enhances the CCEC's access to major domestic markets and to ports on the east coast, reducing water freight transport from Shanghai to Chongqing to 12 days. Over the last decade the CCEC's connectivity to southern China has also increased, and the newly-planned Land Sea Economic Corridor from Chongqing to the coast of Guangxi will enhance that further. Both Chongqing and Chengdu have been important nodes in the building of the Silk Road Economic Belt across Eurasia, including through the China Europe Freight Railway, which has now been operating successfully from Chongqing for a decade. At the moment, in terms of international trade, the CCEC and western China play a less significant role than coastal urban clusters, but the improved connectivity offers potential for trade links to grow, especially with nearby markets in southeast Asia. These developments have been discussed well at previous CMIA meetings.

Table 1: Key economic indicators for four main urban clusters (2018/2019)

	Chengdu-Chongqing	Yangtze River Delta	Guangdong-Hong Kong-Macao Greater Bay Area	Beijing-Tianjin-Hebei
GDP (2019, RMB billion)	6,506	19,735	11,587	8,458
GDP per capita (2018, RMB)	57,089	119,737	152,548	70,065
GDP per square km (2019, RMB million)	27.2	92.6	207.2	39.1
Total imports and exports as a proportion of GDP (2019)	19.2%	54.6%	123.6%	47.3%
Manufacturing (secondary) industry / GDP (2019)	38.3%	41.8%	32.4%	28.7%
Services (tertiary industry) / GDP (2019)	53.2%	54.1%	65.3%	66.8%
Average urban disposable income (2018, RMB)	35,508	54,128	90,868	43,511

Source: Compiled from China Merchants Bank Research

Third, there have been significant measures taken to enhance integration and cooperation between Chongqing and Sichuan within the CCEC since January 2020, set out in the Chongqing government briefing for the CMIA meeting. The spatial and developmental planning in Chongqing and Sichuan have been more closely coordinated, helping to develop an integrated region based on two 'pillars' or 'cores'. We have taken note of a number of valuable and constructive initiatives:

- Plans for the integrated development of areas between Chongqing and Chengdu, including through the 'Guiding Opinions on Accelerating Integrated Development of Districts and Counties Adjacent to Sichuan' and the 'Promotion Plan for a Functional Platform for Regional Development Built by the Adjacent Areas of Sichuan and Chongqing'.

- The establishment of cooperation platforms and coordinated development demonstration zones, including the Gaozhu New Area, the integrated development pilot of Suining (Sichuan) and Tongnan (Chongqing) and the Integrated Development Demonstration Zone of southern Sichuan and western Chongqing. The Gaozhu New Area looks a particularly valuable initiative for Chongqing and for enhancing connectivity with adjacent areas of Sichuan.

- Transport and infrastructure connectivity have been prioritised through the Action Plan for Promoting the Construction of the Chengdu-Chongqing Economic Circle and Strengthening the Construction of Transportation Infrastructure (2020-2022) and a pilot for integrated transport development.

- Further development of the high-speed rail network and expressways in the region, which will also contribute to greater integration within the CCEC and connect the region to other parts of China, in particular to Shanghai through the Chongqing-Chengdu section of the Shanghai-Chongqing-Chengdu high-speed railway.

- Other measures have been piloted or discussed to integrate regulation between the two areas, including integrating the provision of public services, the issuing of the first business licence which can be applied in each of the two jurisdictions, and mutual recognition of 'red and black lists'.

Figure 1: National spatial layout, 14th five-year programme

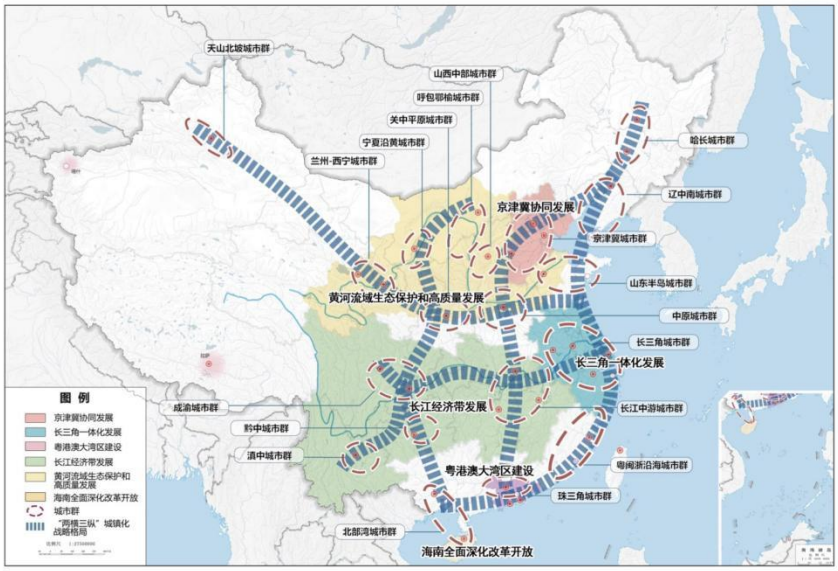


图 3　城镇化空间格局示意图

The wider relevance of the CCEC to China's next stages of development can be seen in the outline plan for the 14th five-year period and development to 2035, approved at the National People's Congress in March 2021. This plan emphasises the importance of the development of China's central and western regions, as part of the overall attainment of the country's development goals. Promoting the construction of the Chengdu-Chongqing economic circle is identified as the first priority in the latest iteration of the Develop the West policy. In addition, the plan identifies the need to relieve infrastructure bottlenecks along the Yangtze River, including at the Three Gorges. It further calls for better coordination of development in the areas between provinces and for integrated planning and management. All of these themes are directly relevant to the construction of the CCEC.

The advantageous location of the CCEC is indicated as well in the spatial layout set out in the 14th five-year plan (see Figure 1 from 14th five-year programme), and even more clearly in the February 2021 document issued by the central authorities on the planning of national transport networks.[15] This location and connectivity remains a key advantage of the CCEC.

Economic trends in the CCEC

The potential for the CCEC can be seen in analysis of a number of economic trends. First, continuing to develop consumption is crucial to the next stages of building the CCEC. Analysis of consumption patterns across the CCEC shows that consumption is concentrated in the two main urban cores, with a 'break' in between. There are significant differentials in the levels of

[15] http://www.gov.cn/zhengce/2021-02/24/content_5588654.htm

consumption between the urban core in Chongqing and other districts within Chongqing (see Table 2 for a classification of consumption levels by city or district within the CCEC), and between Chengdu and other areas in Sichuan. These differences explain most of the difference in consumption levels in the CCEC. Data also shows that the gaps in consumption levels across the CCEC have reduced over time, but there is space and a need for raising consumption levels in areas of the CCEC outside the city cores. The same research indicates that consumption 'hotspots' in Chongqing are mainly concentrated in Chongqing city proper, including Jiangbei, Jiulongpo, Nan'an, Shapingba and Yuzhong. On the other hand, 'cool' spots for consumption are concentrated in northeast Chongqing.[16]

Table 2: CCEC consumption levels by district (2016)

High	Chongqing Yuzhong district
Relatively high	Chengdu municipality. Some districts in Chongqing city proper: Jiulongpo, Nan'an, Jiangbei, Yubei.
Medium	Sichuan: Mianyang, Deyang, Leshan, Zigong. Chongqing:, Yongchuan, Beibei, Ba'nan, Fuling, Jiangjin, Wanzhou, Qianjiang.
Relatively low	Sichuan: Ya'an, Yibin, Meishan, Suining, Luzhou, Guang'an. Chongqing: Hechuan, Rongchang, Qijiang, Changshou, Dazu, Tongliang, Bishan, Kai county.
Low	Areas between Chengdu and Chongqing and northeast Chongqing

Source: Adapted from Mao & Wu (2020)

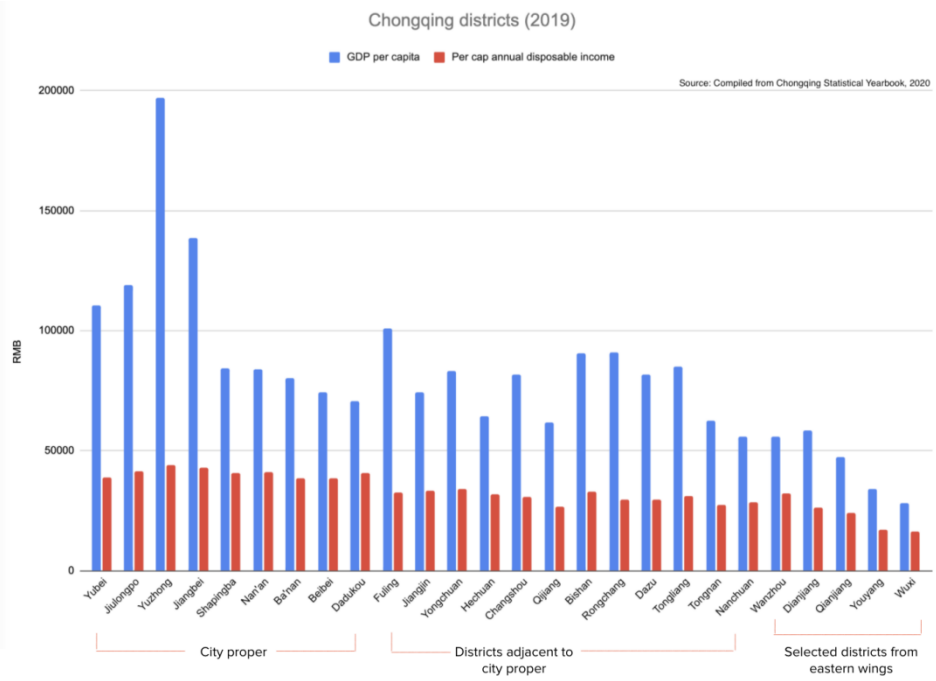
A second, related, trend is urbanisation, as consumption patterns are partly correlated to levels of urbanisation. Within the CCEC, urbanisation levels are notably higher in the two urban cores. Chengdu's urbanisation level is over 79%, compared to an average of 57% for the whole of Sichuan (2020-data). In Chongqing, the city proper has urbanisation level over 95%, compared to 69.5% for the whole municipality (2020 data). Within the Chongqing city core, six districts have urbanisation levels above 95% (Yuzhong, Dadukou, Jiangbei, Nan'an, Shapingba, Jiulongpo) while the other three districts (Beibei, Yubei and Ba'nan) have urbanisation levels above 80%. Many of the peripheral counties where consumption is low also have low urbanisation rates, such

[16] Mao Zhonggen 毛中根 & Wu Youmeng 武优勐 (2020). An Analysis of the Evolution of Consumption Spatial Structure of Urban Agglomerations in Western China: A Case Study of Chengdu-Chongqing City Cluster. 中国西部地区城市群消费水平空间结构演变分析：以成渝城市群为例。*Journal of Xiangtan University (Philosophy and Social Sciences)* Vol. 44, No. 2. 湘潭大学学报（哲学社会科学版）第 44 卷 第 2 期 。

as Qianjiang, Kaizhou and Dianjiang, while in Sichuan, a number of cities have urbanisation levels around or less than 50%.

Third, there is still a notable disparity between urban and rural disposable income in both Chongqing and Sichuan, though the ratio of urban to rural disposable incomes has been declining consistently over the last decade, and is now around 2.5 in both places. Urban disposable income in both Chongqing and Chengdu is approaching RMB40,000. Across the CCEC, it was RMB35,508 in 2018, still lower than the national average of RMB39,251. GDP per capita was RMB57,089, compared to a national average of RMB65,880. Within Chongqing, there is a notable difference in levels of GDP per capita and disposable income between the city proper and other districts (see Chart 1).

Chart 1: GDP and annual disposable income per capita, by district (2019)



A fourth area is sustainability and renewable energy. The CCEC region of China performs relatively well in the use of renewable energy. Both Sichuan and Chongqing have set ambitious targets for the proportion of renewable energy in their provincial energy mix by 2021, with Sichuan aiming for 79% and Chongqing 48.5%. These are higher than the overall national target of 40%.[17] This relates to an important priority for further development in China and elsewhere. In advance of the next major global talks about climate change, to be held in Glasgow in November this year, there is a growing focus on ecological development. Under President Xi, China has made

[17] Data sourced from British Chamber of Commerce in China (2021). *British Business in China: Position Paper 2021*, p. 92 (available at https://www.britishchamber.cn/en/british-business-in-china-position-paper/).

developing ecological civilisation one of its major priorities, and committed to targets for carbon emissions to peak by 2030 and reach net zero by 2060. As noted below, this is an important strategic priority for the Jardine Matheson Group in China.

Experience sharing: The Jardine Matheson Group's commitment

The Jardine Matheson Group has been investing in Chongqing for nearly two decades, making it one of the first major multinationals to invest in the city. This investment covers a range of businesses which contribute to and benefit from the economic development of this region, in particular the rapid growth in income levels, consumption and service sectors. In 2020, the revenue of Jardine Matheson Group businesses in Chongqing was RMB33 billion (up from RMB29 billion the previous year), and these businesses employed over 20,000 staff. In Sichuan, revenue was RMB24 billion, with around 15,000 employees. Across the CCEC, therefore, total revenue was RMB57 billion, and staff numbers 35,000.[18]

Some of the main businesses are as follows:

- Jardine Matheson is one of the biggest foreign investors in Chongqing and a key investor in Yonghui Superstores. Yonghui has 145 supermarkets with a total of 18,481 employees in Chongqing; in Sichuan, it has 104 stores, of which 53 are in Chengdu and 30 are under preparation. Yonghui is now also the second largest shareholder of Hongqi, which is the biggest retailer in Sichuan, with over 3,300 convenience stores. In recent years, Yonghui has committed over RMB 2 billion to build two modern supply chain industrial parks at Jiangjin and Pengzhou.

- Jardine Matheson's subsidiary company – Hongkong Land has 15 projects in Chongqing and Chengdu. Over last 10 years, HKL has built remarkable city iconic projects such as Landmark Riverside Shopping Park and Danzishi Old Street in the South of Chongqing Prosper, and the 'Ring' in the North. Both have become attractive destinations for tourism, culture, shopping and popular IPs.

- Another major business line is in automotive dealerships. In Chongqing, Zung Fu has two dealerships, while Zhongsheng has five dealerships, covering a range of brands. In Chengdu, Zung Fu has four dealerships and one service centre, as well as dealerships in Yibin, Zigong, Dazhou and Pengzhou (the latter is under construction). Zhongsheng has 16 dealerships in Sichuan for eight brands.

[18] Source: Jardine Matheson Representative Office, Chongqing.

- The Maxim's Group operates in both cities, with one Genki Sushi in Chongqing (since 2014) and one Jade Garden and two Genki Sushi stores in Chengdu.

The development of Jardines' business in southwest China is supported by the representative office in Chongqing which opened in March 2012. With this office supporting its presence across the CCEC and Central China, Jardine Matheson is able to approach business in the region in the spirit of integration and cooperation across the two core cities and other areas of the CCEC, in line with the goals of constructing the CCEC.

The pattern of Jardine Matheson 's businesses across the CCEC offers good experience for the development of this region in a number of areas.

First, Jardine Matheson 's businesses in this region reflect the dual core structure of the CCEC, under which the most dynamic and developed areas are concentrated around the urban core of Chongqing and Chengdu. Both of these cities have offered rapid growth across the different business lines, as can be seen in the increase in the automotive dealership businesses and the investment in real estate through Hongkong Land.

Second, over recent years, Jardine Matheson's footprint has spread from these urban cores to adjacent areas. This is particularly evident in Sichuan, where businesses are now operating in Yibin, Zigong, Dazhou and Pengzhou. This pattern reflects the trend in the development of the CCEC, as areas adjacent to the two core cities develop more rapidly and are further integrated into the planning and infrastructure development of the CCEC. This is a crucial part of the future development of the region.

Third, the Jardine Matheson business footprint reflects the growing prosperity of this part of China. The cities of Chongqing and Chengdu have been transformed over the time that Jardine Matheson has been investing in this part of China and we have witnessed the emergence of this region of China as the fourth urban cluster and a significant part of the domestic economy of China. This is a powerful story, which needs to be communicated well to the outside world.

The Jardine Matheson Group has also responded to the ecological imperative across its China businesses, in line with one of the core goals of the CCEC construction. Sustainability is now one of the group's four strategic priorities. For example, Hongkong Land raised US$500 million through its first green bond in the first half of 2021, and the proceeds will be used to fund sustainability initiatives. Another example is to reduce plastic use, with the Mandarin Oriental achieving a nearly 70% reduction in its annual plastic footprint.

In southwest China, Hongkong Land has been working on a route to 'carbon neutrality'. Its commercial project, 'the Ring', opened in April 2021, has been developed under the ideal of harmonious coexistence of city and nature, and was recently awarded LEED Gold pre-certification (LEED: Leadership in Energy and Environmental Design). In its main commercial project in Chengdu, WE City, due for completion in 2024, the company has prioritised green building. The design was completed in accordance with the green building two-star standard and the site has obtained LEED gold pre-certification for construction. Since July 2019, Hongkong Land started to plant trees at Alashan in Inner Mongolia and cultivate 'Hongkong Land Forest' there, by working with China Green Foundation.

The bigger picture: opportunities and challenges in an era of change

As noted above, a number of trends are coming together to make this a period of change not seen for a long time. This poses opportunities and challenges which go well beyond the CCEC.

Among the challenges are impediments to good bilateral relations between China and the West, including the U.K. As the British Chamber of Commerce in China notes in its latest position paper, the British government's China policy is 'conflicted' and UK-China relations have shifted recently. As the Chamber notes, 'some quarters of Parliament have expressed a desire to reduce bilateral engagement [but] dialogue is crucial if we are to address our differences and harness areas of common interest'.[19]

The Jardine Matheson Group appreciates the efforts made by the Chinese government to reach out to and engage with British businesses, including through online meetings with Premier Li Keqiang at the Spring Festival and again in July. Our experience was that this provided an important opportunity to share our views on the challenges ahead and to appreciate the Chinese government's commitment to maintaining good relations with British businesses. The Chinese government's commitment to continued steady opening up to foreign businesses and to the further improvement of the business environment is welcome. It will continue to be important to demonstrate the benefits of this in concrete ways, and we look forward to further discussion with the Chongqing government about ways of demonstrating the benefits of continued economic engagement between China and the West.

Policy suggestions for the CCEC

Based on this experience and analysis of the CCEC, we have the following policy suggestions for further development of the CCEC:

[19] British Chamber of Commerce in China (2021). *British Business in China: Position Paper 2021*, p. 9 and p. 3.

1. There is a continued need to strengthen the radiation effect of the vibrant economies of the two core cities, Chongqing and Chengdu. This requires strengthening connections with surrounding counties and cities, including through infrastructure development and encouraging industrial investment and industrial transfer to these areas.

2. Continued investment in infrastructure will contribute to this radiation effect and to greater connectivity within the CCEC. The development of new and existing rail and road links between Chongqing and Chengdu is needed, alongside the ongoing development of faster connections to other domestic markets across China. In addition, further investment in urban development in second tier and satellite cities in the region will help to develop the CCEC further and could allow economic and social activity to spread out across the region, bringing more balance within the CCEC.

3. Further investing in local tourism can contribute to developing the economies of districts which neighbour the two urban cores. This could be focused on the belt between Chongqing and Chengdu, where levels of consumption are currently relatively low, but where there is space for this area to become a common 'back garden' for both cities.

4. The business environment across the CCEC can be further improved by aligning regulations in the different areas of the CCEC, promoting greater transparency and consistency in the application of government policy (as called for by the British Chamber of Commerce in China), and instituting enhanced consultation with local and foreign businesses in the region. Removing administrative barriers between different parts of the CCEC will allow for the smooth flow of factors of production. These steps can help companies to operate in the CCEC as one integrated region, and to plan their investment over the long term.

5. Chongqing can continue the work it has developed over the last two decades to open up to foreign investment and facilitate business and other travel to Chongqing (consistent with the need to manage the pandemic). There is also benefit in further building ties with the fast-growing economies of southeast Asia (where Jardine Matheson is also growing its businesses).

6. All of these measures should be based on a high-level commitment to joint planning and integrated management of development across the CCEC. Clearly, much progress has been made in this area since the last meeting of the CMIA, and further intensifying the coordination of planning and policy making across the region, and promoting more exchanges and cooperation between the cities will help take the development of the CCEC to another level.

The Chengdu-Chongqing Economic Circle

To Empower High-quality Development

Chen Anning
Executive Vice President of Ford Motor Company
President and CEO, Ford China

Contents

Introduction

On January 3, 2020, the sixth meeting of the Central Committee for Financial and Economic Affairs proposed to promote the construction of the Chengdu-Chongqing Economic Circle (CCEC) in southwest China. In October 2020, the meeting of the Political Bureau of the CPC Central Committee deliberated the Guidelines for the Construction of Chengdu-Chongqing Economic Circle, which further clarified the mission of creating significant growth and a new power source to drive the nationwide high-quality development, and elevated the construction of the CCEC as a national strategy.

One of the important missions of the CCEC is to find a way to realize high-quality development. Having positioned itself as "an inland open gateway", "a smart city", Chongqing is striving to become a leader in high-quality development and an example for high-quality living. The city is determined to become a pioneer to shoulder great responsibilities and make great achievements.

This paper argues that, to realize high-quality development, Chongqing should, in addition to leveraging the CCEC initiative, focus on technological innovations, industrial upgrading, digital economy and green ecology. Developing cutting-edge technologies against the backdrop of the fourth industrial revolution will be an enduring driver for the development of Chengdu-Chongqing area. The intelligent revolution will bring new models and new business forms and will create new jobs and new drivers for growth.

The CCEC will benchmark the construction standards and laws of world-class city clusters, which is conducive to the construction of a grand city cluster and economic circle and build the area into an iconic name card of China towards the world.

The paper suggests that Chongqing should leverage its inherent advantage as one of China's automobile industry bases, take high brand added-value automobile manufacturing as a core and intelligent connectivity and autonomous driving technologies as a breakthrough, and continue to transform and upgrade the automobile industry to empower the development of Chongqing's economy. Chongqing should also do well in the transformation of green ecology to contribute to the realization of China's goal of peak carbon emissions and carbon neutrality and to inject a green power source to drive high-quality development of the CCEC. Meanwhile, we encourage the Chongqing Municipal Government to continuously create a first-class business environment, to stimulate the vitality of various market players, and to support the development of emerging industries and new business forms while enhancing the hard power of the local economy.

We believe that Chongqing will fully leverage the great development of the CCEC and take the preemptive opportunities during the implementation of the "dual circulation" strategy.

Main Body

Chapter 1 Building the CCEC and exploring the power sources to drive high-quality development

China's city clusters emerged as a result of the development of China's regional economies and urbanization since the implementation of the reform and opening up policy. With the development of China's industrialization and urbanization, China's economy has demonstrated a general situation where a few regional economies develop and compete with each other, dominated by their respective city clusters. In October 2020, the meeting of the Political Bureau of the CPC Central Committee deliberated and approved the *Guidelines for the Construction of Chengdu-Chongqing Economic Circle*. Following the Beijing-Tianjin-Hebei region, the Yangtze River Delta, and the Guangdong-Hong Kong-Macao Greater Bay Area, the CCEC has become the "fourth pole" of China's economic development. The spatial structure of China's economic development is undergoing profound changes, and central cities and city clusters are becoming the main spatial forms bearing development elements. The scale effect of metropolises is more prominent than ever before.

Apart from eastern China and the coastal areas, the Chengdu-Chongqing area, located in western China, includes two national central cities, which is a unique advantage over any other city clusters in central and western China. In western China, the Chengdu-Chongqing area, with a large population, a great economic volume, outstanding technological power, a complete industrial system, and strong development momentum, has the potential to lead and drive the development in western China. When it comes to fostering a new economic growth pole in China, the Chengdu-Chongqing area is definitely well-positioned. Therefore, the construction of the CCEC has been regarded as a national strategy, a most significant measure to solve the unbalanced and inadequate development of China, and to build a critical growth pole to drive high-quality development in central and western China.

In the first year of the "14th Five-year Plan", China is taking the initiative to optimize regional economic layout, promote coordinated development between different regions, and promote the construction of the CCEC. It is a critical measure to create a new development pattern, whereby domestic and foreign markets can drive each other, with the domestic market as the mainstay. To drive high-quality development in the new development pattern is a significant theme in promoting the construction of the CCEC.

In 2021, in the face of an external environment characterized by evolving complexity and major global health crisis, China's economy is undergoing considerable pressure. As part of the players in the internal circulation of China's economy, foreign-funded enterprises operating in China are committed to providing better products and services for local consumers and contributing to the vitality of China's economy, and we expect to put forward ideas and suggestions to drive high-quality development of Chongqing as well as the CCEC.

As a kernel and hub of a regional economy which is of strategic significance, Chongqing is shouldering the long-term mission of establishing an open highland in the inland of China. How to leverage its advantages in location, industries and systems and proceed with its transformation and upgrade? How to empower high-quality development and contribute to sustained and sound development of China's economy? These are the new issues that require joint efforts by the public and private sectors during the post-epidemic recovery period.

Chapter 2 Empowering industrial transformation and update leveraging the advantages of the city clusters

2.1 Experiences from foreign countries

There are a number of world-class city clusters – the one on the Atlantic coast in the northeast of the US, the one on the Pacific coast in Japan, the one in the Great Britain, and the one in Ruhr Industrial Zone, Germany. These typical city clusters offer a lot of useful experience in their development and construction, particularly in how to optimize the industrial structure, how to make use of organizations as coordinators, and central cities as economic drivers, and how to strengthen collaboration within the region.

The Chicago-Pittsburgh city cluster is located in the Great Lakes region in the central United States. Surrounding Chicago, this city cluster extends from New York on the Atlantic Coast in the east to Chicago in the west, across the south shores of the Great Lakes, which covers 35 cities, including a few large and medium-sized cities such as Pittsburgh, Cleveland, Toledo and Detroit, and a number of small cities. This city cluster is the largest manufacturing center in North America, where Pittsburgh and Detroit contribute to 70% of steel output and 80% of automotive output in the United States.

As a major base of the auto industry in North America, the Greater Detroit Area in Michigan has unique geographical advantages and a well-established manufacturing tradition, which has been driving the development of the automotive industry in terms of transportation & logistics, supplier support and talent pool. With the continuous development of intelligent connected vehicles (ICVs), autonomous driving and mobility services in recent years, the Greater Detroit

Area is attracting considerable high-tech investments and brains, leveraging its position as a major base of the auto industry.

In recent years, the guiding policies and supportive resources provided by the public sector have played an important role in transforming and upgrading Detroit's economy. Firstly, the city has released a series of supportive policies in taxation, loans and venture capitals to encourage reinvestments from local businesses, to attract new capitals from home and abroad, and to create new and high-level job opportunities. Secondly, non-profit organizations are working with the government in launching a variety of targeted talent training programs to help enterprises address the shortage of talents. Lastly, Detroit focuses on building and publicizing its comprehensive competitive advantages – fast and convenient transportation network, green living environment and vibrant urban culture so as to reshape the image of the city to attract more young talents.

In addition to attracting foreign capitals, Detroit's economic vitality and potential growth have attracted a new round of reinvestments from local companies like Ford. With the support from the governments of Michigan and Detroit, Ford is building a 1.2 million-square-foot high-tech park in Corktown, Detroit. The park will provide a new workplace for the electrification and autonomous driving teams of Ford and help Ford transform from an automaker to a smart mobility services provider. In addition, the government of Michigan is planning the nation's first dedicated road for ICVs and driverless vehicles between Detroit and Ann Arbor, known as the “Michigan Smart Mobility Corridor”. The project has achieved full coverage of industry-university-research ecosystem, promoting the establishment of ICV and autonomous driving standards, and exploring a new way of mobility for the future. This project will be jointly executed by the public and private sectors. As one of the initiators of the project, Ford will support the project with our expertise in intelligent connectivity, autonomous driving technologies and mobility operations.

2.2. Upgrade of the auto industry empowering high-quality development of the city

As a pillar of the national economy, the automobile industry is characterized by extended industrial chain, extensive social involvement, and a high degree of globalization. As the largest industrial city and the manufacturing center in western China, Chongqing has been the highland that leads the development of China's automobile manufacturing industry, with its auto production and sales volume both coming out top for years in China. By virtue of a solid industrial foundation and its advantages in cluster development, Chongqing has attracted carmakers from America, Europe, South Korea, and Japan, as well as a number of domestic brands to compete in the inland vehicle manufacturing market. Currently, there are nearly one thousand above-designated-size auto parts manufacturers in the city, covering the complete supply chain of engines, transmissions, braking systems, steering systems and other major assemblies, forming a strong automobile industrial cluster with dozens of major carmakers, including the leading brand of CHANGAN

AUTO, and nearly a thousand supporting enterprises. The city's huge scale of automobile industry has provided an essential premise and foundation for its transformation and upgrading.

With the vigorous rise of a new round of technological revolution, the automobile manufacturing industry, which integrates such emerging technologies as new energy, intelligent connectivity, autonomous driving, and AI, is becoming increasingly electrified and intelligent and shared.

At present, China is promoting research on and application of intelligent vehicles. In February 2020, the National Development and Reform Commission (NDRC) and 11 other ministries jointly released the *Intelligent Vehicle Innovation and Development Strategy*, which sets the goals of realizing conditional scale production of intelligent vehicles by 2025, and building up a complete system of standardized intelligent vehicles by 2035. The Strategy has clarified the major tasks of developing intelligent vehicles, including promoting essential technologies, improving infrastructure, and improving relevant laws and regulations. The Strategy has also put forward specific measures to guarantee the organization and implementation of these tasks and released a number of supportive policies. In recent years, several countries and regions have reached a deep consensus on the development of ICV and accelerated demonstrative applications. Currently, China's ICV industry is developing rapidly, and is entering the early commercialization stages, specifically, automobile evolution and industrial planning.

Another issue is the transfer of value and, consequently, the substantial changes in marketing and service models. The synergy of hardware and software is driving a deeper understanding of the significance of "user-centric" by the industry. Connected by data, software and services, the car makers-user relation has changed into a sustainable partnership.

China's new energy vehicle (NEV) market is also expanding rapidly. As early as 2014, President Xi Jinping emphasized that "the development of NEV is the only way for China to grow from a mere big market into a real power in terms of the auto industry." With joint efforts across the industry, China's NEV industry, after years of cultivation by continuous support from policies, is now empowered by the market itself, in addition to the supportive policies, and the market is expanding rapidly. China sold more than 1 million NEVs yearly for the last three consecutive years, ranking first in the world for six consecutive years. In 2020, the sales volume reached 1.367 million, with a year-on-year growth of 10.9%, and the market penetration rate increased to 5.4%. We have every reason to say that China's NEV industry has entered a high-speed track for growth.

Moreover, China's auto industry is more open than it was. China has lifted restrictions on foreign investment in special purpose vehicles (SPVs) and NEVs in 2018, and in commercial vehicles in 2020. According to the official timetable, all the shareholding restrictions on the

admission of foreign-invested carmakers and the restrictions on the number of joint ventures will be lifted by 2022, which means China's auto industry will be fully opened to the world. As a result, the major carmakers will continue to increase investments and collaborations in China, which will effectively promote the improvement and upgrading of China's industrial chain and drive its technological progress.

The "14th Five-year Plan" period is a critical time window for the transformation and upgrading and high-quality development of China's auto industry. We should fully leverage the advantages in people's income growth, the huge market and sound systems, overcome all difficulties, follow the strategic direction of electrified and intelligent vehicles, and strive to build China into an auto power.

The Chongqing Municipal Government has also released the "14th Five-year Plan" (2021-2025) to drive high-quality development of the city's manufacturing industry. The Plan has put forward the initiative to "promote intelligent, green and humanistic transformation and development of its manufacturing industry; to deepen the introduction and penetration of emerging information technologies; to promote intelligent manufacturing and new, service-oriented manufacturing modes, to accelerate innovation in and development of the Industrial Internet, to make the manufacturing industry more digitalized, connected, and intelligent; to promote fundamental changes in the industrial patterns and business forms." In a word, the Plan is highly in line with the national strategy to transform and upgrade the auto industry.

Chapter 3 Recommended Actions

We would like to put forward the following targeted recommendations to the Chongqing Municipal Government as part of the effort to drive high-quality development of Chongqing through the transformation and upgrading of the automobile industry, leveraging the CCEC strategy.

3.1 Accelerate the construction of smart city

In recent years, Chongqing has been implementing a strategic action plan, based on big data, intelligent technologies and innovation, making vigorous efforts to build itself into an intelligent manufacturing highland and a smart city. The Smart China Expo, a national event hosted by Chongqing, has become an event with international influence. Besides, one of the important purposes of the CCEC is to build up a major innovation center with nationwide influence.

The Ministry of Industry and Information Technology (MIIT) has successively approved four state-level pilot zones of Intelligent and Connectivity Vehicles (ICV) in Tianjin (Xiqing District), Chongqing (Liangjiang New Area), Hunan (Changsha) and Jiangsu (Wuxi), and based on these

pilot zones, the best practices and applications will be promoted in the cities in a large scale. Demonstrative ICV projects are being carried out in various places, including special areas such as parks, ports and mines, and specific scenarios such as link roads, environmental sanitation, logistics, etc. Chongqing should also make every effort to enhance its infrastructure for ICV, establish the infrastructure for large-scale, city-level ICV applications, and realize full coverage of the connectivity. Taking full account of the local scenarios of urban roads – with a lot of mountain roads, bridges, tunnels and complex overpasses, as well as the rainy and foggy climate, efforts should be made to build the most multi-dimensional and diversified ICV application scenarios in China, and to build a trial and demonstration highland of 5G-V2X the Cooperative Vehicle Infrastructure System with mountainous characteristics. Chongqing should fully leverage the CCEC strategy, deepen collaboration between Sichuan and Chongqing, so that both provinces can work together to promote the construction of an intelligent expressway between the Chengdu and Chongqing and realize intelligent mobility.

Michigan is planning the nation's first dedicated road for ICVs and driverless vehicles between Detroit and Ann Arbor. According to the plan, the road has a total length of 60 km single trip. In the early stage of the project, efforts will be made to support the Advanced Driver Assistance Systems (ADAS), L4 automatic driving vehicles, and the testing, verification, and application of the intelligent road infrastructure. In the later stage, commercial operation will be launched and applied to various types of ICVs and driverless vehicles, including city buses, shuttle buses, freight vehicles and private cars. The smart road is based on the transformation of existing urban arterial roads and expressways in southeast Michigan. For urban arterial roads, high-speed, intelligent charging piles and data-downloading facilities for ICVs will be installed; The design of intersections will be optimized to enhance safety of pedestrians; building smart platforms will be built for passenger boarding and alighting. For expressways, physical barriers will be set to isolate the dedicated road from other roads; More recognizable road lines and digital traffic signs will be installed; digital infrastructure will be installed to support the cutting-edge Cellular Vehicle-to-Everything (C-V2X) technology, to achieve reliable real-time V2V, V2I, and V-C (cloud) connection. The combination of the C-V2X technology and the HD map of the smart road can enhance the perception and the route planning algorithm of ICVs and driverless vehicles.

As one of the initiators of the project, Ford will support the project with our expertise in intelligent connection, auto driving technologies, and mobility operations. Ford will also support quick testing and verification of the new functions and services of ICVs in real-world scenarios. By virtue of its worldwide experience in intelligent connection and mobility, Ford China looks forward to working with Chongqing and helping it with smart city governance and road planning, to allow the people to enjoy safe, convenient and efficient travelling. Ford is willing to work with all parties to build a humanistic, tech-driven and future-oriented smart city by improving smart

infrastructure, putting "brain" into the city and diversifying the application scenarios of intelligent connection. In China, Ford has worked with multiple partners to test the vehicle-road synergy based on the C-V2X technology, and mass-produced China's first vehicles with the C-V2X functions.

We also expect to work with Chongqing in discussing, formulating and implementing new rules and standards which are conducive to the development of ICV technologies, to help enterprises introduce and utilize emerging technologies including C-V2X, and to enable China to realize large-scale commercialization of ICVs for the first time in the world. We believe that, with the government's support, Chongqing will form a closed loop of ICVs from R&D and testing to mass production, and realize the transformation, upgrading and leaping development of its automobile industry.

3.2 Green transformation to facilitate the realization of China's carbon reduction goals

In September 2020, China made a solemn commitment to the world that it will achieve carbon neutrality by 2060, which is a manifestation of China’s determination to take its responsibilities as a responsible power in protecting our environment and addressing the climate change. In November of the same year, The General Office of the State Council issued the *Development Planning for New Energy Industry (2021-2035)*, which sets a goal that the sales volume of NEVs will account for 40% of total sales volume by 2030. The *Plan* also stresses that the new energy industry requires the improvement of our innovative capabilities, the construction of a new industrial ecology, the promotion of industrial integration, the improvement of the infrastructure system, and in-depth opening-up and collaboration.

The Chongqing Municipal Government has issued the *Three-year Action Plan to Build the First-class New energy and ICV Application Scenarios (2021-2023)*. According to the Plan, Chongqing will rank in the top echelon in China in new energy and ICV application scenarios by 2023 in terms of the construction scale and level. In the field of NEVs, the city is going to build more than 200 battery swapping stations, with a capacity to serve 20,000 battery-swappable vehicles; The demonstrative application scale of battery-swappable vehicles will grow rapidly. The city is going to release over 150,000 NEVs, including 1,000 hydrogen cell vehicles, with 10 hydrogen stations.

Ford has been advocating the guiding philosophy of low carbon and low energy consumption persistently across the world, and has always publicly and firmly supported the Paris Agreement. To this end, Ford is committed to making unremitting efforts in developing electric vehicles (EVs) and new energy technologies across the globe. In June 2020, Ford made a significant commitment to achieving carbon neutrality worldwide by 2050, with its idea and vision in perfect conformance

with China's goals on addressing the global climate change. Since 2018, Ford has begun to formulate and implement a global ambition across the company to accelerate electrification. A total of over $11.5 billion will have been put in developing NEVs by 2022. Inspired by its iconic models such as the Mustang, the SUV family and the pickup truck family, and by leveraging its core products, brands, and superiority, Ford is going to accelerate the implementation of the electrification strategy.

To achieve the strategic goal of accelerating electrification in China, Ford is planning to bring more EV models to China. Ford is making proactive investigation and planning to achieve final implementation of launching the new NEV models in China. If the project goes smoothly, the electrification process of the whole Changan Ford family will be accelerated. Hence, we expect the Chongqing Municipal Government to give more support for the development of NEVs according to the corporate development status and investment planning.

3.3 Building the best business environment and stimulating the vitality of various market players

President Xi Jinping pointed out that the opening-up policy is China's basic policy, and that China will expand its opening up across all respects. China has announced to the world its commitment to the reform and opening-up policy and its determination to share the market with the world. This has been testified to by the fact that China has lifted restrictions on the admission of foreign automakers into its auto market. Ford highly recognizes the continuous improvement of the business environment of Chongqing, and the effort it has made to support the development of enterprises by delegating the power of the government, while enhancing its governing capability and providing supportive services to enterprises, so that the market will play a decisive role. In the context of major setbacks and uncertainties in Sino-US relations in recent years, Ford is more than willing to work with the Chongqing Municipal Government to reinforce mutual trust. Ford will continue to take root in Chongqing, provide more cutting-edge smart vehicles to Chinese consumers, and contribute to the upgrading of China's auto industry and the realization of China's carbon reduction and neutrality goals.

The century-old industry is undergoing revolutionary changes. In this process, the government should, based on the needs of the market and the industry, maintain market order for fair competition, create an environment where all market players can enjoy the same favorable policies, and guide and support integrated development across various industries. In this process, enterprises should play their roles as the main market players. The government, the industry, universities, and research institutes should play their respective roles, make concerted efforts and seize every opportunity to achieve industrial transformation. We have reasons to believe that Chongqing, relying on the CCEC strategy, will be able to achieve high-quality development in more extensive and deeper sense.

Transform Chengdu-Chongqing Economic Circle into the Silicon Valley in China's West

Hannes Androsch
AT&S Chairman of the Supervisory Board

Introduction

Chongqing has always been vital for opening up the Western region in China. Strategically located, it has functioned as a trading hub to connect regional economies, extending to its neighbors along Russia's Volga River to reach Western European economic hubs. As an important manufacturing base, Chongqing has continued to deliver an impressive economic performance during a period when China has been entering the 'new normal' of slower growth. Progress to date in developing traditional pillar industries, the new digital economy, new industries, and an open economy provides a good foundation for the city to develop further its status as a growth pole in inland China, taking advantage of its strategic location at the intersection of the major 'belt and road' initiative and the development of China's Yangzi river economic belt.

In 2020, the China's central government proposed to integrate Chongqing's economy with its neighbor Chengdu. This national strategy aims to promote high-quality growth and technology innovation in long-term, and finally benefit the less developed western region of China. According to government papers, the Chengdu-Chongqing city cluster[20] consists of 42 cities, districts, and counties in Sichuan and Chongqing, covering 185,000 square kilometers and nearly 100 million people. The economic rim expects to make the two megacities important growth engines, innovation hubs, and smart cities to live for the vast regions in western China. The plan also asks Chengdu and Chongqing to play a leading role in China's Belt and Road Initiative and promote economic connectivity with regional countries.

Looking forward, the vast economic potential of the Chengdu-Chongqing should built on more than its geographic or strategic location. Its distinctive advantages in industry clustering and digital & ecological innovation should be reinforced in order to provide the formidable foundation as it transforms into the "Silicon Valley in China's west".

Valuable reference could be drawn from the legendary success of Silicon Valley in its global innovation development. In 1950s, the transistor inventor returned to the Silicon Valley and started a business, since then this basic technology have been continuously renewed that bred numerous

[20] https://news.cgtn.com/news/2020-10-16/China-to-unveil-strategic-plan-for-Chengdu-Chongqing-economic-rim-UDAUxJFlWU/index.html

innovations, from transistor to semiconductor integrated circuit, chips to computers, operating system to smart phones, etc. The industrial chain of transistors have been extending both upstream and downstream and became a driving force of productivity and economic growth. Besides, venture capital continues to provide financial supports to the start-ups in the Silicon Valley. Another key enabler is the rich talent pool featuring high education background and high technological expertise. World top education institutions serve as a continuous source of high-level talents. The talent pool gets continuously diversified by attracting talents from all over the world, making the talent eco-system self-extending. It is evident that the three enablers - solid foundation of technologies, sustained venture capital investment and culture, contributing to Silicon Valley's success.

AT&S looks at the critical elements of realizing the dual-city's vision and mission, and is intended to propose that the cooperation between Chongqing and Chengdu should start with the efforts to jointly promote scientific and technological innovation. As a key path to development the region, the government should strengthen scientific research and technological innovation, as well as establish and improve systems for using new technologies. It is proposed to accelerate the application of scientific findings in order to improve the quality of people's lives and create new industries and jobs. The government should apply principles of openness and mutual benefit in strengthening scientific and technological exchanges and collaboration to promote cities development.

Additionally, Chengdu-Chongqing region should recognize that digital innovation and ecological innovation are essential to a vibrant social, economic and cultural life of the region. Cities should invest in digital infrastructure and green tech so as to strengthen services across multiple sectors, and to build an intelligent digital nervous system supporting cities operations.

Finally, it concludes with a detailed view from AT&S on its capability to catalyze innovation and drive sustainable growth in semiconductors and microelectronics market.

Chapter one – Fuel a constant propellant to science and technology innovation

The success of cities can be measured by the capacity they have to bring out new ideas and spread them. Therefore, the government's role is to design policies that foster linkages and innovation networks. Key to the ability of cities to innovate is its ability to develop systems that allow it to use the assets of science and technology innovation.

The rise of digitalization that has occurred in the past decades is having a direct impact on cities. Regional and urban disparities are reinforced or diminished through access and utilization of electronic infrastructure. One challenge for government is to develop strategies that would

enable cities to actively participate in the knowledge and digital economy.

Located in the Silicon Valley, the Stanford Science Park emerged in the 1950s as a university-owned park associated with Stanford University. It pioneered the use of clustering of technology-based firms and property-based initiatives close to centers of learning. It initially hosted Hewlett Packard, General Electric and Lockheed Martin and played a pivotal role in the development of Silicon Valley. Nowadays, it remains at the forefront of innovation as it is home to some of the most groundbreaking new companies, like Apple.

This chapter will suggest a framework of measures that local governments can adopt to employ science and technology innovation as a strategy for building Chengdu-Chongqing Economic Circle a sustainable power house in China.

1.1 Key elements and advantages of science and technology innovation

The sustainable development of cities is challenged by many risks related to population, mobility, climate change and resource scarcities. The application of scientific and technological advances in the areas of energy, mobility, medical & health and digitalization can help meet those challenges and provide solutions for sustainable city development. Science and technology innovation can be a key driver of economic growth and prosperity.

Developing an innovation culture within the Chengdu-Chongqing region can help science and technology innovation initiatives take wing. The government can achieve an innovation culture by promoting entrepreneurial spirit, enhancing training of the technological talent pool, strengthening science and technology innovation policies, stimulating the growth of high-tech industries including applications of 5G, big data, Artificial Intelligent (AI) and IoT, expanding the protection of intellectual property, and fostering scientific awareness through public education.

Creating an innovative environment requires strong links to the science and technology innovation communities. Such links permit industry's commercialization of public-sector research results, which can augment industry's own research agenda. Feedback to the research community allows it to better orient its research to address social and economic problems. Innovation environments often take the form of science and technology innovation (S&T) Centers. S&T centers closely related to universities are strong engines of economic growth. They are instruments that can help sustain a knowledge-based economy and enable market-oriented technological development. As places of creation and innovation, S&T centers attract investments, as well as highly-qualified professionals.

In the Chengdu-Chongqing region, S&T centers can be focal points for fostering innovation and connecting cities with the global economy. A S&T center can be defined as an organization

whose main purpose is to improve the well-being of the community where it is located by encouraging a culture of innovation and competitiveness through knowledge-based institutions and related businesses. Managed by professional experts, a S&T center nurtures and directs the exchange of knowledge and technology between universities, R&D institutions, companies and markets. By doing so, a S&T center promotes the establishment of innovation-based companies by incubation and spin-off processes.

S&T centers are a core element for sustainable development in urban environments in the digital era. They allow cities to be connected and attractive in the global economy by developing industries that will lead the way in the decades to come. In order to achieve this purpose, S&T centers are characterized by several key features:

- The establishment and management of a S&T center results from a collaborative effort of multiple stakeholders: firms, government authorities, academia, members of the financial sector as well as educational and research institutions.
- A S&T center involves the provision of infrastructure and support services for businesses. This supposes strong investments in real estate in order to make available of first-class office space and facilities.
- S&T centers, by enabling technology transfers (both in terms of physical hardware as well as the more important software of knowledge, skills, procedures, know-how, etc), perform an economic development function. It draws together large businesses and start-ups in the same place: they enable clustering as well as the development of networks and trust. This allows the transmission of ideas and knowledge, which foster new companies, innovation and ultimately, growth.
- Local governments can identify a specific economic sector they wish to develop because they can judge whether they have a comparative advantage in it. This is why a S&T center may have a focus on a particular type of industry such as semiconductors and microelectronics.

1.2 Policy Options

In the Silicon Valley, innovation plays a central role. Innovation is a generator of employment as well as of stronger productivity through knowledge creation and its following application and dissemination. Likewise, innovation is a tool to advance social development. In order to foster innovation, it is essential to prioritize efforts in long-term sources of growth: education, infrastructure and research. This process should comprise structural reforms in innovation policy. Innovation policy needs a new conceptualization in order to shift from a targeted policy focused on R&D and specific technologies to a more comprehensive approach comprising the many actors and factors that play a role in innovation performance.

With this, the policy's goal should not be merely innovation as such, but its applications driven by digitalization in order to make cities smarter and better for both individuals and society at large. In this process, both cities' governors have an essential role to play.

- Chengdu-Chongqing can concentrate on the development of science and technology innovation centers. The establishment of a S&T center sustains the local production of goods and services oriented to the digital economy. Further, it attracts innovative companies in digital technologies driven by 5G, big data, AI and IoT is the main means of networked organizations.
- Chengdu-Chongqing can also focus in the establishment of a new social organization, in which the main organizational support is digital technologies. Through the new interaction networks opened by 5G technology for example, various groups and social movements can find new channels of expression.
- Finally, Chengdu-Chongqing can prioritize the consumer use of digital applications.

Through promoting these actions, local governments can ensure that the Chengdu-Chongqing region is truly attractive and connected to global technology networks. Allowing connectivity and interaction is an important step to foster innovation. Innovation cannot occur if a region is not integrated and up to date with the major orientations occurring in globalization. An innovative environment may be territorially located within a city and its surroundings, but through networks, it interacts and is connected to the rest of the world.

1.3 General Guidelines for developing S&T Centers

When the government aiming to enhance integration into the digital economy through the establishment of S&T centers, we would propose the following general guidelines that would assist in its conceptualization and development:

- A Project Management Team (PMT) composed of management and local development experts, responsible for leadership of the center should be designated. Local governments can assist the PMT by organizing workshops, drawing on best practices, case studies and S&T center master planning development from advanced economies - sharing such information might prove essential to understand how to successfully develop S&T center. The specific aim of these workshops should be to assist in the preparation of feasibility studies that carefully assess the challenges associated with developing a S&T center and also the opportunities which the city can take advantage of in order to increase the center's chances of success.
- A S&T center should focus on the challenges of their potential customers in order to truly address their needs. This can be achieved by the inclusion of the stakeholders and the parties

involved in the conceptualization and management of the center - through collaboration and cooperation, S&T centers can preserve stakeholder trust and rally their support.

- Further, local governments must remember that the success of a S&T center is strongly determined by the development of a long-term vision for it. The challenge that local leaders face is to imagine a vision combining both a solid practical approach based on needs with an ambitious projection, in order to generate enthusiasm. The long-term vision and strategy of the center should be established in a master plan that embodies how the S&T center will achieve its objectives.
- From project inception, local governments should also seek ways to secure funds and generate interest amongst potential international center clients. Carefully developed feasibility studies and a clear vision established in a master plan might prove essential to legitimize the center as an investment project.

The government should be proactive in the development of S&T center strategies and truly include stakeholders in the planning and management process as well as to clearly understand the objectives they wish to pursue. In addition, other factors also intervene in success of the center and are important to take into account. Of these factors, the existence of an entrepreneurial culture in local society is most relevant. It should be a priority of the S&T center to encourage such a culture by cooperating closely with universities and businesses.

Another frequent factor in the success of S&T centers is the presence of projects that serve as an anchor to development. Such projects lead the way, generate initial revenues, attract small companies for servicing large companies and foster enthusiasm, thus triggering development. Finally, and perhaps more importantly, local governments must adapt science centers to local circumstances. Whilst valuable lessons can be learned from experiences with S&T centers around the world, models should not be copied; each project's characteristics should depend on what is at hand. The idea is to adjust the S&T center to "answer to local competitiveness".

1.4 The pivotal role of universities

The presence of Stanford University was a key factor in the development of the technology enterprise in the Silicon Valley. More than anything, it was Terman[21], his students, and the encouragements and opportunities that he gave them that enabled this great enterprise to flourish.

In the development of science centers in the Chengdu-Chongqing region, local governments have to remember that universities play a pivotal role.

Universities are spaces where new ideas and knowledge are created. They are also sites where

[21] https://en.wikipedia.org/wiki/Stanford_Research_Park

interaction and networks leading to innovation are fostered. The government should remember that for a S&T center to succeed, it is essential to establish strong linkages with universities. When a science center is developed, local governments can get universities involved as either shareholders (with an ownership share) or as stakeholders (with an interest in the management of the center). It is up to local leaders to carefully assess what place research will take in the overall strategy of the center. However, it is important not to overemphasize the institutional aspect. Institutional linkages could prove to be less significant when compared to the synergies that can emerge between research institutions and companies through the sharing of premises and the sharing of knowledge.

Therefore, the government should concentrate on how to encourage synergies between research-based institutions and business to occur. Physical proximity between research institutions and business encourages the development of a culture of both formal and informal meetings in a relaxed environment. In addition, if interaction between research and business occurs, it can lead to an enhancement in the mutual understanding of both parties. Business and research could cooperate in defining what kind of knowledge should be produced and what kind of knowledge should be applied. This could prove to be of great importance in the establishment of a strategy for the creation of value.

In the Silicon Valley, Stanford University has a history of working with industry to solve real-world problems. Collaborations among world-class faculty and students with industries covers professorships, faculty scholars and student fellowships, recruiting, sponsored research and technology transfer.

At its core, technology transfer is the process of transitioning scientific findings from universities to industries with the aim of development and commercialization. This process involves identifying new technologies, safeguarding them with patents, copyrights or other types of intellectual property protection, and licensing those rights to industry. Stanford University has a string of blockbuster success stories to its name—from DNA gene splicing to Cisco, Yahoo, and Sun Microsystems. The Office of Technology Licensing (OTL) promotes the transfer of Stanford technology for industrial or society's use and benefit while generating income to support research and education. In 2020, Stanford received $114 million in gross royalty revenue from 847 technologies. 84 of the inventions generated $100,000 or more in royalties. Ten inventions generated $1 million or more. OTL evaluated 594 new invention disclosures and concluded 121 new licenses/options. 56 of the licenses were nonexclusive, 35 were exclusive and 30 were option agreements. 42 of the 121 agreements were with Stanford start-ups and 23 of them involved

equity.[22] No wonder the university is considered a world leader in technology transfer.

What is the secret of Stanford's success? The university's symbiotic relationship with Silicon Valley has played a vital role, giving life to many of the Stanford's OTL most marketable technologies and providing the all-important local infrastructure of ideas, can-do thinking, and capital.

Additionally, Stanford graduates, faculty and staff have launched approximately1200 companies in the last 50 years. More than 50% of Silicon Valley product is due to companies started by Stanford alumni.[23]

The case of Stanford University illustrates the importance of technology leadership in the success of a S&T park. In the development process of the park, the role played by a visionary leader with a clear ambition was essential in orchestrating political support for the project. Further, the leadership nurtured networks between different actors in both the private and public sphere – professors, researchers, local and regional authorities and business. Stanford is a pioneering example in S&T park development. It is one of regional development projects using science and technology as a strategy of development, therefore its story and characteristics are most valuable.

1.5 Case study: Styria, the most innovative region in Austria

Styria (Steiermark) is[24] the second largest of the nine states in Austria and located in the southeast of the country. In 2020, its total population was 1.24 million (Eurostat, 2020). Its capital city is Graz. Styria shares its border with Slovenia as well as the federal states of Carinthia, Salzburg, Upper Austria, Lower Austria and Burgenland.

Its economic sector has undergone significant structural changes over the past decades, heading towards a more diversified industry and services landscape. Until the late 1980s, the iron and steel industry, as well as the automotive industry were the dominant economic branches. However, these sectors suffered from a dramatic decline during the 1990s. Only the latter sector (automotive suppliers) has fully recovered and regained international visibility.

Major industries nowadays include automotive industry, mechanical engineering and electronics. It is one of the strongest Austrian regions in terms of R&D. Indeed, it is the region that launches the most innovative products and services. This dynamism is based on Styria's high-

[22] https://facts.stanford.edu/research/innovation/
[23]http://www.iphandbook.org/handbook/chPDFs/ch17/ipHandbook-Ch%2017%2013%20Page%20OTL%20at%20Stanford%20University.pdf
[24] https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/styria

powered educational system, the research community, the business environment and its residents.

There are several universities and institutes in Styria and the corporate sector finances 75% of research in Styria (Statistik Steiermark, 2018). These professional public research institutes, which focus on applied research and technology development in the areas of materials, health, information and communication technology, water, energy and sustainability, as well as economic and innovation research. Moreover, the knowledge and technology's transfer is the region's core competence and success story: most Austria's competence centers conduct their research and other work in Styria, university spin-offs are part of the daily routine, and independent research institutions are always open for businesses.

AT&S, headquartered in Styria, is one of the largest and most successful suppliers of advanced interconnect technologies. Since it was established, AT&S focused its research and development activities on exploiting the opportunities arising from mega trends, such as digitalization and ecological optimization. Partnerships and cooperation in R&D with local and international universities and research institutes are key for AT&S to stay on the edge of technological development. In 2020, a joint laboratory was opened at the Graz University of Technology to deal with exploring new high-frequency systems. Deeply rooted in Chongqing, AT&S has started cooperation with Chongqing University on a range of academic and educational programs including internship programs, designed curriculums for the IC substrates industry, talents recruitment and joint R&D projects since 2019. AT&S spends roughly 10% of its annual revenues on R&D and is an enabler for future technologies.

Chapter Two – Driving competitiveness through the Digital Clusters

China's economic development during the 14th Five Year Plan period (2021-2025) is guided by "dual circulation[25]," a concept that seeks to place domestic production and consumption at the forefront of development, reinforced by value-added foreign trade and investment. It is applicable to Chengdu-Chongqing region. The dual circulation strategy aims to lean on foreign expertise and investment in areas where no suitable domestic alternative exists, while at the same time encouraging consumers and businesses to "buy in China."

The local government should view technological self-reliance as not only important for Chengdu-Chongqing's economic rise, but also for sustainable development. The 14th FYP calls for continued investment to achieve technological breakthroughs in several "key and core technologies,[26]" including artificial intelligence, integrated circuits, and quantum computing. Efforts to advance the digital economy will also drive indigenous innovation in cutting edge

[25] https://www.reuters.com/article/china-economy-transformation-explainer-idUSKBN2600B5
[26] http://www.xinhuanet.com/english/2021-03/05/c_139786697.htm

technologies, including cloud computing, big data, the Internet of Things and notably block chain – the technology's first inclusion in a national FYP.

Industry clusters like Silicon Valley play a central role for modern innovation, business competitiveness, and economic performance. It yields tremendous economic gain for the regions. In 2019, Silicon Valley's output was $275 billion, around 1.3% t[27]o the GDP of the US. The region's per capita output reached $128,308, twice the average for the US. To achieve the goal of becoming an economic powerhouse in China's west, Chengdu-Chongqing should plan to build the relevant industry cluster and emphasize scientific leadership over the next few years. This chapter reviews what constitutes an industry cluster, the growing influence of digital technologies for businesses and society, as well as the degree to which policy makers can purposefully foster them.

2.1 Industry clustering

The development of industry clusters has resulted from a combination of many regional factors: relevant pools of indigenous knowledge and skills; the regional location of engaged educational and training institutions; access to venture investment capital and affiliated talent networks; along with supportive government policy and funding. Many industry clusters including those in Silicon Valley have benefited from all of these factors.

The emergence of new industry clusters in places largely lacking the significant presence of venture capital firms or personnel, demonstrates that early stage industry clusters have been able to attract significant enough investment from government and private sources to successfully establish themselves. As global market competition for industries increases, there will be multiple success models for such industries, ranging from models that are largely self-organized, to those preplanned and directed by either local, regional or national government policy.

Strategic foresight exercises can assist local governments to map out a long term cluster development strategy and to provide the stable financing for R&D that research intensive industries frequently require. For both cities, the incentive policies to attract industry need to be supplemented by others that secure the city finances and ensure that related services and housing meet expectations of the industrial talent pool. But providing services and infrastructure are not enough. Cities must also market themselves aggressively by organizing events and seeking out business investors, both domestic and international. Such marketing is a reliable way of infusing capital and ideas into existing clusters and growing new clusters.

2.2 Expanding industrial value chain

[27] https://www.visionofhumanity.org/the-contribution-of-research-and-high-technology-from-silicon-valley-to-the-us-economy/

As the heartland of China's electronic industrial development, the Chongqing has successfully attracted many microelectronics or consumer electronics players from US, Europe, South Korea, and Japan into the domestic market. While, Chengdu is home to hundreds of thriving software start-ups and Chinese tech giants such as Tencent, Alibaba[28] – which have either set up research centers or subsidiary companies in the city.

In order to sustain the comprehensive competitiveness of this dual-city, there are significant synergies in expanding semiconductors and microelectronics value chain with existing clusters. Having a stronger semiconductor and related fields manufacturing footprint in the Chengdu-Chongqing region could bring additional benefits to the local economy. Development of local high-tech clusters that create high-quality jobs and economic prosperity. Its distinctive advantages in the high-technology industry will provide the formidable foundation as it transforms into the "Silicon Valley in China's west".

Maintaining robust domestic manufacturing capabilities is also essential to ensure that the China semiconductors and microelectronics industry has a highly resilient supply chain. In 2020, 84.1%[29] of the China's ICs consumption were imported. As the COVID-19 crisis has shown, high concentration outside of China makes a supply chain vulnerable to disruptions such as natural disasters, pandemics, or geopolitical conflicts. Given the strategic nature of the semiconductor industry for the China economy and national security, bolstering supply-chain resiliency through establishing the whole value chain in the Chengdu and Chongqing region is imperative.

In addition, high-tech companies could create jobs, significantly expanding the Chengdu-Chongqing talent pool of highly skilled semiconductor manufacturing technicians, foster the development of local high-tech clusters and reinforce the position across the semiconductors value chain. Revolutionary applications, such as augmented- or virtual-reality experiences, the Internet of Things, Industry 4.0 systems, and self-driving vehicles, are on their way to becoming commercial realities. Together with continued leadership in R&D, strengthening its capabilities in manufacturing would position the Chengdu-Chongqing semiconductors industry to lead the way in the new innovation frontiers of materials, architectures, and fabrication processes that will power the critical advancements in computing and electronics for the next decades.

2.3 Digital transformation driving economic growth

[28] https://www.scmp.com/native/business/china-business/topics/gitf/article/3102036/how-chinas-new-city-cluster-cheng-yu-can
[29] https://finance.sina.com.cn/stock/hkstock/hkstocknews/2021-04-14/doc-ikmxzfmk6708245.shtml

In the context of China's dual circulation economic strategy, building smart cities in Chengdu-Chongqing region will be an important driving force for industry transformation, innovation and development, and refined urban management.

With the development of cloud and AI technology, the government could consider setting out new goals, bringing ubiquitous cloud and pervasive AI and building all-scenario intelligence for cities, industries, and enterprises. It helps create business opportunities for tech companies to extend their approach from B2C to B2B, open up capabilities to all of society, enhance productivity and innovation capabilities, and enable the era of the smart economy. By collaborating with different industrial partners, the government should take key role to make the goal of all-scenario intelligence possible.

All-scenario smart city: This represents a new stage in smart city development. Intelligence in every corner of the city will power accurate analysis, system predictions, coordinated command, scientific governance, and scenario-based services for entire cities. Enterprises with a more open environment for innovation will continue to spawn new industries and new ecosystems. Residents will be able to enjoy convenient urban services, which will increase their quality of life. It will facilitate a city with an innovative smart ecosystem for all based on joint creation, sharing, and mutual benefit.

All-scenario smart enterprise: New technologies, such as cloud, AI, computing, and 5G, in all enterprise operation scenarios, will help companies deploy intelligence. This will enhance service experience, optimize business processes, and enable business innovation. It will help companies build competitive advantages and the ability to innovate in the intelligent era.

All-scenario smart industry: It will revolutionize technology and drive industrial transformation, and create high-value scenarios, service models, and business models in industries. It will accelerate digital transformation and intelligence in industries and boost productivity.

By developing the three key scenarios – all-scenario smart city, all-scenario smart enterprise, and all-scenario smart industry, it allows the Chengdu-Chongqing region build key capabilities for smart economy, which will benefit individual, industry and society.

The technologies including 5G, big data, Artificial Intelligence and Internet of Things enables digital transformation and support all-scenario intelligence. These technologies and systems bring a significant data volume increase and lead to the high demand for interconnect solutions. To achieve all-scenario intelligence in the Chengdu-Chongqing region, AT&S takes a forward-looking approach with high investment and a targeted expansion of the value chain.

AT&S, one of the leading manufacturers of high-end printed circuit boards and IC substrates, has demonstrated a significant commitment to ensuring digital transformation and the sustainable future of Chongqing since the company's manufacturing operations began in 2011, with the vital support of the Chongqing Government and Liangjiang New Area Development Zone.

Since AT&S entered into China in 2001 and established its manufacturing site in Chongqing in 2011, AT&S has continued to invest in Chongqing, financially supporting the city's semiconductors and microelectronics industry ecosystem with the state-of-the-art manufacturing facilities, and through sustainable business practices that have resulted in strong corporate governance, the introduction of advanced manufacturing techniques, workforce training and close relationships with other high-tech industries to maintain the highest industry quality standards in Chongqing.

As demand is expected to be strong in the future, capacity expansion at AT&S Chongqing continues. The company is committed to supporting the government and industries with the effective implementation of these digital innovations in the Chengdu-Chongqing. AT&S's substrates are currently a dominating technology for the application in high-performance computers, which can be found in the heart of most servers, personal computers, 5G base stations and, in the future, also in cars. By 2025, AT&S aims to be among the three largest high-end substrate suppliers worldwide and to achieve its goal to become an interconnect solution provider in line with the "More than AT&S" strategy.

Chapter three – sustainable development in Chengdu-Chongqing region

Located in the upper reaches of the Yangtze River, the Chengdu-Chongqing economic circle is the most densely populated area with the highest concentration of industries and the most cities in west China. It is desirable that both Chongqing and Chengdu creates its own specific general plans for low carbon eco-cities over the next decade. But the motivation should be pursuing a long-term path for sustainable development plan instead of only attracting investment. Therefore, a clear vision shall be outlined to support the evolution of low carbon eco-cities in the Chengdu-Chongqing region in the beginning and to provide clarity and guidance at this critical stage - the beginning of 14th Five-Year Plan.

3.1 Importance of an integrated approach

Low carbon eco-cities should be integrated at all stages of development, adapted to local situations. Several requirements will support this goal:

- For the next 5 years, low carbon green-tech solutions should be considered in the very early stages of urban planning and design. The Chengdu and Chongqing area is an integrated

system, where energy supply, transport, buildings, commerce, public services and people are closely linked and constantly interacting. Therefore, the establishment of effective low carbon strategies and green-tech solutions requires an integrated approach and management techniques to span traditional department "silos" and create cross-discipline collaboration and efficiencies among different types of infrastructure planning including urban planning, transport, water and energy at city levels;

- Low carbon eco-cities development is not a rigid concept and it is meant to be perfectly adapted to local conditions, needs and priorities. With the establishment of Chengdu-Chongqing region, new area is required to build swift cross cities renewable energy trade mechanism, connecting regular energy cooperation between the Chengdu-Chongqing and other area with rich clean energy resource. It can not only solve shortage supply of clean energy in the Chengdu-Chongqing region, but boost economy development in undeveloped regions, in line with the national strategy - "Great Western Development". While, it is critical for the authority to fully open the renewable energy market to all industry players, including both Chinese and foreign companies, enrich variety of clean energy in the market and make their price reasonable and competitive.
- Government leadership, business models, financing and technologies are the basis for achieving the eco-cities concept. Business models are essential to promote technology adoption, partnerships and commercial viability. Also, green-tech must be available, affordable and relatively mature to be used to meet economic and ecological targets. In addition, innovative financing is a key factor, especially for some green-tech involving high CAPEX and long payback periods such as wind and solar technologies. Among all these issues, the most important one is still the set-up of appropriate government policies, which will act as the catalyst for the development of low carbon eco-cities, by encouraging and attracting Chinese and foreign private investment and participation in the following areas including urban planning and design, transport, buildings, water, renewable energy, distributed energy systems and financing of green-tech solutions. The government supervision bodies also need to establish the right key performance indicators to track progress and monitor implementation.

3.2 Building low carbon eco-cities

To be better adapted to the situation in the Chengdu – Chongqing region, several domains are listed below for further consideration of the low carbon eco-cities development:

- Technology innovation: since around 68 universities are located in Chongqing and 58 in Chengdu, large scale R&D capabilities and innovation should be clustered, associating enterprises and R&D competences to accelerate development and attract national and international skills for achieving low carbon and ecological targets;

- Extensive application of existing green-tech solutions: focused on development of emerging and mature low carbon industries such as the solar distributed energy solution, electrical vehicle and more extensive application of electrical and compressed natural gas (CNG)/ liquefied natural gas (LNG) vehicles as well as the LNG vessels on the Yangtze river;
- Energy efficiency and consumption reduction: as one of the largest energy consumers in China, the Chengdu-Chongqing area should continuously reduce energy consumption and improve energy efficiency. The target can be achieved through:

✓ creation of complete energy recycling system with recycled energy used in the industrial parks;

✓ Encourage all manufacturing sites to expand renewable energy usage during production process and their supply chain. It helps them to meet global clients' requirement with carbon neutrality targets and increase competitive edge;

✓ Fully open the renewable energy market to all industry players, including both Chinese and foreign companies. Enrich variety of clean energy in the market and make their price reasonable and competitive.

Local governments, state owned, private or foreign companies in the Chengdu-Chongqing region should take the initiative in implementing action plans. In addition, city planners in the digital age can no longer rely solely on top-down management processes that are organized and carried out exclusively by authorities. Public participation, representing the diverse interests of communities and businesses, leads to better planning and public policy development. By using its unique geographical position and making the most of its natural resources assets, AT&S is convinced that the Chengdu-Chongqing could take digital transformation and sustainability opportunities to reach a new high.

3.3 Case Study: San Jose, Silicon Valley's Green Vision

San Jose is a city located in the Silicon Valley. This is a renowned location where investors, manufacturers, suppliers and technology innovators have established dense networks of relationships that can provide cost and innovation advantages for the region. This one million city has been more recently trying to leverage this hotbed of innovation with a "Clean Tech Strategy" that sets goals for economic growth and job creation in clean technology jobs in clean energy, and resource efficiency.

As part of a larger "Green Vision," the city's Clean Tech Strategy has set a goal by 2022 of creating 25,000 clean tech jobs from its total of about 12,000 jobs in the clean tech sector in 2015. This strategy intends to leverage the region's easy access to venture funding, highly skilled engineers and entrepreneurs, world-class research institutions, supportive government policies, and technology incubators like San Jose's Environmental Business Cluster.

The San Jose clean technology strategy uses traditional business retention and attraction approaches combined with sophisticated networking of technology and governmental partnerships that are:

- Providing incentives and services at every stage of growth to encourage both established clean technology companies and start-up firms to stay and grow in San José;
- Incubating next-generation technologies through partnerships with local universities and Energy's National Renewable Energy Laboratory-backed Environmental Business Cluster;
- Providing city demonstration opportunities for innovative clean technology products; Creating opportunities for local residents to receive training for employment in clean technology industries;
- Advocating for legislative changes that will support the clean technology industry's growth.

One of highlights is the city of San Jose and the Environmental Business Cluster developed an Electronic Transportation Development Center, where emerging and established technology companies collaborate on the design, development, prototype fabrication, and technology licensing for clean energy technologies. The city is establishing pilot programmes for new technologies such as electric school buses, refuse trucks and fueling stations, while incorporating designs and electronics from the Silicon Valley region to make the vehicles cleaner, safer, and more secure.

San Jose's Green Vision programme provides goals and milestones so city can leverage the Silicon Valley's leading base of technology and business model innovation in the creation of clean technology economic development. In addition to partnering with a nationally supported technology innovation center, the Environmental Business Cluster, San Jose tracks the number of local clean technology sector jobs and has set longer-term job creation goals for the city's clean technology sector. San Jose has attempted to utilize a number of operational tactics for supporting clean technology industries by making its buildings, land and operations open to pilot project collaboration, as well as matching smaller clean technology and energy efficiency companies with contract opportunities provided by the city's many large corporations.

Conclusion

Over the past decade, the Chengdu and Chongqing area has generated the bulk of our affluence. Nowadays, it faces economic, ecological and social challenges as it has step in a new period of transforming the development model, optimizing the economic structure and achieving synergy between national policy and both cities' advantages and development strategies.

In conclusion, we would highlight that technological innovation, digitalization and ecological

civilization are three key pillars to transform Chengdu-Chongqing Economic Circle into the Silicon Valley in China's west.

Chengdu-Chongqing region should recognize that digital transformation is essential to a vibrant social, economic and cultural life of the region. The dual-city should invest in information and communication technology infrastructure and applications driven by 5G, big data, AI and IoT so as to strengthen services across multiple sectors, and to build an intelligent digital nervous system supporting cities' operations.

Chengdu-Chongqing should further strengthen scientific research and technological innovation, as well as establish and improve systems for using new technologies. The government should accelerate the application of scientific findings in order to improve the quality of people's lives, optimize industries clusters, and create new job opportunities, apply principles of openness and mutual benefit in strengthening scientific and technological exchanges and collaboration around the world.

Finally, we all should respect nature, consider the urban ecological environment as an asset, integrate environmental issues into urban planning and administration, and accelerate the transition to sustainable development. It is government's responsibility to promote the use of renewable energy sources and build low-carbon eco-cities. Cities and citizens should join together to create sustainable lifestyles and an ecological civilization in which people and environment coexist in harmony.

To this end, AT&S is looking forward to working closely with Chongqing to support the dual-city's strategy. AT&S is committed to supporting Chengdu-Chongqing region becoming a global semiconductors and microelectronics manufacturing base in order to achieve the government's objective of transforming Chongqing into a high-technology and innovation hub.

Scientific and Technological Innovation and Digital Transformation to Accelerate the Construction of a Modern Industrial System

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Background

Drawing "a concentric circles", telling "a tale of two cities" and building "economic circles". The Chengdu-Chongqing Economic Circle is an important mission entrusted to Chengdu and Chongqing by the central government. After being positioned as "important strategic fulcrum of the Western Development", "important junction of the Belt and Road and the Yangtze River Economic Belt", "inland opening highland" and "national central city", Chongqing once again stands under the spotlight of the national major strategic deployment. As Sichuan and Chongqing are committed to reform, actively planning and strengthening coordination, they have worked around seven key tasks and made some initial achievements for more than one year since the construction of the Chengdu-Chonging Economic Circle. In this process, Chongqing has made remarkable achievements in industry, scientific and technological innovation, ecology, talent and other aspects. Meanwhile, there is still a lot of room for improvement in the future.

I. Jointly building a scientific and technological innovation center with national influence

In the past year, Chongqing has rapidly formed the spatial layout of scientific and technological innovation and an ecosystem of a range of scientific and technological innovation, whether around the construction of the West (Chongqing) Science City, or with Liangjiang New Area, Qijiang High-tech Zone, Yubei National Agricultural High-tech Industry Demonstration Zone as the carriers. However, compared with the cities in the Yangtze River Delta, the Guangdong-Hong Kong-Macao Greater Bay Area and the Beijing-Tianjin-Hebei region, Chongqing still has a significant gap in the density of scientific and technological innovation, the intensity of scientific and technological research and development, the proportion of new high-tech enterprises, the concentration of scientific and technological innovation talents, and the acceleration of economic growth through scientific and technological innovation. In order to build an influential scientific and technological innovation center, it is also necessary to further accumulate the key elements of scientific and technological innovation, including talent, capital and technology, to be more advantageous.

1 . Convert from the traditional "attracting large businesses and investment" to "attracting innovative businesses and talents", expand the incubation of startups, scale up the innovated industry, and retain the original resources of scientific and technological innovation.

Local governments have traditionally tended to attract large manufacturing companies. To attract these businesses, governments usually invest a lot of resources and capital. Although these enterprises can positively influence and promote the development of local industries and make

great contributions to the local economy, local governments usually face the problem of large initial investments and long return periods. In particular, once manufacturing enterprises move for a lower labor price, land cost, policy cost or other key production factors, the dividends of technology, talent and capital that these firms have created will wither away, which will be a severe loss inevitably faced by governments. In addition, the enterprises introduced by local governments are usually very mature and of a certain scale, of which their headquarters, research and development departments and other functional departments have generally already made deployment and layout. They may add or relocate factories in different regions according to the favorable conditions offered by local governments, but they are unlikely to relocate their core functional departments, which limits the knowledge spillover in the production location and the original impetus for scientific and technological innovation of these enterprises. For Chongqing, neither of these situations is conducive to its success in building an influential scientific and technological innovation center.

As a result, Chongqing needs to go beyond the traditional investment model and focus not only on manufacturing enterprises, but also on attracting and nurturing startups with greater innovation potential and cutting-edge R&D technologies. Companies often have a path dependence on the original city where they grow and develop. If the government provides advantageous conditions for startups, they grow with the city. Chongqing could consider creating a scientific and technological enterprise incubator with national appeal. As more and more new technology startups gather and grow in Chongqing, their technology, IP, capital and so on will gradually settle down in the local area, forming an active and sustainable scientific and technological innovation ecology. Meanwhile, such scientific and technological innovation ecology will also achieve the corresponding talent agglomeration effect, which is one of the most important driving forces of scientific and technological innovation. When these scientific and technological innovation talents are always willing to stay in the local area, more innovation and entrepreneurship projects will be continuously stimulated, thus attracting another important driving force: capital. The Matthew effect will be prominent. If the elements and advantages of scientific and technological innovation accumulate over time in Chongqing, the level and influence of scientific and technological innovation in this city will be greatly improved.

2. Expand the "track", strengthen the supply, and promote a number of scientific and technological innovation enterprises with development potential to become stronger and bigger.

Excellent incubators not only provide basic space and services for startups, but also have the ability to absorb and gather innovative factors and resources, which is also an important condition to promote the rapid growth of scientific and technological enterprises. This requires the government to start from the following three aspects:

(1) ***Expand the "track" for the application of new technologies in scientific and technological enterprises***. On one and, Chongqing can take the initiative to help scientific and technological enterprises solve the problem of supply and demand and guide the application of new technologies in existing industries, and on the other hand, it can vigorously cultivate new industrial clusters led by new technologies. For example, in the context of China's carbon peak and neutrality goals, the city can focus on new energy, reduction of industrial carbon emissions, low-carbon parks and other areas, facilitating the application of new technologies in these fields, as well as promoting the effective combination of scientific and technological

innovation and industrial innovation. This can promote not only the rapid growth of startups, but also the industrial transformation of Chongqing.

(2) ***Create a quality ecosystem for startups.*** Internally, the government can guide incubators to cultivate a group of startups in complementary industries and guide incubation in the whole industry chain, so that such enterprises can gather, cooperate with each other in the process of growth, and gradually form a core industrial chain with cutting-edge technologies in the future. Externally, the government can help facilitate collaboration between these companies and large, industry-leading companies. Relying on the leading advantages of large enterprises in technology, market and management level, startups can not only obtain the support of technologies and funds from the large enterprises, but also learn advanced enterprise management experience from them. In the meantime, with the help of the market influence of the large enterprises, startups can obtain access to invaluable validation projects, accumulate actual business experience, and achieve the breakthrough from "0" to "1" smoothly. If newly-established firms can successfully cooperate with the paired large enterprises, they can enjoy the management output and market access of the large enterprises and quickly scale up from "1" to "N".

(3) ***Enhance the transformation of scientific and technological innovation achievements by relying on the advanced manufacturing clusters***. If the two points above can promote the transformation of original scientific and technological innovation achievements, then the scale-up of achievement transformation cannot be separated from a complete industrial chain, high-tech talents and necessary capital support, which can be realized in various advanced manufacturing clusters. An advanced manufacturing cluster is an advanced manufacturing network with leading technology, high synergy and global influence formed by leading enterprises, scientific research institutes and related supporting institutions, providing fertile soil for technological research, development and innovation to large-scale industrialization, effectively boosting the link between suppliers and demanders. With the support of advanced policies and measures, well-established industrial chains, scientific and technological talents and various mechanisms and resources including finance, it forms a network of the government-industry-university-research institute-user cooperation mechanism, promoting enterprises to timely understand and adapt to changes in the market demand, accelerating the spillover and diffusion of the cluster's technologies, driving technological innovation to achieve group-type breakthroughs, and becoming the cradle of future enterprises. "Advanced manufacturing clusters are seen as a driver of economic growth and technological innovation in both European and American countries and in China. For example, in the European Union, modern manufacturing clusters generate more than 87% patents, leading to higher productivity, wages and economic growth rates"[30].

[30] FX361.com: Research on Transformation and Upgrading of Manufacturing Clusters under the Context of "Next-generation Information Technology", September 24, 2019

The Schneider Electric Green Co-innovation Campus Program

Since 2020, Schneider Electric has launched **Green Co-innovation Campus Program （the "Program"）** in two major fields of green and intelligent manufacturing and green energy management in the hope of gathering more innovative forces in an open and win-win ecological environment and constantly provide new ideas and solutions for the digital, intelligent and low-carbon development of the manufacturing and energy industries.

Schneider Electric and its co-sponsors and cooperative organizations, during each session of the Program, conduct preliminary on-line screening, review and comprehensive evaluation on more than 100 registered startups and finally select over ten of them to enter the acceleration camp. These enterprises will jointly conduct research accompanied by the mentor group, aiming at the common pain points and difficulties at present or in future in the industry, to put forth industry-wide leading and innovative solutions that are efficient, applicable and replicable. Through client-side verification and with the help of Schneider Electric and its partners' broad market channels for rapid replication and promotion, the enterprises can access potential customers efficiently. In addition, high-quality innovative and high-tech enterprises can also have opportunities to obtain direct investment of Schneider Electric's venture capital to jointly tap business opportunities worldwide.

This year marks the second session of the **green-smart manufacturing ecosystem co-innovation campus program** which is hosted by Schneider Electric and the Center for International Economic and Technological Cooperation (CIETC) of the Ministry of Industry and Information Technology. Thanks to CIETC's strong relationships with the industry parks, the program has been introduced into those industrial parks that have full range of industrial sectors and strong sense of pioneering in the field of furthering in-depth integration of digitization and manufacturing as well as "carbon neutrality", which has not only gained more advantages in exploring the typical digital transformation scenarios of green-smart manufacturing, transformation of technical achievements, cultivating the small and medium-sized scientific and technological innovation enterprises for long-term benefits, but also laid a good foundation for the industrial parks to create an environment of scientific and technological innovation, cultivate new industrial ecosystem and realize the transformation of manufacturing industry.

"The year 2021 is the first year of the '14th Five-Year Plan'. It is imperative to promote in-depth integration of the digital economy and the real economy, which requires all parties to reach a consensus and go forward hand in hand. The **green-smart manufacturing ecosystem co-innovation campus program** *will build a platform of joint innovation for win-win results, assisting innovation-based companies in developing replicable digital solutions based on actual customer demands to drive the healthy development of the whole ecosystem."*

---LI Yikai, Deputy Director of CIETC

II. Optimizing the layout of production, cultivating advanced manufacturing clusters with international competitiveness, and promoting high-quality development of manufacturing industry

Chongqing has always been an important industrial area in southwest China. The manufacturing industry is the foundation of Chongqing. In recent years, Chongqing has been committed to building a national advanced manufacturing center. In the papers submitted in the past three years, Schneider Electric has put forward suggestions, from the aspects of enterprises, supply chain and industries, including "promoting the intelligent transformation of enterprises and using cloud platforms", "building a smart logistics system to improve supply chain efficiency" and

"enhancing the industrial chain resilience through digital technologies", for the transformation and upgrading of Chongqing's manufacturing industry. We have also observed that Chongqing has achieved good results in boosting the transformation of its various industrial enterprises by organizing and implementing the special action of intelligent manufacturing diagnosis and evaluation, intelligent factories and digital workshops, promoting applications of the Cloud and industrial internet technologies, etc.

However, at present, the world economic pattern is changeable, the future of the global epidemic is unclear, and the evolution of a new round of scientific and technological revolution and industrial reform is accelerating. At the same time, in order to cope with global climate change and environmental constraints, all countries in the world regard green development as the primary goal, and the Chinese government also made a commitment to the "3060 carbon emission reduction target" at the UN General Assembly in last year. All these put forward newer and higher requirements for the industrial sector as the lifeblood of the national economy to achieve long-term development. Under the new situation, "to develop the manufacturing industry, we should not only focus on increasing the quantity, but also emphasize on optimizing the stock, to build industries and industrial clusters with good growth potential"[31]. In order to transform Chongqing from a traditional industrial town to a national advanced manufacturing center, it also needs to make efforts at the industrial level, from single enterprise to the industrial cluster, to further optimize the layout of production, improve the technology and efficiency level of clusters and parks, so as to enhance the core competitiveness of the manufacturing industry, combined with the situation of many local industrial categories, the proportion of high-energy consumption industries and the uneven development level of small and medium-sized enterprises.

1 . Focus on green energy management, optimize the industrial layout, and boost the green and low-carbon transformation of the manufacturing industry

Manufacturing is one of the main fields of energy, resource and environmental consumption, and also the main battlefield of green development. Promoting green and low-carbon development of the manufacturing industry is the key and inevitable choice to achieve the carbon peak and neutrality goals.

In recent years, Chongqing has accelerated the pace of industrial structure adjustment and greatly developed emerging manufacturing and service industries. However, as a traditional industrial city, Chongqing's industrial economy still accounts for a large proportion, and new industrial investment still covers projects with high energy consumption including energy construction, oil, gas, chemicals and materials, etc. Statistics show that the total industrial energy consumption of enterprises above the designated size in Chongqing last year accounted for 48% of the city's total energy consumption. Among them, the energy consumption of the six high-energy-consuming industries accounted for 83.1% of the city's industrial energy consumption of enterprises above the designated size, and the energy consumption of the material industry alone accounted for more than half.[32] All these have a huge impact on the reduction of industrial carbon

[31] The Ministry of Industry and Information Technology of the People's Republic of China (MIIT): "Vigorous Promotion of High-quality Development of Digital Economy, written by XIAO Yaqing, Study Times", July 16, 2021

[32] *Letter of Chongqing Economic and Information Commission on Providing Information on Industrial Energy Consumption in 2020*, 2021

emissions in Chongqing. Meanwhile, taking electricity as an example, Chongqing restricts or even no longer approves thermal power projects year by year. However, as the utilization of new energy sources (photovoltaics, wind) and clean energy sources (hydropower) is not high due to geographical and climatic factors, and new industrial investment also boosts energy consumption, Chongqing is currently facing the situation that the power supply side cannot meet the growing demand side, and it is difficult to change the energy consumption structure in a short term with this trend.

Recently, Schneider Electric Business Value Institute has conducted research on the carbon emission reduction strategies of industry leaders in China in the context of the carbon peak and neutrality goals. The results show that "energy saving" has unsurprisingly become the most important way of carbon emission reduction for leading enterprises from the policy measures of energy conservation and emission reduction during the "10th Five-Year Plan" to the "carbon peak and neutrality" plan during the "14th Five-Year Plan". "In addition, 'establishing a long-term plan for a sustainable energy management system' is widely accepted by leading enterprises. About 66% of companies surveyed have chosen this option, which is higher than the proportion of energy substitution and carbon emission reduction by saving raw materials". At the same time, more than 80% of respondents agreed that "technological capabilities are the primary factor in achieving carbon emission reduction targets, and better technological capabilities can help companies address policy concerns, and companies need continuous technology acquisitions and R&D activities to provide room for business optimization". In particular, about 60% of executives said that "digitization is beneficial to 'carbon asset management and cost optimization' of enterprises, 'energy consumption tracking and carbon output report', and 'energy risk prediction and control'."[33]

Those enterprises with advanced energy-saving and carbon reduction concepts and technologies and sound energy-saving measures will be more able to obtain competitiveness and achieve sustainable development. Based on the situation above, Chongqing should strengthen energy conservation and carbon reduction in the manufacturing industry, and encourage the promotion and application of advanced technologies and services. For example, through the lean improvement of consultation, construction of a digital system, clarification of carbon emission targets and production and operation indicators, etc., the city should set up the management, tracking and analysis system of carbon emissions and production and operation indicators, to promote the continuous improvement of management efficiency and continuous reduction of carbon emissions and boost the manufacturing industry to build core low-carbon capacity and enhance industrial competitiveness.

[33] Executive Insights for Carbon Neutral and Sustainable Development, 2021

Case of industrial carbon neutrality: Faurecia Partners with Schneider Electric on Carbon Neutrality

The Faurecia Group, a giant in the automotive components industry, has proposed to archive carbon neutrality at the Group level by 2030. Faurecia's Yancheng Factory, as the focus of their entire plan, further shortens the time frame and puts forward the deadline for achieving this goal to 2025. With the help of Schneider Electric, starting with sustainable consulting and planning, 17 carbon reduction opportunity points were identified for the Faurecia Yancheng Factory, utilizing the EcoStruxure framework based digital solution that is integrated with cloud computing, edge control and terminal equipments, with the assistance of systems and products including smart meters and various metering products, power monitoring (PO), and EMS+, etc., to achieve energy saving and emission reduction, and thus setting a benchmark for emission reduction within the Group.

"*Partnering with Schneider Electric will allow us to advance rapidly in this first stage of our initiative leveraging their global footprint and technology to deploy solutions across all our sites.*"

--- Patrick Koller, CEO of Faurecia

(1) ***Promote a number of leading enterprises to take the lead in achieving the "Carbon Peak and Neutrality" goals.*** Any actions taken by the leading enterprises in this industry will have driving and chain effect throughout the entire supply chain. Chongqing owns a wide range of industries and is home to a large proportion of SMEs. This city is provided with an increasingly complete industrial chain that effectively promotes its low-carbon transformation spurred by leading supply chain enterprises and followed by SMEs on the chain. Chongqing can establish a systematic "portrait" for key industries and key energy-using fields, sort out the obstacles in the structural transformation of the energy consumption at the current stage, and select a number of leading enterprises to pioneer carbon reduction actions, which shall start with conducting the full-life-cycle green and low-carbon plan of an enterprise from its own product development to manufacturing and operation, rationally introducing digital energy management technologies to improve energy efficiency and reduce carbon emissions, also building a green supply chain management system, and promoting the implementation of carbon reduction by enterprises on the supply chain through more stringent procurement and production standards to lead the systematic carbon reduction of the entire industrial chain.

(2) ***Facilitate the low-carbon transformation of a number of traditional industrial parks.*** Industrial decarbonization is at the core of low carbon economic development. If individual enterprises tend to focus more on regulatory compliance and cost reduction, and rely more on quantified energy efficiency and lean transformation in the short term to reduce carbon, then the government need to think deeper about how to give impetus to a sustained process of carbon reduction at the industrial level. This needs to start from both scaling-up and systematization. First of all, Chongqing can take industrial parks as the carriers and let the park administration committees take the lead to build a public service platform for energy management, which can collect and analyze real-time data on the energy consumption of enterprises in the parks through digital technology in a unified manner, and put forward proposals for energy reduction and optimization to achieve carbon reduction. Furthermore, sustainable carbon reduction also relies on the long-term, systematic monitoring and

supervision of the above efforts, and this needs to be implemented by enterprises or institutions with assessment, monitoring and consulting capabilities. Therefore, the government shall encourage the industrial ecosystem and business models carried around low-carbon consulting services. This shall not only mean the application and implementation of low-carbon products and technologies, but also the achieving of long-term planning and execution through professional services to increase low-carbon economic benefits, and ultimately accomplish the achievement of improved quality, reduced costs and increased efficiency in the manufacturing industry.

Case of Zero Carbon Park: EUREF Campus – Urban Districts Redefined

Together with its partner EUREF and DENA (German Energy Agency), Schneider Electric has turned a disused gas station in Berlin's Schöneberg district into Europe's first and world-leading zero-carbon campus. The 5.5-hectare park is home to more than 200 innovative companies and nearly 3,500 people. Since its completion in 2014, the EUREF-Campus has reached the 2050 climate protection target set by the German Federal Government and has validated the economic viability of the target, creating a benchmark project for zero-carbon parks worldwide.

Schneider Electric and its partners jointly devise zero-carbon solutions and plan ahead to balance social and economic benefits. And the digital solutions based on the EcoStruxure framework ensure carbon neutrality in the operational phase. Sustainable digital solutions for smart parks encompass building control products, variable speed drive, building operation systems (EBO) and power management systems (PME), and also drive the implementation of micro-grid-based smart dispatch EMA solutions for renewable energy, energy storage, and plug-in cars.

(3) ***Create a number of "Carbon Neutral" innovative demonstrations.*** Developed scientific and technological and large-scale scientific and technological progress are one of the most important conditions for industrial layout. Choosing science and technology suitable for local industrial structure adjustment is an important means to realize the rational adjustment of industrial layout. Apart from the above efforts on the "stock", Chongqing can endeavor to break some "new grounds" by introducing advanced technologies and innovative ideas, cultivating new business models of "Carbon Neutrality", and making steady progress in the improvement and upgrades for local industrial productivity layout in key sectors or industries that are conducive to stimulating the restructuring of current energy consumption. For instance, to tackle the current challenges of electrical power supply, Chongqing can advance the technology layout and reserve in the fields of micro-grid, integrated energy services, energy storage, and con-currently cultivate new industries and new business models that provide end-to-end solutions for the whole process of energy production, transmission, storage and use, from professional top-level design and consultation to hardware products as well as software systems, and then to services of the entire life cycle. All these can be piloted in areas with relatively complete industrial infrastructures, but also with urgent needs for industrial restructuring, open and inclusive policies as well as institutional environments, and with the appeal for the gathering of factors such as technology, talents, and capital. Chongqing

High-tech Zone, for example, as an important region and construction carrier of the Western (Chongqing) Science City, is still juggling to manage a large number and wide range of traditional industrial enterprises and emerged structural contradictions at this stage, as well as its urgent need to accelerate the transformation, upgrading, and green development. Nevertheless, as the pace of construction accelerates, more and more science and technology enterprises, research projects, and talents are flocking to this region, and the government of the High-Tech Zone is actively implementing policy and system reforms to optimize the business environment[34]. Therefore, relying on new technologies and services, "carbon neutral" parks or factories can be built in the region to improve the green level of traditional parks and factories on the one hand. And on the other hand, low-carbon concepts can be integrated into the construction of the entire urban facilities, including campuses, hospitals, communities, industries, from the dimensions of zero-carbon energy, zero-carbon buildings, zero-carbon transportation, carbon capture, utilization, and storage (CCUS) to promote the large-scale development of new industries and new business models. All these methods require the government to proactively play the roles of policy guidance and regulatory supervision. And if possible, a variety of fiscal, taxation and financial approaches can be employed in the early stage for the promotion of those methods first in critical pilot areas, and then extended to a city-wide replication and application.

2. Cultivate advanced manufacturing clusters led by digitization to further enhance the core competitiveness of Chongqing's manufacturing industry

Digital technologies have fundamentally changed not only the production mode and business model at the enterprise level but also the value system among organizations at the industrial level. Apart from the characteristics of high agglomeration under the geographical proximity of general industrial clusters and industrial linkages under the specialized division of labor, advanced manufacturing clusters own features which are presented as more advanced technologies, organizational forms, and manufacturing modes, creating synergies and generating economies of scale. However, with the wide implementation of technologies such as big data, Internet of Things, mobile Internet and cloud computing, the remote connection and synergy between organizations in the industrial chain has been greatly improved, which realizes the efficient integration of geographically dispersed and distributed activities and promotes a more ecological connection between organizations instead of simple geographical aggregation. A higher-level advanced manufacturing cluster is required to not only realize the transformation of production itself, but also solve the connection and synergistic problems between organizations within the cluster and between the cluster and the outside. Such a cluster is no longer a purely regional production collaboration system, but an industrial ecosystem with leading technology, close collaboration, and efficient operation, thereby providing strong support for the improvement of quality and efficiency of the entire industrial chain. All these can be achieved through the deep integration of digital technology and industry.

(1) Expedite the digital capacity building of the manufacturing industry from single enterprise to the entire value chain. The first thing to address in an advanced manufacturing cluster is the

34 Selected from: Planning and Construction of Western (Chongqing) Science City and The 14th Five-year Plan for Ecological Environmental Protection of Chongqing High-tech Zone and Long-term Goals for 2035

"advanced nature" of the manufacturing industry itself. In the post-epidemic era, the resilience building empowered by digitization of industrial chain and supply chain has been elevated to an unprecedented level. The world is in an accelerated transitional phase from the industrial economy to the digital economy. "For the development of manufacturing industry, digital transformation is no longer a 'multiple choice', but a 'mandatory course' that matters of survival and long-term development "35. In addition, under the strong impetus of a new generation of information technology, the paradigm of technology and economy has been transformed, and the source of competitive advantage of the manufacturing industry in the global value chain has been changed from the traditional labor intensity to the enhanced intensity of knowledge, technology and capital. This has seriously weakened the competitiveness of manufacturing industry in developing countries that participate in the international division of labor with the advantage of lower labor cost. Quite the opposite, developed countries have revitalized the manufacturing industry with a "re-industrialization" strategy, offsetting their labor disadvantage with advanced manufacturing technology, and seizing the high ground of advanced manufacturing development. Considering the impact of the Covid-19 pandemic, countries attach great importance to the security of the supply chain and the localization of manufacturing. The trend of bringing manufacturing home remains the theme for this certain period of time, which significantly challenges the international competitiveness of the domestic manufacturing industry. In view of the situation, the import substitution of high-tech products is an urgent problem to be solved for the development of advanced manufacturing industry in China. Owning a satisfactory range of full-fledged domestic industrial systems, China is making continuous progress in the development quality of the manufacturing industry, yet, is still facing difficulties such as low technical reserves and technical restrictions imposed by other countries in critical products, important areas, and crucial technologies. These products, such as certain high-end equipment, core components, semiconductors, and precision instruments, have a wide range of applications and great market value if technological breakthroughs are achieved. Efforts to strengthen the transformation of scientific and technological innovation achievements, to build the resilience of the industrial and supply chain, and to tackle the technical obstacles become the focuses of a period of time in the future. In recent times, China has launched a series of policies and measures, emphasizing basic and applied research to provide scientific and technological support for the manufacturing industry on the one hand, and accelerating the whole industry chain to improve management, reduce business costs and enhance the supply chain's ability against risks through digital means on the other. In this context, Chongqing shall seize the momentum and adapt to changes through the special actions like reinforcing the industrial chain, nurturing SMEs with expertise, precision, specialty, and innovation, cultivate high-tech industries to shore up points of weakness, and also pay attention to the current status of the local manufacturing industry so as to invest more efforts in increasing the quality and efficiency of available enterprises. Advanced manufacturing clusters driven by digital technology have more obvious competitive advantages, which is conducive to accelerating the manufacturing industry to the high-end of the global value chain.

The prevalence of enterprises at different stages of development determines that there is no standard answer for digital transformation solutions in manufacturing. Such solutions

[35] The Ministry of Industry and Information Technology of the People's Republic of China (MIIT): *"Vigorous Promotion of High-quality Development of Digital Economy, written by XIAO Yaqing, Study Times",* July 16, 2021

must be tailored to industry characteristics, the actual level of development and the business needs of enterprises. At the same time, instead of being limited to the traditional cognitive technology transformation or on-site improvement, digital transformation covers the transition and upgrade of corporate strategy, management, organization and operation at all aspects as a top-down and step-by-step systematic project. So it does not necessarily require enterprises to shift their focus to "big and comprehensive" layout, large-scale investment in software or automation equipment, but to make steady progress in developing programs and goals of each stage for the enterprises based on their actual conditions and through the means of "overall planning, step-by-step execution", "software before hardware, treatment before medication", and "small successes piling and efficiency first" in order to continue promoting the digital upgrade and significantly improve the efficiency of enterprises. Chongqing continues to promote the digital transformation of the manufacturing industry and implement a series of measures to strengthen the industry chain, including the recent released Key technical requirements for 33 important industrial chains during the "14th Five-Year Plan" period of Chongqing. Moving forward, according to the structure of local industrial enterprises, Chongqing can first select a group of leading enterprises with industrial chain control to implement transformation in key industrial chains. Such enterprises own a sound organizational structure, clear strategic orientation, possess production processes and technologies of certain levels, and are laid on solid foundations for transformation. Their pioneering transformation will secure an outstanding stimulation effect on the transformation of the whole industry chain.

In addition, the "advanced nature" of the manufacturing industry also reflects in the transformation of the traditional production-based manufacturing to the service-oriented manufacturing, which can reshape the competitive advantage of the manufacturing industry by realizing high-level synergy and value appreciation of various stakeholders in the value chain. "According to the smiling curve, in the value chain, the added value is more obvious at both ends, namely, design and sales, and the added value to production in the intermediate link is relatively low. Service-oriented manufacturing helps enterprises to achieve higher added value. From the development practice of the global manufacturing industry, service-oriented manufacturing has become an irresistible trend. The service income of some famous manufacturing enterprises has accounted for more than 50%. By expanding the service path, the business scale and efficiency have achieved substantial growth."[36] The deep integration of new-generation information technology and the manufacturing industry has spawned various new production technologies, such as intelligent manufacturing, flexible manufacturing and network collaborative manufacturing. Moreover, the manufacturing industry is boosted by the involvement and transformation of whole elements, whole process and whole industry chain, which makes the single product and "rigid production" with stable consumption transform to "production on demand". This makes it possible to develop the customized production and services based on customer demand through the integration of products and services, the integration of decentralized manufacturing resources, and the high collaboration of participants in the value chain. The manufacturing industry has been endowed with richer connotation and denotation, and the

[36] People.cn: *People's Comments of People's Daily: Vigorous Development of "Service-oriented Manufacturing",* August 5, 2020

value chain of enterprises has been extended. Therefore, the rate of labor productivity and the value-added rate of products has been continuously improved.

Chongqing has complete categories of manufacturing industry, relatively perfect industrial system and rich application scenarios, which is a good ground to cultivate service-oriented manufacturing. In that case, manufacturing enterprises need to be guided and encouraged to further actively apply the new generation of information technology in product R&D and design, production and manufacturing, brand marketing and after-sales services, so as to foster more innovative business models and types, promote the transformation and upgrading of the manufacturing industry in Chongqing from manufacturing to "manufacturing + service", and enhance the core competitiveness of advanced manufacturing clusters. For instance, efforts can be made to encourage enterprises to better link between production and consumption, build the service platforms featured by personalized customization and digital platforms that run through the whole life cycle of products, realize flexible production and mass customization services based on market demand, and expand such services as data fusion, analysis and processing, and predictive maintenance. Also, leading enterprises can also build key industry supply chain cooperation platforms, develop intelligent management of production logistics, etc. Meanwhile, the government can also promote the cluster to increase the investment of service elements and improve the proportion of service in the manufacturing industry from multiple aspects of the demand side, industry chain and value chain. For example, promote to establish the service-oriented manufacturing industry alliances that gather resources such as production and manufacturing, R&D and design, system integration, testing and certification and professional outsourcing, build the industrial cloud service platform and the industrial big data platform for clusters, encourage the development of network manufacturing collaboration and data collection, mining, analysis and application services aiming at the added value of the industrial chain, and guide and cultivate a group of providers for system integration and solutions in key areas by "setting benchmark and model", so as to provide customers with integrated services of the whole value chain and create new economic growth points and so on.

Schneider Electric Green Smart Manufacturing (Chongqing) Innovation Center

In 2018, relying on the strategic cooperation framework between Schneider Electric and the Chongqing municipal government and with the strong support of the Administration Committee of Chongqing High-tech Industrial Development Zone, Schneider Electric partnered with a local company to create the Schneider Electric Green Smart Manufacturing (Chongqing) Innovation Center (the "Center") in Chongqing High-tech zone. Schneider Electric has integrated its global resources to provide advanced technology, customized solutions, efficient equipment and support by its professional teams for the operation and customer services of the Center and continued to empower the local operation team in Chongqing, while the local company takes charge of the operation and promotion of the platform, and building a green smart manufacturing business ecosystem in Chongqing and cultivating local partners and talents.

Since the Center was officially put into operation at the end of 2019, Schneider has visited more than 20 enterprises to provided on-site diagnosis services, and implemented five green smart manufacturing service projects. Among them, the first customer, Chongqing Jinqiao Machinery Manufacturing Co., Ltd., has basically completed the primary stage of smart manufacturing upgrading and transformation and obtained the certification of Digital Workshop of Chongqing in 2020. According to the production data of Jinqiao factory, the efficiency per capita was increased by 40%, the number of on-site labor was reduced by 35%, the site consumed was reduced by 12%, the number of in-process products on the production line was reduced by more than 70%, and each lean production line was available to more than 10 products on average. Meanwhile, the safety risk of the production line was significantly reduced, the overall quality of the product was enhanced, and the working environment on site was significantly improved. Despite the impact of COVID-19 in 2020, Jinqiao still performed well in business owing to the substantial production efficiency improvement, with its annual tax increased from RMB 11.08 million to RMB 13.82 million. Due to the sound results of the project, Jinqiao factory was also highlighted as a typical case in the documentary of the industry integration development of Chongqing High-tech Zone published on the website of the National Development and Reform Commission. Moreover, major media, such as CCTV1, also gave an in-depth interview for Jinqiao factory.

The Center has narrowed the distance between the international leading technology innovation platform and traditional manufacturing enterprises. With advanced technologies, services and rich experiences of Schneider Electric, local small- and medium-sized factories in Traditional automobile and motorcycle and Electronics industry in the Hi-tech Zone have direct access to the world's advanced production management system, technical equipment, information means and business vision, which make them more willing to achieve the independent transformation. Meanwhile, by building the transformation model enterprises like Jinqiao, it can effectively stimulate more regional enterprises to accelerate smart manufacturing and digital transformation.

(2) ***Improve the digital cluster ecosystem and enhance the scale effect of industries.*** An important feature of advanced manufacturing cluster is "to build an internal organizational network featured by 'network and interaction' and form a close and efficient division of labor and cooperation mechanism between industrial chain, innovation chain and value chain, which can encourage large and SMEs to make joint efforts, so as to realize the collaborated development of upstream and downstream industrial chain, as well as production, supply and

marketing"[37]. Advanced manufacturing clusters led by digitization have more characteristics of industrial ecological communities. Through the intensive aggregation, efficient flow and sharing of key elements (data, information, resources, technologies, capital, etc.) of the advanced manufacturing industry, various organizations and subjects involved in the industrial chain and value chain are not only be confined to the "networking and interaction" within the cluster but also able to be connected and collaborated across clusters and fields. Hence, the boundary of clusters was faded, and clusters are more interconnected and collaborative, forming a business value ecosystem covering the whole industrial chain and value chain. In such an ecosystem, the link between supply and demand is more accurate, idle resources can be better allocated, labor productivity is higher, industrial and supply chains are more systematic, and they also are more resilient to risks. The new value is not created linearly through production but through the high collaboration among various entities in the system, which has more scale effect and is more sustainable.

To build such an ecosystem, Chongqing can start from three aspects: platform construction, organizational efficiency and operation mechanism. First, accelerate the construction of industrial Internet platforms and public service information platforms, further promote the efficient flowing of information and data, and improve the resilience of supply chains. Second, optimize the management mode of clusters, like setting up special promotion agencies, industrial alliances or steering committees to guide large and medium-sized enterprises to access the cloud and platform, and realize more collaborated production division and improve cluster efficiency through efficient information and resource sharing as well as precise linking between supply and demand. Third, provide an acceleration mechanism for the above two aspects. For that, the government should organize and coordinate among institutions, alliances and platforms, take necessary policies initiatives and promote the collaborative operation system from horizontal and vertical dimensions as well as multi-party cooperation formed by participants from all the aspects.

(3) ***Strengthen the innovative application of digital technologies and explore the virtual transformation of advanced manufacturing clusters.*** Although, digital technology can enable advanced manufacturing clusters in a city or region to achieve a better performance in the professional division, transaction cost, production efficiency, technology and knowledge spillover and so on, thus promoting the competitiveness of local manufacturing. However, such clusters are still grown based on geographical space, which to some extent limits the cross-regional allocation of resources and slows down the acquisition of new technological knowledge and digital development of industries in local manufacturing. Moreover, when foreign enterprises need to join the advanced manufacturing clusters in cities or regions, they are often affected by the local business environment, natural conditions, investment policies, technological innovation vitality and so on, or they will slow down or stop the pace of move-in, which is not conducive to the sustainable upgrading and development of local clusters. In the future, virtual clusters beyond geographical space will be more suitable for the growth of advanced manufacturing industry.

[37] CCID Research Institute: *CCID's View: Accelerate the Development of Advanced Manufacturing Clusters,* March 30, 2021

"With the in-depth integration of information and communication technology and manufacturing industry, virtual industry clusters with specialized division of labor and overall collaboration, which break through geographical space limitation, have gradually become a new form of industry development."[38] Compared to the advanced manufacturing industry cluster with geographical boundaries at present, virtual clusters are more platform driven and global in spatial dimension due to network virtualization, so they can be more inclusive to all participants in the value chain and more conducive to the flow and integration of information, technology, data and other elements in a wider range, so as to boost the productivity and enable more agile response of the supply chain.

Chengdu and Chongqing, under the framework of "Chengdu-Chonging Economic Circle", are committed to jointly promoting "one chain of industries and one city of scientific innovation", which will form a pattern of joint development of surrounding areas of both cities. In terms of industrial and productivity layout, this goal just provides an opportunity for Chongqing to try the virtual transformation of advanced manufacturing clusters. Meanwhile, The above-mentioned practices that drive the overall digital and intelligent transformation of the cluster through the digital transformation of leading enterprises, as well as that improve the cluster industrial ecosystem, strengthen the layout of industrial Internet platform, information sharing platform and promote enterprise cloud platforms, can lay a solid foundation for the transformation of cluster virtualization. Chongqing can adopt the market-oriented pattern guided by the government, organize and plan ideas and schemes for cluster virtualization transformation to take the lead in carrying out local pilot projects for the virtual transformation of advanced manufacturing clusters that meet the needs of cluster development. Later, it can also cooperate with Chengdu and other regions to promote and replicate within the Economic Circle, which can strengthen the cross-regional and cross-industry association and coordination between the major advanced manufacturing clusters in Chengdu and Chongqing, and provide new momentum for the economic growth of the "Chengdu-Chonging Economic Circle".

Summary

Over the years, Schneider Electric has been proactively participating in the construction and development of Chongqing and continuously deepening the multi-level and multi-dimensional cooperation with the local government, enterprises and partners. At the same time, it has witnessed Chongqing to seize opportunities, meet challenges and adhere to reform, innovation and opening-up, constantly making new achievements in promoting high-quality economic and social development. Entering the "14th Five-year Plan" period, we believe that Chongqing will still carry forward the pioneering and innovative spirit, adapt to the new situation, focus on new goals and new deployments under the new situation and strategy framework, strive to promote all undertakings of Chongqing to a new level and provide strong support for the construction of "Chengdu-Chonging Economic Circle". Schneider Electric will continue to share new technology and experience with Chongqing, and develop and grow together with Chongqing.

[38] China Information Technology Weekly: *CCID's View: Focus on virtual Industrial Clusters and Promote Virtual Transformation of Advanced Manufacturing Clusters,* September 28, 2020

Chengdu-Chongqing Economic Circle Leading China's High-Quality Development with Smart Manufacturing

Antoine Simonnet
Chief Supply Chain Officer, HP

Table of Contents

Opening Remarks

The 2020 Chongqing Mayor's International Economic Advisory Council took place at a time of considerable uncertainty as the COVID-19 pandemic brought disruption to governments, businesses and citizens all around the world. One year on, the global situation is far from ideal but positive developments can be observed in many places. In Chongqing, a rigorous government response to the pandemic has had clear successes, with the city keeping the virus under control and recording an impressive 3.9% growth in GDP over 2019 levels.

A closer look at Chongqing's economic performance reveals an equally striking change: in 2020, the growth in added value of the city's high-tech industries increased 13.3%. This impressive growth is a strong indication of a profound change in manufacturing accelerated by the recent pandemic. As manufacturers in China and elsewhere were struck by volatile changes to market demand, material supply and the availability of their workforce, the value of accurate data monitoring, collection, sharing and analysis at individual plants and across supply chains became clearer.

The adoption and use of these technologies- known as 'smart manufacturing'- has the potential to reshape the manufacturing industry in Chongqing by bolstering the resilience of its supply chains and improving the quality and sustainability of its output.

Smart Manufacturing: Overview and Timeline

In its draft 14th Five-Year Plan for the Development of Intelligent Manufacturing, the Ministry of Industry and Information Technology (MIIT) defines smart manufacturing as:

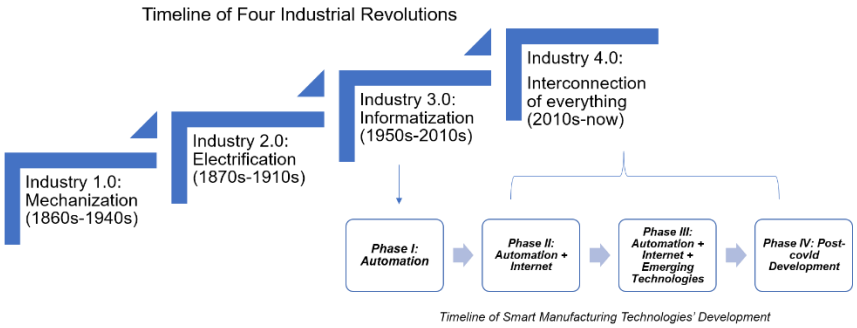
an advanced production method based on deep integration of new generation information technology and advanced manufacturing technology, running through all aspects of manufacturing activities including design, production, management and service, and featuring self-awareness, self-decision, self-execution, self-adaptation and self-learning.[39]

As this definition indicates, the essence of smart manufacturing is the integration of virtual networks and physical production, enabling efficient collaboration between factory components and across industrial chains for better performance.

The technological evolution of smart manufacturing can be divided into four phases: 'Automation', 'Automation + Internet', 'Automation + Internet + Emerging Technologies', and the present stage, which we will label 'Post-Covid Development'. Macro-industrial development

[39] Source: Ministry of Industry and Information Technology

is also often divided into stages, from “Industry 1.0” to “Industry 4.0”. While the first phase of smart manufacturing took place in “Industry 3.0”, the subsequent phases belong to “Industry 4.0”.



Phase I: Automation

In the automated manufacturing phase, a factory would use information technologies to form an internal network communication system capable of managing some parts of the manufacturing process and connecting equipment, materials, components, and labor. Such a factory is commonly described as an “automated factory”. Relevant technologies include advanced robotics, 3C (computing, communication and control), and management methods such as manufacturing execution systems (MES) and supply chain management (SCM).

A typical application scenario is the textile industry’s use of information technologies to increase efficiency and reduce reliance on human labor. Specific applications include:

- Raw material allocation: workers in traditional factories need to manually carry raw materials and calculate the required amount for each product. An automated factory can distribute raw materials automatically to different production lines through intelligent production platforms.
- Production: informatized equipment can adjust temperature and humidity according to environmental changes to ensure quality.
- Testing: an automated factory can provide real-time feedback on the quality of each production line for a better yield rate, eliminating the need for manual sampling.

Phase II: Automation + Internet

Through the development and application of Internet technologies, including Internet of Things (IoT) and Industrial Internet technology, greater interconnection is not only achieved within a factory but also between the factory and upstream and downstream enterprises and even customers. This allows for closer coordination across the industry chain and better responsiveness to customer needs.

A typical application scenario is the use of industrial internet in the auto industry. By deploying industrial internet across the complex chain of auto parts manufacturers, OEMs and other companies, enterprises within the network can share business data at any time. Each enterprise can identify market changes and conduct real-time optimization of their production and sales processes, including R&D and design, material procurement, manufacturing, marketing and logistics. Some auto companies even allow users to order customized vehicles through mobile apps, which connect to auto parts manufacturers and OEMs via the industrial internet and allow them to coordinate production of the requested vehicles.

Phase III: Automation + Internet + Emerging Technologies

This third phase is defined by the application of emerging technologies such as artificial intelligence (AI), big data, cloud computing, human-computer interaction (HCI), virtual reality / augmented reality (VR/AR), deep learning (DL) and machine learning (ML). Critically, these technologies endow manufacturing systems with the abilities of learning and cognition, allowing them to make decisions that were traditionally the responsibility of human workers. This an advanced stage of smart manufacturing: many of these technologies have only recently started to enter the practical manufacturing process and many require further research and development.

A typical application scenario is the use of intelligent power management in large manufacturing plants, which typically have very high electricity consumption levels. Through ML algorithms, factories can automatically analyze energy costs, equipment maintenance, inventory and other factors. On the basis of this analysis, factories can allocate power according to needs in real-time, lowering costs while maintaining high performance even with an unreliable power supply.

Phase IV: Post-Covid Development

The coronavirus pandemic has compelled manufacturers to build on the technologies of the third phase by introducing equipment that addresses the difficulties of the new situation. One major development is the mass deployment of collaborative robots or ‘cobots’. The use of these robots, designed for close interaction with humans, solves some of the challenges raised by social distancing.

Summary: Key Technologies

The major smart manufacturing technologies and their potential future trends are as follows:

- **Cloud:** provides manufacturers with a comprehensive real-time perspective on the production process. Given the growing demand for remote operations in the post-pandemic period, cloud adoption is likely to become essential for the manufacturing industry.

- **Industrial IoT (IIoT):** provides real-time performance monitoring and virtualization to assist management; also expected to become commonplace.
- **3D printing** (otherwise known as additive manufacturing, AM): allows for quick low-cost production of prototypes, empowering mass production of customized products.
- **AI / machine learning:** AI and ML technologies will continue to evolve, providing factories with the ability to automatically generate insights and make decisions.
- **Blockchain:** used to monitor supply chains, assure production quality, detect counterfeits and ensure regulatory compliance; likely to be applied widely.
- **Big data analytics:** processes the data captured through devices and terminals and generates advanced insights, including predicting supply chain risks and guiding improvements to production efficiency.
- **Cobots**: enhance the productivity of human workers by performing repetitive or complex tasks. Demand for these robots is likely to remain high post-pandemic.

Chongqing: A Future Leader in Smart Manufacturing

With its strong industrial foundation and central location, Chongqing is well-positioned to develop into a smart manufacturing powerhouse and innovation highland with international influence. This development will be further enhanced by the Chengdu-Chongqing Economic Circle (CCEC), which will form massive industrial and supply chains across the two cities.

Chongqing is one of China's oldest industrial bases and today ranks among its most important manufacturing centers. Geographically, Chongqing stands at a strategic connection point between East and West China, linking the mid-lower reaches of the Yangtze river with the central western region. As a window to Southwestern China, the city will remain a critical node in the Belt and Road Initiative (BRI). It also plays a key role in commercial and industrial cooperation with Central Asia and Europe through the China-Europe Railway, and with Southeast Asia through the New International Land-Sea Trade Corridor. In combination with the city's network of academic institutions and supply of talents, these economic and strategic advantages give Chongqing a very strong basis for smart industrial transformation.

HP have been a proud member of this industrial ecosystem for more than 12 years. Since opening our Chongqing PC Production Base in 2009, we have worked hard to keep our operations at the cutting edge with regular upgrades and new smart technologies. Today, our Chongqing production line uses big data, automation and industrial IIoT systems to boost productivity and security. Our IIoT system is equipped with a monitoring dashboard providing real-time information about yield and quality at each production line, together with a smart diagnostic system for detecting abnormal operations and a suite of end-of-line audit tools that automatically

upload test data. By harnessing the power of these technologies, our Chongqing factory can rapidly respond to changing and complex demands while delivering consistently high-quality output.

In addition to enhancing our own productivity, we are committed to supporting the smart transformation of our local partners and suppliers. In 2019, we launched the SurePartner project to bring smart manufacturing systems to Chongqing-based ODMs. To date, we have supported the intelligent transformation of 32 production lines across three local ODMs at a total cost of around USD 30 million. Through these smart manufacturing systems, HP and our partners can coordinate production more accurately than ever before. Our team of 30 senior engineers provide support as well as guidance and training to ensure that our partners can continue to share in the benefits of this rapidly evolving technology.

Our next step will be to expand the support program to our parts suppliers. We have already selected partners in this sector for pilot projects. We hope that these efforts will continue to generate interest among local businesses and will give us the opportunity to help launch smart transformation journeys across the whole industry chain.

In recent years, the Chongqing government has introduced a range of policies which have greatly benefitted the smart transformation efforts of HP and our local partners. Looking to the future, we believe that the government can build on these policies to address some of the remaining challenges for smart manufacturing transformation, which include:

- **Low awareness:** more efforts are needed to publicize the advantages of smart manufacturing and encourage manufacturers to upgrade traditional production methods.
- **Nascent smart manufacturing ecosystem:** Chongqing needs to foster an integrated and interconnected supply chain, which will serve as the foundation for holistic smart manufacturing transformation programs.
- **Lack of effective connection between manufacturers and service providers:** more efforts are needed to develop and introduce smart solutions suitable for Chongqing's manufacturers. In particular, there is a strong need for a Chongqing-based platform that can match smart solution providers with manufacturing enterprises in need of guidance and support.
- **Untapped potential of the CCEC:** the Chengdu-Chongqing Economic Circle presents substantial opportunities for the two cities to leverage their complimentary manufacturing industries, international partnerships and research institutions.

Transforming Chongqing into a smart manufacturing powerhouse will involve addressing these challenges. Our vision for Chongqing's smart manufacturing development is twofold:

- Leveraging smart manufacturing technology to transform Chongqing's traditional industry base, raising its efficiency and productivity.
- Fostering the development of local companies that focus on key technology and solutions, transforming them into smart manufacturing leaders in the domestic and global markets.

As such, we would like to highlight some relevant international best practices that can inform this process.

International Best Practices

1) Made Different, Belgium: Raising Awareness of Smart Technology and Guiding Corporate Transformation through Industry-Led Programs

Belgium has multiple programs related to smart manufacturing, with each implemented on a regional basis. As a federal state, Belgium is divided into several regions and language-based communities, the largest being Dutch-speaking Flanders in the north and French-speaking Wallonia in the south. In 2013, Flanders launched its Made Different program to transform the region's manufacturing companies into 'Factories of the Future'. In 2015, the Flanders government judged that Made Different was sufficiently well-developed to be run by regional business organizations and withdrew from the program. In 2017, Wallonia followed suit with the launch of its Made Different Digital Wallonia initiative.

Both the Flanders and Wallonia Made Different programs are **mainly industry-led**, with varying degrees of local government involvement between them. In Flanders, Made Different was initially coordinated and supported by the regional government and two business groups. The first, Sirris, is a collective research center for technology companies with over 140 in-house experts spread over 8 different sites in Belgium. The second group, Agoria, is a technology federation with more than 2000 member companies from the manufacturing industry and digital and telecom sectors. Today, the Flanders program is mainly coordinated by Sirris and Agoria, and it retains a flexible structure with a low level of institutionalization. In Wallonia, the Made Different program is overseen by Sirris, Agoria and the regional digital agency, which designed and launched the initiative and now acts as a key coordinator, centralizing and disseminating information and organizing awareness events.

The Made Different programs **follow a mixed funding approach**. Though companies carry the cost for their participation, both regional governments have made funding available in the form of grants. However, as the programs are largely industry-driven, there is no public funding scheme dedicated to Made Different. Instead, companies are eligible for parallel public grants which can cover up to 75% of participation costs. In Wallonia, the regional government has introduced the `chèques technologiques´ voucher scheme, which aims to cover the cost of evaluations of SME

innovation capacity by qualified third parties. SMEs can benefit from up to 40 vouchers every year, with each voucher worth 500 euros.

In both regions, Made Different follows a two-step process in transforming the local manufacturing industry**. The first phase focuses on raising awareness of smart manufacturing**. Program coordinators organize roadshows across their respective region to present success stories of enterprises that have adopted smart manufacturing technologies. These events also give companies the opportunity to interact with Made Different representatives. Another key element of this strategy is the annual 'Factory of the Future' Awards, organized by Agoria and Sirris to celebrate companies that have successfully upgraded their manufacturing operations.

The second phase of the program involves guiding companies through the smart transformation process. Sirris and Agoria arrange for their in-house experts to assess a participating company's current operations and design a transformation plan in consultation with them. The company will then proceed to implement the plan over a timescale of around two years, during which time Made Different experts provide continuous support.

Since their respective launches in 2013 and 2017, both the Flanders and Wallonia programs continue to engage manufacturing businesses. Today, the Belgian manufacturing industry ranks among the most innovative in the world.[40] Within the Belgian economy, technology companies boast the highest economic growth and added value of any sector, totaling €39 billion in 2019.[41]

2) NAMIC, Singapore: Building a Leading Additive Manufacturing Ecosystem through a Government-Led Collaboration Program

In contrast with Made Different, Singapore's National Additive Manufacturing Innovation Cluster (NAMIC) provides an alternative model focused on **just one technology and with a much larger role for the government in decision-making and funding.**

Singapore's manufacturing industry is a major part of the economy, accounting for around 21% of national GDP and employing 12% of the workforce.[42] Though fairly diverse, the manufacturing industry is dominated by electronics (largely semiconductors), chemicals, precision engineering and biomedical manufacturing. These advanced sectors have played a very significant role in leading Singapore's recovery in the aftermath of the coronavirus pandemic. Key

[40] Source: Global Innovation Index 2020
[41] Source: Agoria
[42] Source: Channel News Asia

manufacturing is forecast to achieve a growth rate of 8.3% in 2021, far higher than the 4-6% predicted for the Singaporean economy overall.[43]

The government has placed innovation-driven manufacturing and engineering at the center of its development strategy. The Ministry of Trade and Industry has been publishing 5-year plans for science and technology since 1991, and the most recent completed plan set aside S$3.2 billion (~USD 2.36 billion) for advanced manufacturing and engineering. This plan, known as the *Research, Innovation and Enterprise (RIE) 2020 Plan (2016-2020),* identified additive manufacturing (AM) as one of four 'essential enabler' technologies which will support key industry verticals such as aerospace and electronics. The AM process, in which a material is built up in layers according to a digital 3D design, utilizes sensors and analysis for real-time quality control and is an increasingly important part of the smart production system for low-volume, high-complexity manufacturing industries.

The RIE 2020 Plan built upon the NAMIC initiative, which was launched in 2015 to translate upstream AM research at Singapore's public research institutions into downstream commercial applications. From the beginning, the government sought to achieve this by helping companies connect with researchers and funding their development and use of AM technology, with an initial target of engaging more than 1,000 companies in four years.

Unlike Made Different, NAMIC is led by government and academia. Administration of the program is the responsibility of an innovation and enterprise subsidiary company of the Nanyang Technological University (NTU) Singapore, with support from two government statutory boards: Enterprise Singapore and the Economic Development Board of Singapore. **Technical expertise and facilities are provided by development hubs at three universities**, each with a specific industry focus: the NTU Singapore Center for 3D Printing (focus includes aerospace, construction, electronics), the National University of Singapore Center for Additive Manufacturing (biomedicine), and the Singapore University of Technology and Design (SUTD) Digital Manufacturing and Design Center (consumer industries, transport). Public funding for the program comes from the National Research Foundation, a government department which administers funds established with the RIE 2020 Plan.

NAMIC plays a comprehensive role in curating joint AM development projects between companies and technical experts. An evaluation panel of officials and academic representatives first evaluate project applications submitted by companies; after issuing approval, NAMIC then identifies a research partner, supports management of the project, develops a commercialization plan and provides joint funding with the enterprise. For example, in 2016, NAMIC provided

[43] Source: Straits Times

funding for aerospace start-up Gilmour Space Technologies and SUTD to develop a 3D printer for solid-fuel mixtures for rockets. This technology was later showcased with successful rocket launches in Australia.[44]

In addition to supporting business-led innovation, the NAMIC program also directs research according to commercial and national needs. This is conducted by inviting bids for AM solutions to set problems, with winning proposals awarded public funding. In March 2020, for example, NAMIC issued a call for proposals from teams of AM suppliers, classifiers and end-users to trial the printing of replacements of broken marine parts at Singapore's ports. Six projects were subsequently awarded funding and will be completed in 2022.[45]

The scale of the NAMIC program has exceeded the initial expectations of the Singapore government by engaging over 1,800 organizations and curating more than 230 projects within its first five years**. The development of this ecosystem has allowed Singapore to claim regional leadership in this field, with approximately 40% of the ASEAN AM market**.[46]

The dynamic AM market has also led many MNCs to expand their presence in the country. In 2017, HP opened the Smart Manufacturing Application and Research Center, a 6,000 sq ft 'engineering playground' for technical teams to trial AM, cobots and other advanced technologies for real-world application. We took a step further in 2020 with the launch of the Digital Manufacturing Corporate Lab, a research and training center jointly overseen by HP and Nanyang Technological University. We are very active in deploying new technologies across our manufacturing operations. In recognition of our digital transformation, HP Singapore has been inducted into the World Economic Forum's Global Lighthouse Network. We hope that this honor will heighten awareness of smart technology and aid our efforts to encourage digital transformation throughout the local ecosystem.

3) LCR 4.0, Liverpool, UK: Connecting SMEs with Research Teams for Technical Advice and Access to Development Facilities

The smart manufacturing initiative of the Liverpool City Region (LCR) offers a third model in which academia and businesses work together to support the transformation of SMEs and start-ups.

Like Singapore, the LCR's manufacturing sector is dominated by advanced industries, in this case automotive, chemicals and pharmaceuticals. However, manufacturing occupies a much

[44] Source: Straits Times
[45] Source: Singapore Press Center
[46] Source: Additive Manufacturing White Paper, thyssenkrupp, 2019

smaller share of the LCR economy at 14% of total GVA (2015).[47] Innovation has traditionally been an area of weakness for the LCR economy, with average business R&D expenditures for the city ranking below the national average (2013).[48] A likely contributing factor has been insufficient awareness of smart technology.

In response to these concerns, LCR 4.0 was launched in November 2016 to provide local SMEs and start-ups with the support, research and knowledge needed to adopt and utilize smart manufacturing technologies. The three-year program was the first of its kind in the UK and aimed to help around 200 businesses establish research collaborations.

Unlike Singapore's NAMIC initiative, the management of LCR 4.0 did not directly involve the government. The only public body responsible for the program was the LCR Local Enterprise Partnership (LEP), an official body led by private sector representatives. LCR 4.0 was led by the University of Liverpool's Virtual Engineering Center, with support from the LEP and three other research institutions: Liverpool John Moores University, the Hartree Center (a public-funded supercomputer center) and Sensor City (a university innovation hub). The program received dedicated funding from the European Regional Development Fund (ERDF).

With parallels to Belgium's Made Different program, **the LCR 4.0 initiative provided participating companies with consultations and technical advice on how to upgrade their manufacturing processes**. After applying through LCR 4.0 or by contacting its member institutions directly, local businesses would receive advice on their current operations and technical support for any recommended upgrading projects. The program also gave small companies access to the advanced manufacturing facilities and equipment at its four participating research institutions. Some enterprises utilized this technology and expertise to develop product prototypes: the company SportScientia, for example, produced its first smart health monitoring insoles for sports shoes with the facilities and technical support of Sensor City.[49] Over the program's three years, both the in-house upgrading and institution-based R&D projects involved a diverse range of smart manufacturing technologies including AM, augmented reality (AR) and sensors, though the most common focus was systems integration.

By its conclusion in 2019, LCR 4.0 had set up 248 R&D collaborations (exceeding its initial target) and facilitated the entry of 57 new products into the market. Just as significantly, the program seems to have had a positive impact on innovation in the city's manufacturing industry,

[47] Source: University of Liverpool
[48] Source: University of Liverpool and Liverpool John Moores University
[49] Source: Sensor City

with 82% of participating companies reporting that LCR 4.0 enhanced their innovative capacity.[50]

International Best Practices: Summary Table

	Made Different Belgium	**NAMIC** Singapore	**LCR 4.0** Liverpool, UK
Duration	2013 - *ongoing*	2015 - *ongoing*	2016 - 2019
Scale	Engaged 300+ companies (end of 2017)	Engaged 1,800+ organizations, 230+ projects	Helped 303 SMEs, 248 R&D collaborations
Technology focus	Multiple smart technologies	Additive manufacturing (AM)	Multiple smart technologies
Aim	Raise awareness of and support smart transformation	Promote translation of academic research to commercial application	Promote adoption of Industry 4.0 technologies by local businesses
Participating businesses	SMEs	MNCs to start-ups	SMEs and start-ups
Key activities	Organize roadshows and present awards; provide guidance to companies undertaking smart transformation	Establish and fund joint projects between businesses and research hubs; tender AM feasibility trials	Provide advice on smart manufacturing from technical experts; connect businesses with research facilities
Public Funding?	No dedicated funding scheme	Yes (government funding)	Yes (EU funding)
Governance	Industry-led, with regional government support	Co-led by government and academia	Co-led by academia and industry
Outcome	Flanders program has run successfully without government involvement since 2015; inspired Wallonia program	Established Singapore as an international AM hub; multiple MNCs have since established AM centers in the country	Enhanced companies' innovative capacity; 57 new products

Recommendations

Taking the above practices into account, we would like to offer the following recommendations for Chongqing:

[50] Source: LCR 4.0

1) Promote business–academic joint R&D through a smart manufacturing pilot zone

Smart manufacturing systems are still at an early stage of development, with advances in 5G and computing power presenting huge opportunities for further innovation. Chongqing has the potential to lead these breakthroughs and, given the prominence of its automotive and electronics industries, would benefit most from R&D in cloud computing, advanced automation, AR, machine learning, sensors and AI.

Our international case studies suggest that one of the most effective ways to achieve these breakthroughs is through **joint R&D partnerships between businesses and research centers**. Chongqing already possesses a strong base of academic and research institutions focusing on intelligent manufacturing, including the International Science and Technology Innovation Base for Smart Industry. Furthermore, as a major manufacturing hub with prime international transport links, Chongqing is well-placed to leverage the resources of the major MNCs that already conduct operations in the city. An instructive model for this is the NAMIC program in Singapore, which has supported the establishment of joint **business-research innovation centers** such as the HP-NTU Digital Manufacturing Corporate Lab.

The impact of these R&D collaborations could be maximized by **developing a smart manufacturing pilot zone for the electronics industry. Through this project, the Chongqing government could attract leading technology companies, research institutes and start-ups to invest in critical smart manufacturing technologies**. While advances in AI, cloud, big data and similar innovations are beneficial on their own, their value can be multiplied by coordinating development with other smart technologies. Similarly, as 5G and industrial internet can only bring true supply chain resilience when they are embraced by all members of the industrial chain, participation in the pilot zone should be open to everyone, from international MNCs to local start-ups.

The HP team are ready and willing to share our extensive experience of joint R&D programs for the benefit of Chongqing and its manufacturers. By sharing our solutions and coordinating with a diverse range of businesses through a pilot zone, HP can make a valuable contribution to the transformation of the city's entire manufacturing ecosystem.

We know that a major obstacle to smart transformation is a lack of available capital among companies. As such, Chongqing should consider expanding public funding for companies participating in the pilot project and offering incentives for corporate investments in smart manufacturing technology and solutions. These measures would allow Chongqing to build on the success of existing schemes such as the Chongqing Industrial and Informatization Special

Programs. Chongqing should aim to provide strong and consistent policy incentives to ensure that its efforts to foster a smart manufacturing industry ecosystem are successful.

2) Develop an advisory platform to support corporate smart transformation

While leading innovation in smart technology should be a core objective for Chongqing, an equally important task is bridging the space between research centers and businesses on the ground. The adoption of smart technology is a complex undertaking for many manufacturers, involving a multitude of unfamiliar concepts, software and equipment. What's more, the application of this technology depends on a wide range of factors, including the nature of a company's operations, its place in the industrial chain and the existing quality of its infrastructure.

To ensure that smart upgrading efforts help local companies develop into future leaders, Chongqing should **ensure that its manufacturers have access to expert advice**. As demonstrated by all three of our international case studies, one of the most effective ways to do this is by developing an advisory platform which connects companies to smart solution providers, such as business advisors or technical experts from research institutions. Given the complimentary nature of the Chengdu and Chongqing industries and the array of research centers across the two cities, the utility of this platform could be maximized by making it available across the CCEC, giving companies access to those experts most suited to their specific operations.

3) Organize a flagship CCEC smart manufacturing event

Low levels of awareness of smart manufacturing and doubts about the value of upgrading among businesses are also challenges that Chongqing's regional transformation efforts will need to address. While the launch of an advisory platform and pilot zone would attract attention, other publicity activities will also be needed to ensure that companies of all sizes are aware of the benefits of smart transformation.

Belgium's Made Different programs have demonstrated the effectiveness of roadshows and outreach events in promoting awareness. Chongqing should look to build on the success of its annual Smart China Expo by **developing a dedicated smart manufacturing event for the CCEC area**. Drawing on the recent example of the Yangtze River Delta Intelligent Manufacturing Summit held in Shanghai, a 'CCEC Smart Manufacturing Summit' could gather companies of all sizes and sectors from across the two cities to showcase their successes in transforming their operations, share experiences and best practices in forums, and coordinate cross-industry implementation and innovation.

Such an event could also be used as a platform for **awarding honors and rewards to exemplary smart technology adopters**. Chongqing has already made progress with this type of

incentive with the announcement of the 10 Chongqing Smart Manufacturing Model Enterprises at Smart China 2020.

4) Develop practical talent training programs for graduates and workers

The widespread adoption of intelligent technology will quickly and profoundly transform the manufacturing job market. According to a 2018 report by the China Development Research Foundation and Sequoia China, automation will replace one fifth of all jobs in China's manufacturing sector by 2030.[51] Rather than bringing a permanent growth in unemployment, talent will remain a core factor in the success of any smart manufacturing ecosystem.

To make sure that industrial upgrading is a success for everyone, Chongqing should remain proactive in its efforts to provide training for the workers of the manufacturing sector as it continues to evolve. Chongqing faces two key problems in its supply of university-educated talents: the proportion of students from manufacturing-related disciplines who choose not to enter the industry is high, while the level of practical experience among those graduates who do could be improved. To address this, Chongqing should consider **establishing programs for university students to undertake work placements at manufacturing companies**. The Chongqing Big Data Industry Talent Alliance, established in 2019 with more than 50 universities and several major tech enterprises, could provide a basis for this placement program.

The smart factory workforce is not only dependent on graduates, as new technologies also offer jobs that do not require a university degree. Many factory workers whose existing skill sets have been automated can be trained for these types of roles, such as CNC (Computer Numerical Control) machinist and mold maintenance technician. Chongqing could promote reskilling by working with companies to provide funding for workers during their training, which typically lasts for several months.

Summary

As it enters the new phase of manufacturing, Chongqing has tremendous potential to emerge as a global smart industry leader. To ensure that its transformation is as rapid and as beneficial as possible, we recommend focusing on four tasks: leading innovation, promoting technology adoption, raising awareness and training experienced talents. Through these efforts, Chongqing can build a smart manufacturing ecosystem that connects technologies and companies across the Chengdu-Chongqing Economic Circle.

[51] Source: Global Times

With an interconnected smart manufacturing network, Chongqing can be confident of its continued high-quality development with a resilient supply chain and globally competitive output.

Fast-upscaling of the Industrial System and Sustainable Innovations Unlock Chengdu-Chongqing Economic Circle's full potential to be the Powerhouse for the Country's Future Growth

Markus Kamieth
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Overview: "Chengdu-Chongqing Economic Circle" is China's new growth engine

Over the past decades, China has constituted remarkable achievements in economic and social development. As China progresses to be a global powerhouse for upscaled manufacturing, innovative and sustainable development with a higher-level of opening-up and greater-focus on its domestic market growth, a new, vibrant economy center based on a fast modernizing industrial system is essential to the country's new development phase.

Western China is becoming increasingly critical in Chinese government development strategies, as proven in the "Go West policy" and the consequent Western Development Strategy. In January 2020, the Chengdu-Chongqing Economic Circle (refer to as "the Circle" below) was proposed as a national strategy and listed as the "fourth pillar region", following the Yangtze River Delta region, the Guangdong-Hong Kong-Macao Greater Bay Area, and the Beijing-Tianjin-Hebei region.

BASF believes the Circle will play an increasingly important role in the country's future development. With a solid industrial infrastructure, and a rich pool of talents as well as other resources, the Circle can be the driving force of coordinated regional development and a growth engine for high-quality development in western China and beyond. Chengdu and Chongqing, the core cities of the Circle, each have distinctive manufacturing industries with complementary strengths.

Nevertheless, the region still has its shortcomings and limitations despite its growth potentials. For example, the lower level of urbanization compared with first-and-second-tier eastern China cities, an imbalanced socio-economic development across the region, and a still developing industrial system.

With deep expertise in the chemical industry, BASF hopes to share its best practices in sustainability and digitalization, thereby contributing to unlocking the region's enormous potential, creating a well-balanced industrial system that drives coordinated, high-quality development in

the western region which responds to the country's goals in carbon neutrality and high-end manufacturing.

Part I: BASF actively supports the Circle to drive high-quality, sustainable development

BASF has been a committed partner to China since 1885. With large production sites in Shanghai, Nanjing, and Chongqing, BASF is a major foreign investor in the country's chemical industry. In 2020, BASF posted sales of approximately €8.5 billion in China and employed 8,948 people at the year end. China is currently BASF's second-largest market.

BASF offers a wide range of high-quality products and solutions in the region and works closely with local partners, contributing to the domestic cycle of product distribution and consumption, with offices in Chongqing and Chengdu being the gateway to the company's customers in Western China.

The effort is fully reflected by the BASF MDI production site in Chongqing, which just celebrated its 10th anniversary in July 2021. With an investment of RMB 8 billion in 2011, the site has played a vital role in supplying high-quality MDI[52] to support the development of core industries in western China and bringing a complete polyurethane-based new material industry chain to the region.

BASF creates chemistry for a sustainable future. It is the company's purpose of combining economic success with environmental protection and social responsibility.

By leveraging leadership in technology and sustainability, the company has been putting efforts to optimize and stabilize its value chain further. For instance, BASF built a steam methane reformer in 2019 on its MDI production site in Chongqing, contributing to the reliability of MDI integration. The product is now widely used in lightweight automotive components, energy-saving insulation in buildings, and storage and transportation of food products, contributing to the transformation of key downstream industry chains, including automobiles and home appliances in the west part of the country.

At the same time, the company has been applying world-class safety and environmental standards to the construction and operation of the site. For example, BASF and the local industry park have established a three-tier system to protect the water environment to ensure that untreated wastewater is not discharged into the Yangtze River, similar to BASF worldwide water protection

[52] MDI is an essential component for polyurethanes – an extremely versatile plastics material that contributes towards improved insulation, provides lighter materials for cars, and helps save energy in buildings.

practices such as in Ludwigshafen on the Rhine in Germany and Antwerp on the Scheldt in Belgium. Moreover, the site was built with the highest international earthquake resistance standards.

The site celebrated 8 million safe working hours in April 2021, reflecting the company's firm commitment to protect its employees, its neighboring communities and minimizing the environmental impact.

Part II: Unlocking the potentials: the Circle in the next decade

The development of the Circle is a significant strategic move in China's 14th Five-Year Plan and climate target. Making full use of the policy benefits will significantly promote high-quality, coordinated development in the western region.

1. Deepen collaboration in the automotive industry to promote the industrial upgrading

Chengdu and Chongqing are traditional automobile manufacturing centers, gathering well-known domestic and international automobile manufacturers.

The auto industry is experiencing the accelerating trend of electrification, connectivity, smart technologies and sustainable mobility like car-sharing. The advantage of lithium resource reserves in the Circle may benefit the entire electro-mobility value chain, both in the western region and in a national scale.

Under such circumstances, Chengdu and Chongqing should join hands with all key stakeholders in private and public sectors to complete the transformation and upgrade in the direction of new energy vehicles and intelligently connected vehicles by combining the auto manufacturing expertise with innovative, co-creation research capabilities of all relevant partners. Furthermore, Chengdu and Chongqing may consider a consolidated, overall planning to amplify economic growth and local market demand.

BASF, one of the largest chemical suppliers in the automotive industry globally, supplies and develops functional materials and solutions that enable vehicles to be built more efficiently with a lower environmental impact, whatever powertrain technology they use. BASF's product range includes plastics, coatings, catalysts, automotive fluids as well as battery materials. In Chongqing and Chengdu, the automotive industry holds a high share of sales value for BASF, at 30% and 50%, respectively.

BASF's advanced lightweight automotive materials, from engineering plastics to foams and composite systems, reduce vehicle weight while providing strong strength and resilience to structural components. Cooperating closely with customers worldwide, BASF also develops,

produces and markets a high-quality range of innovative and sustainable automotive OEM and refinish coatings to drive future mobility. As the world's leading supplier of catalysts, BASF protects the air people breathe through wide applications of its mobile emissions technologies.

Battery materials is one of the strategic growth areas for BASF. Improvements in driving range, charging time and cost generation are the key factors driving greater consumer adoption of electric vehicles. Cathode active materials (CAM) are central to the performance, affordability, reliability and sustainability of batteries for electric vehicles. To support the growing eMobility market and customer demands, BASF continues to further improve the materials that power today's electric vehicles and develop next-gen technology to meet the anticipated needs of the global battery market. As a leading CAM supplier to battery producers, BASF's 2025 goal is to double the on-road range of a mid-size electric vehicle from 300 to 600 kilometers on a single battery charge, halve battery size, and reduce charging time to 15 minutes.

BASF is also well positioned in the whole battery material value chain, including recycling with strategic partners. Earlier this year the company announced to form a joint venture to produce CAM and precursors with Shanshan, a leading lithium ion battery materials supplier in China. With this collaboration, BASF will further contribute to accelerate the transformation of the transportation industry towards electromobility.

2. Encourage the use of renewable energy

As an energy-intensive company, BASF is committed to reducing emissions along the value chain and expanding the use of renewable energy. The company is aiming for net-zero CO_2 emissions by 2050. That also contributes to China's new long-term climate targets to reach peak emissions before 2030 and to achieve carbon neutrality by 2060.

At the heart of the long-term transition toward net-zero CO2 emissions by mid-century is the use of new technologies, which will replace fossil fuels such as natural gas with electricity from renewable sources. BASF will progressively switch to renewable sources to meet its electricity needs and intends to invest in wind parks to facilitate this.

In the first half of this year, BASF has forged partnership with leading energy company Vattenfall to build the world's largest offshore wind farm in Northern Europe, which aims to electrify the chemical production processes, which are currently based on fossil fuels.

Under China's national objective of achieving carbon neutrality in 2060, the enthusiasm for the development of new energy industries such as wind power and photovoltaics is soaring. According to the figures recently released by the National Energy Administration, in 2020, China's wind and photovoltaic installed capacity increased by 120 gigawatts, including 48.2 gigawatts of solar power

generation. BASF is certainly keen to leverage renewable energy in China. For example, the company will use 100 percent renewable electricity at the first plants of the under-construction Zhanjiang Verbund site, a USD 10 billion investment. At BASF's Shanghai Pudong Innovation Park and Caojing site, the photovoltaic power stations help reduce 3,000 metric tons of CO2 emissions each year.

A precondition for the transformation of chemical production is the reliable availability of large quantities of renewable electricity at competitive prices. Sichuan Province has abundant hydropower, wind power and photovoltaic resources. More supportive policies and competitively priced renewable energy could further enhance the region's high-quality development. Cooperation in building a clean, efficient, safe and reliable energy system in the Circle will provide a more comprehensive energy reserve to promote the economic development of the central and western regions.

There is a need for favorable, direct renewable energy purchase and cross-grid transmission policies in Sichuan Province and Chongqing city. In addition, if electricity can be transferred to the eastern region through an ultra-high voltage grid, transforming the resource advantages of the Circle into economic advantages will further narrow the development gap between the east and west and promote coordinated development.

3. Drive low-carbon technologies and foster business opportunities

In China’s western region, there is a high proportion of energy-intensive industries and a relatively low proportion of emerging industries. Innovation in energy technologies is critical for the country to achieve its future climate target. This paper suggests that further government incentives for companies that provide low-carbon technologies and smaller carbon footprint of their products would benefit the region's innovation ecosystem and accelerate the economy-wide deep decarbonization. This attempt could also stimulate investment in new business areas and bring job opportunities for the Circle.

At BASF, the company believes chemical industry with low-emission shall contribute to a climate-friendly economy. The climate action focuses on BASF’s strength: finding innovative solutions to address new challenges. BASF bundles measures to help reduce the greenhouse gas (GHG) emissions of its energy-intensive production.

Since 1990, BASF has cut its GHG emissions by half – while more than doubling its production. The company achieved this through efficiency measures as well as the use of catalysts to reduce nitrous oxide emissions. Further reduction of greenhouse gas emissions will be increasingly

difficult due to the high degree of efficiency the company has already reached with its optimized processes based on best available existing technologies.

Therefore, in addition to improvements to existing plants, BASF explores new processes and technologies for decarbonization. One of the most critical new technologies BASF is currently developing is electrically heated steam crackers to produce essential chemicals such as ethylene, propylene and butadiene. These chemicals are building blocks for numerous value chains and are essential for chemical production.

Another core technology for decarbonization is producing emission-free hydrogen based on methane (from natural gas or biogas). BASF works together with cooperation partners in a project funded by the Federal Ministry of Education and Research (BMBF) to develop a methane pyrolysis technology. The process uses comparatively little energy and, if it is run using electricity from renewable resources, is even CO_2-free.

Some innovative future technologies have been applied in China to reduce CO2 emissions from the production of key chemicals. In June 2019, BASF and Sichuan Lutianhua Co., Ltd., a major chemical producer in China, signed a Memorandum of Understanding (MoU) to co-develop a pilot production plant at Lutianhua's plant in western China. This cooperation which is the result of close collaboration of several parties along the value chain will significantly reduce carbon emissions and increase energy efficiency in producing dimethyl ether (DME) from syngas compared to the traditional process.

BASF supplies new, high-performance catalyst systems that enable one-step conversion of syngas to DME while Linde provides its newly developed process design and engineering for direct DME synthesis. Additionally, the cooperation has been facilitated by the Open Innovation Platform of China Petroleum and Chemical Industry Federation (CPCIF).

Transparency is another crucial enabler for carbon management. BASF has been publishing a comprehensive corporate carbon footprint since 2008, the first industrial enterprise worldwide to do so.

As an integrated company with specialty and base chemical production, BASF is a key enabler in helping its customers decarbonize their value chains. By the end of 2021, the company will provide its customers with carbon footprints for all of its 45,000 sales products. With a proprietary digital solution, the overall CO_2 emissions for each sales product can be determined.

4. Encouraging railway transportation mode with lower carbon footprint

In connection with intermodal roads and waterways, railway transportation is a much safer, economic, efficient, and environmentally friendly means of transportation. Currently, long application processes and regulation limitations have been preventing chemicals, especially dangerous chemicals, to be massively transported on track within China and beyond, which is in sharp contrast to Europe.

Industries across the board rely on efficient supply chains. The Circle is the connection point between the Belt and Road, and the Yangtze River Economic Belt. In the west, it has an extensive rail connection to Europe through Central Asia. It is also linked to Southeast Asia through the Southern Transport Corridor, providing a gateway to Thailand, Vietnam, Malaysia and Singapore. The rail link between Chongqing and Duisburg, Germany, which opened in 2015, can carry goods along the 11,179 km route in 13 days at its fastest.

Leveraging the policy benefits of the Circle Initiative in this vital location will further strengthen Chongqing's position as a new logistics hub. BASF is willing to work with local and national authorities to make it easier to transfer chemicals through the railway system. It will undoubtedly help reduce the region's carbon footprint and improve transportation efficiency, helping the Circle gain new economic development opportunities.

As one of the world's first chemical companies to do so, BASF is currently exploring the option of regularly scheduled freight train transport of chemical products between Europe and China. The customers could receive their goods in far less time with lower carbon footprints. The first block train with 42 containers passed through Chongqing and completed its maiden voyage to Xi'an in April 2020, overcoming many difficulties along the way, including adapting the train to the different tracks.

Conclusion: the Circle is where the future lies

During the 14th Five-Year Plan period (2021-25), China is going to accelerate the development of the dual circulation paradigm where domestic and foreign markets boost each other with the domestic market as the mainstay and introduce more opening-up measures. This top-level strategy calls for coordinated regional development for all large city clusters in the country.

Chongqing and Chengdu are stunningly attractive places with rich cultural heritage, modernized metropolitan areas and exciting economic prospects.

The potential of the Circle in areas including new energy, artificial intelligence, and distinctive tourism industries have been steadily unleashed. This creates new opportunities as well as market needs for high-quality chemical materials, which are essential to almost all industries.

This paper believes that cooperating with international chemical companies like BASF will benefit the Circle in becoming the leader in upscale manufacturing and sustainable development.

Looking forward, favorable policies will certainly help the Circle to further unlock its untapped potentials. This paper has every reason to believe that Chongqing and Chengdu will become China's inner land's Guangdong-and-Shenzhen in the next decade.

Leverage Transformative Opportunity of Intelligent Connectivity to Build Larger and Stronger Automotive Industry

Frank Meng
Executive Vice President, Chairman of Qualcomm China

Abstract

Intelligent, connected, electrified and shared cars are future destination of automotive industry's transformation and upgrade journey. During the disruptive fast change of world's automotive industry, important development opportunities are emerging for car manufacturing in Chengdu and Chongqing.

This paper fully analyzes the opportunities for car manufacturing in the context of industry changes and the foundation of car manufacturing in Chengdu and Chongqing. Then it makes three targeted development recommendations around overarch design, commercialization and ecosystem construction:

1. Identify unique scenarios and improve overarch design to differentiate from other cities in China;
2. Improve infrastructure to build interconnection system between Chengdu and Chongqing for driving commercialization;
3. Build industry ecosystem and cultivate leading enterprises.

In addition, leveraging the advantages of Qualcomm, prioritized cooperation programs can be suggested for technology innovation, industry chain building and demonstrative applications, contributing to the intelligent connected car industry in Chengdu and Chongqing.

Leverage Transformative Opportunity of Intelligent Connectivity to Build Larger and Stronger Automotive Industry

As a pillar industry of national economy, automotive industry makes great contributions to regional GDP and consumption. Intelligent, connected, electrified and shared cars are future destination of automotive industry's transformation and upgrade journey. Currently, world's automotive industry is experiencing disruptive and rapid changes, and important development opportunities are emerging for China's automotive industry, though without success stories to duplicate. Already hubs for automotive, electronics information technology and software industries, Chengdu and Chongqing can leverage the transformative opportunity of intelligent connected vehicle to build ecosystem around it and drive upgrade and transformation of local automotive industry. A larger and stronger automotive industry can fuel new energy to the economic growth of these two cities.

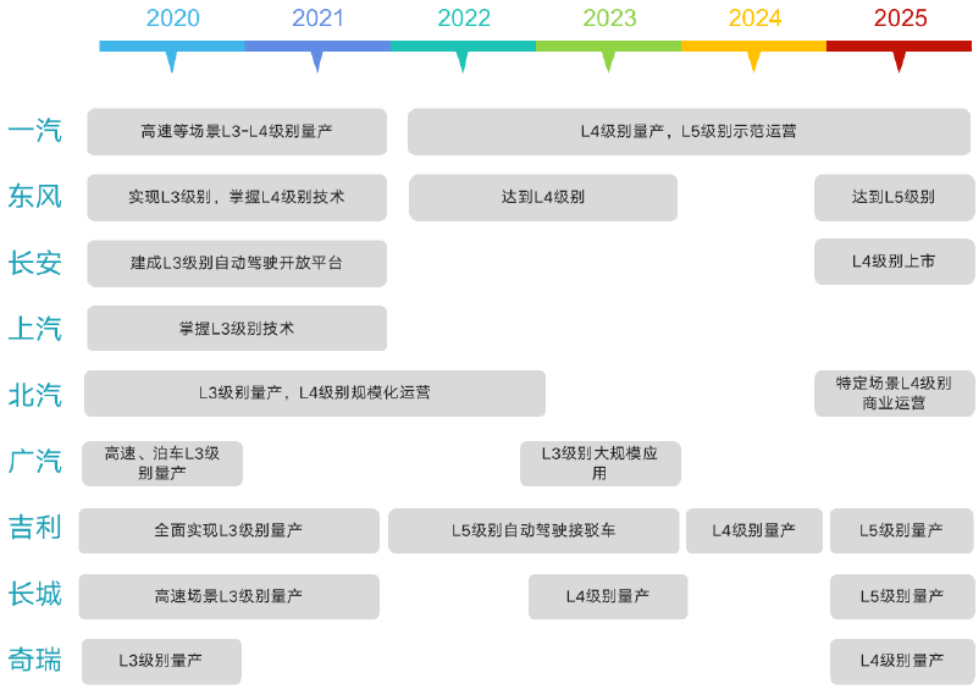
I. Intelligent, Connected, Electrified and Shared Car Disrupts Automotive Industry

Intelligent, connected, electrified and shared cars are disrupting automotive industry chain. Traditional fuel-driven cars are mechanical products mainly consisted of engine, clutch and gearbox, and their key technologies are distributed across material, design, fabrication and integration. With high barriers of whole vehicle design and production technology and challenging product rollouts, the market is dominated by a few of international carmaker giants. However, with the rise of intelligent, connected, electrified and shared cars, cars are driven by electrical motor instead of internal combustion engine, reducing components by over 1/3 and significantly lowering technical barriers in materials, design and production. Also in the context of industry changes, traditional automobile supply chain and market structure are being disrupted, giving an important opportunity to catch up to late-coming regions and players.

Car and ICT deeply integrates along with the evolution of whole vehicle electronic and electrical architecture. Traditional car usually uses distributed electronic and electrical architecture, in which hardware and software couples at spare part level and spare part functions integrate at whole vehicle level, so spare part suppliers like Bosch and ZF lead the market for their robust product reliability achieved in years. But for intelligent and connected cars, distributed architecture can no longer meet the requirements of functions and continuous iterations and upgrades, requiring more centralized electronic and electrical architecture, decoupling hardware and software at spare part level, more standardized and modularized hardware and more complete and full-stack controlled software. Under such trend, car spare parts tend to be homogenized while onboard software and intelligent functions become key market differentiators for various car brands, calling for deep integration between automotive industry and ICT industry. With advanced

electronic and electrical architecture and onboard intelligence, Tesla has successfully disrupted the lucrative luxury car segment dominated by traditional fuel-drive carmakers like BMW, Benz and Audi, entering the middle and high-end market and maintain steady sales. China is an early starter in areas such as Internet, big data and AI, and Chinese companies have better understanding of consumer demands. Building on existing automotive, electronics, information technology and software industries, they already have solid foundation for developing intelligent connected cars. Chinese brands are accelerating their initiatives to play more active role in the development and application of intelligent connectivity and attempting to capture larger market share.

Figure 1: The Layout of Intelligent Connected Products of Major Domestic Automobile Enterprises



Data Source: CCID Consulting, August 2021

Major Chinese cities are actively embracing intelligent connected car industry. Major cities in China that have economic power, industry expertise and development potential are actively embracing intelligent connected car, expecting to benefit from this opportunity. As they have different conditions, they are choosing different development paths that are distinctive from each other. With numerous universities, talents, a sound policy system, high-tech companies, Beijing hosts over 50% of leading intelligent connected car companies in China and drives industry growth with technology. Shanghai has a strong economy and a market easily accessible by emerging industry, and it shapes the industry with capital investment that quickly incubates advanced technology. As a hub of advanced Internet, communication and electronics and information technology industries and home for leading players like Huawei, Tencent and BYD, Shenzhen drives industry growth when these companies, particularly those industry giants,

transform to Tier-1 (tier-1 supplier for whole vehicle maker) suppliers. Automotive industry in Wuhan and Changsha is already established and they transform and upgrade the industry by building demonstrative zones. Wuxi is building IoT-based application ecosystem to streamline intra-city transport connectivity system and help build industry ecosystem around smart transportation.

Table 1: Layouts of Various Major Chinese Cities for Developing Intelligent Connected Car Industry

Typical Cities	Advantageous Resources	Development Path	Path Characteristics
BeiJing, ShangHai, GuangZhou, etc.	Talents and capital	Technology-driven growth across industry chain	Leverage advantageous talent and capital resources to incubate innovative ventures and monetize advanced technologies, creating presence on key nodes along the industry chain
ShenZhen, NanJing, ChengDu, etc.	Supportive industries	Transformation led by industry leading players	Building on supportive industries like electronics and information technology and led by industry leaders like Huawei, Tencent and China Automotive Innovation Co., Ltd., drive other companies along the industry chain to transform and establish presence
ChangSha, WuXi, HuZhou, SuZhou, etc.	Land	Build infrastructure to attract industrial investments	Develop testing application scenarios for intelligent connectivity, build complete supportive policy system and leverage land resources to attract ventures possessing key technologies that are incubated in Beijing and Shanghai to drive local industry growth
WuHan, ChongQing, ChangChun,	Traditional automotive manufacturing, land	Demand-driven industry upgrade	Though with strengths in traditional automotive industry, they are becoming obsolescent and transformation and upgrade is imperative. Ventures on certain nodes of the industry chain can be attracted to support the production of whole vehicle

Data Source: CCID Consulting, August 2021

II. Building on Solid Manufacturing Foundation, Chengdu and Chongqing Are Industrial Transformation-Ready

Chengdu and Chongqing have solid manufacturing foundation. Chengdu and Chongqing have built solid manufacturing foundation for automotives, electronics and information technology industries which promises great growth potential. Chengdu and Chongqing are one of leading automotive production bases in China, hosting the head offices of whole vehicle makers like Chana

Auto, YeMa Auto and Nanjun Auto as well as the production facilities of leading Chinese whole vehicle makers like FAW, SAIC, Geely, Chery, BAW and Dongfeng. They produced 2.293 million finished vehicles and achieve revenue over RMB500 billion in 2020. **In terms of industry chain**, Chengdu and Chongqing have a complete automotive industry chain, across which nearly 1,000 automotive spare part suppliers have formed an extensive supply network for whole vehicle production. Also global leading spare part suppliers such as Bosch, Valeo, Denso and Faurecia all have their affiliates in Chengdu and Chongqing. **From the perspective of related industries**, Electronics and information technology industries of Chengdu and Chongqing have capitalization over one trillion RMB to be the 4th largest electronics and information technology hub in China. Hosting software industry with capitalization more than 500 billion RMB, the two cities are also important software industry base in China. Leading nationally in areas like network information security, digital entertainment and big data center, they have the foundation and capability to develop intelligent connected car industry.

Automotive industry in Chengdu and Chongqing has clear need to transform. At present, comparing to leading regions such as Beijing, Tianjin and Hebei, the Yangtze River Delta and the Zhujiang River Delta, the automotive industry in Chengdu and Chongqing faces bottlenecks as **numerous but less competitive players and weak industry integration**. **In terms of industry,** Chengdu and Chongqing now host a large number of industry players, but most of them are simply traditional car production bases and their suppliers. They generally lack technology development capability and a very few of them can develop new energy car and intelligent connected car, including Changan, ZEV and Yema, but with limited model options. With the change and evolution of automotive industry, market share of traditional fuel-driven cars is being gradually ceded to intelligent cars and new energy cars, which directly affects automotive production and industry size in these two cities. When production capacity already persistently exceeds demand, transformation becomes an imperative. **Industry integration** is the other challenge for these two cities. Though they have established Internet, software and electronics and information technology industries, players in these sectors rarely interact with those automotive players. In areas that are at heart of intelligent connectivity, such as environment sensor, processor chip, autonomous driving solution and car connectivity terminal, these two cities lack high-tech companies and local industry leaders that can integrate the best resources of the region. Hindered by incomplete industry ecosystem and weak industry integration momentum, these two cities need and want to upgrade and transform automotive industry as well as integrate regional advantageous industry by developing intelligent connected cars.

Unique development path shall be defined for Chengdu and Chongqing to make them immediately industry transformation ready. At overarch design level, governments of these two cities have strong interest in developing intelligent connected car industry. Since 2018, they've

rolled out *Guidelines for Accelerating Automotive Industry Upgrade and Transformation*, *Chongqing City's Policy Initiatives for Accelerating New Energy and Intelligent Car Industry Development*, *Chengdu City's Implementing Initiatives for Developing Intelligent Connected Car Industry (2019-2021)* to continuously increase support to intelligent cars. In May 2021, Sichuan province and Chongqing city signed the *Strategic Partnership Agreement for Collaborative Developing Automotive Industry of Chengdu and Chongqing*, eliminating the barriers against collaborative development of automotive industry across these two regions. About demonstrative zone of intelligent connected car industry, the two cities have national Chongqing intelligent car and intelligent traffic application demonstrative zone and national demonstrative projects like Chongqing (Liangjiang New Area) car connectivity piloting zone, to ensure testing and validation of related technologies for intelligent connected car. However, Chengdu and Chongqing are still lagging, if comparing to cities starting the industry concurrently, such as Changsha, Wuxi and Shenzhen. Intelligent connected car industry in these two cities lacks unique development path and focused industry chain deployments, and while developing the industry, they are facing the competition from tier-1 cities like Beijing, Shanghai and Shenzhen and are forced to be homogenized, which amplifies their disadvantages in talents and capital and limits their capability to aggregate and integrate industry resources. Clearly defining unique development path for these two cities and focusing resources on advantageous nodes on the industry chain is crucial for them to accelerate regional intelligent connected car industry and drive automotive industry transform and upgrade.

Table 2: National Demonstrative Zones for Intelligent Connected Car

SN	Demonstrative Zone Name	City	Characteristics of Demonstration Zone
1	National Intelligent Car and Intelligent Traffic (Beijing and Hebei) Demonstrative Zone	Beijing	Six types of demonstrative applications including environment-friendly travel, intelligent road network, intelligent driving, convenient parking, happy life on wheels and intelligent management.
2	Changchun China National Intelligent Connected Car Application (Northern China) Demonstrative Zone	Changchun	China's first intelligent car and intelligent traffic test and experience base in frigid zone.
3	Wuxi National Intelligent Traffic Comprehensive Test Base	Wuxi	Intelligent traffic administration technology comprehensive test platform, traffic policeman hands-on training platform and intelligent connected car driving safety test platform.
4	National Intelligent Connected Car	Shanghai	Intelligent car, V2X connectivity and communication test and demonstration.

	(Shanghai) Pilot Demonstrative Zone		
5	Zhejiang Intelligent Car and Intelligent Traffic Application Demonstrative Zone	Hangzhou	Yunxi town deploys intelligent car information interaction scenarios compliant with LTE-V car connectivity standard.
		Jiaxing	Wuzhen pilots projects committed to building transparent demonstrative road around video technology, 4G+ broadband mobile test network and intelligent parking application.
6	Guangdong Intelligent Connected Car and Intelligent Traffic Application Demonstrative Zone	Guangzhou	Industry ecosystem centered on 5G pilot network and IoT.
7	Chongqing Intelligent Car and Intelligent Traffic Application Demonstrative Zone	Chongqing	Eight types of applications including intelligent driving, intelligent road network, environment-friendly travel, anti-theft tracking, convenient parking, resource sharing, massive traffic guidance and traffic status intelligent management.
8	Wuhan Xiangjiang New Zone Intelligent System Test Zone	Changsha	High-speed way simulation and test environment, and UAV takeoff and landing runway.
9	Wuhan Intelligent Connected Car and Intelligent Traffic Application Demonstrative Zone	Wuhan	Various types of demonstrative applications including intelligent driving, intelligent road network, environment-friendly travel, convenient parking and traffic status intelligent management.

Data Source: information published by government and sorted by CCID Consulting, August 2021

Table 3: National Car Connectivity Pilot Zones

SN	Pilot Zone Name	City	Application Scenarios
1	Tianjin (Xiqing) National Car Connectivity Pilot Zone	Tianjin	Provide car connectivity information service for government, public transport, police and healthcare, explore autonomous driving scenarios like autonomous parking, logistics, sanitation and vehicle grouping and drive deep integration between car connectivity and intelligent traffic.
2	Jiangsu (Wuxi) Car Connectivity Pilot Zone	Wuxi	Digitally upgrade and retrofit roadside facilities of 280 junctions and 500+ points/sections; deploy road node facilities for 5G edge computation; build massive urban and open road V2X network covering 220 km^2; build car connectivity application service system encompassing car connectivity big data center ("one center") and traffic information open platform, V2X data application service platform and traffic status diagnosis and information publishing platform ("three platforms").
3	Hunan (Changsha) Car Connectivity Pilot Zone	Chang sha	Expand application scenarios and accelerate commercialization by promoting commercial car connectivity project applications in four areas as intelligent logistics, urban open roads, unmanned port and operation and maintenance of intelligently connected city; focus on intelligent upgrade of important vehicles including bus, dangerous chemical truck, school bus, sanitation truck and muck truck and launch demonstrative and commercial intelligent bus operations.
4	Chongqing (Liangjiang New Area) Car Connectivity Pilot Zone	Chong qing	Deploy at scale Cellular Vehicle-to-Everything (C-V2X) network at trunk high ways and urban roads and coordinate and match the cadence of 5G to the evolution of intelligent city; deploy car connectivity capabilities to pivotal regional traffic infrastructure, improve their core system capabilities and drive deployment across entire road network; align industry capabilities to complex road transport realities, strengthen technology innovation and product development, build rich and practical car connectivity application scenarios, effectively increase onboard terminal users and drive industry transformation, upgrade and high-quality growth; deepen policy and system innovation, build healthy and sustainable deployment and operation models, create openly informative and interconnected cloud service platform, build complete security management system and capture best practices that can be duplicated and promoted.

Data Source: information published by government and sorted by CCID Consulting, August

III. Suggestions for Securing Development Opportunities and Building Intelligent Connectivity Commercialization Pilot Zone

Identify unique scenarios and improve overarch design. An intelligent connectivity development path that best fits the industry landscape of Chengdu and Chongqing can be found by identifying their advantageous resources and development factors. Efforts can be focused on improving local standard system, enabling test, inspection and certification service providers and encouraging development and deployment of applicable solutions to address the cross-boundary scenarios of these two cities and Chongqing's mountainous terrain scenarios. Their traditional advantages in network information security and mobile payment data security can be effectively leveraged to build these two cities into China's intelligent connected car network data security center by solving most interested top issues about intelligent connected car communication and data security. By focusing efforts on fields like communication, security and big data analytics, they can differentiate themselves from other competitor cities in China.

Improve infrastructure and build interconnectivity system for these two cities to facilitate commercialization. Demands for facilities that support intelligent connected car applications can be combined with construction of new type of infrastructure to improve communication network, intelligent roads and edge computation centers, boost integrated application of 5G communication system and roadside infrastructure, build urban cloud control platform and big data center, construct intelligent traffic system that integrates vehicles, roads, cloud and network and ultimately, ensure regional deployment and operation of intelligent connected cars. Leveraging their unique cross-boundary scenarios, a set of standards and systems can be developed for building communication and road infrastructure that enables cross-boundary interconnectivity between the two cities, firstly those application test scenarios fitting both of them. Software and technology companies of these two cities can be encouraged to transform into intelligent connectivity application and service providers, in particular supplier of commercialized autonomous driving products that are based on vehicle-infrastructure cooperative system. Also infrastructure construction can be driven with commercialized applications and intelligent connectivity car related companies can be encouraged to explore running commercial services. In this way, industry growth can be fueled with commercial applications and commercial operation pilot zone for intelligent connected cars can be created.

Build industry ecosystem and cultivate industry leaders. To enable collaborative development of industry cluster across Chengdu and Chongqing, these two cities shall be clearly positioned and assigned with development priorities, to avoid homogenized and low efficient resource competition within the region. In addition, to fully leverage the research organizations in these two cities, government can bridge them and companies to create collaborative innovation platform across industry, education and academia as well as industry alliance for developing and

monetizing core technologies of intelligent connected car, such as sensor, chip and software algorithm. Software, electronics and information and Internet technology companies can be encouraged to create industry alliance or joint venture with automotive companies, so that they can complement each other when developing and producing core spare parts of intelligent connected car. Companies that have in-house development capabilities at advantageous nodes of the industry chain shall be given special care to make them bigger and stronger. As Chengdu and Chongqing are key nexuses on "One Belt and One Road", their advantageous location can be used to serve domestic and overseas market opportunities. In China, they can meet the demands from purchasers and vendors in domestic market. On international market they can attempt to play a role in global automotive supply chain by improving product competitiveness and developing local industry leaders.

IV. Qualcomm Partners with Chongqing to Bolster Intelligent Connected Car Ecosystem

After continuous investment in automotive sector for 15 years, Qualcomm has built a massive technology portfolio across four core business areas including onboard information processing and Cellular Vehicle-to-Everything (C-V2X), digital cockpit, cloud-side terminal management, Advanced Driver Assistance Systems (ADAS) and Autonomous Driving (AD). It has equipped over 150 million cars in the world with these technologies and solutions and is leading global onboard information processing, Bluetooth solution and onboard infotainment system markets. Qualcomm wants to be the technology keystone for the intelligent connected car ecosystem across Chengdu and Chongqing, helping build the ecosystem by forming extensive and profound partnership with the two cities through following three initiatives:

Firstly, Qualcomm will build collaborative innovation center for automotive technologies and products in Chengdu-Chongqing region. Deep cooperation between Qualcomm and Thundersoft provides proven example that can be referenced by other industry players in this region. In 2018, the two companies founded Chongqing Collaborative Innovation Intelligent Automotive Research Institute and Qualcomm China Intelligent IoT Collaborative Innovation Center respectively in Yubei District and Chongqing Economic and Technological Development Zone and put them into operation. In the future, Qualcomm will continue its extensive and deep cooperation with local related companies and research organizations, providing communication and computation technology support to intelligent connected car companies in this region and helping them develop and commercialize applications, services and products.

Secondly, Qualcomm can fully leverage its leadership in Qualcomm partnership ecosystem. Qualcomm will help develop the intelligent connected car industry chain across Chengdu and Chongqing, work with partners to test Chongqing's application scenarios while helping Chongqing improve intelligent connected car spare part supply system, and assist the product development

and production of SME innovative companies in the region.

Finally, Qualcomm will accelerate demonstration and application of Qualcomm's advanced car connectivity technologies in Chengdu and Chongqing. Qualcomm Snapdragon automotive 5G platform is automotive industry's first automotive-grade 5G DSDA platform that offers complete and industry-leading 5G connectivity. It supports multiple connection technologies from 2G to 5G, FDD and TDD network, Stand-Alone (SA) and Non-Stand Alone (NSA) running, RF front end and key bands of global leading operators, Cellular Vehicle-to-Everything (C-V2X) direct communication and High-Precision Multi-Band Global Navigation Satellite System (HP-GNSS). Based on these capabilities, Qualcomm car connectivity solution features lane-level high-precision navigation, cloud connection at several Gbits, Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communication for vehicle safety and high bandwidth low latency remote operation to support key requirements like vehicle safety, vehicle grouping, autonomous driving and always-connected driving experience. It enables carmakers, tier-1 suppliers and roadside infrastructure customers to develop faster and safer differentiated products for next generation of connected cars and also supports diverse emerging travel services. Qualcomm expects to work with industry partners like Tencent, Lenovo, China Mobile and carmakers to build typical application test scenarios for C-V2X in Chongqing, helping these two cities build world-leading 5G car connectivity pilot zone and thus create new growth point for them.

Suggestions on the Development of 5G+ Manufacturing in Chongqing

Chris Houghton
Senior Vice President, Ericsson

Hello Mr. Mayor, Ladies. and Gentlemen!

It is my great honour to attend the 16th Annual Meeting of the Chongqing Mayor's International Economic Advisory Council on behalf of Ericsson. I attended the 15th Annual Meeting last September and proposed the idea of "accelerating the application of 5G technology and industrial cooperation to help Chongqing develop an open economy at a high level". Just one year on, China has made great achievements in 5G construction. **The Economic Operation of the Communications Industry in the First Half of 2021 Report** released by the Ministry of Industry and Information Technology (MIIT) states that China has 961,000 5G base stations and nearly 370 million 5G connections, which accounts for 80% of the world's total, by the end of June.

Just as that the massive deployment of 5G in only one year demonstrates the speed and growth of China's "new infrastructure", the next stage of 5G implementation and application innovation will also determine the speed and quality of China's smart society establishment. Industries are also looking forward to being re-empowered by the emerging technologies represented by 5G. In many manufacturing scenarios, 5G is the only way to meet the high demands for low-latency networks and stable connectivity. Therefore, Ericsson hopes to choose the topic of 5G+ manufacturing to talk about how to use 5G to enable the manufacturing industry in Chongqing and even the Chengdu-Chongqing region to be more competitive and stronger.

Today, the Chongqing and Chengdu-Chongqing regions are facing a historic opportunity for development. Given its special position and importance to the Belt and Road Initiative, Chongqing undertakes multiple missions. In January 2020, China made a major decision to accelerate the construction of the Chengdu-Chongqing economic circle. In May 2020, China government proposed to accelerate the establishment of a new development pattern recognizing the domestic market as the mainstay, with the domestic and foreign markets reinforcing each other, and issued the **Guiding Opinions of the Central Committee of the CPC and the State Council on Promoting the Development of the Western Regions and Forging a New Pattern in the New Era.**

The key status in the Belt and Road Initiative and a series of major decisions such as China's proposals to accelerate the Chengdu-Chongqing economic circle construction and establish a new western region development pattern have put the Chengdu-Chongqing region under the spotlight.

The Chengdu-Chongqing region have taken a historical role for building and supporting the Belt and Road Initiative, constructing a prosperous two-city economic circle, setting a key strategic point for western China's development and developing new "dual circulation" development pattern in western China.

Under the historical responsibility of exploring a new development pattern, the manufacturing industry has always been the backbone in promoting the Chengdu-Chongqing region's two-city prosperity and establishment of an "economic circle". The major leadership of Chongqing has repeatedly stressed that Chongqing is committed to building and growing the city through industry.

Chengdu-Chongqing region has always been an important manufacturing base. According to Chongqing Daily, Chongqing's output of microcomputers, mobile phones, automobiles and motorbikes by the end of 2020 accounted for over 24%, 9%, 6% and 29% respectively of the national output, evidence of the city's leading position in consumer electronics, automobile, and motorbike manufacturing. In 2020, Chongqing's industrial value added was RMB 699.077 billion, ranking fourth among all major cities in China after Shanghai, Shenzhen and Suzhou, which accounts for 27.8% of the nation's GDP. For the 14th Five-Year Plan, Chongqing has set an ambitious total industrial output target of RMB 3 trillion with an average annual growth of 6% in industrial value added, which is 30% of GDP. This means that industrial manufacturing will be more firmly established as the backbone of Chongqing's economic development.

Data show that Chongqing and Sichuan accounted for 44% of western China's 2019 automobile production. Chongqing currently has more than a dozen OEMs, over 400 first-tier high-quality auto parts producers, and over 1,000 second and third-tier supporting entities. Its auto parts localization rate has exceeded 70%. Sichuan, on the other hand, has more than 10 key OEMs such as FAW-Volkswagen, FAW-Toyota, Hyundai, Geely Volvo and DPCA. The strong industrial foundation represented by automobile manufacturing has made the Chongqing-Chengdu region's successful past and will determine its future.

So, how to make the future development of Chongqing manufacturing industry greater? Chongqing already has the answer. As the main leadership of Chongqing said, Chongqing should deploy innovation around the industrial chain while adjust the industrial layout based on innovation and take advantage of scientific and technological innovation to promote industrial transformation, adjust the industrial structure and cultivate advanced international-grade manufacturing clusters to accelerate high-quality manufacturing development.

This is what Chongqing has exactly thought and done. **The Implementation Plan for the Development of Intelligent Manufacturing in Chongqing (2019-2022)** states that by 2022, Chongqing will empower implementing intelligent transformation in 5,000 enterprises, build 10

industrial internet platforms with strong domestic competitiveness, 50 intelligent factories, and 500 digital workshops. Transforming from a “manufacturing-focused city” to a “smart manufacturing city” is one of Chongqing's commitments.

Based on the above consensus, Ericsson would like to propose the following three suggestions for the development of the manufacturing industry in Chongqing and the Chengdu-Chongqing region, with its own resources and expertise in consideration.

Suggestion 1: To build the “Chongqing Manufacturing 5G Innovation Demonstration Park”

The key points of **Chongqing's intelligent manufacturing empowerment action in 2021** suggests eliminating “dumb” equipment”. "Dumb equipment" refers to equipment that is not networked and connected, cannot automatically report and be intelligently managed, and is not on the cloud platform. In the current era, "dumb equipment" can only work with itself without interaction with external information which leads to production inefficiency and hinders scientific and effective management.

This is an interesting viewpoint that brings the following to light - equipment that is not connected or networked is not only "dumb", but also "dead"! Responding to market changes often requires adjustments to the production line, but such large-scale adjustments always have plenty difficulties. The "dumb" and "dead" equipment can hardly adapt to new changes, which impacts the flexibility and efficiency of production and severely restricts the growth of enterprises.

Ericsson attributes the existence of "dumb equipment” to two factors: the equipment either cannot connect to the network or the network it connects to is not qualified, stable, or fast. From this perspective, enabling equipment to "see and hear well" and "work together" with other equipment is the foundation and key step for Chongqing to accelerate high-quality manufacturing development and build a "smart manufacturing city". 5G is an inherently powerful tool to deal with dumb equipment. By introducing the stability, high speed, and large broadband of 5G into the manufacturing industry, "dumb equipment", "dumb manufacturing" and "dumb factories" will be eliminated.

Chongqing has seen the problem and is in coordination with Sichuan to make improvements. In July 2020, 67 companies were selected for **the 2020 Chongqing Smart Manufacturing and Industrial Internet Innovation Demonstration Projects**, including Chongqing Chuanyi Control Valve Co., Ltd with 5G wireless coverage supported by Ericsson. The selected enterprises bid for financial subsidies of up to RMB 10 million. Among the 67 enterprises, 51 of the selected projects are about 5G+ Industrial Internet, covering a wide range of industrial categories such as automobile,

steel, and pharmaceuticals. This indicates that Chongqing's 5G+ Industrial Internet of Things (IIoT) already has a solid foundation that is already growing in strength.

Furthermore, **the Key Points of the Construction of a Demonstration Zone for the Integrated Development of Industrial Internet in the Chengdu-Chongqing Region in 2021** jointly developed by the Chongqing Municipal Commission of Economic and Information Technology and the Sichuan Provincial Department of Economic and Information Technology states 13 secondary industrial internet nodes and 20 5G+ Industrial Internet projects are planned to be built within the year. Meanwhile, Chongqing 5G Industrial Park construction is being accelerated and the first phase of Tenglong 5G Ba'nan Industrial Park will be put into operation within the year. All these initiatives closely link the development of Chongqing's industrial manufacturing with 5G.

On the basis of this plan, we propose to build the Chongqing Manufacturing 5G Innovation Demonstration Park by relying on the strong industrial manufacturing capacity of Chongqing and the Chengdu-Chongqing region, integrating the manufacturing industry with 5G to improve efficiency and industrial value reconstruction.

The Chongqing Manufacturing 5G Innovation Demonstration Park has three main differences from the industrial internet innovation demonstration projects and 5G industrial parks that have been or are being solicited and built in Chongqing:

- First, it is more focused on the manufacturing industry. In this park, 5G will mainly serve the manufacturing industry, including both the manufacturing process itself and the supply chain, logistics and services of manufacturing enterprises.
- Second, it will cover the manufacturing clusters and strive to build a 5G innovation base for the manufacturing industry.
- Third, it will become the birthplace and port for innovative 5G ideas in the manufacturing industry, to gradually develop and reshape 5G cognition and methodology in manufacturing.

The Chongqing Manufacturing 5G Innovation Demonstration Park should therefore focus on building three key capabilities:

- First, 5G network deployment and private enterprise 5G network building. Through the construction of a 5G network covering the park and the establishment of a 5G private network for the park's manufacturing enterprises, the equipment, production, circulation, and services of manufacturing enterprises in the park will be brought online to allow 5G connection between all manufacturing enterprises in the park. According to the Chongqing Municipal Communications Administration, 39,000 new 5G base stations were built in Chongqing in

2020 with a total of 49,000 5G base stations operation for full 5G network coverage in key areas of the city. With the further 2021 roll-out of 5G construction in Chongqing, 5G network infrastructure in the Chongqing Manufacturing 5G Innovation Demonstration Park is expected to progress smoothly, meaning establishing the 5G enterprise private network is the major task for Chongqing's industrial manufacturers.

- Second, innovate and enrich the capabilities of 5G-based manufacturing scenarios. Attracting relevant innovative enterprises in 5G+ Manufacturing through policy guidance to set up a branch or settle in and focus on fostering 5G-based manufacturing technology and application innovations to empower manufacturing enterprises in the park with 5G for a stronger competitive edge. As we know, manufacturing scenarios are complex and varied, and even manufacturing companies with similar products may have very different production processes and models. Therefore, combining 5G and manufacturing scenarios is a process that cannot be achieved overnight. We can take the "snowball" approach to innovate, validate, and promote one by one, integrating comprehensive 5G capabilities into industrial manufacturing enterprises to create a professional, exclusive, and specialized smart manufacturing system for Chongqing's manufacturing industry.
- Third, build a 5G experience sharing platform. By organizing 5G+manufacturing summits and forums from time to time, the Chongqing Manufacturing 5G Innovation Demonstration Park will become a central base for 5G+ Manufacturing and a 5G+ Manufacturing experience exchange platform. This can bring the 5G+ Manufacturing experience to other manufacturing enterprises and parks in the Chengdu-Chongqing region to nourish the development of the 5G Innovation Demonstration Park with fresh ideas and practices and build the Chongqing industrial manufacturing as a role model of 5G innovation. Historically, most of the influential smart manufacturing summits and forums in China were initiated by industry-related associations or leading technology companies, but Ericsson proposes that the Chongqing Manufacturing 5G Innovation Demonstration Park should be the protagonist of the smart manufacturing summits or forums as Chongqing has a stronger industrial foundation. The Chongqing Manufacturing 5G Innovation Demonstration Park will enable more thorough integration and enrich 5G and manufacturing practices, so the ideas and experiences from Chongqing will be closer to enterprise reality and therefore a significant reference for the industry as a whole.

So what value can 5G bring to the manufacturing industry? Let's look at the case of the latest Mercedes-Benz Factory 56 in Germany and the Ericsson factory in Nanjing.

In September 2020, the Mercedes-Benz Factory 56 in Germany launched production which uses the world's first 5G private network solution for automobile production deployed by Ericsson and Telefónica Germany. Most evident change is that the tracks on the production line have

disappeared, and the cars to be built are carried by automatic guided vehicles which dispatch themselves to the required workstations at any time according to the workers' actual work, with the workers moving to the next process instantly. Statistics show this has increased Factory 56's manufacturing efficiency by 25%. What's more, the revolution in production organization brought by emerging technologies such as 5G will enable companies to better adapt to the future transformation from "mass production" to "mass customization" in manufacturing, the best for meeting increasingly diverse consumer needs.

If the experience of the Mercedes-Benz Factory 56 could be applied to Chongqing's automobile manufacturing industry, what values would that bring? Let's take Chongqing Changan Auto as an example, which is one of the four largest automotive groups in China. Financial reports show that Changan Auto sold over 2 million vehicles in 2020 with sales of approximately RMB 84.5 billion. Assuming that sales are equal to production, if the 5G network can be used to increase manufacturing efficiency by 25%, it means that it will only take 9 months to complete the production and sales that took 12 months before, and Changan Auto will have the extra 3 months to continue production capacity. If this capacity is fully absorbed by the market, Changan Auto's revenue could theoretically increase by RMB 21.1 billion a year.

The automobile industry is certainly not the only one empowered by 5G. As Ericsson's largest manufacturing base in China, the Nanjing factory also completed a 5G-based intelligent factory transformation project last year with a total investment of over SEK 500 million and launched several 5G use cases. For example, inventory with 5G drones has increased efficiency by 50 times and dramatically improved accuracy. 5G-connected surveillance cameras enable real-time monitoring of production processes. 5G AR training enables employees to acquire operational skills faster, effectively solving challenges brought by the pandemic, such as not being able to travel overseas or even out of town for training. 5G has also helped take advantage of the full capabilities in automated guided vehicles, forklifts and other equipment at the Nanjing factory.

The private 5G network and the 5G innovative use cases at Mercedes-Benz Factory 56 and Ericsson Nanjing factory have enabled both factories to not only greatly improve productivity, but also offer manufacturing unprecedented flexibility, stability, and on-demand customized production.

For 5G+ Smart Manufacturing, Ericsson, together with leading global digital information technology solutions provider Hexagon and others have produced the **Connected Manufacturing - A Guide Report on Industry 4.0 Transformation Using Dedicated Cellular Technology**, which examines and quantifies the potential value private 5G cellular networks brings to manufacturing. Studies show that if the five use cases of autonomous mobile robots, collaborative

robots, augmented reality, asset condition monitoring and digital twins can be used to create Industry 4.0, total returns on investment reach 116% in the fifth year. In other words, 5G use cases help manufacturing enterprises recover their technology investments faster as well as create and unlock long-term value.

Suggestion 2: To lead the establishment of the "Chongqing 5G+ Smart Manufacturing Industry Fund"

The role of the government is essential in the process of the 5G integration with industries. The article **What Can We Learn from the 5G Construction in the US and South Korea?** reveals the important initiatives of the US and South Korea in supporting the integration of 5G and industry. The article mentions that in 2017, the US Federal Communications Commission (FCC) established a 5G fund to promote the penetration of 5G into precision agriculture, telemedicine, smart transportation, and more. In 2019, FCC announced a USD 20.4-billion Rural Digital Opportunity Fund for rural broadband network construction.

South Korea has also spared no efforts in developing 5G, allocating KRW 30 trillion (approximately RMB174.4 billion) to develop 5G network services. The Seoul Municipal Government has invested KRW 25.4 billion (approximately RMB 148 million) to build the Seoul Intelligent Transportation System in partnership with SKT.

To maintain Germany's leadership in automobile manufacturing, the German Federal Ministry of Economics and Energy decided in 2018 to extend **the New Vehicle and System Technologies program** and provide €60 million per year for the next four years to focus on autonomous driving, connected vehicles, and innovative vehicles. The basis for this initiative is the recognition that the introduction of 5G networks will have a huge impact on networks and autonomous vehicles.

China is also increasing its focus on funding the development of 5G and industry integration through the establishment of industry funds or direct grants. 2019 saw Beijing establishing a RMB 5 billion 5G industry fund with a focus on investing in technologically leading high-tech companies at home and abroad in the upstream, midstream and downstream segments of the 5G industry chain. In the same year, a 5G industry fund with a total of RMB 2 billion by both social strategic investors and government industrial funds was established in Hangzhou to focus on investing in leading enterprises in the upstream, midstream and downstream segments of the 5G industry nationwide and nurturing the 5G industry market.

In April 2021, the Shenzhen Municipal Bureau of Industry and Information Technology proposed in the Several Measures to Accelerate the High-Quality Development of the Whole 5G

Industry Chain in Shenzhen (Draft for Public Consultation) that it would encourage industrial parks to merge the 5G industry chain, use 5G to improve management services, identify and cultivate a number of specialized 5G industrial parks with development and mutual promotion, and provide subsidies for 30% of the parks' investment in new software and hardware (up to RMB 50 million).

In this regard, Chongqing has also taken initiatives. As mentioned above, enterprises selected for the 2020 Chongqing Smart Manufacturing and Industrial Internet Innovation Demonstration Projects receive up to RMB 10 million in subsidy. Chongqing's Jiangjin District has also released the 2021 Support Direction for Smart Manufacturing and Industrial Internet Innovation Demonstration and Application Pilots in Jiangjin District, which provides subsidies of up to RMB 1.5 million for a single selected project. All these show that Chongqing governments at all levels consider meeting the needs of enterprises to doing what they could for supporting the development of smart manufacturing and industrial internet in Chongqing.

Will Chongqing take another step forward and set up a Chongqing 5G+ Smart Manufacturing Industry Fund to support the higher-level integration of manufacturing and 5G with greater intensity? This is exactly what Ericsson is proposing.

We envision that the Chongqing 5G+ Smart Manufacturing Industry Fund will be used in three directions.

- First, it will be used for the construction and expansion of the Chongqing Manufacturing 5G Innovation Demonstration Park.
- Second, it will be used for the 5G transformation of enterprises in the Demonstration Park. By investing in the 5G technological transformation of targeted enterprises, encouraging them to build a Global Lighthouse Factory with 5G and actively explore 5G innovation scenarios.
- Third, Chongqing will invest directly in high-tech, high value-added manufacturing enterprises with government and private capital cooperation. This is the so-called PPP mode, which is similar to Hefei's direct investment of billions of RMB in BOE and NIO in 2008 and 2020 respectively. Through equity participation and other means, it provides funding and supporting services for the local development of those enterprises while also cultivating "seed" players for the future capital market, enabling these companies to develop and grow locally and finally achieving both financial and capital market returns.

In the government-led establishment of the Chongqing 5G+ Smart Manufacturing Industry Fund and support for the development of 5G+ Manufacturing, efforts can also be made to build the "global lighthouse factory" , which will not only improve the overall level of smart

manufacturing in Chongqing, but also serve as a benchmark of Chongqing's strong industrial manufacturing foundation.

The Lighthouse Factory is considered a leader in the fourth industrial revolution and is jointly assessed by the World Economic Forum and McKinsey as a factory pioneering the large-scale application of new technologies that deeply integrates digitalization and manufacturing and provides valuable inspiration for other manufacturing enterprises. By March 2021, there had been 69 Global Lighthouse Factories, 21 of which in China. Among these 21 factories, two are in the Chengdu-Chongqing region, namely the Siemens Chengdu factory and the Foxconn Chengdu factory. As a major manufacturing city, to establish a Global Lighthouse Factory in Chongqing should be a great model to drive the manufacturing industry's digital transformation.

Ericsson is willing to share its resource and experiences about how to build a Global Lighthouse Factory. The Ericsson Louisville factory in Texas, USA was awarded as a Global Lighthouse Factory as a comprehensive and genuine 5G smart factory in 2021. Since starting operations in early 2020, 25 different 5G use cases have been developed, with output per employee increasing by 120%, manual material handling reduced by 65%, order delivery times shortened by 75% and inventory levels reduced by 50%. The factory has also achieved significant results in terms of conserving resources and reducing carbon emissions – its energy efficiency is 24% higher than that of comparable factories in the US and 17% of the electricity required is generated by the factory's solar panels. The factory's integrated environmental system consumes 24% less energy and 75% less water indoors than that of comparable buildings.

Suggestion 3: Introduce Ericsson's "Dual Plan" to unleash the potential of 5G for industry and consumption

As a multinational company with a 146-year history, Ericsson has arguably pioneered civilization's communication, having participated in and driven the development of mobile communication standards from 1G to 5G. To promote the integration of 5G with industry and consumption, Ericsson has launched the **Ericsson Industry 4.0 partner program** and **Ericsson Startup 5G program** worldwide, with both already released in Chinese Mainland. We will take advantage of the development of 5G+ smart manufacturing in Chongqing to create a 5G ecosystem with the city's key manufacturing companies and related innovative 5G application companies, to accelerate 5G application in manufacturing and consumption.

The Ericsson Industry 4.0 partner program aims to connect global service providers, system integrators, technology equipment partners, independent software providers, and other partners to build an industrial IoT industry ecosystem and help companies accomplish their visions for Industry 4.0 smart manufacturing. SIMCom Wireless Solutions Limited, the global leader in

the module industry, is one of the Chinese companies that have joined Ericsson's Industry 4.0 partner program. Both companies have conducted many tests on the module side to explore the implementation of industry applications.

It should be emphasized that, in addition to automobile manufacturing, Chongqing also has powerful capabilities and clear vision for manufacturing high-end equipment, steel, biomedical and medical devices, among others. For the Chongqing enterprises that have already deployed their industry chain in Industry 4.0, we hope that **the Ericsson Industry 4.0 partner program** will play a role, and we can work together in building successful transformation cases in key Chongqing industries. We also hope that Chongqing's success stories can be promoted overseas through the program.

For the consumer market, Ericsson has just launched the global **Ericsson Startup 5G program** in July of this year. **The Ericsson Startup 5G program** identifies and seeks innovative start-ups around the world to provide network technology support and share insights, helps 5G ecosystem partners develop 5G-based consumer services, and explores areas such as home entertainment, gaming, live streaming and sports events. By introducing the Ericsson Startup 5G program in Chongqing, Ericsson hopes to bring together more 5G-based innovative companies and foster new 5G applications to expand and enrich 5G-based digital applications in Chongqing.

In addition to **the Ericsson Industry 4.0 partner program** and **the Ericsson Startup 5G program**, Ericsson has more resources and platforms like our global testing and terminal network certification services for working with partners to build 5G ecosystems. In simple terms, we provide global network testing and certification services for all kinds of equipment in accordance with real network environments, ensuring that equipment manufacturers' chips, modules and all kinds of terminals are compatible with various global communication networks of different generations in addition to NB-IoT and CAT IoT. **Ericsson's terminal ecosystem portal (Device Hub)** is also open to companies that have passed the test. Once passed, car companies, chip companies and other manufacturing companies with high demands for forward-looking product pre-research and testing enable products to be retrieved by global operators and testing agencies, thus opening up new channels for overseas sales collaborations and enabling Chinese companies to participate in the global device supply chain. In this regard, OPPO, the leading vendor in the global mobile phone market, is already using Ericsson's testing, certification, and terminal ecosystem portal to enter the European market.

We would like to discuss further with Chongqing on how these two programs, as well as resources and platforms like global testing services for terminal networks and the terminal ecosystem portal (Device Hub), contribute to the convergence of 5G+ Manufacturing in

Chongqing and attract the Chengdu-Chongqing region's eco-chain companies. By relying on our R&D centres, business delivery, marketing and other resources in Chongqing and Chengdu, Ericsson will also reach out to mainstream industries and key manufacturing enterprises in Chongqing to discuss 5G applications and 5G innovation.

To nurture the local ecosystem and promote the convergence of 5G+ Manufacturing, we may also consider creating a joint 5G lab with backbone manufacturing enterprises in Chongqing to overcome application challenges in appropriate conditions. We will also establish a dedicated local business team for 5G+ Manufacturing. I also hope that the Chongqing municipal government can connect 5G communication companies like Ericsson and other industry-leading companies serving the manufacturing sector in big data, IoT, AI and other fields with foundational local manufacturing industries, manufacturing-concentrated parks, development and high-tech zones to communicate. This is so that technology companies with technical expertise such as Ericsson can plan and promote 5G strategies and innovation together with the Chongqing manufacturing sector to promote the quality development of the manufacturing industry in Chongqing to a higher level.

In addition to the above three suggestions, in order to better promote the development of 5G+ Manufacturing in Chongqing, I also advise that the Chongqing Municipal Government set up a leadership group responsible specifically for promoting 5G+ Manufacturing, leading 5G+ Manufacturing as a breakthrough and a long-term policy for the Chengdu-Chongqing region's industrial development. By starting with a focus on mechanism establishment and guarantees, macro planning and guidance, the government can promote the 5G transformation and reshaping of enterprises at micro level to develop a vision, roadmap and schedule for the unique Chongqing 5G+ Manufacturing industry.

In conclusion, we hope that Chongqing will seize this major 5G opportunity to achieve upgrading of 5G+ Manufacturing to greatly enhance the depth and breadth of its manufacturing industry, establish the Chongqing Global Lighthouse Factory as a benchmark, and once again leapfrog its strong industrial foundation to further growth and strength. This will benefit Chongqing's society and people and bring forth the rise of western China in the Belt and Road Initiative as well as the new development pattern of China's dual-cycle economy. I also hope that Ericsson will take on more responsibilities as a good advisor and partner, to fulfil our firm commitment to Chongqing, the Chengdu-Chongqing region, and the Chinese market.

Thank you.

Accelerate the Development of Chengdu-Chongqing Economic Circle through Digitalization

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Summary

At present, both challenges and opportunities coexist in the development of the Chengdu-Chongqing Economic Circle. On one hand, the Chengdu-Chongqing region is ushering in unprecedented opportunity from the implementation of national strategies that promote its development. On the other hand, there remains significant room to develop the area's economic strength, talent pool, technological innovation and industrial competitiveness compared to the Beijing-Tianjin-Hebei, Yangtze River Delta, and Guangdong-Hong Kong-Macao economic circles. Chongqing's GDP exceeds RMB 2.5 trillion, but its overall strength and competitiveness lags behind China's eastern developed regions. There is an obvious bottleneck in infrastructure, shortage of industry influence on economic development and weak capacity for technological innovation. We suggest "digitalization" as a means of accelerating regional collaboration, new infrastructure and digital talent, and improving the quality and efficiency of main industries and strategic emerging industries, that promote the Chengdu-Chongqing Economic Circle as China's next growth engine of economic development.

Accelerate digitalization for cross-boundary synergies that leapfrog development

Four major regional economic circles form the map of China's economy, with the Beijing-Tianjin-Hebei Economic Circle in the north, Yangtze River Delta Economic Circle in the east, Guangdong-Hong Kong-Macao Economic Circle in the south and Chengdu-Chongqing Economic Circle in the west. Together, the Beijing-Tianjin-Hebei, Yangtze River Delta and Guangdong-Hong Kong-Macao economic circles represent about 18% of China's population, living on 2.8% of the nation's land and contributing about 38% of the GDP. These combined areas have served as the main driving force behind China's economic take-off since reform and opening up. The implementation of key national strategies such as the high-grade development of the "Belt and Road," Yangtze River economic belt and western region have repositioned the Chengdu-Chongqing Economic Circle as China's fourth growth engine of regional economic development. However, compared to the other three economic circles, Chengdu-Chongqing has significant room

to develop in economic strength, talent, technological innovation and industrial competitiveness. What path should Chongqing take as a relative latecomer, to truly lead?

We suggest both cities can make full use of digitalization by integrating it into every aspect of the Chengdu-Chongqing Economic Circle – by fully integrating the real economy and digital economy – to propel development forward and leapfrog ahead.

A new generation of IT, as represented by 5G, artificial intelligence (AI), big data and Internet of Things, is reshaping all industries and bringing unprecedented industry transformation. In an era of unprecedented change, we need to break through old boundaries and fully integrate our efforts to seize strategic opportunities for development.

Take the construction of transportation hubs as an example. In June, the "Comprehensive Transportation Development Plan of the Chengdu-Chongqing Economic Circle" was introduced. By 2025, the length of railways in the Chengdu-Chongqing region will total 10,000 kilometers. At present, the Chengdu-Chongqing region is actively promoting the construction of a series of key transportation projects, covering high-speed rail, aviation, waterways and highways, to build a comprehensive transportation network. Integrating vehicles, roads and cities in the Chengdu-Chongqing region with an eye toward digitalization and carbon savings will enable the creation of smart roads, human-centric urban traffic infrastructure and more competitive auto industry – which represents a multidimensional leapfrog in development.

Promoting the construction of an intercity transportation infrastructure using data-driven technologies and green energy can guide urban energy consumption, systematically solve transportation problems, make management more energy efficient, enhance the "intelligence" and "green savings" of the Chengdu-Chongqing Economic Circle, and present new economic opportunities.

Creating synergy between vehicles, roads and cities can accelerate the application of new technologies, improve their efficiency and use, spark innovative technologies, including self-driving and new energy vehicle technology, and drive the transformation and upgrading of the automotive industry in Chengdu and Chongqing to electric, connected, data-driven and shared-use cars. There are 45 automobile enterprises and 1,600 auto parts enterprises in Sichuan and Chongqing. Their evolution requires more interaction between the production and use of vehicles, roads and cities.

Many cities have already discovered the benefits of greater vehicle-road-city integration. For example, Seattle, where Microsoft is headquartered, is known for its clean and green development. Seattle continues to promote transformational changes in urban transportation, and parking and

road management, in addition to opening new public transportation services that provide a strong foundation for the city to rapidly shape new transportation patterns and adapt to emerging technologies. Its successful experience offers valuable lessons to be learned.

Also worth mentioning is the Hangzhou-Shaoxing-Ningbo Expressway under construction in the Yangtze River Delta, known as the country's first "intelligent highway." It has four notable features. First, it is intelligent. The creation of a "human-vehicle-road" integrated sensing system will fully support self-driving cars for a future free-flowing road, without the need to stop to pay tolls or charges. Second, it is fast. Through the management of intelligent technology, the entire road's efficiency can be improved 20% to 30%. Third, it is green. Construction of photovoltaic and wind power generation systems and charging piles through the effective use of a variety of spaces, including roofs, guardrails and carports, makes it possible to provide mobile charging services for electric vehicles. Fourth, it is safe. Safety services and warning systems set up for multiple scenarios are expected to significantly reduce traffic accidents.

Microsoft has extensively explored the integration of digital technology around the world with the transportation industry. For example, last year, Microsoft invested in Cruise, a self-driving company owned by General Motors (GM), to accelerate the commercialization of self-driving cars. Microsoft and GM joined forces to explore a new infrastructure for intelligent transportation that integrates the cloud, vehicles and transportation. Electric car manufacturer Arrival also recently entered a partnership with Microsoft to develop an open data platform for the automotive industry using Microsoft Azure. In Chongqing, Changan Auto is teaming up with Microsoft to create Changan New Energy's in-car voice platform.

In promoting the transformation and upgrading of the transportation industry, development of digital cities and intelligent connected vehicles, and integration of vehicles, roads and cities, Microsoft hopes to contribute to the integration of the economic circles of infrastructure from transportation "on the ground" with technology "on the cloud" in the cities of Chengdu and Chongqing. We will also help transform and upgrade the automotive industry in Chongqing to produce more electric, connected, data-driven and shared-use cars.

In an era of unprecedented change, promoting industrial change requires a cross-boundary vision that is highly integrated and strategic. Breakthroughs are tied to the opening of data chains and the construction of data-driven new business models that meet individual needs.

Take the industrialization and modernization of agriculture as an example. Chongqing is vigorously promoting the development of specialty agriculture and accelerating its modernization. One predicament is that agricultural development is inherently unpredictable. Another is the low utilization of upstream and downstream synergy along the value chain. A Microsoft accelerated

company, GAGO Inc., has been solving these problems by collecting ground and meteorological data in real time through satellites and drones; integrating soil, plot, crop and agricultural information; and "dumbing down" big data services through image analysis and data analysis algorithms. This has allowed users to access accurate data services targeting yield estimates, pest control, irrigation plans, machinery deployment and agricultural finance, so farmers can work according to weather conditions and the entire agricultural chain can collaborate more efficiently. In Inner Mongolia, farmers and herders adopting GAGO's services can save more than 30% of water and 20% of fertilizer, increase the area under management per capita more than three times and manage irrigation 10 times more quickly, while ensuring high yield.

Digitization in agriculture not only impacts planting, but making decisions based on accurate data and opening up the agricultural data chain can enable agricultural business entities in the industry chain, including providers of capital, credit, marketing and related services, to operate and manage agriculture with a more modern mindset and tools. This can potentially bring a new fission to agricultural development.

The realization of zero carbon goals also relies on greater cross-border integration. Countries and regions around the world are actively promoting carbon neutrality. The "14th Five-Year Plan for National Economic and Social Development of Chongqing Municipality and the Outline of Visionary Goals for 2035" proposes accelerating green and low-carbon development and taking vigorous measures to promote a peak in emissions by 2030. Achieving carbon neutrality is a huge, multidimensional, systemic project that includes the adoption of new energy sources, energy conservation and emissions reduction, as well as the development of new technologies. This will all require cross-border collaboration on a larger scale and more extensive joint research and international cooperation to jointly solve key challenges.

Microsoft is actively promoting carbon neutrality and has announced that it will be carbon negative by 2030, removing all carbon emitted into the atmosphere since the company was founded by 2050. Based on this goal, Microsoft has not only adopted more new energy sources to improve quality and efficiency, but has also developed software to calculate carbon emissions, which is applied to suppliers' carbon footprint measurement. In hopes of "reabsorbing" the emitted carbon, Microsoft is cooperating with Tsinghua University, to research technology that detects carbon emissions in real time and new materials for carbon absorption. This requires computer science expertise, as well as material science and bioengineering, and the crossover of disciplines and boundaries between industry, academia, research and application. Microsoft hopes to further collaborate with Chongqing on its proprietary research promoting carbon neutrality.

The Chengdu-Chongqing Economic Circle's economy and industrial foundation is currently not as strong as those in Beijing-Tianjin-Hebei, Yangtze River Delta and Guangdong-Hong Kong-Macao. It may take a long time to catch up by traditional methods. The adoption of digitalization and more open sharing of breakthroughs introduce new variables for a new pattern of development.

Fully implement digitalization to promote high-grade development of the manufacturing industry

As the main body of the real economy, manufacturing is the foundation for Chongqing's development and plays an irreplaceable role in creating economic value, optimizing the supply chain, innovation and developing a high-quality ecosystem. In 2020, the output from Chongqing's industrial enterprises with an annual revenue of RMB 20 million or more exceeded RMB 2 trillion. With 31 major industry categories, Chongqing has built a complete manufacturing ecosystem producing a variety of products but is facing challenges, such as deficiencies in industrial and innovation capacity, pioneering enterprises and the formation of emerging industries.

In August, the city issued the "14th Five-Year Plan for the High-quality Development of Manufacturing Industry in Chongqing," proposing that by 2025, the city's output from industrial enterprises with an annual revenue of RMB 20 million or more would exceed RMB 3 trillion, with the added value from the industry reaching RMB 900 billion, accounting for about 30% of GDP. Through the implementation of the "Strategic Emerging Industry Cluster Development Project" and "Main Industry Quality Improvement Project," Chongqing will cultivate an electronic information industry worth trillions of yuan, as well as RMB 500 billion automotive, RMB 300 billion equipment, RMB 600 billion materials, RMB 500 billion specialty consumer goods and RMB 100 billion biomedical industries, and other industrial clusters, laying the foundation for the formation of an advanced manufacturing center.

Achieving a major breakthrough in the transformation and upgrading of core industries will require a significant increase in scale of emerging industries and the rapid development of industry clusters in electronic information, automotive, equipment, materials, specialty consumer goods and biomedicine. As a result, we recommend Chongqing fully digitize its manufacturing.

First, digitalization can accelerate the quality and efficiency of core manufacturing industries and construction of a modern industrial system.

Take the elevator industry as an example. Elevator manufacturing is an important pillar in Chongqing's manufacturing industry and an important part of Chongqing's 14th Five-Year Plan to build a "RMB 300 billion equipment industry." The Chongqing Dazu High-tech Zone contains the largest elevator industry cluster in China's western region. The Dazu High-tech Zone has

accumulated more than 10 elevator and spare parts production projects, including the Chongqing Fuji Elevator Production Base, Schmidt Elevator Production Project, Schmidt Elevator Research Institute Project and Kuaike Elevator Production Project.

The digital transformation of ThyssenKrupp AG offers an example of how the elevator industry can learn to improve quality and efficiency and upgrade from manufacturing to "intelligent manufacturing + service."

A few years ago, ThyssenKrupp joined with Microsoft to kick off its digital transformation. Our first project was ThyssenKrupp's development of MAX, a real-time predictive maintenance solution based on Microsoft Azure that collects data in real time through elevator sensors and analyzes it in real time through an AI learning system. This enables it to predict which parts need to be repaired or replaced before a failure occurs. With MAX on board, elevator operators reduced downtime due to elevator failures by 50%, saving passengers worldwide up to 95 million hours per year.

Our second project allowed ThyssenKrupp to use HoloLens mixed reality technology to improve its home elevator business. Home elevators take a lot of time to measure, customize and install because each family's staircase and needs are different. Real-time visualization made possible with the integration of HoloLens holographic glasses, cloud computing and the manufacturing system, made delivery time four times more efficient.

In addition, ThyssenKrupp is using "digital twin" technology at its elevator test tower in Rottweil, Germany, to create virtual models of the physical systems in a building, including elevators and HVAC systems. Owners and asset operators can optimize operational performance and create a better experience for tenants, employees and visitors.

From meeting individual customer needs, to providing predictive maintenance services, to providing multidimensional building data services, ThyssenKrupp Elevator is accelerating its transformation from manufacturing to "intelligent manufacturing + service."

Second, digitalization has a "multiplier" effect. Strategic emerging industries tend to be both knowledge and technology intensive. In the era of data-driven scientific research, the empowering effect of digital technology becomes even more prominent. Digital technology will play a vital role in all stages of development – from the rapid development of key technologies, to further enhancing business vitality, to fostering close collaboration between upstream and downstream enterprises.

Take biomedicine as an example. Biomedicine is a strategic emerging industry that Chongqing has targeted to develop during the 14th Five-Year Plan period. One of the field's challenges is determining how to build a biomedical research and development system covering the entire process of drug discovery, pharmaceutical research, safety evaluation and clinical trials; and how to support the global collaboration of biomedical companies in a more efficient and compliant manner. Chongqing Proton Pharma solved these problems by adopting a platform for international digital collaboration.

Proton Pharma is a leading pharmaceutical contract development and manufacturing company in China, providing global pharmaceutical companies and new drug development organizations with customized R&D and manufacturing services for chemical drugs, biologics and formulations, from early clinical studies to the full drug launch lifecycle. The company has R&D, manufacturing and operations in China, USA, Belgium, Switzerland and the UK. As companies grow bigger and more global, making these facilities around the world work together efficiently and operate in compliance has become a challenge. As a result, Proton Pharma chose to work with Microsoft to adopt Microsoft Global Exchange Online and Microsoft 365 E1 solutions to unify its overseas and domestic office enterprise platforms for collaboration, improving productivity and communication efficiency, as well as meeting GDPR and copyright requirements.

Accurately predicting protein structure can accelerate disease awareness and drug development. However, proteins are variable and the potential conformation (i.e., structure) of a protein fold is astronomical. Traditional biological methods for exploring protein structure take a lot of time and workforce. Now, using AI and digital technology, the efficiency and accuracy of deciphering protein structures has been greatly improved.

At Microsoft Research Asia, researchers have developed a deep learning framework based on industry data, which can make protein structure prediction more efficient and accurate through powerful computing power and sophisticated algorithms. In the computer system built by Microsoft Research Asia, simulating the process of protein dynamics of cells in a real water environment, which used to take more than 10 years to complete, can now be done in weeks.

New energy is another emerging industry that Chongqing targets to develop in the 14th Five-Year Plan period. Presently, the low market share for clean energy, such as wind, photovoltaic, geothermal and solar energy, is related to a low utilization rate and other uncontrollable factors. Concord New Energy is a well-known renewable energy company in China that has invested in, and operated, wind and solar power plants under its umbrella. Because wind energy and solar energy are unpredictable, the company is working with Microsoft to build a platform for new energy equipment management that integrates the Internet of Things, big data and cloud computing

to improve equipment energy availability and time availability. Improving these two key indicators will help wind farms produce millions more yuan of power per year.

Third, digitalization greatly effects the development of pioneer enterprises and accelerates internationalization

China is vigorously promoting the development of "pioneer," "small giant" and "hidden champion" enterprises, and the integration and innovation of big, small and medium-sized enterprises in the upstream and downstream of the industry chain. In January, the Ministry of Finance and the Ministry of Industry and Information Technology issued the "Notice on Supporting the High-Quality Development of 'Small Champion' SMEs" ("Notice"), specifying that the central government will allocate more than RMB 10 billion for the development of "hidden giant" SMEs. The Notice clearly spells out the government support of the digital transformation of enterprises, promoting their migration to the cloud, strengthening international cooperation and further enhancing their potential.

Out of the Ministry of Industry and Information Technology's recent announcement of a third batch of "small giant" enterprises, Chongqing has 53. In total, 118 national-level and 859 municipal-level "small giant" enterprises are in Chongqing. Behind these enterprises' rapid development are stories of digital empowerment. Guogui Technology is an example.

Guogui Technology is a world-leading supplier of auto tuning accessories and one of the field's "hidden champions." With overseas offices in the USA, UK, Germany, Australia and Russia, it is engaged in the development and production of high-performance products, such as connecting rods, crankshafts, pistons, turbochargers, shock absorbers, air springs, reinforced chassis parts and tuned cars. Its brand MAXPEEDINGRODS has an audience of more than 4 million global enthusiasts. It has developed into a manufacturer of auto tuning accessories that are well known in the European and American markets. Guogui Technology has chosen "e-commerce on the cloud" to better carry out businesses globally in compliance with all laws and regulations and to provide better service for its global customers. Guogui Technology built the MAXPEEDINGRODS e-commerce platform based on Microsoft Global Azure. By supporting e-commerce services through a global cloud service platform, Guogui Technology can quickly meet the different needs of its worldwide customers and bring a better service experience to meet the different needs of various markets.

More and more enterprises in Chengdu and Chongqing are accelerating going global "on the cloud." In the process, they generally face several major challenges. First is the challenge of compliance. Enterprises must comply with a series of rules for foreign investment and international operations. They must abide by both international economic and trade rules and the laws and

regulations of the host country, as well as industry standards and local customs. Second, globalizing operations across geographies brings a range of new challenges, from enterprise management in different territories, to new ways of communication, to a need for new database capabilities. Third, are challenges to sustainable development. There are many environmental protection standards and other regulations at the global, regional, national and even local levels, and companies face a series of requirements and responsibilities for sustainable development in their international operations. Companies need to strengthen their compliance, digital transformation and sustainability capabilities to be better able to adapt to international market requirements.

Microsoft is actively helping Chinese companies go global through its experience in global compliance and sustainability, and global cloud service infrastructure capabilities.

China International Marine Containers Group (CIMC) is an example. As a world-leading supplier of logistics and energy equipment, CIMC's products and services are available in more than 100 countries and regions around the world. It is a diverse, multinational industrial group with 50% of its business taking place overseas. However, the high cost and long lead time to deploy large-scale localization seriously affects its operations and development. It urgently needs a more stable cash flow brought about by cost reductions. In June 2018, CIMC increased its cooperation with Microsoft and began a large-scale migration to the Microsoft 365 cloud. With a flexible means of ordering services based on actual staffing numbers, Microsoft 365 not only has a lower direct purchase cost and richer features than traditional methods deployed locally, but also eliminates the need to build, operate and maintain local servers and related services, significantly reducing the total cost of ownership of its office automation system. At the same time, Microsoft 365 applications also enable CIMC to meet stringent compliance while expanding to overseas markets, create modernized collaborative and mobile offices, reduce operational costs and improve efficiency, and see better results from digital management.

Microsoft is also working with local governments, industrial parks and industry clusters to speed the process of helping enterprises go global.

In April, Microsoft signed a strategic memorandum with the Sichuan Tianfu New Area Management Committee to cooperate in building the "Tianfu Outbound Center." The center aims to help Chengdu and Chongqing build digital trade, designate the outbound industry as its main business and cultivate the international market to build a highland of outbound industry worth RMB 10 billion. Microsoft plans to accelerate 60 key brands in three years and provide them with dedicated technical support, consulting services, and digital marketing and operational services;

support 300 SMEs to go global; provide guidance to more than 1,000 outbound enterprises; and train more than 500 people.

Microsoft is willing to share our experience and contribute more to accelerate the quality and efficiency of Chongqing's core manufacturing industries and development of strategic emerging industries, and to support Chongqing's enterprises going global with digitalization.

Accelerate digital talent cultivation to meet an era of innovation

People are the body and soul of innovation. If Chongqing wants to become a powerhouse of intelligent manufacturing and promote high-quality economic development in the digital economy era, it needs high-quality digital talent. If Chongqing hopes to use digitalization to leapfrog its development, it needs to strategically cultivate digital skills.

According to the study, "Future Ready Business: Assessing Asia's Growth Potential Through AI," conducted by Microsoft and IDC, most Chinese companies face three major challenges in advancing the adoption of AI technologies: lack of expertise, resources and sustainable learning programs. The McKinsey Global Institute report "Reskilling China: Transforming the World's Largest Workforce into Lifelong Learners" assesses the current Chinese education and training system from an economic perspective, with special attention to skills development. The report proposes that the education and training of the post-industrial society will move towards the three "Es," namely Everyone, Everything and Everywhere, meaning that every worker needs lifelong learning, and education and training should be everywhere.

We believe a focus on the following three areas will resolve the current digital skills and talent gap and propel digital education towards the three "Es." First, promote digital thinking and digital skills curriculum. The development and changes taking place in all industries today are inseparable from digital technology and data-based thinking. Training in digital thinking and skills should be part of all stages of education. Intermediate and higher vocational education for IT-related majors needs to offer practical training and internship opportunities for future practitioners to help students obtain the latest industry knowledge before leaving school. These same learning opportunities also need to be provided to students in non-IT fields.

Second, demystify digital skills. Strengthening the internal drive of intermediate and higher vocational school students and those currently in the workforce, as well as building their self-confidence and interest in lifelong learning is crucial. It requires the demystification of digital technology. With the evolution of technology, especially the popularization of convenient no code and low code tools, the threshold for mastering digital skills is gradually lowering.

Third, pay attention to internationally-recognized industry certifications. According to an IDC survey, certified employees are generally 15% more productive than non-certified employees in terms of salary and 20% more productive as a team. Internationally-recognized industry certifications enhance the skills and employability of vocational school students and help gild their resumes.

According to the "14th Five-Year Plan for National Economic and Social Development of Chongqing Municipality and the Outline of Visionary Goals for 2035," Chongqing will add more than 150,000 highly skilled workers by 2025, to total over 6.6 million, and will apply distinct employment guidelines to govern each key industry cluster.

Microsoft CEO Satya Nadella advocates the idea of lifelong learning. Microsoft's development has benefited from the establishment of a learning culture. Microsoft has built technology platforms and collaborated with local governments and companies based on this concept of digital empowerment. Microsoft has joined the China Guanghua Science and Technology Foundation to build an online training platform for vocational school students that is expected to reach nearly 400,000 teachers and students from more than 200 technical schools across China; providing training courses on topics including digital literacy, computer science, basic data and AI, as well as professional development courses provided by LinkedIn. Microsoft is also using simple and engaging technical practices that allow vocational students to experience the thrill of digital technology and the joy of applying what they have learned. Microsoft is also actively cooperating with local governments and vocational education, human resources and related institutions to support colleges and universities to meet industry needs, accelerate industry training, create valuable talent-building forums and participate in the regional upgrade of industries.

Three years ago in Sichuan, Microsoft and the Chengdu Tianfu New Area Management Committee signed an agreement to cooperate in building the "Tianfu New Area Artificial Intelligence High-end Talent Cultivation and Certification Base." Since then, we have made progress in three areas. First, we have carried out 17 thematic activities to boost enterprise AI empowerment, including an online salon for enterprise digital transformation in the post-epidemic era, Microsoft's Digital Transformation Workshop for Small and Medium-sized Enterprises, Microsoft's Enterprise and Talent Outbound Program Sharing Session, Wenjiang District New Infrastructure Empowering New Economy Summit and Artificial Intelligence Summit in the Chengdu-Chongqing Economic Circle. Second, we have offered AI-enabled enterprise transformation services, visited 30+ local enterprises in need of digital transformation, provided them with consulting services and implemented transformation solutions. Third, we have created an AI talent training service, Joint Microsoft Academy AI Tutor Teachers Group, totaling more than 960 technical professionals who have obtained Microsoft Global Certification certificates.

Thirteen training camps have been held for high school, undergraduate and postgraduate students. Free courses were opened to the public and webinars using Microsoft's educational resources gave high school students employment, career planning and technical knowledge, reaching more than 8,000 people.

In summary, digitalization is of great significance to the construction of modern industrial systems, high-quality development of industries and development and growth of emerging industries. During the 14th Five-Year Plan period, we suggest that Chongqing accelerate the training of digital talent, create digital platforms and include digitalization as a key element in the design and promotion of each industry. Microsoft hopes to have opportunities to cooperate with Chongqing to promote the quality and efficiency of manufacturing, as well as the rapid development of biopharmaceuticals and other emerging industries, to accelerate and leapfrog development.

Coupling Technological Innovation and Coordinated Synergy to Drive Green and High-quality Development

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Abstract

The ongoing energy transition and industrial upgrade within the context of China's 14th Five-Year Plan and carbon neutrality pledge present new opportunities and challenges for the development of Chongqing and Chengdu-Chongqing Economic Circle. Based on ABB's global experience and local knowledge, we are honored to share our observations with case studies, and offer the following recommendations for Chongqing:

1. Advance energy transition and foster a complete hydrogen energy ecosystem with more focus on core technology support, green hydrogen investment and life cycle cultivation.

2. Leverage industry resources and regional cooperation to further develop high-end manufacturing clusters and develop AI-enhanced robotics to empower industry upgrade, efficiency improvement and carbon emission reduction.

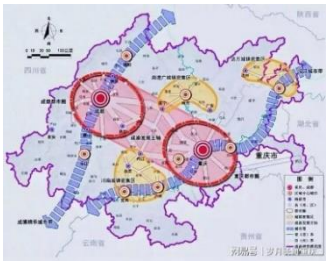
3. Further promote digital infrastructure, smart parks and green buildings enabled by innovative technologies to speed up the low-carbon growth for a green economic circle.

These actions would help further unlock the potential of Chongqing and the Circle in building a modern industrial system and fuel its development into an inland growth engine and a world-class city cluster.

1. Introduction: the tale of two cities

Located in the upper reaches of the Yangtze River, the Chengdu-Chongqing Economic Circle is the most densely populated area with the highest concentration of industries and the most cities in the vast western region which covers 71 percent of the territory, but accounts for just 20 percent of China's economy.[53] This city cluster has risen to a national strategy and is expected to become the fourth pillar of China's economy, following the Yangtze River Delta, Pearl River Delta, and Beijing-Tianjin-Hebei regions.

[53] Belt and Road News: Chengdu-Chongqing Economic Circle to Accelerate Development, Nov 2020



The dual cores of the Economic Circle are Chongqing, one of China's four provincial-level municipalities and Chengdu, the capital of its adjacent Sichuan Province and about 270 km northwest of Chongqing. As the bridgeheads for the development of the west China, Chongqing and Chengdu saw their GDP growth by 3.9 percent and 4.0 percent respectively in 2020 despite the COVID-19 impacts, ranking fifth and seventh among cities in mainland China.

It has been a long history for the two cities to strengthen connection and promote coordinated regional development, which are reflected in the plans for the Chengdu-Chongqing economic zone unveiled in 2011 and the "Chengdu-Chongqing Urban Agglomeration Development Plan" approved in 2016.

In early 2020, President Xi Jinping put forward for the first time "promoting the construction of a two-city economic circle in the Chengdu-Chongqing region and forming an important growth pole for high-quality development in the west." The Economic Circle has risen to a national strategy.[54]

2. New opportunities and challenges

2021 marks the first year of China’s 14th Five Year Plan, featuring high-quality development. China is promoting a new model to advance regional integration and interaction, characterized by central cities leading development of city clusters and in turn city clusters driving regional development.

In the ranking of “major regional cities”, it is worth mentioning that Chongqing has been among the top five for several continuous years. Chongqing has jointly carved out a strong position as a gateway with Chengdu, which ranks sixth place, in the form of the twin-city economic circle in the Chengdu-Chongqing region.[55]

The relationship between the two cities can be considered as “co-opetition”, a mix of competition and cooperation. It will bring new opportunities to the city cluster based on coordinated development mechanism. To cultivate and enrich this new mode “co-opetition”, cities should, firstly, have an overall picture of the megatrends; and secondly, form a clear vision and positioning to leverage respective advantages and generate synergy.

[54] Seetao: The Chengdu-Chongqing Twin City Economic Circle has become a national strategy, Sep 2020
[55] PWC and China Development Research Foundation, *Chinese Cities of Opportunity* 2021

China pledged to peak carbon emission by 2030 and achieve carbon neutrality by 2060. Starting with the 14th Five-Year Plan, China will take solid steps toward the goals of achieving peak carbon dioxide emissions and carbon neutrality, with industrial structure and energy mix to be improved.[56]

Cities and city clusters are at the heart of China's low-carbon agenda. The national carbon reduction targets need to be implemented by government at all levels, supported by companies and research organizations. Coordinated actions and cooperation are in all economic processes including production, consumption and trade.

The Chengdu-Chongqing economic circle has many advantages and opportunities to accelerate coordinated development. They share geographical advantages, history and cultural similarities, have a comprehensive transportation network, and have strong industry foundation and high industrial diversity, covering automotive and electronic information, telecommunication equipment manufacturing and service sector,[57] making the region better positioned to intensify collaborative innovation, strengthen infrastructure connectivity, and develop high-end industrial clusters.

The highlight of the regional industrial chain cooperation is "green upgrade". Now, more than ever before, cross-regional and cross government, academia and enterprise cooperation are needed to form a green and intelligent industrial ecosystem enabled by technology innovation.

3. A green journey powered by technological innovations

Reaching the targets of sustainable and high-quality development involves many changes, especially in the transformation of the energy structure, increase of production efficiency and reduction of energy consumption, which will bring huge opportunities for technology innovation.

Technology innovation is already and will continue to play a critical role. It will necessitate the deployment of existing sustainable technologies, such as hydrogen, fuel cell technology, smart manufacturing and smart city solutions, while creating and rolling out new breakthrough technologies.

3.1 Driving energy transition

Energy policy is a key mechanism for delivering the carbon neutrality commitment and a cap on total energy consumption needs to be set in the 14th Five-Year-Plan. The rapid development of more energy-efficient technologies, electrification of end-users and swift shift of renewables all

[56] *Report on the Work of the Government*, 2021
[57] China Daily: Chengdu-Chongqing economic rim: China targets western super-region boost, Nov. 2020

play a central part in reducing emission. By 2050, nearly 90% of all electricity generation will be from renewables globally. [58]

There is a growing consensus that clean hydrogen will play a key role in the world's transition to a sustainable energy future. Hydrogen, especially if it is generated from renewable sources, holds tremendous potential to help us decarbonize the economy, reach climate goals and improve the resilience of energy systems. Studies by the International Energy Agency, McKinsey & Company, the Energy Transitions Commission, and the Hydrogen Council all confirm that hydrogen can help solve many challenges facing the current energy industry.[59]

China is the largest producer of hydrogen in the world with the total hydrogen production of 25 million tons per year. Hydrogen energy and electric power will cooperate and complement each other to become the main consumer of China's terminal energy system and drive the formation of an emerging industry of ten trillion yuan.[60]

China is pushing hydrogen energy to achieve its carbon-reduction goals. Hydrogen was written into the national Government Report for the first time in 2019. Many cities are making plans to develop hydrogen as a clean energy source, traditional fossil-fuel giants are shifting to hydrogen energy business and automakers are accelerating in developing hydrogen-fueled vehicles. China aims to build 1000 hydrogen-refuelling and hybrid retail outlets from 13 today, as well as 7000 distributed solar power generation stations by 2025.[61]

3.1.1 Chengdu-Chongqing Hydrogen Corridor and Chongqing Hydrogen Valley

With rich resources and a strong industrial foundation, Chengdu-Chongqing economic circle is making strategic deployment in developing a mature hydrogenation infrastructure and hydrogen industrial chain in the region.

Based on the city's strong automobile industry foundation, Chongqing is accelerating its layout in the field of hydrogen energy and promoting the green transformation of the automobile industry. Chongqing is establishing a hydrogen-power corridor with Chengdu and will apply together with Chengdu for a new Chinese government program offering incentives for developing core fuel cell technologies.

In March 2021, the first national hydrogen power quality supervision and inspection center in China started construction in Liangjiang New Area of Chongqing. In the same month, six

[58] IEA report: *Net Zero by 2050*
[59] RMI: *Zero Carbon Investing - opportunities from China's Carbon-Neutrality Goal*, Feb 2021
[60] Sichuan Daily: Creating a national demonstration city for fuel cell vehicles, Dec 2020
[61] Upstream: Sinopec's green hydrogen ambitions, May 2021

hydrogen fuel cell companies collaborated with Chongqing Jiulongpo District Government to build a leading hydrogen energy sci-tech industrial park, aiming to create the Western China Hydrogen Valley in Chongqing. After completion, the park will form a closed loop of the ecological chain and further enhance the core supporting capacity of Chongqing hydrogen energy industry development.[62] Hydrogen Valleys are an important step towards locally integrated hydrogen ecosystems. Not only can they provide sustainable energy, they are also major drivers of industrial development and job creation.[63]

Sichuan province is also increasing its efforts in developing hydrogen industry with a large hydro installed capacity of 77GW in the end of 2019 and a total hydro curtailment above 9.2TWh, as well as huge potential for hydrogen production by electrolysis. More than 100 hydrogen energy enterprises and research institutes established, covering the main fields of the whole industrial chain. The province has released its five-year Hydrogen Industry Development Plan last year, to deploy 6,000 fuel cell vehicles and build 60 hydrogen stations,[64] aiming to build it into a domestic and international hydrogen energy industry base.

3.1.2 Hydrogen industrial chain and clean technology

We can examine hydrogen energy in a larger context. As we move towards net zero, the de-carbonization process evolves from being one-dimensional to a multi-dimensional clean tech ecosystem, encompassing four key interconnected technologies on the path to net zero emissions:

Renewable power: The technology that dominates the 'low-cost de-carbonization' spectrum today and has the potential to support the de-carbonization of >45% of China's anthropogenic GHG emissions, as well as being critical for the production of clean hydrogen longer term ('green' hydrogen).

Clean hydrogen: A transformational technology for long-term energy storage enabling increasing uptake of renewables in power generation, as well as aiding the de-carbonization of some of the harder-to-abate sectors, with a critical role in several industrial processes, long-haul transport, and heating of buildings.

Battery energy storage: Critical in the electrification of transport and industrial-scale short-term power storage.

Carbon capture technologies: Vital for the production of clean ('blue') hydrogen, while also aiding the de-carbonization of industrial sub-segments with emissions that are currently non-

[62] The Paper: Hydrogen Valley in Western China, Mar 2021
[63] Roland Berger: Hydrogen Valleys: first elements of the new hydrogen economy, June 2021
[64] Sichuan Government: Sichuan Province Hydrogen Energy Industry Development Plan was issued, Sep 2020

abatable under alternative technologies. [65]

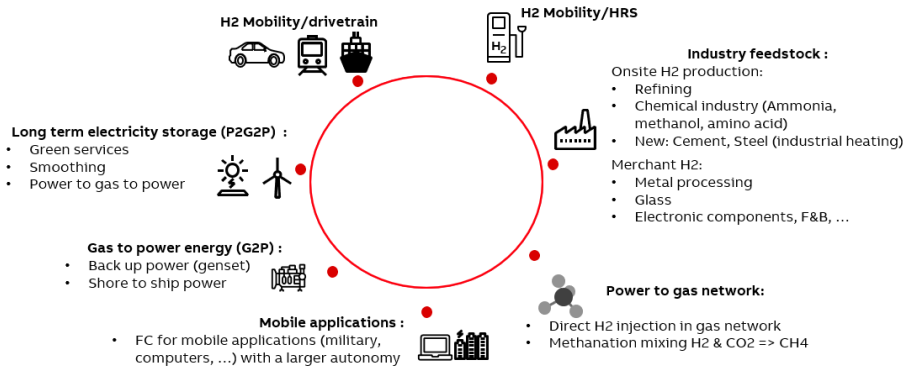
The development of the hydrogen industry will create an ecosystem consisting of production, storage, transportation and use that will jointly promote technological progress, cost reduction, and market expansion of the hydrogen industry.

Where the hydrogen comes from is important. Depending on the method of production, hydrogen is classified with a color scheme. Hydrogen is now mainly produced industrially from natural gas, which generates significant carbon emissions. That type is known as "grey" hydrogen. A cleaner version is "blue" hydrogen, for which the carbon emissions are captured and stored, or reused. The cleanest one is "green" hydrogen, which is generated by renewable energy sources without producing carbon emissions in the first place.[66]

Hydrogen is versatile and can be used in a broad range of applications. It has several uses, from storing renewable energy to fueling heavy transport, and as a feedstock in energy-intensive processes. Most importantly, hydrogen only emits water and heat when used as a fuel, releasing no carbon. In fact, if hydrogen is produced from renewable sources, the whole hydrogen value chain is carbon-free. Hydrogen thereby serves as an excellent complement to electricity and offers a solution to decarbonizing industrial processes and economic sectors where reducing carbon emissions is both urgent and difficult to achieve.

3.1.3 Making green hydrogen more accessible and affordable

All forms of hydrogen - green, blue or gray, will play a role as the industry scales up to meet the growing demand while the industry takes shape. However, green is a goal. Only green hydrogen can realize the clean energy aim of hydrogen. As the main route to produce green hydrogen, water electrolysis powered by renewable energy only accounts for 4% of the 25 million tons of hydrogen currently produced annual in China. Another 40% comes from coal gasification,



[65] Goldman Sachs: *Carbonomics China Net Zero*
[66] IEA: The clean hydrogen future has already begun, Apr 2019

and 12% from steam methane reforming and other fossil-based routes.[67]

Cost of production currently is a major barrier to adoption of green hydrogen. Green hydrogen is approximately six times more expensive today than grey hydrogen to produce and between two to three times more expensive than hybrid "blue" hydrogen.[68] In such emerging fields, cross-border cooperation to promote technological development is particularly important.

As a member of the European Clean Hydrogen Alliance, ABB is helping to scale up the hydrogen value chain and helping customer transition to a less carbon-intensive future with technology. For example, in June 2021, ABB joined forces with Swiss utility Axpo to develop modular green hydrogen production plants in Italy, aiming at creating an optimum operating model to produce affordable, green hydrogen. In this project, ABB is leveraging our automation, electrical and digital technologies and domain expertise to minimize the total cost of producing green hydrogen, which includes reducing the cost of running the plant. This is essential to unlock the potential of green hydrogen and enable its widespread uptake in the future.

3.1.4 A pilot project of hydrogen energy supply chain

The development of hydrogen storage and transportation technology is an indispensable foundation for a hydrogen ecosystem. In the Asia-Pacific region, the Hydrogen Energy Supply Chain (HESC) Project is the world-first initiative to establish an integrated supply chain for sustainable hydrogen, to safely produce and transport clean liquid hydrogen from Australia's Latrobe Valley in Victoria to Kobe in Japan.

The project is poised to position Australia as a leader in hydrogen production, and with the world's fifth-largest energy consumption, yet low fossil fuel resources, Japan considers hydrogen key to meeting future energy requirements. ABB is supporting the HESC project in both countries by providing electrification and instrumentation solutions in Australia, and automation solutions in Japan.

Liquefication supports in reducing hydrogen to 1/800th of its volume for more efficient transportation over long distances, with its long-term use as a fuel considered a potential solution for lowering greenhouse gas emissions.

The pilot phase of the project will demonstrate a fully integrated supply chain between

[67] RMI: *Zero Carbon Investing - opportunities from China's Carbon-Neutrality Goal*, Feb 2021
[68] IRENA: Green hydrogen cost reduction, Dec 2020

Australia and Japan by 2021. The commercial phase will be operational targeted in the 2030s. The project has the potential to be a game-changer – providing an innovative, economically viable and environmentally conscious solution to producing clean hydrogen safely, through gasification of coal with carbon capture and storage (CCS).

The development of the climate-friendly hydrogen industry chain will create an ecosystem consisting of production, storage, transmission and utilization, which will not only bring huge economic and environmental contribution, but also promote market expansion of renewable energy industry as a whole.

3.2 Building intelligent manufacturing base featuring AI and robotics

COVID-19 has been accelerating the shift to automation and digitalization. The promotion of new economic development models and new infrastructure in China has brought new opportunities in many industries, such as new energy vehicles, 5G and consumer electronics, and logistics where robots have huge potential.

The robot industry, a highlight of the strategic emerging industries in Chongqing, is an important part of Chongqing's efforts to build an "intelligent manufacturing city". Both automotive manufacturing and electronics are the main application fields of industrial robots. As an important production base of automobiles and electronic products, Chongqing is vigorously promoting the transformation and upgrade of its traditional manufacturing industry, which has stimulated huge demand for industrial robots and vitality of robotics R&D innovation.

So far, the city has more than 300 robot enterprises and R&D institutions. In the first quarter of 2021, the robot production volume in Chongqing reached 7,785, an increase of 126.4%, forming a complete industrial chain integrating R&D, manufacturing, testing, components and parts supplying, personnel training and application services.[69]

In 2020, the Ministry of Science and Technology of China supported four cities including Chongqing to construct a national new-generation artificial intelligence innovation and development pilot zone, and Chongqing has once again been awarded a national mission in the field of AI.[70] This will also drive the transformation of traditional key industries such as automobile and electronics.

3.2.1 Megatrends and AI-robotics integration

China has been the world’s largest and fastest-growing robotics market since 2013. According

[69] Chongqing government: Accelerating the layout of the industrial chain, May 2021
[70] iChongqing: Chongqing AI Innovation and Development Pilot Zone Research Launched, Jun 2021

to the World Robotics 2020 Industrial Robots report presented by the International Federation of Robotics (IFR), in 2019 the sales of robots in China surpassed 140,000 units, accounting for 37% of world sales. The robot density (number of multipurpose industrial robots in operation per 10,000 persons employed) in China is also soaring (187 in China and 113 worldwide on average by the end of 2019). However, if compared with the top three countries (Singapore 918, Korea 855 and Japan 364), there is still great room for further development.

COVID was a big catalyst for the changes in industry and accelerated four mega-trends of the individualized consumer, labor shortages, uncertainty and digitalization. To address the challenges and opportunities posed by these megatrends, we not only need automation solutions that can enhance productivity, quality, flexibility, and simplicity, but also need to harness the power of AI to make robots more intelligent.

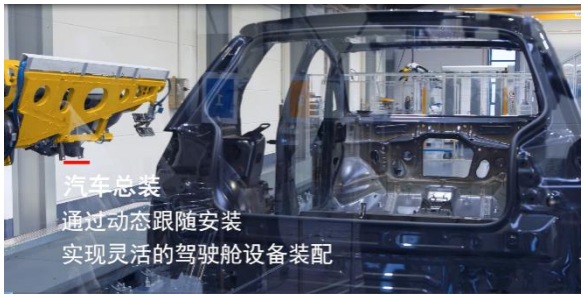
Robotics itself is also transforming and the integration of AI is essential to that shift. ABB is now focusing on three main areas of AI robotics, which are vision and sensing to make robots perform more quickly, accurately and efficiently; greater autonomy and mobility to allow robots to work on complex tasks; reinforcement learning to teach robots to work in uncontrolled environments.

One example is about deep learning, which offers the possibility to detect and localize objects, with diverse and complex backgrounds. ABB robot uses deep learning together with sensor fusion, to accurately assemble a vehicle cockpit as the car body travels down the production line. This means that people no longer need to perform this ergonomically challenging work that can lead to injuries from repetitive tasks.

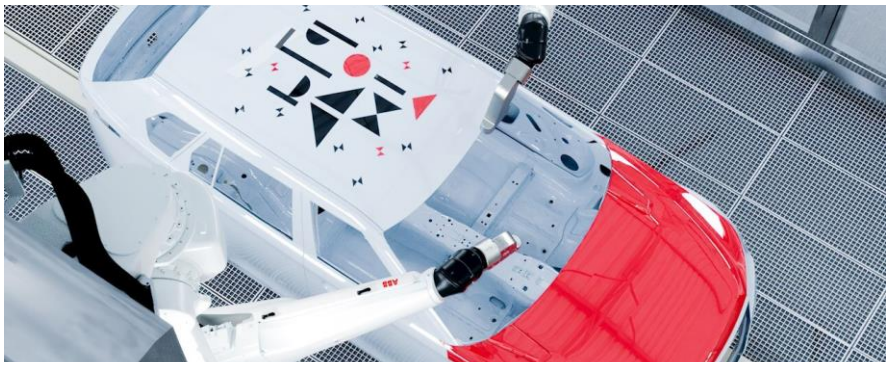
3.2.2 Unlocking sustainable potential with robots

Robots can play a critical role not only for productivity increase and quality improvement, but also for resource saving and reduction. For example, Last year, ABB launched PixelPaint, an innovative solution for two tone and decorative painting applications. Traditionally, about 30% of paint is wasted. With PixelPaint, 100 percent of the paint is applied to the bodywork surface, so there is no overspray. This reduce operating costs and improve environmental performance by ensuring that no paint is lost. With no need for masking or de-masking, a customized paint job can be carried out in a single pass, reducing cycle times by around 50%.

Robotics is moving from the factory floor, to warehouses, hospitals, restaurants, shops and beyond. In doing that, we extend the potential for people to work directly with robots, while doing more value-added work. Robots can support and elevate the jobs of human workers, across all industries. Construction industry is one of the examples.



Robotic automation offers huge potential to enhance productivity, efficiency and manufacturing flexibility throughout the construction industry, including automating the fabrication of modular homes and building components off-site, robotic welding and material handling on building sites and robot 3D printing of houses and customized structures. As well as making the industry safer and more cost effective, robots are improving sustainability and reducing environmental impact by enhancing quality and cutting waste.



3.2.3 Factory of the Future

By deploying the industrial internet of things, we can explore new ways to leverage AI and robotics for industrial production. ABB's factory in Heidelberg, Germany, which makes miniature circuit breakers, is an example of what such a factory might look like.

The Heidelberg facility is equipped with seven types of ABB robots, all of which are connected to the industrial IoT and monitored to ensure optimum performance. Since these connected robots were introduced, productivity has further increased, and the assembly line is much more flexible: It can produce three times more product variants than previously. Another key feature of this intelligent factory is the ABB Ability smart sensor solution. The sensor connects low-voltage electric motors to the industrial IoT, allowing them to be monitored continuously.

The combination of automation and smart technology will effectively enhance productivity, increase efficiency, reduce waste and costs and make work safer and more rewarding for people,

all essential in meeting the challenges of sustainable and high-quality development.

3.3 Developing smart infrastructure for a green economic circle

City infrastructure is an important part of the green development. Today cities are facing a rising multitude of challenges caused by urbanization, such as energy shortages, traffic congestion and environmental degradation to mention a few. Evolving concepts such as smart cities, sustainable communities and low carbon cities have been employed to formulate initiatives to tackle these challenges.

A "smart city" represents an opportunity to integrate smart infrastructure, smart environment, smart living and smart mobility towards the sustainable future. Infrastructure is the foundation on which cities are built. It impacts every aspect of a city, from economic development to the quality of people's lives, safety, environment, and resiliency. Globally, many cities are making use of information and smart technology to increase efficiency, reduce costs and improve the decisions made regarding urban planning, pollution prevention and the management of urban infrastructure.

3.3.1 Speeding up low-carbon growth

During the 13th Five-Year Plan period, Chongqing's ecological and environmental quality continued to improve. The number of days with good air quality increased to 333, and the average concentration of fine particulate matter decreased by 42.1%. The city built 10 green industrial parks, 115 green factories and 170 green mines, achieved the national targets for energy conservation, emission reduction, carbon reduction. [71]

Under the "dual carbon" targets, Chongqing is speeding up the formulation of its action plan towards carbon-peak, promoting the construction of zero-carbon demonstration zones and low-carbon pilot and demonstration projects, and improving the formulation of carbon emission management system. Various smart technologies have been deployed by Chongqing in the effort to meet its carbon target.

3.3.2 Upgrading infrastructure with smart technologies

Urban resilience is an increasingly prominent challenge for policymakers. For example, gas leaks in urban areas may expose people to potential risks, cause considerable economic losses and release greenhouse gases into the atmosphere. With the fast expanding gas network in China, the capacity to rapidly detect and locate gas leaks is critical to the security and resilience of gas

[71] CENews: Chongqing has fully fulfilled national targets for energy conservation and emission reduction, Mar 2021

infrastructure.

ABB has provided mobile gas leak detection services to Chongqing Energy Group to strengthen the municipality's gas infrastructure. This vehicle-based system relies on a detection algorithm in ABB's software and BeiDou Navigation Satellite System's positioning service to provide fast, precise and efficient inspections of gas pipeline networks. During the pandemic, this system has contributed significantly to ensure the reliable operation of urban gas networks.

To complement this vehicle-based system, last year ABB launched a highly sensitive mobile gas leak detection system that can be mounted on drones for monitoring gas pipelines in remote locations. The cloud-connected, multi-gas solution can also be used to quantify the three most important greenhouse gases methane, carbon dioxide and water vapor continuously while flying. The fast response and high precision of the analyzer allow scientists and researchers to reliably quantify greenhouse gas fluxes which provides important information when studying the complex environmental processes affecting climate and pollution.

3.3.3 Constructing smarter and cleaner industrial parks and buildings

According to the International Energy Agency (IEA), industry accounts for 37 percent of global energy use and some 30 percent of global energy is consumed in buildings. Taking industry for example, based on the data of the Intergovernmental Panel on Climate Change, industry generates about 21 percent of global greenhouse gas emissions - not just from burning fossil fuels, but also from chemical processes, waste management and other production-related activities. Fortunately, the advanced solutions needed to make industry smarter and cleaner have already been developed.

To demonstrate how digital energy management will drive the transition to sustainable energy, ABB developed a carbon-neutral and energy-self-sufficient factory at its site in Lüdenscheid, Germany. The site's solar power plant generates enough climate-neutral solar power to cover 100 percent of the factory's power requirements on sunny days and has reduced the site's CO2 emissions by some 680 tons per year.

The facility features an intelligent ecosystem in which all components are digitally networked and controllable, an approach that enhances energy efficiency, sustainability and resource conservation. This digital solution enables the constant surveillance and optimal control of energy production, consumption and storage and operates largely autonomously.

ABB is committed to helping its customers to reduce their annual CO2e emissions by 100 megatons by 2030 and meanwhile, to lead by example, with the aim to achieve carbon neutrality in its own operations by 2030. Locally in Chongqing, ABB has always taken a sustainable approach to its business. ABB Jiangjin Turbo Systems Co. Ltd. was listed as national ‘Green Factory’ by China Ministry of Industry and Information Technology in 2019. The company has adopted a series of measures to achieve clean production, low-carbon energy, intensive land use, harmless raw materials and recycling of waste. For example, the factory managed to save 30%-50% energy compared with general industrial buildings.

As buildings account for nearly 40% of total global CO2 emissions related to energy and processes, huge potentials exist. A recent success example is that ABB has supported the construction of the New Development Bank Headquarters in Shanghai by installing an intelligent and integrated building controls system to manage indoor lighting, electric curtains and windows that involve more than 8,000 control circuits. Energy savings of more than 15% compared to conventional systems can be expected.

In Chongqing, OPPO, one of the world's largest manufacturers of mobile devices and a growing global player in 5G, is building its major new technology park, due for completion in 2024. The campus will serve as an important production base and logistics center that houses smart manufacturing, automated warehousing and software, and hardware R&D. ABB’s digital energy

management and power systems, interfacing effectively with other plant management systems, will help guarantee the reliable uptime and to improve energy efficiency, productivity and sustainability of the modern manufacturing site.

4. Recommendations

Based on the above case studies together with ABB's global experience and local knowledge, we would like to make the following recommendations for the consideration of Chongqing's government:

4.1 Advance energy transition and foster a leading hydrogen energy ecosystem

From the construction of "Hydrogen Valley" to the development of "Chengdu-Chongqing Hydrogen Corridor", Chongqing is at the forefront towards a locally integrated hydrogen ecosystem. Under China's carbon-neutrality target, further development of the hydrogen industry requires efforts from two ends: first, the hydrogen source must be truly green and clean; and second, the market demand must be expanded with more application scenarios in transportation and industry to be explored, which will also drive the scaling of hydrogen production and the increase of cost-effectiveness.

Despite abundant resources and an increasingly mature hydrogenation infrastructure, more synergy and coordination among cities in the Chengdu-Chongqing region are needed to better generate greater momentum. Hydrogen technologies across the whole value chain, such as water electrolysis, fuel cell technology, hydrogen storage and transmission technology, are still in its early periods of growth with various challenges. The Chongqing government can take more proactive measures to further encourage research and development of core technologies, to provide policy support for pilot and demonstration projects, to promote viable commercial structures and business best practices, and to guide the development of the industry toward stability and sustainability.

4.2 Jointly develop high-end manufacturing clusters featuring AI-enabled robotics

Chongqing has solid industrial foundation and policy advantage in driving regional cooperation to develop high-end intelligent manufacturing clusters and pilot joint innovation centers in Western China. To move forward, a closer integration of automation technologies, represented by robotics, and smart technologies, represented by artificial intelligence, could be very beneficial for the efficiency increase, quality improvement and emission reduction, all essential in developing emerging industries and promoting the transformation and upgrade of industries with traditional strengths, such as automobiles and electronics.

Partnering and stakeholder cooperation can help leverage diversified assets, address local needs and ensure continuous commitment from all parties. One of the good examples is the Smart China Expo in Chongqing, which serves as a great platform to promote global exchanges of smart technologies and international cooperation of the smart industry. As an active participant in this event, ABB strongly support this initiative and would like to join hands with the local government, associations, academia and industry insiders to contribute to smart technology innovation and future green development.

4.3 Drive low-carbon growth with digital infrastructure, smart parks and green buildings

As a leading city of the Western China, Chongqing is committed to becoming a leading eco-city, and setting the benchmark for the city cluster in terms of green, low-carbon and sustainable development. With the pressure of rapid urbanization and the growing demand for green development, higher attention should be paid to urban sustainability, both in residential communities and in industrial parks.

The government can take the lead through wider application of energy-saving and emission reduction technologies from around the world and further encouragement of pilot projects and innovative solutions to improve the energy efficiency of buildings and industrial parks and enhance the sustainability and resilience of urban infrastructure

As a global technology leader with deep roots in China and a long-term partnership with the Chongqing government, ABB highly appreciates the long-term strong support provided by the Chongqing government, and the new actions taken by Chongqing to catalyze innovation and foster new growth engines.

We are confident that Chongqing will continue to be a leader in the development of western China and in pioneering a new model of coordinated development. We hope that the above cases and analyses from China and across the world can provide actionable suggestions that can support Chongqing's vision of building a modern industrial system and driving regional sustainable and high-quality development.

Collaborate to Build a Modern Industrial System - On Upgrading Chongqing's Industrial Structure to Meet the Carbon Peaking and Neutrality Goals

Simon Yang
SVP, bp Group
President of bp China

To meet the announced goal of reaching the carbon emissions peak by 2030 and carbon neutrality by 2060 (collectively known as the "carbon peak and neutrality goals"), the Chinese government is stepping up efforts to formulate an action plan for achieving carbon peak by 2030 and corresponding sector- and industry-specific implementation plans, devising supporting policies in terms of finance, pricing, fiscal and tax, land use, government procurement and standardization, and accelerating to form the "1+N" policy system for achieving carbon peak and neutrality. This will bring new challenges and opportunities for the development of enterprises, cities and the nation as a whole. A green and low-carbon modern industrial system is key to achieving the carbon peak and neutrality goals. Therefore, we should closely examine the relationship between these goals and Chongqing's high-quality industrial development, and make sure that Chongqing's advanced manufacturing industry can play out its strengths on the journey toward carbon neutrality, which will have great practical significance for the city's sustainable development.

1. Carbon Neutrality and Chongqing's Industrial Development Direction

1.1 Carbon neutrality trends at home and abroad and the transformation of China's energy system

The carbon neutrality strategy is all-encompassing for it takes into account all aspects of economic and social development. Throughout the world, its fundamental purpose is to enhance harmony between economic development and ecological progress, and to build a resource-efficient modern economy that is equitable and prosperous. **The key to its implementation** is to cap the total carbon emissions, including carbon budgeting and reduction in absolute emissions and in carbon intensity, **so as to promote the optimization of the industrial structure and the transformation of the energy system and the technology system.**

In this context, developed countries have proposed their own timetables for the exit of fossil-fuel vehicles, roadmaps for hydrogen development and for building a green supply chain. They have also increased investment in the mitigation of climate change, and formulated relevant fiscal, tax, price and financial policies. In addition, society-wide engagement and commitment are

emphasized in national carbon neutrality strategies, and cities and enterprises are encouraged to put forward their own carbon neutrality goals in light of their reality. Fair transformation is also stressed, and job training encouraged in emerging industries related to climate change which are expected to create more jobs.

A low-carbon energy system represents an important path toward carbon neutrality, and has a far-reaching impact on building a modern industrial system. To achieve carbon neutrality, coal, oil, natural gas and other fossil energy sources will be gradually phased out from industrial production, transportation and domestic end-use and replaced by the low-carbon, and even zero-carbon new power systems. Decarbonizing China's energy system includes the following efforts:

(1)Electrification of end-use energy and increase in the proportion of electricity generated from non-fossil energy. In the future, the dominant energy for consumption will be electric power which has huge space for growth. The thriving electric vehicle industry is a case in point. *bp World Energy Outlook* (2020 Edition) predicts that the world's share of electricity in total final consumption will increase from a little over 20% in 2018 to around 45% by 2050; and the share in China will gradually increase from 27% to about 55%. On the power-supply side, the proportion of electricity generated from non-fossil energy will grow rapidly. It is estimated that by 2025, the installed capacity of renewable energy will account for about 50% of the total installed capacity of power generation in China, and the annual power generation of renewable energy will account for more than 50% of the total incremental power consumption. The energy mix will become increasingly clean, low-carbon and efficient.

(2)An intelligent and more efficient power system empowered by digital and energy storage technologies. The power generation technology will see breakthroughs and will then be used together with emerging technologies and models such as the energy storage technology, smart grid, energy Internet, multi-energy complementary system and distributed energy use system, to promote the rapid evolution of the power system to an intelligent cyber physical system.

(3)Pilot use of hydrogen energy in various fields of transportation and manufacturing. With the rapid development of global industrial technologies, the application of hydrogen energy, now a raw chemical material, is rapidly permeating into transportation, construction and energy storage fields. In the future, it will be more widely applied in hydrogen metallurgy, green-hydrogen chemicals, hydrogen energy storage, hybrid energy systems and smart energy systems. The International Energy Agency's Sustainable Development Scenario predicts that the global demand for hydrogen for end use will reach around 90 million tons by 2030.

(4)Pilot application of CCS technologies. As China's energy mix is coal-based, carbon

capture and storage (CCS) and bioenergy carbon capture and storage (BECCS) will play a bigger role in the future. It is estimated that the installed capacity of coal-fired CCS and biomass-fired BECCS will reach 230 GW and 53 GW respectively by 2050, and capture 710 million tons and 310 million tons of carbon dioxide respectively, laying the foundation for achieving carbon neutrality by 2060.

The transformation of the energy system will also bring new economic growth points and jobs. The investment is expected to increase by about RMB 138 trillion, more than 2.5% of the annual GDP. The number of employees per unit of capacity in the renewable-energy industries can reach 1.5-3.0 times that of the traditional-energy industries.[72]

1.2 Impact of current domestic and foreign carbon reduction measures on industrial development

1.2.1 Inspirations and impacts of the carbon emissions reduction targets proposed in China's 14th Five-Year Plan

The 14th Five-Year Plan of China sets the goals of reducing energy consumption per unit of GDP and carbon dioxide emissions by 13.5% and 18% respectively, and by the end of the Plan period (2021-2025), increasing the proportion of non-fossil energy in primary energy consumption from the current 16% to about 20%. It also puts forward to implement the strategy of building China into a manufacturing powerhouse and keep the proportion of the manufacturing industry basically stable. Against this background, **the manufacturing industry, as a major energy consumer, must step up efforts to reduce carbon emissions and realize green transformation while continuing development.** Some energy-intensive industries, such as iron & steel, building materials and non-ferrous metals manufacturers, need to adapt to the new requirements by optimizing the industrial layout and adjusting the energy mix and way of supply, and start to formulate their respective carbon peak plan. In addition, as most domestic manufacturers are located in industrial parks and development zones, which together account for 31% of the country's carbon dioxide emissions, the steep emissions cut in these parks and zones is essential for the manufacturing sector to achieve the carbon peak and neutrality goals.

1.2.2 Status quo of China's carbon trading market and its impact

The national carbon emissions trading market was officially launched in July this year. It is generally based on intensity rather than aggregate, and reflects a flexible aggregate linked to the actual output of the covered industries. The carbon emissions of enterprises capped include not

[72]Data source: Li Zheng, Chen Siyuan, Dong Wenjuan, Liu Pei, Du Ershun, Ma Linwei, He Jiankun. Research on the Path of Transitioning to a Low-Carbon Power Industry under Carbon Constraints [J/OL]. *Proceedings of The Chinese Society for Electrical Engineering*. 1-15 [2021-05-18]. https://doi.org/10.13334/j.0258-8013.pcsee.210671.

only the direct emissions generated on the site, but also the indirect emissions generated by the consumption of electricity and heating. At present, the carbon market only includes the electricity industry, and is striving to include all the eight major energy-intensive industries by the end of the 14th Five-Year Plan period (2021-2025). The steel, cement and electrolytic aluminum industries with a good carbon emissions data base will probably be the next in line to be included in the market. This year, Chongqing has included some 30 power generation enterprises and self-owned power plants in the national carbon market. As one of the city's major industries, the chemical industry will be included in the 2021-2025 period. **For Chongqing's energy-intensive industries, it will be necessary to take seriously their energy conservation and emissions reduction, equipment substitution, and carbon quota management and trading strategies.** As the national carbon market continues to develop, enterprises will take greater initiative to plan for low-carbon development, which will have a positive impact on the green and low-carbon development of the entire industrial chain.

1.2.3 Impact of the EU's CBAM on China's exports

The EU has cut the free carbon market quota and adopted the Carbon Border Adjustment Mechanism (CBAM), with the aim to reduce emissions by 55% by 2030. The CBAM will set a corresponding credit policy for products that have already implemented carbon pricing. The policy covers direct carbon emissions from the production of five types of raw materials: electricity, steel, cement, aluminum and fertilizers, and will thus greatly affect the export competitiveness of these industries. **Although most Chinese cars and solar PV panels exported to the EU will not be included in the near future, the policy implication will prompt enterprises to prefer suppliers of low-carbon products.** In fact, some automakers have announced and started to work toward their own carbon neutrality targets.

1.3 Challenges for decarbonizing Chongqing's current industrial system

1.3.1 Industrial development in Chongqing

In recent years, Chongqing's economy has maintained a relatively high growth rate, among the fastest-growing in the country. Its industrial structure has been continuously optimized: the proportion of the primary sector is significantly reduced, that of the secondary sector has maintained a stable level and picked up slightly, and that of the tertiary sector has significantly increased. The secondary sector is still dominated by the "6 plus 1" pillar industries, of which the electronics manufacturing industry, the biggest of them, maintains a strong growth momentum, and the auto-making industry is large in scale but growing at a slower pace. The strategic emerging manufacturing industry represented by the new-generation information technology has made outstanding contribution and become the main driver of industrial growth. Judging from Chongqing's medium- and long-term positioning, the city expects to maintain a medium- to high-

speed economic growth before 2035 by leveraging its unique geographical advantages and building a world-class intelligent manufacturing industry cluster. After 2035, as its status further consolidated as the economic center of the upper reaches of the Yangtze River and the highland of the inland opening-opening, its economy will gradually mature as more efforts will be directed to improve the modern service and finance industries.

1.3.2 Challenges facing Chongqing's industrial development to achieve carbon peak and neutrality

In recent years, Chongqing has made remarkable achievements in low-carbon development and energy conservation. In 2020, its carbon emission intensity was 0.70 tons/RMB 10,000, a cumulative decrease of over 22% over 2015, exceeding the national target of 19.5% set for the 13th Five-Year Plan period. As to capping the total energy consumption and the energy intensity, Chongqing consumed 88.75 million tons of standard coal in 2020, an increase of 11.27 million tons over 2015, below the national control target of no more than 16.6 million tons of increment for the 13th Five-Year Plan period; its energy intensity was 0.39 tons of standard coal/RMB 10,000, a decrease of 19.4% over 2015, beating the national goal of reducing by 16% during the 13th Five-Year Plan period.[73]

Chongqing's 14th Five-Year Plan sets the goal of reducing carbon intensity by 18%, which raises higher requirements for developing the low-carbon energy system, industrial system and consumption. As a traditional industrial city, Chongqing still faces challenges in the continuous decarbonization of its industrial system. **Chongqing has a heavy industrial economic structure,** with energy-intensive industries such as thermal power generation, steel and cement accounting for more than 80% of total industrial emissions, and strategic emerging industries are still underdeveloped: the added value of high-tech industries accounts for a relatively low proportion of the added value of industries above the designated scale. **Its energy mix dominated by coal, and 75.86% of the total energy consumption is fossil energy,** of which coal consumption accounts for 58.38% of the fossil energy consumption. **The city's hydro, wind, solar energy and other renewable energy for development and utilization is also very limited**. On the other hand, **Chongqing is still in the stage of industrialization, and has a strong demand for energy to launch new projects.** Therefore, it is necessary to explore solutions to sustainable carbon reduction from multiple fields, which is both a challenge and an opportunity for Chongqing.

[73]Data source: *White Paper on Chongqing's Response to Climate Change 2020.*

2. Thoughts and Suggestions on How to Make Sure Chongqing's Advanced Manufacturing Industry Can Exert Their Advantages on the Way to Carbon Neutrality

2.1 Carbon accounting and carbon management in the advanced manufacturing industry

(1) It's necessary to specify the organizational boundary and operational boundary of quantifying the carbon emissions of advanced manufacturing, formulate specific methodologies for carbon emissions accounting, carbon disclosure and carbon management, promote the carbon-related standardization in advanced manufacturing, prepare carbon disclosure information reports of key enterprises, and establish a scientific carbon disclosure system. The statistical boundary of carbon neutrality of an enterprise includes not only the direct emissions within the enterprise, the emission of power and heat it purchased, but also all kinds of greenhouse gas (GHG) emitted throughout the life cycle of its products, i.e. carbon footprint, referring to the GHG emitted by raw materials and in stages from production (or service delivery), distribution, use to disposal/recycling. A life cycle assessment model should be built based on the production process of the advanced manufacturing industry, and the carbon emission data related to the product life cycle should be collected.

In the automobile industry, a pillar industry of Chongqing's economy, most of its emissions reduction will take place at the supply chain. Automakers need to address the issue of carbon accounting in the entire life cycle of vehicles including automotive materials, production and logistics, use to end-of-life recycling. Manufacturers of new-energy vehicles may take the lead to establish a carbon trading technology system, including carbon footprint, carbon verification and carbon disclosure, to accelerate carbon reduction across the automobile industry.

(2) A public service platform should be built for achieving carbon peak and neutrality in the advanced manufacturing industry. It's necessary to build a life cycle carbon emission database, carbon footprint calculator and a public service platform in the advanced manufacturing industry. The public service platform can attract enterprises to participate in the implementation and promotion of relevant standards, and thus assist them in completing carbon disclosure, and the carbon footprint calculation and accounting of their products. Chongqing should also assess how much low-carbon technologies, processing techniques, energy and raw-material substitution can contribute to carbon reduction in the advanced manufacturing industry, and identify the technological and management needs of enterprises based on their actual carbon emissions, and determine their emission reduction targets and carbon asset management measures. There should also be an early-warning and feedback management system to make sure that carbon peak and neutrality goals are fully met in the advanced manufacturing industry.

2.2 Leveraging local advantages to continuously optimize the industrial structure

Over the years Chongqing has cultivated a modern industrial system of a considerable scale. Chongqing can seize the strategic opportunity of developing the Chengdu-Chongqing twin-city economic circle, **make full use of their complementary advantages,** strengthen cooperation, **extend and improve the industry chain**. Especially in the automobile, electronic information, natural gas and chemical industries where both enjoy a superior edge and broad development prospects, the two cities should work to promote the integrated development of related industries, and build up their competitiveness in the country.

While strengthening the pillar industries, Chongqing should proceed from local conditions and **consider strengthening the development of low-carbon energy in such fields as new energy equipment industry, wind energy, hydrogen energy and energy storage,** and strengthening the guidance and support of relevant policies. The Sichuan-Chongqing region has abundant hydrogen resources, a solid foundation for the automobile industry, and has advantages in developing the industry chain of hydrogen fuel cell vehicles. Chongqing may support the construction and operation of hydrogen filling stations, explore the development mode of integrated oil-, gas- and hydrogen-filling and electricity-charging stations, break the bottleneck to the demonstrative operation of hydrogen fuel cell vehicles, and promote the large-scale application of hydrogen fuel cell vehicles.

2.3 Reducing carbon emissions from basic energy supply and developing clean hydrogen energy

(1) Promoting Sichuan-Chongqing energy integration and supplying Sichuan's clean energy to Chongqing.

The power supply in Sichuan is dominated by hydropower while that in Chongqing by coal-fired power, so they can explore energy integration to regulate hydropower and thermal power and promote the optimal allocation of resources on a larger scale. Chongqing relies mainly on thermal power and its electricity generation will continue to decline. Moreover, according to the analysis of the balance of supply and demand, its maximum power shortage by 2025, 2035 and 2050 will reach 9.4 million kilowatts, 25 million kilowatts and 36.5 million kilowatts respectively. Therefore, to guarantee reliable power supply, it must first of all introduce zero-carbon renewable power from outside. In contrast, Sichuan is rich in hydropower which is given the priority to generate electricity. In the context of Sichuan-Chongqing integration, Chongqing may consider using the time-varying price signal to guide the regulation of grid load on a time scale, improve the utilization efficiency of assets, and help the city import more clean energy.

(2) Accelerating the in-depth decarbonization of energy and power systems and advancing the reform of the electricity market.

The increasing proportion of electricity generated by renewable energy connected to the grid poses a challenge to the safe and stable operation of the power system. As renewable energy generates more and more electricity, the power system needs to be more flexible to meet the demand for peak shaving at any time. Before 2030, peak shaving based on a more flexible thermal power system and a connected and multi-energy grid will suffice to absorb the intermittent electricity generation by renewable energy. But after 2030, as carbon emissions decline faster and the share of renewable energy keeps increasing, the grid will need massive application of energy storage technologies, smart grid technologies and technologies for the distributed renewable energy network to ensure its stability. It will need the electrochemical energy storage technology, hydrogen energy storage technology, energy Internet technology, virtual synchronization technology, grid-side energy storage technology and demand response technology, etc. In the future, the deep decarbonization of the electricity system will depend on the institutional development of the electricity market, and it is necessary to **continue the ongoing reform and develop a low-carbon and efficient marketplace.**

(3) Developing clean hydrogen and fully utilizing zero-carbon electric power

Chongqing has a good hydropower foundation, and can import more clean hydropower from Sichuan, so it can **use hydropower to produce hydrogen and develop clean hydrogen energy**. Chongqing has the cost advantage for producing hydrogen using hydropower. When the electricity price to industrial users is around RMB 0.3 per kWh, the cost is close to that of hydrogen production using conventional fossil energy, and during the flood season (June-October), the cost will be even lower by using off-peak abandoned hydropower.

To promote hydrogen production by electrolysis, Sichuan and Chongqing can include the hydrogen production enterprises into the list of enterprises with access to direct power supply and give them the lowest transmission and distribution price. In this condition, large-scale hydropower enterprises can build hydrogen-producing stations in or near their power station, and use the electricity generated to power the hydrogen production. Hydrogen produced will be transported to the hydrogen filling stations by hydrogen tube trailers after pressurization. Or the hydrogen filling station can be built in the place where hydrogen energy is absorbed, so that it can enjoy the discount price of the directly-purchased electricity, and shorten the transport distance of hydrogen by means of electricity transmission.

In order to encourage hydrogen production using hydropower, Sichuan has issued relevant support policy. For example, it sets the flat-rate price of power transmission and distribution for

electrolytic hydrogen at RMB 0.105/kWh, and the price of electricity for industrial users is about RMB 0.3/kWh. And in the demonstration zone of absorbing curtailed hydropower energy, the electricity price paid by users is encouraged to be not higher than RMB 0.22/kWh around the year.

2.4 Digitalizing the whole system of power source, grid, load and storage, and building an efficient energy supply, use, transmission and storage system

To meet the carbon peak and neutrality goals, the energy system needs to become a multi-energy integrated one, dominated by renewable energy and supplemented by other kinds of energy. Digitalization and energy Internet are essential to build such a power system featuring clean energy and new energy. Information technologies such as cloud computing, big data, the Internet of things, blockchain and other mobile, intelligent technologies are also important to realize the "integration of power source, network, load and storage" and build a multi-energy smart supply system. **An important path toward high-quality manufacturing development in Chongqing is to promote the innovation and development of the industrial and energy Internet and upgrade the manufacturing industry.**

2.5 Promoting the development, promotion and popularization of technologies for energy conservation and carbon reduction

(1) Promoting the use of advanced energy-saving technologies and equipment, improving targeted energy management, and tapping the potential of smart energy use and big data in energy conservation

With the advancement in technologies such as the utilization of waste heat and pressure at medium and low temperature and industrial intelligence, the potential and space for energy conservation and carbon reduction have been expanding. Among them, the most promising technologies include secondary reheating, power generation by recovering waste heat from sinter coolers, power generation by top-pressure difference of electric furnaces. The in-depth development of the "Internet Plus" mode and application of information technology have made it possible to conduct real-time monitoring, precise analysis and dynamic adjustment of enterprises' energy consumption. In the future, Chongqing's industries should place more emphasis on the application of intelligent and information technologies, implement the whole-process management of energy use for production, identify abnormalities through statistics of energy use, and let big data play a bigger role in energy conservation.

(2) Transforming the traditional high-carbon intensity production mode, and developing zero-carbon fuels/feedstocks and process substitution

The hydrogen energy and biomass energy should be more widely used in petrochemical, chemical, steel and other industries, and become an important technical support for deep

decarbonization in the industrial sector. At the same time, the level of industrial electrification should be increased and fossil energy replaced with low-carbon energy to further cut emissions in the industrial sector. For example, in the cement industry, replacing cement ingredients or fuels with low-grade raw materials such as urban domestic waste and industrial waste can significantly reduce energy consumption and emissions. In the iron and steel industry, the direct-reduced iron (DRI) process emits only about 1/3 of the CO_2 emitted per ton of steel by blast furnaces, and hydrogen can replace the pig iron production using coke and other fossil fuels, and when hydrogen is produced by renewable energy, deep decarbonization can be achieved. If the CO_2 emission intensity per unit steel product is 1.8 t per ton of steel, the carbon emission of the steel industry in Chongqing is about 18.07 million tons, and if the current DRI process which can reduce 50% of the emission is adopted, it will at least cut 6.02 million tons of emission. The expanded use of biomass energy will also replace large quantities of industrial raw materials and save a lot of fuels.

(3) The application of CCS/CCUS technology

The future retention of coal-fired and natural gas generation capacity will largely depend on the development and application of the CCS/CCUS technology. The CCS/CCUS technology can capture 90% of carbon emissions by coal-fired power plants, and turn these plants into low-carbon power generators. In addition, CO_2 sequestration in depleted gas reservoirs is also one of the applications of the CCS/CCUS technology. Chongqing has several natural gas fields which can sequester about 938 million tons of CO_2. For example, it may consider early demonstration of the whole process at the Wolonghe Gas Field and the Huangcaoxia Gas Field which were developed early and are at the end of their exploitation as their natural resources are nearing depletion and several production wells are closed, but which have natural gas transmission pipelines and other facilities near their discharge sources. The scale of the application of CCS/CCUS technology depends on how fast its cost falls.

2.6 Piloting carbon trading in enterprises included in the China ETS and vulnerable to the impact of CBAM

The EU's CBAM covers direct carbon emissions from the production of five types of raw materials: power, steel, cement, aluminum and fertilizers, with the aim of reducing emissions by 55% by 2030. The EU Emissions Trading System (EU ETS), under which the carbon border tax will operate, has set a ceiling on the total amount of carbon emitted and will gradually lower it, which, plus the tightened carbon emission permit system, will drive up the carbon price steadily. In terms of top-level design, China will gradually catch up with the EU on the progress in carbon quota reduction, the trading price will be pushed to a higher level, and the domestic carbon trading price might beat the expectation. To make China's exports more competitive for the EU importers, Chinese steel, aluminum and related industries should be gradually included in the national carbon

trading market, and moreover should set the same carbon emissions reduction targets as their EU counterparts. Chongqing can launch pilot projects in key enterprises and industries to promote the development of China's carbon market and catch up with the world class in the future.

2.7 Developing the circular economy and reducing the use of primary resources

Developing the circular economy and improving resource utilization efficiency represent an important path to reducing the industrial energy demand and carbon emissions. Resource utilization efficiency is an important link between green, low carbon development and circular development. According to the UN Environment Programme's International Resource Panel, by developing the circular economy, the world could extract 28% less resources by 2050, and reduce the carbon emissions by 3.6 billion tons per year in energy-intensive industries such as steel, cement, electrolytic aluminum and plastics. Therefore, developing circular economy and increasing waste recycling are an effective way to develop the low-carbon heavy industry in the future.

3. Low-Carbon Practices of bp as a Multinational Energy Enterprise

In February 2020, bp announced the goal to become a net-zero company by 2050 or before, and released a strategic development plan in August, according to which it will transition from an "international oil company" (IOC) to an "integrated energy company" (IEC) and from one of the world's largest suppliers of fossil energy to an integrated energy supplier of low-carbon electricity and energy and more diverse end-use energy services. To this end, our annual investment in low-carbon areas will increase by as much as 10 folds over the next decade, to USD 5 billion.

While decarbonizing our own business, we are actively looking for opportunities to work with cities, industries and other companies to provide them with integrated energy solutions. For example, we are working with tech giants Microsoft and Amazon and supplying renewable power to their data centers. We serve as planning and technical adviser for the city of Aberdeen and develop integrated energy solutions for it to use green energy, improve building energy efficiency, and accelerate the electrification of mobility. The following are some cases of our efforts in the space of clean energy and low carbon transportation:

Case 1 The blue hydrogen and carbon capture and storage project to build a net-zero industrial corridor

bp is developing plans for the UK's largest blue hydrogen production facility, targeting 1GW of hydrogen production by 2030. The project would capture and send for storage up to two million tonnes of carbon dioxide (CO_2) per year, equivalent to capturing the emissions from the heating of one million UK households.

Industries in Teesside account for over 5% of the UK's industrial emissions and the region is home to five of the country's top 25 emitters. bp is exploring a carbon capture and storage project in Teesside with a number of companies. With close proximity to North Sea storage sites, pipe corridors and existing operational hydrogen storage and distribution capabilities, the area is uniquely placed for H2Teesside to help lead a low carbon transformation, supporting jobs, regeneration and the revitalisation of the surrounding area.

The project's hydrogen output could provide clean energy to industry and residential homes, be used as a fuel for heavy transport and support the creation of sustainable fuels, including bio and e-fuels. The project would be developed in stages, with an initial 500MW of blue hydrogen capacity in production by 2027 or earlier and additional capacity to be deployed by 2030 as decarbonisation of the industrial cluster and hydrogen demand gathers pace. bp sees potential for further hydrogen demand in Teesside beyond 2030.

Case 2 An integrated energy solution for Aberdeen, a heavy-industry city

In September 2020, Aberdeen City Council announced a new and ground-breaking partnership with bp to help the Council achieve the goals of the recently-approved Net Zero Vision to reduce carbon emissions and become a climate positive city. Under the agreement, the Council and bp experts in low carbon energy systems, mobility and technology will work together to develop and deliver green energy solutions. The partnership will explore opportunities in service of the city's decarbonisation, economic and social ambitions, working across several themes, including:

- Hydrogen for transport, heat and power, building on the city's strong track record of innovation in transport;
- Built environment to understand and improve building energy use and efficiency;
- Mobility and electrification to develop solutions for clean, low emission vehicles and increase the fuel efficiency of the council's fleets;
- Circular economy exploring value-adding opportunities such as energy from waste.

The Net Zero Vision supports Aberdeen's leading role in energy transition and provides a unique opportunity. Aberdeen is already leading the way in the UK in developing and deploying renewable technologies to combat global warming and climate change.

Case 3 Integrated solutions for the Volvo's automobile plants

Volvo Car Asia Pacific and bp China will collaborate as strategic partners in China with the aim of furthering respective net zero, climate neutral and sustainability aims and providing integrated energy solutions along and across value chains. On top of extending the existing local strategic partnership in auto aftermarket to 2025 under global agreement, we will further focus on co-development of market specific value propositions that can help drive future sustainability related developments, including roadmap for aftermarket low carbon transition, carbon neutral charging solutions, renewable energy supply and other decarbonization projects, and joint sustainability advocacy in China.

Case 4 Creating a zero carbon transport system through carbon-neutral charging

Our EV charging joint venture bp-xiaoju ("bp-xiaoju") has achieved carbon neutrality in its charging business. All customers using the bp-xiaoju network of electric vehicle (EV) charging sites across China will charge carbon neutrally. While EVs do not generate direct tailpipe carbon emissions, the power provided through the grid comes from a range of sources, including from fossil fuels. The new offer means that customers in China charging EVs at any bp-xiaoju EV site will automatically have the lifecycle carbon emissions from the power purchased offset. This is China's first carbon neutral EV charging offer and is based on international and national standards for carbon neutrality. The whole process was assured for bp-xiaoju by CTI, an accredited third-party verification service provider.

Concluding Remarks

The development of the Chengdu-Chongqing twin-city economic circle is an important national strategy for regional development. Facing strategic opportunities that come with it, Chongqing can accelerate the building of a modern industrial system on the way toward carbon neutrality, promote high-quality development of the manufacturing industry, and transition to a green and low-carbon economy. It shall, through sound carbon management and carbon accounting, continuously optimize the industrial structure, adjust the energy structure, reduce the carbon emission of basic energy supply, strengthen the building of a digital, intelligent energy system, promote the development and application of energy-saving and carbon-reducing technologies, develop the circular economy and increase the use of renewable resources, to ensure that its advanced manufacturing industry will continue to exert advantages as China strives to achieve carbon neutrality.

As a multinational energy company in transition, bp hopes to seize and benefit from such a great opportunity to boost regional development in Chengdu and Chongqing, and contribute to the high-quality development of Chongqing and the entire Chengdu-Chongqing economic circle in

such areas as integrated energy solutions, low-carbon transportation, carbon trading and management.

The Development of Japan's Hydrogen Energy Industry and the Development of Chengdu-Chongqing Economic Circle's Green Industry

Miyata Koichi
Chairman of the Board, SMBC

Topic 2: Working Together to Create a First-Class Business Environment

High-quality economic development requires a first-class business environment. Factors such as a a market that promotes fair competition, stable and flexible policies, a climate of respect for innovation-driven technologies, and outstanding talent are key components in constructing a systematic, collaborative, and effective environment.

- Opinions and suggestions on creating a high standard market system
- Opinions and suggestions on attracting and promoting the mobility of talent in the Chengdu-Chongqing Economic Circle
- Opinions and suggestions on creating a distinctive international consumption area from the perspectives of the potential growth of consumption, conditions, and environment of consumption.
- Opinions and suggestions on working to transform into a green city suitable for an environment where people and nature co-exist in harmony.
- International experience, etc.

Viewpoint of SMFG

The Development of Japan's Hydrogen Energy Industry and
the Development of Chengdu-Chongqing Economic Circle's Green Industry

Advisor, Sumitomo Mitsui Financial Group
Chairman of the Board, Sumitomo Mitsui Banking Corporation
Koichi Miyata

Summary

Development of Japan's Green Industry
A Report on the Trends in the Hydrogen Industry in Japan
and Related Financial Initiatives

With the development of the green industry, and the growing tendency to place more emphasis on the realization of the goal of "peak out of carbon dioxide emissions, carbon neutral", Japan is accelerating the construction of a "zero-carbon society" by improving the perspective of strategic goals. Hydrogen energy will play an important role in the future of "carbon neutrality" as an energy source for strategic development. However, until now, development has been restricted for various reasons, and large-scale development has not been realized. This paper introduces Japan's green industry and hydrogen energy industry from the perspective of policies and corporate trends and analyzes issues in the development of hydrogen energy.

1．Growth Strategies in Japan's Green Industry

(1) Overview

In December 2020, the Japanese government announced its "Green Growth Strategy through Achieving Carbon Neutrality in 2050" (hereinafter, "strategy"), an industrial policy that aims to realize a "virtuous cycle of economy and environment" in the wake of measures to combat global warming. The strategy is to achieve carbon neutrality and construct a "zero carbon society" by 2050. At the same time, the Japanese government announced that it has set a target for hydrogen energy supply in Japan of up to a maximum of 3 million tons in 2030 and 20 million tons in 2050.

At a recent summit meeting, Prime Minister Suga pledged that by 2030, Japan would reduce its carbon dioxide emissions by 46% from its 2013 emissions. The new target significantly exceeds the previous target of reducing emissions by 26% and further accelerates the reduction of carbon dioxide emissions.

In Japan's electric power industry, which aims to be carbon neutral, research is being conducted focusing on renewable energy, hydrogen power generation, thermal power generation + CCUS (carbon dioxide capture and storage), and nuclear power, etc. However, for other non-electric power industries, emphasis is placed on responding to electrification and heat demand by hydrogenation and carbon dioxide capture.

(2) Methods for Strategy Execution

In its strategy, the Japanese government announced plans to allocate 240 trillion yen of private sector funds to green investment through policy support from various fields. At the same time, the aim is to promote job creation and economic development by revitalizing private investment through the use of policies.

① *Government Support as Technology Evolves*

Phase	Specific Support Methods
Research and Development Phase	Government funds + private research and development investment
Demonstration Phase	Public-Private co-investment based on the premise of inducing private investments
Mass-Production Phase	Increased demand through public funding, regulation and standardization → cost reduction through mass production
Independent Commercialization Phase	Based on the premise of regulation and standardization, commercialization progresses independently without public support

② *Key Policy Tools*

Policy Tools	Policy	Details	Target Industry/Sector
Budgets	Green Innovation Fund	Establish a 2 trillion yen fund within 10 years to support technology development and investment	Ø Greening and electrification of electricity Ø Hydrogenation in the heat and electric power sectors Ø CO2 fixing and reuse
Tax System	Investment promotion tax policy for carbon neutrality	Tax incentive to promote investment	Ø Introduction of production facilities to achieve carbon neutrality
Finance	Ø Transition finance Ø Risk management support	Ø Structuring long term funding, and performance-linked interest subsidy system (loan size of 1 trillion yen over 3 years) Ø DBJ establishes an 80 billion yen "Green Investment Promotion Fund"	Ø Companies that have received certification under the proposed revision of the Industrial Competitiveness Enhancement Act Ø Renewable energy industry and fuel-efficient technologies, etc.
Regulatory Reform and Standardization	Strengthening / relaxing regulations on new technologies, addressing internationalization standards and price reduction	Consider strengthening the carbon dioxide emissions trading system and introducing a carbon tax	Hydrogen energy, offshore wind energy, automotive batteries, etc.
International Collaboration	Domestic and overseas industrial policy	Strengthen collaboration with Europe and North America through individual projects and technical standardization. Strengthen bilateral and multilateral cooperation with emerging countries.	Hydrogen energy, energy conservation and renewable energy, nuclear power, CO2 recovery and reuse, aviation, etc.

③ *14 Key Industries*

The strategic objective is to set specific development goals and implementation plans in 14 key industries that are essential for the realization of the 2050 carbon-neutral target for the development of future priority industries, and the hydrogen energy industry is one of the four major energy industries.

Key industries include energy-related industries (offshore wind power, ammonia fuel, hydrogen energy, nuclear power), transportation/manufacturing-related industries (automobiles/storage batteries, semiconductors/telecommunications, ships, logistics, transportation/construction, food, agriculture, forestry and fisheries, aviation, carbon cycle) and life/office-related industries (housing and construction/next-generation solar energy, resource recycling, and lifestyle).

Since each industry has a different time frame for market expansion, specific policies will be formulated according to the characteristics of each industry, and ultimately, autonomous market development will be realized.

Source: MINISTRY OF ECONOMY, TRADE and INDUSTRY 「Green Growth Strategy Through Achieving Carbon Neutrality in 2050」and Related News

2．Trends in Japan's Hydrogen Industry

(1) *Key Position of Hydrogen Energy*

By promoting the realization of carbon-neutral targets, hydrogen energy has established an important position in energy that cannot be ignored.

- Promoting Carbon Neutrality: Hydrogen is a true clean energy that reduces environmental impact without generating carbon dioxide. Therefore, expanding the application area is one of the most effective means in realizing carbon neutrality.
- Energy Safety: Japan's energy self-sufficiency rate has remained at a low level since the Great East Japan Earthquake in 2011, and it relies largely on imports of fossil fuels from overseas. Although renewable energy became more widespread in 2019, fossil fuels remain at a high level of 85%. Compared to fossil fuels, the acquisition of hydrogen energy is for the most part unaffected by geopolitical risks and has a significant advantage. It can be manufactured from a variety of primary energy sources and contributes to the energy self-sufficiency rate in a wide range of fields, such as power generation and the manufacturing industry.
- Industrial Development: Japan now possesses the world's leading fuel cell technology, and in the future hydrogen energy will further improve the international competitiveness of fuel cells. At the same time, it is extremely important to construct a hydrogen energy supply chain for the large-scale use of hydrogen energy. Strong Japanese companies will be incorporated into each phase of the supply chain, and profits are expected from the expansion of the hydrogen energy market.

(2) *Current Status of the Hydrogen Market in Japan*

Until now, the Japanese government has clarified the basic strategy for hydrogen energy, namely 300,000 tons in 2030 and 10 million tons + α in 2050. However, at present in Japan, the hydrogen energy supply is only 200 tons, the number of FCVs owned is approximately 3000 to 4000 units, and the construction of a hydrogen energy value chain has not been completed (note: Japan currently imports 85 million tons of natural gas, and the number of passenger cars owned is 62 million), therefore it can be said that the domestic demand for hydrogen energy is at a low level. The cause can be analyzed from the hydrogen energy price. Currently, the price of hydrogen energy is 100 yen/Nm3, and the price of imported natural gas is 16 yen/Nm3. Hydrogen energy prices are much more expensive than traditional fossil fuels, and prices are a major factor in curbing domestic demand for hydrogen energy. The price of hydrogen energy is much more than

conventional energy and its demand is limited, creating a situation where it is not possible to build a full-scale hydrogen energy supply chain with large-scale capital investment.

(3) Challenges Facing Hydrogen Energy Development in Japan

Although hydrogen energy is an important means for Japan to achieve carbon neutrality, the pace of its development is not yet sufficient. The reasons for the slow pace of development are as follows.

- Fuel・Facilities Cost: Hydrogen energy is a true green energy that does not produce carbon dioxide in the application process. However, the fuel cost and initial investment cost of hydrogen energy are higher than fossil fuels. This lack of economic rationality is one of the factors that significantly curbs market needs.
- Establishment of the Supply Chain: In order to realize the supply of hydrogen energy, it is necessary to develop a series of supply chains from manufacturing, transportation, base stations to hydrogen stations. The challenge is that, in order to build a large-scale supply chain, it is necessary to make expensive capital investments.
- Technology Development: Technology development and verification are required to expand the scale of facilities and reduce hydrogen fuel / equipment costs and if future industrialization cannot be foreseen, continuous investment will be difficult.

Source: MINISTRY OF ECONOMY, TRADE and INDUSTRY 「Basic Hydrogen Strategy」, 「Strategic Roadmap for Hydrogen and Fuel Cells」 and Related News

3. Hydrogen Energy Projects in Japan

(1) Ongoing Demonstration Projects

In Japan, dozens of demonstration projects are underway across the country to build a value chain for hydrogen energy. CO2-free Hydrogen Energy Supply-chain Technology Research Association (abbreviated as “HySTRA)”, Advanced Hydrogen Energy Chain Association for Technology Development (abbreviated as "AHEAD"), etc. are projects to build a large-scale hydrogen energy supply system overseas. In addition, the Aichi Low-carbon Hydrogen Supply Chain project is underway to create hydrogen energy demand in the region through hydrogenation of passenger cars, buses, trucks, etc., and thermoelectric cogeneration.

(2) Action plan

① CO2-free Hydrogen Energy Supply-chain Technology Research Association (HySTRA)

In 2016, the CO2-free Hydrogen Energy Supply-chain Technology Research Association was established in collaboration with Kawasaki Heavy Industries, Iwatani Corporation, Shell Japan, J-POWER and Marubeni, and currently Sumitomo Corporation, ENEOS and Kawasaki Kisen are participating. This project is working to build a zero-carbon hydrogen supply chain that includes the production, transportation, storage and use of hydrogen energy, with the goal of commercialization by 2030.

In this project, unused lignite resources from Australia are used as raw material for hydrogen energy. J-POWER, a member of the project, provides lignite gasification technology, and Kawasaki Heavy Industries, Iwatani Corporation, and Shell Japan provide liquefied hydrogen long-distance, large-capacity transport technology and liquefied hydrogen desorption technology, therefore improving the supply chain and improving energy safety in Japan.

At present, lignite gasification technology, liquified hydrogen long-distance large- capacity transportation technology, and liquefied hydrogen desorption technology are in the experimental research and demonstration stages.

② ***Advanced Hydrogen Energy Chain Association for Technology Development (AHEAD)***

In 2017, Chiyoda Corporation, Nippon Yusen, Mitsui & Co., and Mitsubishi Corporation jointly established *the Advanced Hydrogen Energy Chain Association for Technology Development.* The purpose is to build a hydrogen supply chain in Brunei using the organic chemical hydride method. The characteristics of the organic chemical hydride method are that hydrogen can be transported at room temperature and normal pressure, conventional equipment for petroleum can be used continuously, and currently a demonstration experiment is being worked on.

③ ***Fukushima Hydrogen Energy Research Field (FH2R)***

In 2020, NEDO (New Energy and Industrial Technology Development Organization), Toshiba Energy Systems Corporation, Tohoku Electric Power Co., Inc. and Iwatani Corporation jointly participated in a demonstration project for zero-carbon and hydrogen production using renewable energy such as solar and wind power. FH2R's daily hydrogen production capacity is equivalent to one month's worth of electricity in 150 typical households, which is equivalent to the hydrogen consumption of 560 FCVs. FH2R also plays a role of in supplying hydrogen energy to hydrogen stations and factories.

Source: Official websites of the organizations listed above

4. SMFG's Hydrogen Energy Initiatives

(1) ***SMFG***

As one of the three major financial groups in Japan, SMFG is working to support the domestic hydrogen business. In 2020, SMFG participated in the Japan Hydrogen Association (JH2A), which was attended by 88 hydrogen-related companies, and is promoting funding for companies that are trying to reduce costs through technological innovation in response to hydrogen energy demand.

(2) ***SMFG Group Companies***

Sumitomo Mitsui Finance and Leasing Company (SMFL) started the leasing of mobile hydrogen stations for the first time in Japan. In this business, Japan H2 Mobility (JHyM) will be established in partnership with automakers, infrastructure-related organizations and financial

investment institutions, etc., and it will be possible to control the initial investment for establishing hydrogen stations and secure operating funds.

(3) ***Sumitomo Mitsui Banking Corporation (SMBC)***

SMBC, as SMFG's core financial institution, has been working to support the realization of hydrogen energy strategic goals and carbon-neutral targets through diversified financial services.

① *Strategic Support*

In September 2018, SMBC was the first financial institution to join the Hydrogen Council, an international non-profit organization with a vision and long-term goal of utilizing hydrogen energy, as a Supporting Member.

In March 2020, SMBC participated as a secretariat in the Hydrogen Utilization Study Group in Chubu with the aim of expanding hydrogen demand in the Chubu region and creating a supply chain that uses hydrogen in a stable manner.

② *Capital Support*

The Mirai Creation Fund, jointly funded by Sumitomo Mitsui Banking Corporation and Toyota Motor Corporation, invests in companies and projects with innovative technologies in the core technological areas of "intelligent technology", "robotics", and "technology that contributes to realization of a hydrogen-based society". To date, the fund has invested in six hydrogen-related start-up companies.

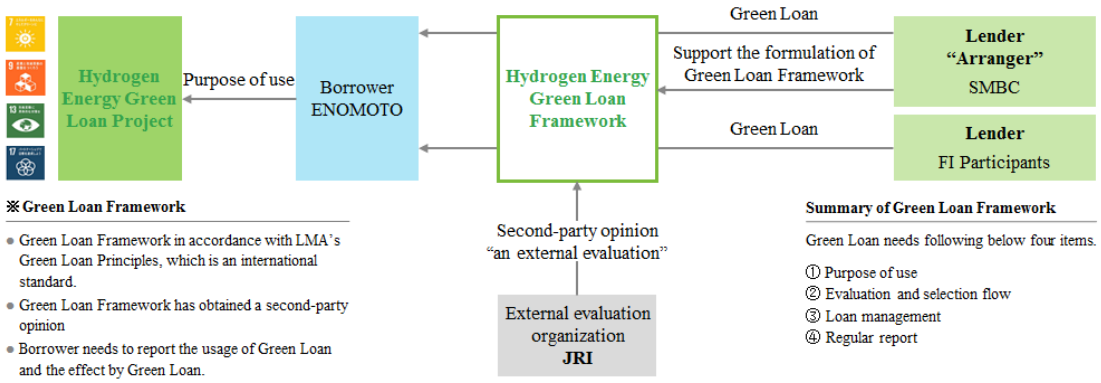
③ *Finance Support (SDGs Green Loans)*

i. SMBC actively provides green finance and sustainability linked loans that meet international standards as funds to companies engaged in hydrogen energy related research and development.

✓ Examples of SDGs Green Loans

Enomoto Co., Ltd. is a manufacturer of precision parts for lead frames and connectors. In order to realize the Hydrogen and Fuel Cell Valley project, industry, government, and academia are working together to research and develop hydrogen fuel cells.
To further promote environmentally friendly hydrogen fuel cells, Enomoto raised funds for research and development of "gas diffusion layer integrated separators" and the establishment of production lines through SDGs green loans.
SMBC has obtained a second-party opinion from an external evaluation organization to support the formulation of its Green Loan Framework in accordance with LMA's Green Loan Principles, which is an international standard.

Hydrogen Energy Green Loan Structure



ii. On May 12, 2021, SMFG announced that it would suspend all financing for new and expanded coal-fired power generation projects from June 2021, including financing for efficient technologies which had previously been an exception. Until now, SMFG has in principle, not financed coal-fired power generation projects, but has not excluded projects that use advanced technologies such as ultra-critical technology.

Source: Sumitomo Mitsui Banking Corporation materials

5. Japanese Company Projects in China

With technological advances in the use of hydrogen energy, hydrogen energy has already become recognized as an important support for power generation in the global energy and transportation industries. China has set a goal of "carbon neutrality and carbon peak" and is incorporating it into its energy strategy.

With the development of hydrogen energy in China, many Japanese companies have partnered with Chinese-owned companies and are active in the hydrogen energy field in China. In June 2020, Toyota Motor Co., Ltd. co-founded the United Fuel Cell System R&D (Beijing) Co., Ltd. with China FAW, Dongfeng, Guangqi, Beiqi, Wuhuatong, demonstrating its focus on research and development of hydrogen fuel cell vehicles (FCEV) in China.

List of Hydrogen Energy Projects in Which Japanese Companies Participate

Dates	Japanese Companies	Chinese Companies	Project Overview
2021/4/1	Choshu Industries	-	Establishment of hydrogen station-related equipment factory
2021/2/1	Toshiba (CHINA)	Hongda	Promote the development of the hydrogen energy industry through the expansion of application areas and channels through strategic alliances
2020/12/1	CMI	Jilin International Energy investment	Concluded a Memorandum of Understanding on improving the utilization rate of new energy and the development of hydrogen energy
2020/12/1	Global Consortium for Energy and Environment	Hunan Nuclear Power Plant	Memorandum of Understanding to promote cooperation in the hydrogen energy sector
2020/12/1	Marubeni and JGC	Juhua Group	Concluded a partnership for low carbonization using a by-product hydrogen plant
2020/12/1	Hitachi Zosen JCOAL	Yulin Economic Technical Development Zone	Concluded a Memorandum of Understanding on experimental projects for hydrogen produced methane
2020/11/1	Sojitz Corporation	-	Investigation to solve problems in transport and storage of hydrogen energy
2019/12/1	Iwatani Corp.	-	New hydrogen production facility established at a factory in Jiaxing City, Zhejiang province

Source of this section: Official Article

6. Recommendations for Chengdu-Chongqing Economic Circle

In order to further develop the hydrogen energy industry in the Chengdu-Chongqing Economic Circle, SMBC, from the standpoint of banking, would like to execute financing that evaluates the efforts of companies related to the hydrogen energy industry. On that basis, in order to properly evaluate each company's efforts in the hydrogen industry and promote the development of businesses that contribute to the environment, I would like to propose actively promoting environmentally evaluated loans based on the evaluations of external evaluation organizations currently engaged in Japan.

Specifically, the financial authorities or government of the Chengdu-Chongqing Economic Circle can consider selecting or establishing an evaluation organization that evaluates the efforts of each company in order to provide generous financial support, which is an issue for the development of the hydrogen energy business. The establishment of a publicly certified external evaluation organization will enable companies that develop businesses that utilize hydrogen energy to be legitimately evaluated, and banks will be able to implement various preferential measures based on the certification of the evaluation organization. As a result, by expanding the range of financing in the costly hydrogen energy business compared to developing businesses using conventional fossil fuels, it is possible to support the development of companies that are the foundation for environmental business expansion. Also, in addition to helping raise public awareness by promoting corporate efforts towards society, it will also be possible to improve the social environment with actual conditions, such as reducing carbon dioxide emissions.

In the development of the hydrogen energy industry in the Chengdu-Chongqing Economic Circle, from the perspective of financial institutions, I would like efforts to be focused towards further co-operation between Chengdu and Chongqing to improve the system that can support the financial aspects that are indispensable for business development.

Leading the Way in Clean and Low Carbon Transformation to Promote Modern Industrial System

Saw Choon Seong
Vice President and President of China, Air Products

I. The Introduction

Chengdu-Chongqing region is the area with the highest level and the greatest potential of development in western China. After the Belt and Road Initiative and the Yangtze River Economic Belt strategy, in January 2020, the central government vigorously promotes the construction of Chengdu-Chongqing Economic Circle, which has become a national strategy and one of the four regional economic centers, along with the Beijing-Tianjin-Hebei Circle in northern China, Yangtze River Delta in eastern China, and Guangdong-Hong Kong-Macao Greater Bay Area in Southern China. It is urgent for Chongqing, an important strategic pivot and a connecting point of the Yangtze River Economic Belt, to accelerate building a modern industrial system and promoting the optimization and upgrading of economic development.

The growing shortage of fossil energy and the serious environmental pollution are the two major crises faced by the world today. The serious impact of the greenhouse effect on climate environment makes people pay more and more attention to the issue of carbon dioxide emission reduction. So, the central government has proposed the goal of carbon peaking by 2030 and carbon neutrality by 2060. Meanwhile, it is formulating various action plans that emphasize on green and sustainable development, request the establishment of clean, low-carbon, safe and efficient energy systems, and explore the clean and efficient use of resources. We have noticed that Chongqing municipal government is also making solid and effective efforts to achieve carbon peak and carbon neutrality.

This article shall analyze Chongqing's energy endowment and industry development needs and provide suggestions and ideas for Chongqing to build a modern industrial system, improve its business environment and build a high quality demonstration area for development, from the point of view of clean and low-carbon utilization of energy, upstream and downstream industry resources integration, the integrated layout of the industrial park, combined with international advanced technology and best practices, based on the global clean low-carbon energy development trend and current situation and tasks of Chongqing energy industry development, as well as Air Products' operating experience of over 80 years and strategy of servicing "energy, environment and emerging market". We expect to contribute to Chongqing's rapid development.

II. Current Status and Challenges of Chongqing's Industrial Development

Chongqing is the only municipality directly under the Central government in central and western China. It is one of the most abundant areas of natural gas in China inland, and also an important area gathering various natural gas chemical industries. Chongqing government gives full play to its advantages of resources and industry foundation, accelerates the new industrialization, and has preliminarily set up a manufacturing system covering all professional categories, and the whole industrial chain, and has built up a world-class electronic information industry cluster, a national automobile industry cluster, the flourishing strategic emerging industries, and the big data intelligent industry. Compared to other domestic areas, Chongqing industrial development has the following characteristics:

1. The industrial growth is fast, but there is still room for green and low-carbon transformation and intelligent management.

Chongqing's industrial development is fast. In 2019 and 2020, the average annual growth rate of industry in Chongqing was 6.2% and 5.8% respectively, both higher than the national level. Chongqing is one of the first batch of national digital economy innovation and development pilot zones, and has made considerable progress in focusing on the exploration of digital industry agglomeration development model, but the degree of integration with energy conservation, environmental protection and intelligence is not enough, and there is still room for development of intelligent manufacturing, green manufacturing and other emerging industries.

2. Scientific and technological innovation has been accelerated, but innovation-driven efforts still need to be strengthened.

Chongqing municipality optimizes the layout of innovation, takes the Western (Chongqing) Science City as the main engine, links the development of Liangjiang Collaborative innovation zone, and speeds up the construction of a science and technology innovation center with national influence. However, the overall R&D investment in science and technology innovation is not high, and the original innovation and basic innovation are insufficient. In 2019, the R&D investment intensity of Chongqing was 1.99%. By the end of 2020, the number of invention patents per 10,000 people in Chongqing was 11.3. Both are slightly lower than the national average level of 2.23% and 15.8, indicating that there is still a potential for improvement.

3. The construction of Chengdu-Chongqing Economic Circle goes with a good start and continuous preferential policies for more openness in business environment.

Chongqing ranks high in China in terms of business environment. In 2020, more than 97% of municipal administrative license items can be addressed “going to government office at most

once", and more than 95% of items can be handled online. The government has also implemented one-to-one services for key foreign investment projects and established a mechanism to help enterprises solve problems. For the tough cross-sectoral, cross-regional problems, the municipal government has set up specialized department in Commerce Commission to communicate with the foreign investment enterprises, coordinate the relevant functional departments and actively track the process and give feedbacks. The deeper the cooperation of Chengdu-Chongqing goes, more national, provincial and municipal level supporting policy have been released, covering industry, investment, tax, fiscal and financial areas. We expect that based on these benefits, the industrial cooperation in Chengdu-Chongqing region will be closer, and a more open business environment will be created from the integration of overall planning and coordination, administrative approval and preferential policies of governments at all levels.

III. Restructuring of the Global Energy and The Development Trend of the Modern Green Industrial Chain

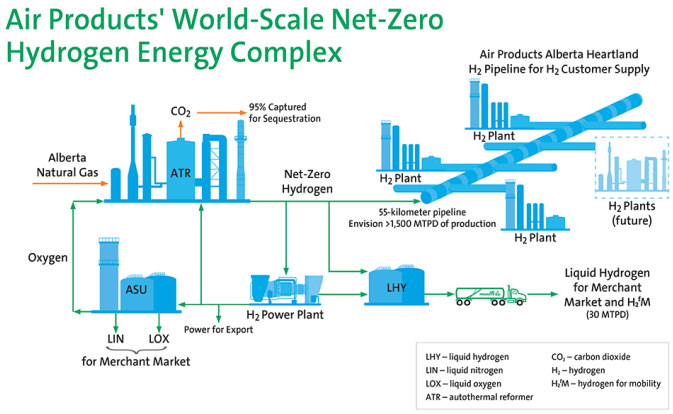
Carbon neutrality and carbon emission reduction have become a global trend and a hot topic. By December 2020, more than 30 countries and regions have clarified their carbon neutrality schedules, accounting for about half of global carbon emissions. One of the keys to carbon neutrality is a revolution in the energy system, namely a significant reduction in fossil energy and a significant increase in renewable energy, so as to achieve a low-carbon energy transition, while continuously improving production efficiency and electrification development, and presenting a diversified energy mix. Natural gas is a low-carbon fossil energy, and plays an important role in the energy transition process. First, it can reduce the dependence on coal and realize low-carbon energy supply. Second, use of natural gas in combination with the technology of carbon capture, utilization and storage (CCUS), can achieve the goal of zero carbon or near zero emissions. In addition, hydrogen energy, especially green hydrogen, is an ideal medium to promote the clean and efficient use of traditional fossil energy and support the large-scale development of renewable energy and is a major strategic direction of the global energy technology revolution and transformation development.

In the background of the restructuring of the global energy pattern, the modern development of the industrial chain has become an important link to achieve the goal of carbon neutrality. The industrialization experience of developed countries shows the development trend of modern industrial chain. First, the industry is transformed towards the high-tech and sophisticated direction, and towards the digital management; second, the upstream and downstream industries of the park are matched to realize rational allocation, comprehensive utilization and intelligent management of resources; third, the operating bodies show a trend of diversification, promoting the development of the park and enterprises by multi-party cooperation; fourth, the integration

of industry and city becomes the new direction of industrial park development; fifth, improve the openness and coordination of the innovation ecosystem, and build an industrial innovation ecosystem in which the whole society collaborates to tackle key problems. From some foreign cases, a High-tech Industrial Park named Adlershof in Germany, which has introduced the high-tech "big park" strategy that integrates scientific research, industry and supporting services in the park, plays a positive role of driving the industrial restructuring and economic development and has become the booster of urban economy. Alberta province of Canada attracts the investment with fine policies, highlighting the upstream and downstream distribution of the industrial chain and resource recycling, in order to realize the clean, smart and safe operation and management of fossil energy. Just in that place, a new net-zero hydrogen complex built and operated by Air Products, is helping to create the hub of western Canada's hydrogen economy. We use natural gas as raw material to produce hydrogen. On the one hand, flammable hydrogen can generate clean electricity for the entire facility and can be exported to the grid; on the other hand, it can provide net zero pipeline hydrogen and liquid hydrogen for transportation and other areas. In addition, clean liquid oxygen and liquid nitrogen produced by our air separation facilities can serve the local commercial gas market with efficient resource allocation, comprehensive utilization and net zero emissions. This project will help improve the basic capacity of the local industry, modernize the industrial chain, and help to achieve carbon neutrality.

IV. Jointly Promote Integration of Chongqing's Clean and Low-Carbon Transformation with Modern Industrial Development

A new round of scientific and technological revolution and industrial transformation is accelerating the development of modern industries to be integrated, intelligent and green. In the context of being equipped with the concept of integrated development and doing a good job in regional coordination, all localities are stepping up efforts to promote high-quality development of manufacturing industries, implementing the development of strategic emerging industrial clusters, upgrading the quality of pillar industries, reengineering the industrial foundation, and upgrading the industrial chain and supply chain, so as to help build a modern industrial system. We have noted that recently, Chongqing has been studying and formulating a series of action plans in areas like manufacturing, scientific and technological



innovation, security, etc.. In the 14th Five-Year Plan of the manufacturing industry, "green" has become a high-frequency word, covering speeding up the construction of green factories and parks, improving the utilization efficiency of energy and resources , reducing the total emission of pollutants and carbon emission intensity, and improving the green development level of the manufacturing industry. These fit well with Air Products' higher purpose: dedicated to collaboration and innovating solutions that help solve the world's major energy and environmental challenges. We will work with all parties in Chongqing to promote the integration of clean and low-carbon transformation and modern industrial development in Chongqing.

1.To Promote Green and Low-Carbon Development of The Entire Industrial Chain of The Park

With unique resource endowment, Chongqing is rich in natural gas and shale gas resources, and has a strong industrial foundation and mature industrial park integration. It is an important energy and chemical industry base in China, especially with a solid foundation in the development of natural gas chemical industry. At present, Chongqing is planning to scientifically layout the energy industry and accelerate the green transformation of key industries such as chemical industry. We suggest promoting the integration of energy supply, realizing rational allocation and comprehensive utilization of resources, adopting a comprehensive perception to develop a complete industrial chain covering both upstream and downstream industries, and introducing a high level of security and intelligent management in the park, so as to realize the clean and efficient utilization of energy in the modern industrial system. While promoting economic development, we need to take into consideration other goals like energy supply, energy structure optimization, industrial development, energy conservation and emissions reduction. These are strategic options for technologies to achieve sustainable development of economy and build a modern industrial system. Currently, Air Products has been discussing with some parks on an integrated solution of design, investment, construction and operation of an industrial gas island. On the one hand, it can recycle carbon dioxide emitted by entities in the park, and use dry reforming technology to transform carbon dioxide and natural gas to syngas (hydrogen and



carbon monoxide) that can serve as the raw materials for enterprises producing high value-added downstream products in the park. On the other hand, it also supplies high quality steam by-product to the park, and the required industrial gas such as hydrogen, oxygen, nitrogen through

the pipeline network for other enterprises in the park, thus improving the overall industrial supporting ability of the park. And hydrogen can also be used as transportation fuel to play a positive role in Chongqing's transportation energy transformation. Air Products is willing to promote the construction of hydrogen infrastructure network, and to make contributions to the clean and low-carbon energy transformation, and the goal of carbon neutral as soon as possible in Chongqing.

2.To Accelerate Collaboration in Green Innovation

The level of basic research and innovation ability is an important symbol of a country's scientific and technological strength and comprehensive national strength. It is of great importance to vigorously promote green technology innovation, change the traditional way of thinking, create an innovative atmosphere in the whole society, build a modern corporate incentive mechanism with innovation in green culture. It will lay a solid foundation to promote economic development and cope with various challenges by promoting front-end basic research, transforming applied research, launching preferential policies, and creating a good public opinion atmosphere for scientific and technological innovation.

To encourage technological innovation, we suggest that Chongqing government build a supportive supply system for the whole industrial chain of the upstream and downstream industries, and carry out a series of measures in terms of standard research and development, supply and demand matching, talent cultivation, park planning, integration of industry and financing, etc. for the coordinated development of surrounding areas. In addition, governmental agencies can use a variety of fiscal, tax and innovation policies to guide enterprises to further increase investment in science and technology, and actively support universities, research institutes and other research and innovation units to strengthen cooperation and collaborative innovation with enterprises, open up the channels from technology and application research and development to industrialization in an all-round way, and vigorously improve the main indicators of scientific and technological innovation development in the "14th FYP" of Chongqing.

3.To Foster Further Openness in Business Environment

Business environment is the core competitiveness of a country or a city. A good business environment is a key factor to make entities, foreign investment and foreign trade stable, and is important to the sustainable development of regional economy. Business environment in open, fair and transparent policy and regulatory manners is taken as one of the important conditions to attract the long-term development of foreign-invested enterprises in China. In addition, in terms of governance specialization, we suggest that further efforts can be made in the forward-looking industrial policies and regulations in accordance with demands and requirements of development.

At the same time, detailed rules for implementation shall be issued with clear target. In addition, it is necessary to actively build a service-oriented and professional government, establish a system for serving enterprise respectively providing one-on-one policy consultation for enterprises.

4.To Formulate Coordinated and Supportive Standard System in Accordance with Local Conditions

It is of great importance to promote the high-quality development of energy and a necessary guarantee to promote the safe, efficient and intelligent operation of the industrial chain of the park to establish a new standard system with the coordinated development and coordination between the standards established by the government and the standards independently formulated by the market. In recent years, significant progress has been made in the construction of a new standard system in the field of energy. However, the environmental complexity and risk level faced by the development of modern industry have been unprecedentedly intensified, and the development space and vitality of standard upgrading need to be further released. The park should take the lead in promoting the construction of new standard system in emerging fields such as smart energy, energy interconnection, energy storage and hydrogen, and adopt policies and measures according to industry conditions, scientifically determine new standard system in various fields, continuously promote the optimization of standard system, and realize the coordination of international and domestic standards. At the same time, the government can further explore cross-regional coordination mechanism of government functions by establishing joint standardization organizations, promoting the mutual recognition and acceptance in standards between Sichuan and Chongqing in terms of inspection and testing results.

5.To Develop International Talent Training Scheme and Improve Energy Technology Research and Development

World-class human resources are a prerequisite for cultivating a culture of innovation and building a high-end manufacturing hub. We suggest that the government focus on promoting the connection between talent policies and industrial development needs, work with Chengdu to build a talent introduction model, optimize talent cultivation policies and improve the inter-regional cooperation and development mechanism of vocational education. In addition, in the optimization of talent growth policies, we can consider relaxing the requirements and restrictions for professional application in terms of household registration, identity, personnel relations, and implement mutual recognition and approval of professional and technical qualifications, continuing education certificates, and foreigner work permits. The governmental agencies should establish a system of permanent residence and work for high-level foreign talents, encourage international companies to have more cooperation with local universities, especially

in technology research and development in the energy sector. In Shanghai, for example, Air Products and the Shanghai Institute for Advanced Research under the Chinese Academy of Sciences have launched a joint research and development cooperation on front-end technologies for comprehensive utilization of carbon dioxide (CO2) aiming to help the development of carbon capture and utilization in China.

V. Conclusion

As it is known to all that the city prospers as the industry thrives, while the city is full of vigor when the industry is strong. Industrial system is playing a fundamental role in high-quality development to build up modern economic system. It is of great significance to fulfill a modern industrial system by promoting the transformation to clean and low-carbon development for stronger international competitiveness of cities. As a multinational company who has been committed to providing solutions for concerted development of energy and the environment, Air products will continue to make efforts in bringing the dynamic innovation of green development with efficiency, intelligence and safety which will create momentum to the modern urban system and the integration planning of industrial park. We will make full engagement together with all parties to forge Chongqing into a leading city featuring in optimal business environment and low-carbon development.

Suggestions on Chongqing's Policies for the Path to High-quality Development of Manufacturing Industry

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Abstract

High-quality development is a crucial way for China's economic development during the 14th Five-year Plan period. International experience shows that a highly competitive manufacturing industry tends to boost the overall quality development for countries and regions.

During the 14th Five-year Plan period, Chongqing has been implementing Central government's plan and continuously accelerating the high-quality development of its manufacturing industry. We suggest that along developing the main priorities in a step by step approach, the city could consider: first, enhance top-level design and strengthen overall planning and coordination. Second, benchmark international experience and cultivate international advanced manufacturing clusters. Third, further opening-up and encourage foreign enterprises in Chongqing to make more contributions. Fourth, actively implement China's *Foreign Investment Law* to improve foreign companies' participation and investment confidence. Fifth, increase the transparency of policies and regulations to companies especially to foreign companies and meanwhile allow more participation of them into the policy study and formulation process. Sixth, facilitate cross-border capital transactions from other cities' practices such as Beijing. Seventh, take multiple measures to ensure the high-quality talents pool for manufacturing industry.

1. Background and connotation of high-quality development of manufacturing industry in Chongqing

1.1 Chongqing's manufacturing industry has made great progress

Manufacturing industry occupies a very important position in Chongqing's economic development. In 2020, the added value of Chongqing's primary industry was 180.333 billion yuan, up by 4.7%; The added value of the secondary industry was 999.221 billion yuan, up by 4.9%; The added value of the tertiary industry was 1.320725 trillion yuan, up by 2.9%. The three industrial structures accounted for 7.2%, 40.0% and 52.8% respectively. [1] Chongqing's manufacturing industry has a sound industrial system, with all 31 major manufacturing sectors, and a manufacturing system with complete categories and diverse products has been basically established. The dominant fields are more prominent. The output of microcomputer, mobile phone, automobile and motorcycle accounts for more than 24%, 9%, 6% and 29% of the national total

respectively. The largest production base of adipic acid and spandex in China has been built. The number of industrial enterprises above designated size exceeds 6,800, among which 1 enterprise exceeds 100 billion yuan and 20 enterprises exceed 10 billion yuan (independent legal person). Innovation capacity continued to improve, and a total of 10 national level key laboratories were established. There are 237 of the world's top 500 industrial enterprises in Chongqing, and the foreign investment in the industrial sector has kept above 4 billion dollars for 10 consecutive years. [2] The manufacturing industry of Chongqing complies with the trend of a new round of scientific and technological revolution, industrial transformation, accelerates the construction of "Smart Town" and "Smart City". As a summary, Chongqing has basically completed the transformation from the national old industrial base to a national important modern manufacturing base, and the high-quality development trend of manufacturing industry has been accelerated.

1.2 High-quality development of manufacturing industry is the fundamental principle of Chongqing

The Central Economic Work Conference held at the end of 2018 pointed out that high-quality development of manufacturing should be promoted to build China into a manufacturing powerhouse. On April 17, 2019, General Secretary Xi Jinping stressed during his visit to Chongqing, "We must unswervingly promote high-quality development, focus on deepening supply-side structural reform, and give higher priority to high-quality development of the manufacturing industry." [3] In March 2021, the 14th Five-Year Plan and Outline of Long-term Goals for 2035 clearly stated that the proportion of the manufacturing industry should be kept basically stable, the competitive advantage of the manufacturing industry should be enhanced, and the high-quality development of the manufacturing industry should be promoted. In July 2021, Chongqing Municipal People's Government issued the 14th Five-Year Plan for High-quality Development of Chongqing Manufacturing Industry (2021-2025). Therefore, to accelerate the high-quality development of manufacturing industry is not only to thoroughly implement the deployment of the central government and the plan of Chongqing Municipal Party Committee and municipal government, but also to promote the leap-forward development of manufacturing industry in Chongqing.

1.3 The basic connotation of high-quality development of Chongqing manufacturing industry

The high-quality development of manufacturing industry is guided by the five new development concepts of "Innovation, Coordination, Green, Openness and Sharing", which reflects the new requirements for the development of China's manufacturing industry in the new era. The evaluation measures of high-quality development of manufacturing industry include: quality of supply, economic efficiency, scientific and technological innovation, green development

and social benefits. [4]

The high-quality development of manufacturing industry in Chongqing has the following four aspects: first, the transformation and upgrading of traditional industries, the prominent competitive advantages of pillar industries, the development of strategic emerging industry clusters, and the forward-looking layout of future industries. Second, we will accelerate the upgrading of the industrial base and the modernization of the industrial chain, foster advanced manufacturing clusters with international influence, and accelerate the development of an important national advanced manufacturing center. Third, the manufacturing sector will enjoy more stable growth, better structural adjustment, greater industrial resilience and more extensive international and domestic cooperation. Fourth, the achievements of manufacturing development are shared to better drive the high-quality economic and social development of the whole city and even the whole country, to produce good economic and social benefits.

2. Suggestions on the main direction and strategic steps of high-quality development of manufacturing industry in Chongqing

2.1 "Four Main Directions" for high-quality development of manufacturing industry in Chongqing

First, intelligent manufacturing. Intelligence is the integrated development of manufacturing, new-generation of artificial intelligence and digital technology. By optimizing the structure of labor force, improving production efficiency and improving product quality, it can enhance the competitiveness of manufacturing and promote the high-quality development of manufacturing.

Second, green manufacturing. Green development is a necessary requirement for building a modern economy. Green manufacturing is the product from design, manufacturing, use to scrap the entire product life cycle in line with the requirements of environmental protection, ecological environment is harmless or little harm, save resources and energy, make the highest resource utilization rate, the lowest energy consumption. In addition to the production process, green manufacturing can also focus on encouraging the industry to continuously improve the "Green Percentage" of products through research and development, that is, to reduce the environmental pollution in the process of product use.

Third, collaborative manufacturing. It includes three aspects: first, improve the level of coordination and collaboration among enterprises in the upper, middle and lower reaches of various industries in the manufacturing industry. Second, the manufacturing sector and the service sector should develop in a coordinated way, and vigorously develop service-oriented

manufacturing to open up new space for improving the quality and efficiency of the manufacturing sector as well as its transformation and upgrading. Thirdly, Chengdu-Chongqing twin cities economic circle strengthens the cooperation of manufacturing industry with the thinking of "A Game of Chess" and develops in the same direction.

Fourth, humanistic manufacturing. Humanistic manufacturing reflects the ideology, culture and values contained in the development of manufacturing industry, including deep thinking on the core competitiveness and philosophical connotation of manufacturing industry; In the development of manufacturing industry, more prominent human role, humanistic care and people-oriented; The high-quality development of manufacturing industry and the all-round development of people promote each other.

2.2 "Four-Stage Strategy" for high-quality development of manufacturing industry in Chongqing

The first stage is to cultivate leading enterprises and leading enterprises in the industry. Encourage the core enterprise with considerable size and strength to conduct relative concentration or effective restructuring in a certain time and space by its own size, industry influence and industry development voice, etc. Promote the coordinated development of industry chain upstream and downstream, thus generate industry scale and functional agglomeration effect as well as spillover effect, enhance core competitiveness of the industry as a whole.

The second stage is to build an international advanced manufacturing cluster. Strengthen the overall planning and carry out characteristic positioning and forward-looking layout for the industrial functions of Chongqing's internationally influential advanced manufacturing cluster. Extend and improve the innovation chain by focusing on the advantageous industries in the manufacturing cluster. Strengthen interaction between innovation chain, industrial chain and global value chain. Through industrial chain upgrading and division of labor, move up to the middle and high end of the global value chain.

The third stage, to promote the formation of Chengdu-Chongqing twin city economic circle. According to development concept of Chengdu-Chongqing twin cities economic circle, through the implementation of "Repair Chain Groups, Toward High-end" and "Industrial Chain Integration and Innovation Chain" strategy, establish industry shaft between the Chengdu-Chongqing twins, layout and construct cross-regional industrial generic technology research, development platform, public service platform, as well as industry technology innovation strategic alliance, pilot maturation, industrialization base of scientific and technological achievements. Strengthen the integration of technology research, product manufacturing, application deployment in Chengyu area.

In the fourth stage, to embed in the Yangtze River Economic Belt and build a global advanced manufacturing base together. Focusing on the national strategic background of regional integration, based on the local resources and industrial foundation of Chongqing, coordinating the factor resources of different regions, different levels and Chengdu-Chongqing Twin Cities economic circle, actively embedding in the Yangtze River Economic Belt, and jointly building a global advanced manufacturing base with Shanghai, Jiangsu, Zhejiang, Anhui, Jiangxi and other brother provinces and cities. Strive to shape new economic growth momentum for our country, make Chongqing a model for construction of a modern economic system.

3. Policy suggestions for high-quality development of manufacturing industry in Chongqing

3.1 Cummins practices and contributions to the high-quality development of manufacturing industry

Cummins is one of the earliest global engine enterprises to enter China. Chongqing Engine Plant began licensed production of Cummins engine since 1981. CCEC Engine Co., Ltd. (CCEC) was the first joint venture of Cummins established in 1995 with Chongqing Mechanical and Electrical Co. Ltd. After many years of development, both parties' cooperation continues to deepen. The company has been awarded as Top 50 Industrial Enterprises in Chongqing, Top 10 Foreign Invested Enterprises in Chongqing, National Green Factory and other titles for consecutive years.

CCEC has made the following contributions on promoting the high-quality development of manufacturing industry:

First, by complying with high standards, the product and product quality, environmental protection, safety and so on constantly improve the operation efficiency and benefits. CCEC is the largest professional manufacturing plant of heavy-duty and high-horsepower diesel engines of Cummins in China. In order to meet the demand of domestic market and domestic OEMs going global, we constantly benchmark and make high standards and forward-looking input in product technology, manufacturing technology and application technology. The products range from few to many, from mechanical to electronic, from low-emission standards to high-emission standards and high-efficiency engines. In 2019, CCEC Technical Center was officially launched in Chongqing to coordinate global research resources, thus push high horse power technical breakthroughs. CCEC has also invested a high-horsepower diesel engine new product production base and power generation technical center with research, detection, testing and other functions, which will provide more powerful technical support for the sustainable development of CCEC.

Second, actively promote localization and improve the quality and resilience of supply

chain. CCEC is the starting point of Cummins production localization in China. Cummins has also localized purchasing of raw materials and parts in China which promotes closer cooperation with local upstream and downstream industry chain enterprises. The power industry is a long value chain and has a strong ability to drive all aspects of the national economy. Cummins actively implement the localization of supply chain to drive the development and internationalization of local small and medium-sized suppliers. This year, Cummins Supply Chain Service Center in China was established to improve the quality and resilience of its supply chain.

Third, we will contribute to the high-quality development of China's equipment manufacturing industry. CCEC product is suitable for heavy-duty truck, construction machinery, mining machinery, petroleum machinery, railway machinery, port machinery, stationary and mobile diesel generator, marine propulsion unit and auxiliary power unit, pump power units and other power units; product emissions meet China, US, Europe, International Maritime Organization (IMO) and other required standards. CCEC engine product technology, manufacturing technology and application technology synchronously develop with Cummins globally, and its power, economy, reliability, durability, safety and environmental quality has gained the trust of major users, and also enhanced the level of Chongqing and China's equipment manufacturing industry.

Fourth, expand export and access to the international market. In addition to supplying domestic market, CCEC's engines have been exporting to overseas market, and equips OEMs products to the global market. The international market has also become one of the new profit growth points of the company and the domestic equipment industry.

3.2 Cummins' policy suggestions on the high-quality development of Chongqing manufacturing industry

3.2.1 Do top-level design and strengthen overall planning and coordination

Suggest to up manufacturing high-quality development leading group, Chengdu-Chongqing circle construction joint meeting, executive deputy mayors coordination meetings, offices, etc. and some of these organizations may invite local leading executives, experts and international experts to join, so as to strengthen the top-level design of manufacturing's high quality development, coordinate the policy formulation, project layout, fund arrangement and performance evaluation between the two cities and various departments, and form a regional economic layout with complementary advantages, meeting each other and high-quality development. In addition, we need to strengthen the innovation of management systems mechanisms, and develop cooperation mechanisms for projects between Chinese and foreign enterprises, state-owned and private enterprises, enterprises and universities.

3.2.2 Learn from international experience and cultivate advanced manufacturing clusters with international influence

The main area of international industrial competition is manufacturing. The successful experience of international advanced manufacturing clusters can be summarized as: attaching importance to perfect policy system, scientific innovation and advanced technology research and development, regional advantages and internal cooperation of clusters, the construction of mature innovation ecosystem and attaching importance to the integrated development of service industry and manufacturing industry. [5] It is suggested to focus on cultivating a new generation of information technology, high-end equipment, new energy vehicles, new materials, biomedicine, new medical equipment and other industrial clusters by comprehensively considering and evaluating the foundation and potential of industrial development, industrial influence and competitiveness, the advantages and disadvantages of industrial cluster in Chengdu-Chongqing area. [6]

3.2.3 Study and formulate a forward-looking institutional framework to guide enterprises on the road of innovation, provide institutional guarantee and stable expectations

Manufacturing innovation, was more dependent on the competition between the enterprises in the past, but now innovation driving force is more and more decided by policies, which includes the government improvement of security, environment, protection of rights and interests of consumers and other various aspects of standards based on the public interests, also form the "Scenario" based on the development of national, regional and local policy. It is suggested that under the national overall development plan, government departments, research and academic institutions, enterprises should be organized to jointly make a framework and forward-looking outline of the future development scenarios and key needs of Chongqing and the Chengdu-Chongqing area, so as to guide enterprises to make an innovation plan with clear objectives and step-by-step approaches and provide stable expectations for enterprise’s innovation.

3.2.4 Actively implement the Foreign Investment Law to enhance the investment confidence of foreign companies

Actively and earnestly implement the provisions of the Foreign Investment Law on the equal participation of foreign companies in government procurement, formulation of standards, preferential policies and other national treatment. It is suggested to focus on the challenges faced by some foreign manufacturing enterprises, especially large foreign enterprises that are complementary to China's industrial chain and have strong pull forces, including the impact of rising costs and tariffs on the competitiveness of their operating in China. It is suggested that not only solve local problems for enterprises, but also act or provide suggestions for enterprises to solve the whole industrial chain problems, continue to maintain the position of these local key

enterprises in the domestic and global supply chain, and enhance the attractiveness of China to foreign investment.

3.2.5 Increase the transparency and participation of policies and regulations related to enterprise development, especially for foreign-invested enterprises

Take the automobile industry as an example. At present, the international large automobile enterprises are tilting more resources to electric, new energy and other directions, but the domestic traditional fuel automobile industry is still increasing investment. Suggestions: first, make an overall plan for the further promotion of traditional energy technologies and the coordinated development of new energy technologies, including encouraging the research and development of energy-saving and emission reduction technologies, encouraging the development of new energy sources such as hydrogen energy at the same time. The second is the national vision and roadmap for climate change, carbon peaking and carbon neutrality, which is directly related to the R&D and investment strategies of many industries, including the power industry. Therefore, the cooperation between enterprises and the government to jointly formulate the action plan and the design of the road map to reach the carbon peak and carbon neutrality can two-way facilitate the development of the next strategic plan of enterprises and the realization of the relevant goals in the government action plan.

In addition, the impact of some industry regulations on driving technological progress is already evident and will become even more significant with "carbon neutrality" and climate change. These laws and regulations mainly affect manufacturers and supply chains. Therefore, the cost of the regulation upgrade needs to be borne by the manufacturers and the supply chain and is difficult to pass on to the buyers and users. These costs and risks caused by the upgrade of regulations also increase the operating costs and risks of enterprises. It is suggested that the government should strengthen policy enforcement, or increase industry self-discipline and compliance, so that industry enterprises can achieve the purpose of reducing costs and attracting customers through technological progress, rather than "exploiting loopholes" in regulations and standards to reduce costs.

3.2.6 facilitate cross-border capital transactions as such other cities' practices as Beijing

On March 12, 2021, the People's Bank of China (PBOC) and the State Administration of Foreign Exchange (SAFE) decided to launch the pilot program of the integrated capital pool of domestic and foreign currency for multinational corporations in Beijing, to facilitate multinational corporations to quickly handle the centralized cross-border domestic and foreign currency receipts and payments, overseas RMB loan and foreign exchange purchase. The pilot project further enriched the business functions of the group's cross-border capital pool, enhanced the risk

prevention and control ability, improved the efficiency of capital use, and saved the overall operating costs of the group. Particularly, allowing enterprises to purchase foreign exchange within a certain quota can help lock the exchange rate costs and avoid exchange rate risks. It is suggested that Chongqing pilot free trade zone and pilot opening of service industry should copy the experience of Beijing and other cities to facilitate foreign exchange and other cross-border capital transactions for companies with such needs. [7]

3.2.7 take multiple measures to ensure the high-quality talents pool for manufacturing industry

Human resources play an increasingly prominent role in supporting the high-quality development of manufacturing industry. It is suggested that Chongqing should explore the establishment of a talent development group to undertake all levels of talent cultivation, introduction, retention and other human resources work required for the high-quality development of manufacturing industry. First, we need to continue to strengthen training, effectively upgrade the skills of workers, improve their employment quality and income level, ensure that enough skilled and professional workers serve as the foundation of the industry, and lay a solid foundation for the high-quality development of the manufacturing sector. Second, by supporting local universities and scientific research institutions, to increase efforts to cultivate high-end applied talents who can adapt to the development of modern manufacturing industry. Third, introduce attractive preferential settlement policies for high-end talents to attract outstanding talents at home and abroad to settle down in Chongqing. Fourth, formulate and implement incentive policies (including tax reduction, honorary awards, etc.) to encourage overseas talents and foreign experts to relocate in Chongqing.

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The "Tale of Two Cities" and the "Economic Circle": Opportunities and Challenges-Collaboration on Building a Modern Industrial System with Innovative Dynamics

ISUZU Motors Limited

I. Positioning of the Chengdu-Chongqing Twin-city Economic Circle[74]

In recent years, the building of the Chengdu-Chongqing Twin-city Economic Circle has been accelerating.

In January 2020, General Secretary Xi Jinping formally issued a decision to promote the building of the Chengdu-Chongqing Twin-city Economic Circle at the 6th meeting of the Central Finance and Economics Committee (CFEC). In October of the same year, a meeting of the Political Bureau of the Communist Party of China (CPC) Central Committee deliberated and approved the program outline for building the Chengdu-Chongqing Twin-city Economic Circle.

China began to attach importance to promoting “regional development” around 2003. In the early years of reform and opening up, the policy of developing the coastal areas in priority led to a widening gap between the economic development of the coastal areas and the inland areas. In the 1990s, the issue of unbalanced economic development between regions became apparent. In October 2003, the Third Plenary Session of the 16th Central Committee of the Communist Party of China (CPC) proposed for the first time a "coordinated regional development strategy", suggesting a regional development approach that promotes “mutual reinforcement, complementarity and common development". At that time, China was roughly divided into four major regions, for which the development plan of “Prioritizing the East”, “Go West”, “the Rise of Central China” and “the Revitalization of Northeast China" was introduced according to the development situations of different regions.

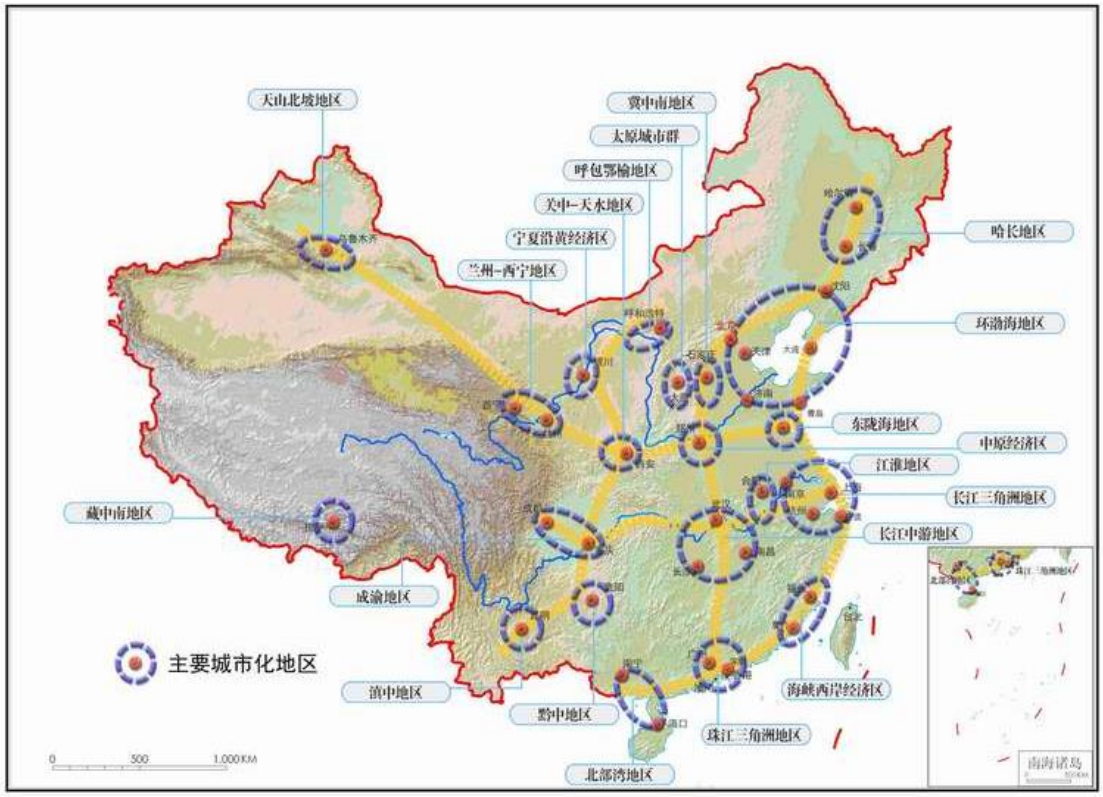
In 2010, the State Council issued a circular on the "National Plan for Main Function Zones".75 It included strategies aiming for optimal development to form three mega-city clusters, namely "Bohai Economic Rim", "Yangtze River Delta" and "Pearl River Delta”, as well as strategies to form large city clusters and regional city clusters targeting at 18 regions. "Chengdu-

[74] “The regional development strategy has achieved remarkable results and the development pattern has taken on a new look. （http://www.gov.cn/xinwen/2018-09/14/content_5321859.htm）

[75] "National Plan for Main Function Zones" (GF [2010] No. 46) （http://www.gov.cn/zhengce/content/2011-06/08/content_1441.htm）

Chongqing region" was also included in this strategy.

Figure 1 Strategic structure of urbanization (diagram)



Source: From Figure 8 of the National Plan for Main Function Zones

In the second half of 2014, the Chinese government introduced the concept of 'economic belt', making efforts to link city clusters and achieve broader inter-regional cooperation. It introduced policies to promote inter-city cooperation and development, which accelerated the formation of five major economic zones: the Coastal Development Axis, the Yangtze River Economic Belt, the Silk Road Economic Belt, the Pearl River-Xijiang River Economic Belt, and the Harbin-Dalian Economic Belt. The Belt and Road Initiative, the Beijing-Tianjin-Hebei Integration Initiative and the Yangtze Economic Belt Initiative, which were subsequently proposed, are known as the three major strategies of economic belt development.

Chongqing is located at an important geographical position in "Economic Belts" as the intersection between the Yangtze River Economic Belt and the Silk Road Economic Belt. In 2016, in order to further improve and refine the National Plan for Main Function Zones, the State Council issued the "Development Plan of Chengdu-Chongqing City Cluster[76]. It is clearly stated in the Plan

75 "Announcement of the Chengdu-Chongqing City Cluster Development Plan" by National Development and Reform Commission（https://www.ndrc.gov.cn/fzggw/jgsj/ghs/sjdt/201605/t20160504_1170022.html）

that fostering the development of the Chengdu-Chongqing city cluster would give full play to its unique advantages of bridging the southwest with northwest of China as well as China with foreign countries, promote the interaction between the Belt and Road Initiative and Yangtze River Economic Belt Initiative, help accelerate the development of the central and western regions, create new space for national economic growth, help safeguard national security, and optimize the layout of the national territory. The Development Plan laid a foundation for the building of the Chengdu-Chongqing Twin-city Economic Circle, whose concrete implementation was accelerated after 2020.

In the past, China's regional economic development policies were formulated by provinces, municipalities, autonomous regions and prefecture-level cities in accordance with the guidelines of the central government. Although these policies were based on the geographical environment and existing industries and other characteristics of respective regions, they were still very similar. This means that the development plans of neighboring provinces, municipalities and prefectures were highly homogeneous, and the industrial structure and industrial functions within a certain region tended to overlap, which made it difficult to form a good mechanism of regional synergetic development. However, seeing from the above changes in regional development and industrial revitalization policies of recent years, now the regional industrial policies are formulated with a broader perspective, with a realization that the synergetic development of neighboring regions can contribute more to the regional economy.

II. Initiatives related to the urban industrial clusters in Japan

A review of Japan's regional economic and industrial policies to date shows that Japan also attaches equal importance to "coordinated regional development" and the formation of "urban industrial clusters" and has been making efforts in this respect.

1. Changes in Japan's policies for regional industrial development

Generally speaking, Japan's regional economic and industrial policies have been evolving along time.

The regional economic and industrial policies implemented during economic boom were designed to prevent the over-concentration of industry in a particular region and to guide the rational allocation of industry in regions. In the 1980s, industries favored local areas more and more, as the industrial structure shifted from heavy industry to processing and assembly industries. In the 1990s, the bursting economic bubble led to a decline in investment by Japanese companies in domestic production bases and a gradual shift of manufacturing plants overseas, and the deindustrialization of local industries became a pressing issue. In contrast to the Japanese economy, which fell into a prolonged recession after the bubble burst, the US economy experienced sustained

growth, and it is believed that one of the driving forces behind America's growth is the regional industrial clusters in Silicon Valley. As a result, the Japanese government realized that it should use Silicon Valley as a model to build the same kind of industrial innovation mechanism in Japan. In the late 1990s, the Japanese government proposed a policy centered on "promoting industrial integration and industrial innovation with resources of each region". The Industrial Cluster Plan introduced in 2001 has played a crucial role in the implementation of this policy.

2. Industrial Cluster Plan (2001-2020)

In 2001, the Japanese government began to implement the Industrial Cluster Plan. Implemented from 2001 to 2020, the Plan was developed to enhance Japan's international competitiveness and to help revitalize the regional economy.

The purpose of the Industrial Cluster Plan was to create a network of industry-academia cooperation, inter-company cooperation and cross-industry cooperation by bringing together companies, universities, research institutes, industrial support organizations, industry-academia cooperation intermediaries and experts in geographical proximity, and through this network, to share and utilize the value of the knowledge (technologies, methods, information, knowledge, insights, etc.) accumulated in the cluster, to energize the innovation model, and to build a mechanism for the creation of new businesses and industries (industry clusters) centered on each region. It aimed to promote the formation of a wide co-development mechanism pillared by industries with competitive advantages.

1) The ultimate goal of forming industrial clusters

The Industrial Cluster Plan was intended to promote innovation through the networking of resources in each region and eventually create an external environment favorable for new businesses and industries. In addition, the Plan set the ultimate goal of forming long-term industrial clusters over the next few decades.

At the first stage, the Plan proposed to create "chain reaction innovation".

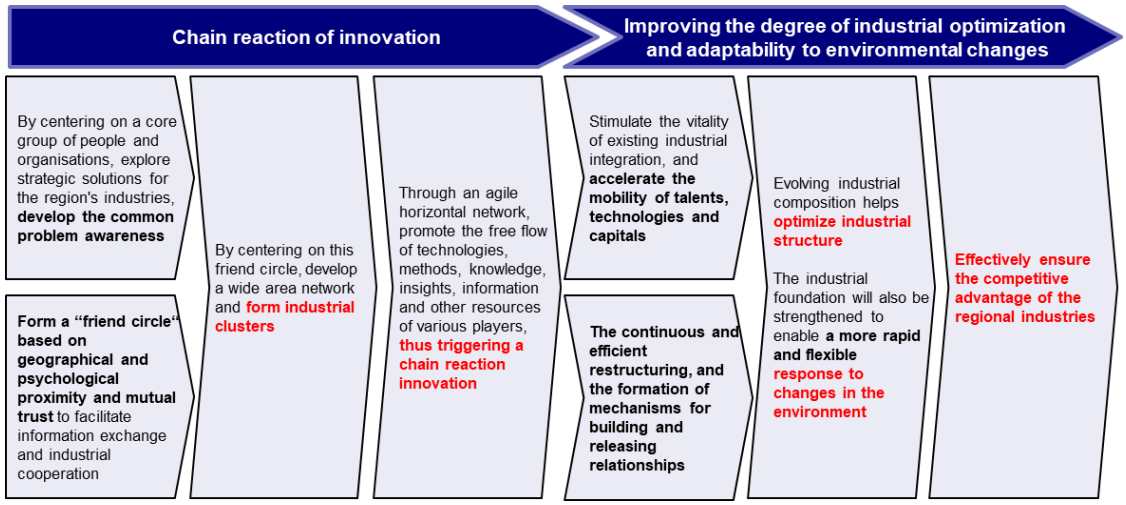
Specifically, it would bring together a wide range of regional players (companies, universities, research institutions,educational institutions, industry support organizations, administrative bodies, etc.) to develop common regional problem awareness through a core group of people and organizations to discuss strategies and solutions relating to the region's industries. By activating face-to-face interpersonal communication, a "friend circle" was formed based on personal trust arising from geographical and psychological proximity, thereby facilitating information exchange and business cooperation. Around this "friend circle", a wide area network was developed and eventually industrial clusters were formed. On this basis, in the industrial clusters, free flow of

technologies, methods, knowledge, insights, information and other resources of various players was promoted, thus triggering a chain reaction innovation.

In addition, the activation of innovation in clusters was considered to be able to improve industrial optimization and adaptability to environmental changes. By activating innovation, existing clusters could be energized and the flow of talent, technology and capital could be facilitated. In terms of business operations, the emphasis of priorities and business cooperation in core areas, the business outsourcing of non-core areas, and the restructuring of inefficient sectors led to a continuous process of efficient restructuring, relationship building and dissolution. In addition to the optimization of the regional industrial structure, the continuous evolution of the industrial structure also strengthened industrial foundation to enable a more rapid and flexible response to changes in the environment. Subsequently, the competitive advantage of the region's industries could be secured.

This helped improve the overall optimization of the industry and its adaptability to environmental changes, which was the ultimate goal.

Figure 2 The ultimate goal of forming industrial clusters



Source: Collected from documents related to the Industrial Cluster Plan of Japan

2) Stages of policy implementation

From, the Industrial Cluster Plan was implemented from 2001 to 2020 by three phases.

Phase I (2001-2005): The start-up period for the industrial clusters. The Japanese government was at the center of the plan, and a mechanism for cooperation between local industrial clusters was established, with the aim of building a "friend circle" to form the basis of industrial clusters.

During this period, 20 priority projects had been selected for promotion in the fields of manufacturing, biotechnology, environment, IT, and semiconductors. A single project even attracted the participation of more than 2,000 and more than 100 universities.

Phase II (2006 - 2010): The growth period of the industrial cluster. The main objective of this phase was to continue to promote the formation of a "friend circle" while helping each project entity to implement specific businesses. It also promoted innovation in the management of participating companies and fostered start-ups.

Phase III (2010 - 2020): The period of autonomous development of industrial clusters. While forming a "friend circle" and further developing specific businesses, it sought independent financial activities of industrial clusters to promote their independent development.

By far, the implementation of the Industrial Cluster Plan was almost completed, and the clusters entered a phase of autonomous development. In addition, in 2016, in parallel with the implementation of the Industrial Cluster Plan, the government introduced the Support Project of Regional Enterprise Innovation, which would succeed the Industrial Cluster Plan.

3. Key points of the Industrial Cluster Plan

1) Creating an environment that nurtured innovation

The first point of interest in Japan's Industrial Cluster Plan was the definition of "industrial clusters". In the Industrial Cluster Plan, the formation of industrial clusters was defined as "a state in which industries with competitive advantages become the core of a commercial environment, in which new businesses can be created continuously and industrial integration is promoted over a wide area". The ultimate goal was industrial integration, but more importantly, it was "continuously generation of new businesses", i.e., the "improvement of the commercial environment" that "nurtures innovation".

In the past, the term "industrial cluster" often only conjured up 'the geographical integration of industries'. China have established "special economic zones", "new economic zones", "economic development zones" and "high-tech industrial parks" to promote industrial integration. In the early stages, the main focus was placed on "attracting investment to newly developed areas" and the "economic development" followed. However, for one thing, these "special economic zones", "new economic zones", "economic development zones" and "high-tech industrial parks" have a limited scope and geographical expandability, and tend to attract enterprises by building new infrastructures and offering tax incentives in specific areas. For another, local governments are still prone to develop the mode of combining "new zone + national key industries", although they determine key industries to be developed in the future based on the development of existing

local industries. While the areas are aware of the need to improve technology by attracting high-tech and related companies, they are less aware of the need to create a commercial environment that nurtures innovation.

In this regard, the “Industrial Cluster Plan” emphasized the “use” of existing “regional resources” and the “creation of a commercial environment that nurtures innovation”. This is key to the future industrial revitalization of the regional economy. In the future, the strengthening of innovation and the formation of innovation networks will be a top priority for the development of China's industrial clusters.

2) Measures for innovation nurturing in the Industrial Cluster Plan

The Japanese government established an innovation nurturing system which promoted (i) the generation of ideas and business concepts, (ii) technology development, and (iii) the implementation of applications and access to markets and took targeted measures.

With regard to “the generation of ideas and business concepts”, the government supported to expand joint research between industry and academia in different organizations, established a system of industry-academia cooperation that was not limited to researchers in related fields but also allowed flexible changes in research team members depending on the progress of exchanges, as well as an "innovation promotion dialogue meeting" mechanism, and created a communication platform to facilitate innovation nurturing. With regard to the “technology development”, the government actively promoted its commitment of letting the enterprises fund collaborative R&D to facilitate the participation of universities in the industry-university collaboration system, encouraged large enterprises to strengthen their collaboration with startups, constructed “innovation intermediary" mechanism that can strengthen the bridge function, and promoted the establishment of industry-university cooperation research laboratories. With regard to the “implementation of applications and access to markets”, the government took initiatives such as establishing the Application Implementation Promotion Office to help set international standards for cutting-edge technologies.

As mentioned above, by promoting cooperation between academic and research institutions, including universities, companies and administrative bodies, and by making flexible use of relevant policies, the Japanese government laid a solid foundation for the continuous development of innovation nurturing. It also promoted research and development through industry-academia-government cooperation, in order to nurture the key industries, small and medium-sized enterprises

and start-ups for the future.

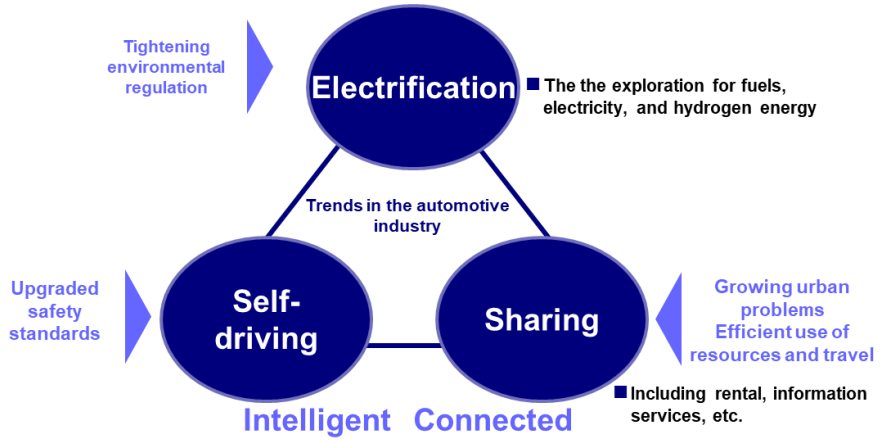
III. Changes in industries and expansion of target areas for industrial revitalization

We have discussed the importance of innovation mechanisms in the revitalization of regional economic industries and the formation of industrial clusters in the previous chapter. The importance of innovation has been increasing, both from the perspective of local economic development and from the perspective of the changes in the industrial environment in recent years. This chapter will discuss the changes in the industrial environment in the context of the automobile industry, to which Isuzu Motors belongs.

1. Changes in the environment of automobile industry

In recent years, the environment of the automobile industry has changed dramatically, practically entering a period of "unprecedented change in a century". This change is known as "CASE", the abbreviation of "Connected", “Autonomous”, "Shared & Services" and "Electric". Innovations are not only taking place within these areas, but also between them, which in turn will have a significant impact on the society as a whole, including the environment, energy, safety and consumer awareness beyond the automobile industry.

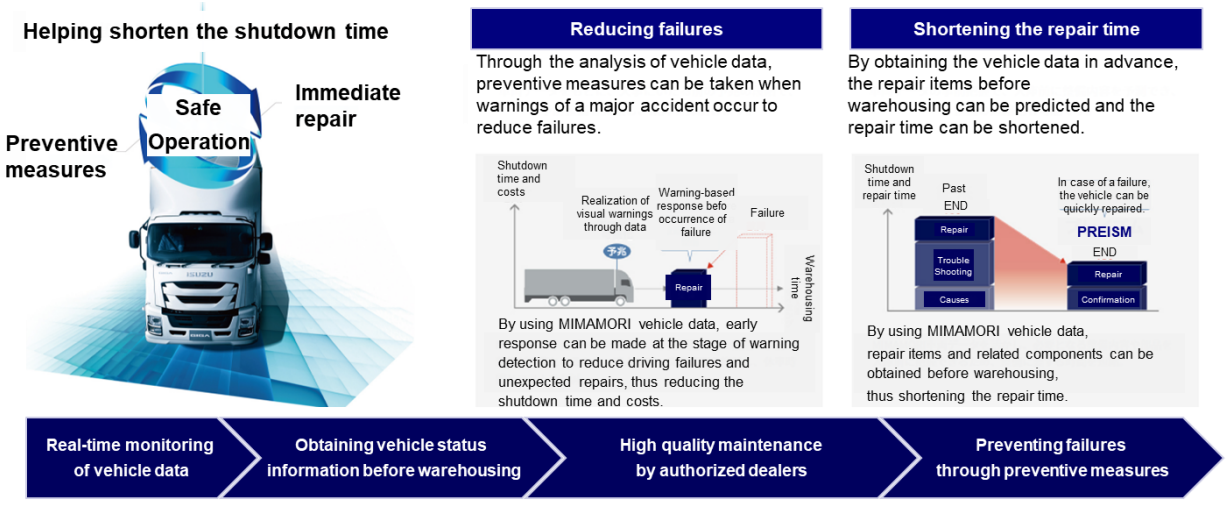
Figure 3 The changing landscape of the automobile industry (diagram)



The basis of “CASE” is the evolution of communication technology. As communication technology evolves, automobiles become one of the "Connected" communication devices that collect, analyze and share real-time vehicle operating data and data on the traffic networks, resulting in a variety of additional services. “MIMAMORI”, a vehicle monitoring and online service system developed by Isuzu Motors, is a typical example of "Connected". This system

enables the acquisition of vehicle operating data, real-time monitoring of the vehicle's driving status, and data analysis for optimal vehicle maintenance services, driving guidance on low fuel consumption, etc. In addition, Isuzu Motors has launched the PREISM proposal-based service system, which uses "MIMAMORI" to monitor the status of vehicles in real time while predicting vehicle breakdowns through the IoT (Internet of Things), and provide repair solutions quickly and accurately (suggestions for optimal maintenance interval, preventive maintenance, etc.) to prevent the loss of vehicle operating efficiency due to breakdowns.

Figure 4 "PREISM" by Isuzu, a proposal-based system service



"Autonomous" covers automatic parking, automatic driverless taxis, self-driving minibuses, self-driving trucks, etc. In the field of autonomous driving, Isuzu Motors is also participating in the development of synergistic technology for truck fleet driving systems in cooperation with four heavy-duty truck manufacturers.

Figure 5 Field experiment of truck fleet driving

Source: Isuzu Motors Limited website (https://www.isuzu.co.jp/press/2020/7_20.html)

"Shared & Services" refers to car sharing and travel sharing. In China, companies such as Didi are already working on these services. Through "Shared & Services", cars have evolved from "belongings" to "mobile" service tools, making the vehicle companies the possible "mobile" service providers as well.

Being "electric" is a major industrial change that is being actively pursued in the context of the global trend towards "sustainability". Fuel vehicles will be phased out and replaced by hybrid and electric vehicles, and in the long run fuel cells and hydrogen will also become the main source of energy for vehicles. The development from fuel engines to “Electric" will largely change the existing industrial structure and have a profound impact on the industrial value chain, supply chain and industrial clusters. While the previous supply system in the automobile industry was pyramid-shaped with the OEM at the top, new energy vehicles, such as EVs, are assembled and manufactured in modules such as motors and batteries, which means that the technical barriers to new entrants in the automobile industry will be significantly reduced. Unlike before, the number of components will be significantly reduced and the importance of “adaptation research" technology will also be reduced, enabling the gradual transformation of the established vertical industry structure with the car manufacturers on top. With the entry of motor manufacturers and startups and the further progress made in the modular architecture and the global standardization of components, the industrial structure will tend to become horizontal. As the supply chain structure of the automobile industry diversifies and becomes more networked, the trend towards "Connected" and "Shared & Services" will lead to the continued expansion of the automobile industry partners to include hardware, software, IT and service companies.

The huge shift towards "CASE" in the automobile industry shows that the automobile

industry no longer only includes industrial elements, but also communications, IT, software, electronics, services and many other industrial elements. This means that automotive companies will need to move beyond traditional manufacturing suppliers and adapt to cooperating with companies from a wide range of industries (electronics, communications, IT, electricity, services, etc.). On the other hand, the success of cooperation and integration with these multi-industry companies will also determine the growth of automotive companies.

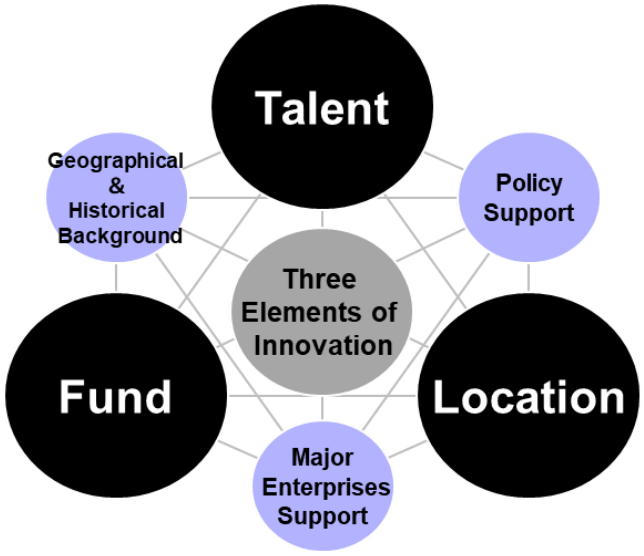
2. The increasing importance of "open innovation" in the context of industrial development[77]

To see from the changes in the automobile industry, it is clear that the industry is becoming more complex and is changing more rapidly. In this context, companies are intensifying their innovation efforts, realizing that the traditional, individual-based R&D model is reaching a ceiling. In terms of innovation, traditional companies are facing the following problems: (i) poor ability to respond to environmental changes, (ii) sole responsibility for R&D investments, (iii) pursuit of short-term profitability, and (iv) low mobility of human and financial resources. In recent years, as product life shortens and technological innovation accelerates, the uncertainty of R&D has also become apparent. Individual-based R&D is susceptible to limited resources and slow speed. In addition, if the research results are not applied within the company, they will be shelved and cannot be used effectively. Furthermore, facing intense industrial competition, companies are placing more emphasis on short-term research than on medium- and long-term research. Enterprise-led innovation may make it difficult to make full use of external human resources and apportion R&D funds reasonably.

The promotion of R&D and the building of new services and business models will not be limited to traditional research based on individual companies or specific partners. It will be replaced by broad-based "open innovation" that promotes cooperation between a wider range of companies and organizations (not only large companies, but also start-ups and research institutes), enabling the flow and sharing of resources, mitigating risks and promoting a wider range of efficient R&D. The key elements of open innovation are people (talent), capital (venture capital/R&D funding/grants) and place (matching platforms, etc.), but as mentioned above, there are still difficult issues facing the industry and companies. To address these issues, the government needs to take effective actions.

Figure 6 The three elements of innovation (diagram)

[77] "Announcement of the Chengdu-Chongqing City Cluster Development Plan" by National Development and Reform Commission（https://www.ndrc.gov.cn/fzggw/jgsj/ghs/sjdt/201605/t20160504_1170022.html）



Source: Nomura Research Institute

IV. Proposals for Chongqing

The building of a twin-city economic circle in the Chengdu-Chongqing region is a process of transforming the regional competition into regional coordination, which will help avoid the overlapping of industries and functions in the region, and activate the geographical and existing industrial strengths and resources of the region, and generate numerous multiplier effects to form new opportunities for regional economic and industrial development. We believe that Chongqing and Chengdu can maximize the results of regional economic development through intra-regional cooperation by leveraging regional advantages and existing resources cultivated and accumulated over the years. The automobile industry is a typical and major industry in the region. Both Chongqing and Chengdu have rich resources and distinctive characteristics in terms of the model types, component types, and the arrangement and distribution of surrounding industries.

However, the concept of the Chengdu-Chongqing Twin-city Economic Circle alone will not produce such an effect, and the key is to form an unpredicted regional economic development mechanism. In that sense new challenges are awaiting us.

From the perspective of the industrial development of the regional economy and the perspective of industry and business, against the background of the growing importance of a broader networked cooperation model and the innovation mechanisms derived from it, this report proposes the following: 1. Expand the coverage of supply chain matching platform, and 2. Strengthen policies to promote open innovation.

1. Expand the coverage of supply chain matching platform

In recent years, industry boundaries have been blurred and the areas of inter-industry

cooperation has gradually increased, as communication technologies update fast and the ways of manufacturing companies providing values to their customers tend to be diversified. As mentioned above, the automobile industry has already covered many related industries such as communications, IT, software, electronic engineering and services. It is important that the demand for supply and demand information in the supply chain will not only be limited to the procurement of parts and components, but will also be expanded to systems, software and related supporting services. This requires the government to promote inter-industry cooperation in a more targeted manner and precisely plan the direction of industrial development.

In the process of building the Chengdu-Chongqing Twin-city Economic Circle, the Sichuan-Chongqing Automotive Supply Chain Collaboration Work Plan has been announced for related industries. The Plan states that the online connection between upstream and downstream enterprises in the industry chain should be promoted. As a concrete measure, the two municipal governments jointly established and launched the Sichuan-Chongqing Automobile industry Chain Supply and Demand Information Matching Platform in June 2020. This Platform provides services mainly for OEMs and component manufacturers, and the service scope is only limited to traditional components and industry-specific products.

We suggest the government define a broader supply chain concept for the automobile industry, expand the service coverage of the supply chain matching platform, and add new service targets such as enterprises engaging in systems and software, service companies, institutions engaging in inspection, testing and certification, as well as financial institutions, incubator companies and accelerator companies that provide financial support for the development of the industry. At the same time, it is recommended to identify a broader range of matching service targets, with a focus on enterprises and organizations in Chongqing, Chengdu and Sichuan Province, and provide incentives to encourage more enterprises and organizations to participate.

2. Strengthened policies to promote open innovation

As mentioned above, the creation of an environment that nurtures innovation is particularly important in revitalizing regional economic industries. The importance of open innovation is also increasing for industries and enterprises. As the enterprise-led R&D is prone to meet bottlenecks, the government is expected to alleviate the singularity and limitations of the innovation mechanism of private entities through the implementation of policies. In terms of creating an environment that nurtures open innovation, there is still much room for implementation of government policies. It is recommended that the Chongqing government should reinforce measures to promote open innovations.

With reference to the measures taken by Japan in its Industrial Cluster Plan, the report

proposes the following policy measures:

Open innovation in generating new ideas and business: Establish a review board to discuss and develop regional industrial strategies that combine social issues, trends and technological trends, and improve a stable system of timely and appropriate joint discussions between government and experts.

Open innovation in technology development: Recruit cluster managers (technology marketing, providing talents for matching services), provide matching venues (holding seminars and events, setting up open innovation centers, project implementation, etc.), ensure mobility of industry-academia talent and funding, introduce venture capital firms and venture capitals, set up sound benchmarks for cooperation evaluation, cooperation methods, standard contract templates, etc.

In the context of deepening multi-industry cooperation and accelerated industrial development, we believe that the government should fully mobilize and utilize the industrial advantages and existing resources of the basic industries in Chongqing and even the entire Sichuan Province including Chengdu. In addition, by promoting inter-industry synergies and inter-enterprise exchanges, the government should activate an open innovation model in order to eventually form industrial clusters with high added value that can continuously generate new industries.

We hope that our proposals will serve as a reference for the city of Chongqing to further strengthen its cooperation with Chengdu and even the entire Sichuan Province to jointly construct a modern industrial system. At the same time, we look forward to higher quality industrial development in Chongqing.

International Exchange and Cooperation in the Chengdu-Chongqing Region from the Perspectives of Geographical Advantages and Harmony Among People

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1. Introduction

In the Chinese classic the *Mencius*, there is the phrase: "Opportunities of time vouchsafed by Heaven are not equal to advantages of situation afforded by the Earth, and advantages of situation afforded by the Earth are not equal to the union arising from the accord of Men." These words can also describe the city of Chongqing, which has developed greatly in recent years by taking advantage of auspicious opportunities such as the Belt and Road Initiative and the Yangtze River Economic Zone. Even in 2020, when the COVID-19 pandemic was raging, Chongqing's economy grew at a rate of 3.9%, far exceeding China's other direct-administered municipalities. The construction of the Chengdu-Chongqing Economic Circle offers another golden opportunity and is expected to further accelerate the development of Chongqing.

The "Outline of the Chongqing Municipality 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035" cites the development of Chongqing into a modernized global city as part of the long-term vision for 2035. Historically, the landlocked city of Chongqing has lagged slightly behind major coastal cities such as Shanghai in terms of economic development. However, due to the development of transportation infrastructure such as railways and air transportation, Chongqing today has become an important production and distribution base for access to the European and ASEAN markets. As the external environment, including the COVID-19 pandemic, becomes increasingly uncertain, how to leverage these geographical advantages is the key to successfully attaining the status of a modernized global city.

When aiming to become a modernized global city, harmony among residents is even more important than geographical advantages. With the largest percentage of elderly people and the highest elderly dependency ratio among China's four municipalities under the direct administration of the central government, Chongqing is at a higher risk of its residents facing the prospect of growing old without growing wealthy. As international exchange and cooperation accelerate and the demand for human resources in relevant fields increases, there will be a pressing need to secure talent (especially highly-skilled talent) in the future.

Based on the above points, this paper focuses on international exchange and cooperation in the Chengdu-Chongqing region, and proposes a strategy for Chongqing from the perspectives of geographical advantages and harmony among people.

Figure 1: Growth Rate of Gross Regional Product in Direct-Administered Municipalities (2020)1

	Chongqing	Beijing	Shanghai	Tianjin
Gross Regional Product Growth Rate (%)	3.9	1.2	1.7	1.5

Source: Compiled from each city's "Statistical Communiqué on National Economic and Social Development"

Figure 2: Population by Age in Direct-Administered Municipalities (2020)2

	Chongqing	Beijing	Shanghai	Tianjin
Resident population	32,054,159	21,893,095	24,870,895	13,866,009
Population aged 0-14	5,098,363	2,591,507	2,436,296	1,868,056
Population aged 15-64	21,482,191	16,389,528	18,385,587	9,952,261
Population aged 65 and over	5,473,605	2,912,060	4,049,012	2,045,692
Percentage of elderly people (%)	17.08	13.30	16.28	14.75
Elderly dependency ratio (%)	25.48	17.77	22.02	20.56

Source: Compiled from "Seventh National Population Census" published by each city.

2. Geographical advantages

Until recently, Chengdu and Chongqing, which are located inland, were disadvantaged in terms of geographical location compared with coastal areas which were linked to countries around the world through maritime transportation. However, as described below, in recent years, land, sea, and air transportation and logistics infrastructure have been developed, and the Chengdu-Chongqing region now occupies an important position as a hub linking various regions of China with Europe and ASEAN.

Based on the China-Singapore (Chongqing) Demonstration Initiative on Strategic Connectivity, the New International Land-Sea Trade Corridor is a logistics route that links Chongqing to Singapore and other countries in Southeast Asia by linking Chongqing with the Qinzhou in the Guangxi Zhuang Autonomous Region by rail, then linking with the other countries

with sea transport from the Port of Qinzhou. It has been in full operation since December 2017. Compared to the traditional routes going through Shanghai, Hong Kong, and Shenzhen, the number of days required for transport has been significantly reduced.

A direct train line running between China and Europe (the China Railway Express) started operating between Chongqing and Duisburg, Germany in March 2011, and today links more than 60 Chinese cities, including Chongqing and Chengdu, with 92 cities in 21 European countries. Chongqing is the number one city in terms of arrivals and departures on the Chinese side. The number of days needed to transport cargo between China and Europe is significantly less than Asia-Europe shipping routes.

The Yangtze River is the largest inland waterway in the world for freight transportation, and it is dubbed the "golden channel." It directly connects Chongqing and Chengdu with the Yangtze River Economic Zone, and serves as a key logistical route for expanding the space for China's economic growth from the coast to the inland.

In addition, Tianfu International Airport, which has three runways including one which is 4,000 meter-class, was constructed in Chengdu and opened in June 2021.

The following four points are expected approaches for strengthening trade and international cooperation by taking advantage of land, sea, and air infrastructure development.

(1) Development and operation of highly transparent trade and investment systems to expand economic cooperation with ASEAN

The 3rd Western China International Fair for Investment and Trade was held in Chongqing in May 2021. In the conference, China and ASEAN countries participated in a forum on new international land and sea trade routes. Chongqing City, Sichuan Province, Yunnan Province, Guangxi Zhuang Autonomous Region, Vietnam, Indonesia, Laos, and other countries jointly announced a cooperation initiative for the New International Land-Sea Trade Corridor (Chongqing) and advocated that the countries and regions along this new logistics route should cooperate to expand trade and investment, optimize supply chains, and work toward the joint development of the regional economy.

In 2020, the value of trade between Chongqing and ASEAN accounted for 17.2% of the city's total trade, and ASEAN was Chongqing’s largest trading partner, surpassing the United States and the EU. In March 2021, Chongqing formulated the "Action Plan for Chongqing Municipality to Deepen Economic and Trade Cooperation with ASEAN 2021-2025" to actively participate in the RCEP. The plan aims to increase trade with ASEAN to over 20 billion USD and direct investment from ASEAN to a total of over 15 billion USD by 2025, and also aims for over 150 companies in

Chongqing to expand into ASEAN markets.

In order to attract direct investment from Asia, including Japan and the Republic of Korea as well as the ASEAN bloc, it is important to increase transparency through consistency with international rules in various investment and trade systems, including operational aspects, taking advantage of the enactment of the RCEP.

(2) Promotion of sustainable finance

As worldwide issues such as global warming are becoming more serious, sustainable development is becoming more important than ever. In order to respond to these social demands, the financial sector is stepping up efforts related to sustainable finance, such as ESG investment.

In the case of Chongqing, cooperation on green finance is already taking place under the China-Singapore (Chongqing) Demonstration Initiative for Strategic Connectivity. In addition, the "Overall Plan for the Comprehensive Pilot Project for Further Opening Up the Service Sector in Chongqing," published in April 2021, sets out plans to build a platform for exchange and cooperation in the field of green finance and to develop financial tools.

Given the current situation in which the market for sustainable finance is rapidly expanding, Chongqing can be expected to improve the sustainability and competitiveness of the municipality as a whole by further accumulating expertise and experience in sustainable finance while making use of the outcomes of existing efforts. To this end, it is important to deepen exchanges with financial institutions and experts from other countries, including Japan, by utilizing frameworks such as the RCEP and the CAI.

(3) Promoting the concentration of high value-added manufacturing industries by taking advantage of the reduction in lead time with Europe

When shipping from Shanghai to Europe via inland water transport on the Yangtze River from Chengdu-Chongqing, the lead time is nearly two months, but using the China Railway Express shortens the lead time between Chengdu-Chongqing and European cities by two or three weeks. This means that a "third mode of transportation" between China and Europe has emerged that has shorter lead times than sea freight and lower transport costs than air freight.

As a result, the lead-time prerequisites for establishing a supply chain in globally-operating manufacturing industries are changing. When considering the location of production bases in China premised on the use of the China Railway Express, it will be possible to build a supply chain with shorter delivery times compared to marine transportation. In addition, Chengdu and Chongqing have shorter lead times than coastal areas, making them more advantageous locations.

In addition to lead time and cost, punctuality and stable transport capacity are also important factors for the transport network that constitutes a supply chain. When maritime and air transport were disrupted during the outbreak of the COVID-19 pandemic, the China Railway Express became a "green channel" for international mail and was rated highly for its stability.

It is hoped that Chengdu and Chongqing will leverage these significant improvements in locational advantages to facilitate the development of industrial clusters as production bases for high value-added products such as electronic devices. Laptop computers are already the main exports from Chongqing, and a variety of high value-added products are being exported, including automotive parts, communications equipment, pharmaceuticals and medical devices. In the future, this direction will be further strengthened, and it is expected that Chengdu and Chongqing will be established as major production bases for high value-added industries by actively attracting production facilities for high value-added manufacturing industries such as semiconductors and electronic devices.

(4) Strengthening functions as logistics hubs in global supply chains by leveraging land, sea, and air distribution networks

Chengdu and Chongqing serve as hubs for land, sea, and air logistics routes linking Europe, Southeast Asia, and various parts of China, as well as Japan, Korea, and other countries. Thus, in addition to manufacturing, a clustering effect of logistics industries can be expected. For example, many companies have established their distribution bases for Europe in the global supply chain in the Netherlands, as it has the Rotterdam and Schiphol airports. Chengdu and Chongqing are gateways for China and Asia with the China Railway Express, and are also strategically located in networks linking China and other Asian countries through the new international land and sea trade corridor and the “golden channel” of the Yangtze river. In addition, the region is expected to enhance its international air logistics functions in the future.

Moreover, from the standpoint of realizing a carbon-free society, railways, are a means of transportation, along with maritime shipping, with low CO2 emission intensity. Therefore, using the China Railway Express to shift some air freight to rail will facilitate green logistics and contribute to achieving carbon neutrality.

It is hoped that Chengdu and Chongqing will leverage these advantages to strengthen and consolidate their functions in global supply chains as logistics hubs, where various means of transport and transportation are available. In order to promote the concentration of logistics industries, it will be necessary to strengthen logistics infrastructure, including the sophistication and facilitation of CIQ functions such as customs clearance, the land, sea, and air cargo transport functions, and the inland depot functions capable of accommodating various modes of transport.

3. Harmony among people

Despite the impact of the COVID-19 pandemic, Chongqing largely achieved the goals of the 13th Five-Year Plan as a result of concerted efforts by the Chongqing municipal government and its citizens. In addition, Chongqing has focused on securing the necessary human resources for its priority industries, etc. through initiatives such as the Chongqing Talent Plan, the Hongyan Plan, the Chongqing "Talents Cup" competition, and the Chongqing talent service card system. As can be seen in the "Outline of the Chongqing Municipality 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035," which sets numerical targets for securing a variety of human resources by 2025 including highly-skilled Chinese and foreign talent, attracting and utilizing highly-skilled human resources is essential for the formation of the Chengdu-Chongqing Economic Circle.

Focusing on the promotion of international exchange and cooperation in Chengdu and Chongqing, attracting and utilizing highly skilled foreign professionals is one effective measure. In order to make the most of the capabilities such professionals possess, it is important to improve the environment for hosting foreign talent. Although Chongqing has already made various efforts to improve the environment for accepting highly skilled foreign professionals, there is room for improvement in the following points.

(1) Multilingual services for foreign talent

China uses a points-based system when issuing employment visas for foreign talent. As part of this system, points are awarded to the applicant for Chinese language ability. However, since the foreign human resources needed by the region are not necessarily fluent in Chinese, multilingual support is one method that will make it easier for foreigners to come and work there.

In Japan, where the birthrate is declining and the population is aging, the focus for about 10 years now has been on accepting highly-skilled foreign professionals in order to maintain and strengthen the country's international competitiveness. As part of such efforts, a multilingual system has been established. For example, the Japan External Trade Organization has established a portal site for the promotion of the activities of highly-skilled foreign talent which is available in both Japanese and English. In addition, the Japanese government and the Tokyo Metropolitan Government have jointly established the Tokyo One-Stop Business Establishment Center (TOSBEC), where the administrative procedures required when establishing a corporation or commencing business operations can all be completed in one place. TOSBEC also provides online consultation, electronic applications, and multilingual interpretation services, creating an environment that is easy for foreign entrepreneurs to use. In addition, the Tokyo Metropolitan Government established the Tokyo International Recruitment Navigation Center to facilitate the

hiring of foreign talent by SMEs in Tokyo and provide support for SMEs and foreign talent. Specialist consultants who can communicate in multiple languages are available to provide employment consultations for foreign nationals.

(Figure) Overview of the Tokyo International Recruitment Navigation Center

Main targets	・SMEs in Tokyo considering hiring foreign talent ・Foreign students seeking employment in Tokyo
Service contents	■ For companies: ・Consultations by specialist advisors on recruitment and retention of foreign talent ・Accompanying support by consultants ・Know-how seminars and matching events related to recruitment and facilitating foreign talent playing an active part ■ For foreign talent: ・Employment consultations by specialist counselors (global career navigators) (available in multiple languages) ・Job-hunting seminars and matching events ・Space with free Wi-fi to use for job-hunting activities

Source: The Tokyo Metropolitan Government website (Japanese)
(https://www.metro.tokyo.lg.jp/tosei/hodohappyo/press/2020/10/23/04.html)

Looking at Chongqing, there is a network in place that covers such information as policies related to attracting highly-skilled professionals, services for highly-skilled professionals, and matching events. The website is currently available in Chinese only, but it should be translated into other languages in the future as it could be a valuable source of information for highly-skilled foreign talent.

(2) Regional cooperation on services for foreign talent

As the linkage of services for human resources, such as mutual authentication of the Chongqing Talent Service Pass A card and the Tianfu Talent Pass A card, progresses towards the formation of the Chengdu-Chongqing Economic Circle, it will be important in the future to build an integrated brand image as an economic zone and convey messages that are easy for highly-skilled foreign professionals to understand.

If we look at the case of the Chongqing Talent Service Pass A card and the Tianfu Talent Pass A card, we find that issuing cards for high-level foreign talent that integrate the services

available and apply to the entire Chengdu-Chongqing Economic Circle has a greater impact. Similarly, the municipality of Chongqing and the province of Sichuan will review the services and preferential measures for foreign talent that they have provided so far, and integrate them across administrative boundaries, focusing on those that can take advantage of economies of scale and those that contribute to improving convenience for foreign talent. As a result, this will contribute to the internationalization of the Chengdu-Chongqing region as a whole and to the establishment of the brand image of the Chengdu-Chongqing Economic Circle.

(3) Trial relaxation of restrictions on foreign nationals' employment

The "Overall Plan for the Comprehensive Pilot Project for the Expansion of the Opening Up of the Service Industry in Chongqing City" stipulates the policy of allowing foreign nationals to take examinations for professional and technical qualifications (excluding legal fields) as part of the provision of benefits to foreign talent. This will lead to expanding the fields where foreign talent are actively participating.

In Japan, nationality clauses are not included in the qualifications for taking most of the national examinations. Attempts are also being made to partially recognize overseas occupational licensing. For example, the National Strategic Special Zone, which covers the Tokyo metropolitan area, provides special treatment for foreign doctors. Based on bilateral agreements between Japan and other countries, foreign doctors who have passed the national examination for medical practitioners in English are permitted to treat all foreign patients.

In order to further improve the living and working environment for foreign talent, it is hoped that a trial relaxation of limitations on overseas occupational licensing will be considered in the Chengdu-Chongqing region in the future in cooperation with the central government.

(4) Providing a new living environment for the post-pandemic world

In China, which was one of the first countries to successfully contain the spread of COVID-19, people’s lives are almost back to normal. Overseas, on the other hand, people's lifestyles and workstyles have changed dramatically due to the impact of the pandemic. In Japan, for example, teleworking rates have increased significantly compared to before the outbreak of COVID-19, and many companies are reforming their working practices and reviewing their work processes.

For workers, teleworking has the advantages of reducing commuting and other travel time, increasing free use of one’s time, and reducing stress, while for companies it also has the benefits of improving productivity and reducing costs for routine work. As a result, an increasing number of companies overseas have announced policies that will allow telework even after the conclusion of the COVID-19 pandemic. At present, the telework implementation rate in China is not high, but

telework is becoming a worldwide trend. In China, companies that allow telework will likely increase in the future, mainly in industries where telework can be easily introduced (e.g. systems engineers, designers, consultants, etc.).

Up until now, the choice of where to live has been greatly constrained by commuting time to work, but the spread of teleworking has increased the number of new options for continuing to work while changing one's home base. For example, Tokyo has seen an increase in people moving out to other prefectures due to the impact of the COVID-19 pandemic. This resulted in an excess outflow of people—including foreigners—moving out in May 2020 for the first time since July 2013. It is possible that this way of living, in which more people work and reside in the same place, will alleviate overconcentration in city centers.

In Chongqing, too, it is important to reduce the regional gap between urban centers and suburban areas. If Chongqing can develop and provide a living environment throughout the municipality that is compatible with a way of living where a person's workplace and residence are combined, it can expect an increase in the number of foreign nationals moving to the suburbs and other areas, which will also deepen international exchange and multicultural understanding at the community level.

Integrated Development of Smart Manufacturing and Smart Logistics: The Key to Driving Advanced Manufacturing Clusters in the Chengdu-Chongqing Twin City Economic Circle

Shane Tedjarati
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Part I: Developing Advanced Manufacturing Clusters – A Vital Task for CCTCEC

The Chengdu-Chongqing Twin City Economic Circle (CCTCEC) is the economic center of China's southwest region. Robust infrastructure, a solid industrial base, and a well-educated population all contribute to CCTCEC's high potential to lead western China's economic and social development. These advantages also enable CCTCEC to provide support for high-quality development strategies nationwide. Therefore, in the past decade, the central government has released several plans to develop the Chengdu-Chongqing area and has increasingly prioritized it in China's overall development strategy.

Since 2011, China's top-level planners in the National Development and Reform Commission (NDRC) have consistently considered CCTCEC as a "base for modern industries of national importance". Furthermore, China's decision-makers remain optimistic that the reach of CCTCEC's influence will grow beyond western China, reaching the rest of the country and even the global community.

At the same time, the central government has required local governments in the Chengdu-Chongqing area to adopt comprehensive and coordinated approaches in establishing CCTCEC, rather than making separate or contrary decisions. In October 2020, the Political Bureau of the Central Committee of the CPC (Politburo) reviewed the Outline of the Plan for Building CCTCEC pointing out that local governments need to work together closely and adopt an integrated development strategy for CCTCEC.

1. Advanced manufacturing clusters are the foundation of Chongqing and CCTCEC's high-quality development.

Developing advanced manufacturing clusters is an important goal for CCTCEC and the Chongqing government to meet the central government's requirements for the twin city region.

Advanced manufacturing – the use of advanced technologies, such as those drawn from ICT, mechanics, and materials science, to improve processes and products in manufacturing, is the key

development driver for CCTCEC and Chongqing's industrial base. Advanced manufacturing is not only capable of adding significant value to the economy, but it can also create demand for a wide range of market players as it relies on resources and talents from a variety of sectors. Therefore, advanced manufacturing can also boost the development of various CCTCEC cities and industries.

Governments in the world's most developed countries and regions consider advanced manufacturing as a vital issue for enhancing a country's competitiveness. The European Commission believes that deploying new green and digital technologies is necessary to foster Europe's manufacturing sector's growth, while the US government has stated that advanced manufacturing plays a central role in economic and defense development. Governments have allocated large sums to fund the R&D of advanced manufacturing technologies (AMT), including more than USD 3 billion invested by the US from 2013 to 2014. Around 50 percent of the European Union's (EU) recent innovation expenditure was spent on advanced manufacturing.

A more important task for CCTCEC is to implement the integrated development strategy. An advanced manufacturing cluster is a highly networked industrial organization, where market players are concentrated in close geographic proximity and collaborate with each other based on their specializations. Activities such as R&D, manufacturing, and sales can be performed smoothly in the region. Moreover, advanced manufacturing clusters' functions are primarily decided by companies and the market. Therefore, clusters have the potential to transcend administrative boundaries and effectively promote cross-city coordination within CCTCEC.

Advanced manufacturing clusters' development is contributing significantly to regional economic growth and social development across the world. Take the Greater Richmond Region for example. Located in the US state of Virginia's central area, the region consists of 17 cities and has a unique geographic position around the midpoint of the country's East Coast, making it ideal for supply chain operations. A non-profit organization, the Greater Richmond Partnership, has been set up in the region and helps companies build advanced manufacturing plants in Greater Richmond.

Over 1,100 advanced manufacturing companies are currently operating in Greater Richmond, including seven US Fortune 500 companies. The region has built up clusters in machinery, fabricated metal products, and fine chemicals. It has made the region's GDP among the highest of all metropolitan areas in the US, despite a population of only 1.3 million. Furthermore, Greater Richmond's proportion of the workforce with higher education is higher than the national average.

2. Advanced manufacturing clusters need integrated development of smart manufacturing and smart logistics to build strong "spots" and effective "networks".

Continued promotion of smart manufacturing, smart logistics, and their close integration is important for CCTCEC and the Chongqing government in order to accelerate advanced manufacturing clusters' development.

Smart manufacturing refers to advanced ICT's application for key sections or stages of manufacturing, such as production, quality control, supply chain, and enterprise management. The purpose is not merely production's full automation, but also to fully release the potential of all manufacturer assets, especially the most important — people. This aspect is particularly important to Chongqing and CCTCEC, as the region enjoys a rich labor force.

For Chongqing and CCTCEC, smart manufacturing technologies need to be widely used to forge strategic emerging industries such as semiconductors, power batteries, and robotics, as well as to upgrade Chongqing's traditional manufacturing sectors. Therefore, smart manufacturing can increase added value and enhance the manufacturing sector's competitiveness in CCTCEC and Chongqing.

Smart logistics can "digitalize" goods and circulation, enabling the identification, collection, and analysis of related data, in order to achieve automated warehousing and data-based decision-making. It can not only lower manufacturing companies' costs, but also significantly increase the efficiency of logistics facilities including warehouses, ports, and airports. Not only will CCTCEC manufacturers be more closely linked, but they will also be more effectively connected to other regions in China and the rest of the world.

Overall, close integration of smart manufacturing and smart logistics will improve the quality of manufacturing and the circulation of goods and information between CCTCEC cities and market entities, therefore adding far more value to all parties involved. By doing so, CCTCEC local governments and companies will be given more incentives to work with each other in building advanced manufacturing clusters.

Part II: Opportunities and Challenges for Chongqing and CCTCEC Advanced Manufacturing Clusters

Current strengths:

1. Central and local governments have released several policies supporting the development of advanced manufacturing, smart manufacturing, and smart logistics in Chongqing and CCTCEC.

a) On August 3, 2021, the Chongqing municipal government released the *14th Five-Year Plan for the High-Quality Development of Manufacturing in Chongqing*. The plan lists

Chongqing's manufacturing industry's prioritized areas from 2021-2025. The plan also emphasizes the need to enhance enterprises-centered R&D activities and expand opening-up and cooperation in manufacturing.

b) On April 20, 2021, the Chongqing municipal government released the *Opinions on Further Promoting the High-Quality Development of Manufacturing and Accelerating the Construction of an Advanced Manufacturing Center of National Importance*. The paper called for increasing the number of smart factories and digital plants in Chongqing, as well as coordinating with the Chengdu municipal government to build globally competitive advanced manufacturing clusters in CCTCEC.

c) On April 13, 2020, the Chongqing municipal government released *Opinions on Promoting the High-Quality Development of Logistics*. This paper stressed the need to improve the efficiency, reliability, and connectivity of logistics in Chongqing, and called for improving logistics' digital infrastructure and for building logistics big data platforms.

d) On August 22, 2020, the NDRC released the *Implementation Plan to Promote the Innovative Deep Integration of Logistics with Manufacturing*. The plan called for the application of industrial IoT in manufacturing and logistics, to achieve real-time data collection and data-sharing between procurement, production, and distribution.

2. Chongqing has a strong manufacturing foundation and has been steadily progressing toward smart manufacturing.

In 2020 and H1 2021, Chongqing's secondary industry demonstrated resilience in the face of the COVID-19 pandemic and a complex international environment. Chongqing's manufacturing sector recorded YoY increases of 6.4 percent and 20.8 percent in 2020 and H1 2021, respectively. In particular, traditional strongholds such as electronics and automobiles performed exceptionally. In 2020, over 70 million laptops were manufactured in Chongqing, making the city the world's laptop production leader.

One of the factors driving Chongqing's manufacturing capability's growth is the penetration of smart manufacturing technologies, which improve production quality while reducing its costs. Laptop maker Compal Electronics (Chongqing) started its intelligent transformation in 2018, supported by the Chongqing Free Trade Port Area's district government. As a result, SMT yield and assembly yield reached 99 percent and 98.5 percent, respectively. At the same time, personnel costs were reduced by 31 percent.

3. Chongqing and CCTCEC are well-positioned and prepared to make the region a global logistics hub.

Chongqing and CCTCEC's geographical location make the region an important logistics hub, connecting China to Southeast Asia, Russia, the European Union, and other parts of the world.

Chongqing has long seized upon this unique opportunity to develop its transportation infrastructure and logistics services at the regional, national, and global scales. In the eyes of the World Bank, Chongqing has developed a world-class transportation system encompassing five forms of connectivity: highways, subways, railways, river ports, and airports.

The Chongqing and CCTCEC's logistics infrastructure and services are significantly contributing to the region's economic growth and China's "dual circulation" strategy. The China Railway Express (CR Express) has also played an invaluable role during the COVID-19 pandemic. In 2020, 5,000 CR Express trains left Chongqing and Chengdu to reach Europe, loaded with medical supplies and equipment, electronic products, and other goods.

Current challenges:

1. Coordination between Chongqing and Chengdu needs to be strengthened to avoid manufacturing overlap and competition.

Economic integration remains a challenge for CCTCEC. Chongqing and Chengdu, as well as other cities in the region, have only just started to set up the necessary mechanisms to coordinate development in CCTCEC. Currently, both Chongqing and Chengdu are heavily investing in sectors such as electronic products, automobiles, machinery, and pharmaceuticals. In some cases, the two cities are competing in the same sector or stage rather than cooperating in exploring a larger market.

2. Manufacturing in Chongqing and CCTCEC needs to move toward the higher end of the global value chain.

Despite being a global manufacturing center for a few select sectors, manufacturing in Chongqing and CCTCEC sits on the relatively lower end of the global value chain. The issue is becoming increasingly pressing for the region and China more broadly since the outbreak of the COVID-19 pandemic and the subsequent disruption in global supply chains. This disruption has accelerated internal discussions within MNCs, motivating the move of low-end manufacturing facilities out of China.

The laptop manufacturing industry in Chongqing serves to illustrate this challenge. Most of the laptops manufactured in Chongqing are business laptops for the low-end market, requiring less investment in advanced manufacturing. However, high-end product lines are the strongest area of growth in global laptop markets, such as gaming laptops, for which customers have higher demands for customizability. Therefore, manufacturers must increase the agility and flexibility of their production processes by applying smart manufacturing and smart logistics technologies. High value-added activities such as R&D and design are also weak links in Chongqing's manufacturing.

3. Chongqing needs to improve the capability and efficiency of regional, national, and global logistics for manufacturers.

Although Chongqing's transport infrastructure and logistics services have developed significantly, its logistical efficiency still needs much improvement.

a) In terms of regional and national connectivity, gaps still exist in railway and waterway infrastructure. Regarding global connectivity, Chongqing's international flight network remains insufficient compared to other global cities. Multimodal freight transport services in Chongqing and CCTCEC are not yet as convenient as those in leading global regions such as the EU.
b) Further digitalization of logistics facilities and services is needed, as well as further integration of smart logistics and smart manufacturing to increase production and supply chain management's agility and flexibility. In this regard, manufacturers and logistics providers in Chongqing and Sichuan province are outperformed by those in Beijing, Guangdong, and Shanghai, according to the Ministry of Industry and Information Technology's (MIIT's) national benchmarking assessments.

Part III: Advice to Chongqing government for CCTCEC advanced manufacturing clusters' development

1. Enhance coordination between Chongqing, Chengdu, and other CCTCEC cities to promote advanced manufacturing.

Chongqing is advised to build coordination platforms with Chengdu targeting advanced manufacturing and conducting regular consultations with CCTCEC local governments and enterprises. The objective is to foster clusters of advanced manufacturing in CCTCEC, in which each city plays a unique role based on its assets and resources.

The EU's Smart Specialisation Strategy is a useful reference in this regard. Through the Smart Specialisation Platform (S3P), the European Commission is helping regions and member states to identify niche areas of competitive strength and build development strategies based on greater coordination between different stakeholders. The S3P includes a number of regions with key interests in various sectors of advanced manufacturing, such as the automotive industry, process industries, machinery, and furniture.

2. Build an advanced manufacturing ecosystem encompassing enterprises, universities, and research institutions.

The key to the successful application of advanced manufacturing technologies lies in how well technical solutions integrate the industrial know-how of specific sectors or even of particular

companies. No company possesses the necessary knowledge to independently achieve its transition toward the upper end of the value chain. Therefore, advanced manufacturing solutions need to be developed based on dynamic cooperation between manufacturers and solution providers. Universities and research institutions should also be included in the network, as they can bring the latest technological breakthroughs and fresh talents to the market.

Chongqing is advised to take the lead in bringing together CCTCEC businesses, universities, and research centers to build an ecosystem for the R&D and application of advanced manufacturing. This kind of ecosystem can have an internationally experienced industry leader as coordinator, which will attract more manufacturing companies to CCTCEC to benefit from the leader's expertise and contribute to the development of advanced manufacturing clusters in the region.

At Honeywell, we value the opportunity to work with partners and young talents to advance our understanding of manufacturing and the opportunity to promote the industrial application of cutting-edge technologies. For example, in Brno, Czech Republic, Honeywell Technology Solutions (HTS) is working on a wide range of aviation software solutions and applications, as well as modern productivity solutions leveraging automation, robotics, and digitalization. Concurrently, Honeywell is also cooperating closely with local universities (Brno University of Technology, Masaryk University, and Mendel University) to conduct applied research and organize workshops for students.

3. Leverage Chongqing's comparative advantages and expanding the manufacturing sector's opening-up in Chongqing and CCTCEC.

As China's "dual circulation" development strategy points out, international resources are largely needed to support the strengthening of domestic industries and the growth of the domestic market. Other metropolitan areas in China, such as Guangdong's Shenzhen and Shanghai's Pudong, are already implementing forward-looking measures to achieve high-quality opening-up of their economies.

Both large MNCs and global "hidden champions" are instrumental for Chongqing and CCTCEC to fill gaps in local industrial chains and enhance R&D capacities. To attract more foreign companies to participate in building advanced manufacturing clusters in CCTCEC, Chongqing is advised to exploit its comparative advantages in the costs of land, energy, and labor to offer favorable conditions for foreign companies to operate locally.

4. Promote the integrated development of smart manufacturing and smart logistics, both in traditional manufacturing sectors and regional emerging industries.

As argued previously, smart manufacturing and smart logistics are essential for Chongqing and CCTCEC to build a high-quality advanced manufacturing sector and to foster advanced manufacturing clusters. The following measures can be taken by Chongqing municipal government:

a) Provide incentives to manufacturers in traditional sectors to adopt integrated smart manufacturing and smart logistics solutions, and invite global leaders in this sector to analyze the situations in local companies and provide adequate solutions.

At present, globally advanced manufacturing leaders, such as those identified by the World Economic Forum as "Lighthouse Factories", are not only investing in automated production and warehousing technologies, but also in predictive analytics and integrated platform solutions, in order to further increase productivity and speed-to-market.

At the site of a Danish pharmaceutical company, a data analytics platform, a digital production process controlling platform, and an app-based shop-floor work management platform are combined into a single and unified platform. This integration reduced communication barriers between different smart manufacturing platforms and further increased productivity. At a German chemical and consumer goods company, more than 30 production sites and 10 distribution centers are connected to one cloud-based data platform. The data platform ensures that information can flow end-to-end across the supply chain whenever and wherever needed. The new platform also brought a double-digit cost and inventory reduction, as well as met growing customer expectations for service and sustainability.

Honeywell is uniquely placed to assist the Chongqing municipal government and local manufacturers in learning from global best practices and advancing the integrated development of smart manufacturing and smart logistics. We have a track record of success in advanced manufacturing for over 390 Honeywell sites worldwide and are prepared to share our expertise with companies in Chongqing and CCTCEC to help the region thrive through innovation and digitalization.

Our Chinese R&D team has customized the Honeywell Operating System (HOS) into a SaaS-based manufacturing operation management platform system named Manufacturing Operations Management (MOM) to meet the demands of Chinese manufacturing companies. As a "brain" for connected factories, MOM integrates the management of people, machines, materials, processes, and environments. Going beyond automated production functions, MOM can also improve the safety and efficiency of manufacturing through advanced analysis and prediction.

Honeywell's one-stop solution for advanced manufacturing has been deployed for the biggest automobile, electronics, and energy companies in China, making our company well adapted to the needs of Chongqing's manufacturing sector. Furthermore, in 2019, we set up

a Smart Manufacturing Research Center in China and are providing advisory services to businesses and governments for manufacturing's high-quality development.

b) Invest in the intelligent transformation of logistics facilities to enable the development of emerging manufacturing sectors in Chongqing and CCTCEC.

Currently, Chongqing and CCTCEC are focusing on exploring areas in the manufacturing industry signaling new momentum for growth. Pharmaceuticals comprise one of the region's emerging sectors, an area reliant on safe and efficient cold chain logistics, the importance of which has been revealed by the COVID-19 pandemic.

Chongqing needs to further improve the quality of cold chain logistics in the region, particularly by equipping facilities with connected devices to monitor the real-time status of temperature-sensitive stock. In this regard, Honeywell's cold chain solutions can provide best-in-class productivity performance in extreme cold conditions and power an intelligent cold supply chain workflow.

Consumer goods are another priority sector that Chongqing and CCTCEC aim to develop during the *14th FYP* period. E-commerce's fast growth is posing new challenges to this sector regarding the efficiency, coordination, and outreach of the supply chain. Honeywell's end-to-end integrated solution currently services a multinational FMCG giant in China and can achieve these goals by upgrading the region's logistics.

5. Accelerate the green and low-carbon transition of manufacturing and logistics.

In 2020, President Xi announced that China would reach "peak carbon" by 2030 and "carbon neutrality" by 2060. Therefore, green and low-carbon transitions in manufacturing and logistics are now inevitable missions for Chongqing and CCTCEC. Honeywell believes that the Chongqing municipal government could focus on two areas in this regard:

a) Encourage the use of smart energy solutions in factories, industrial parks, and logistics facilities to maximize energy efficiency.

In June 2021, Honeywell launched the latest Honeywell Intelligent Energy Management Solution (HiEMS) in China. HiEMS can collect and monitor a building's consumption data for various types of energy and provide energy-saving insights based on AI and big data analysis. HiEMS will be an effective tool for Chongqing to reduce its carbon footprint.

b) Address energy conservation and emission reduction issues in data centers.

As the Chinese economy becomes increasingly digitalized, data centers have become a major source of energy consumption and consequently of carbon emission as well. Currently, data centers in China account for around 2.3 percent of China's total electricity consumption. Chongqing should address this issue as soon as possible, starting with cooling

systems in data centers, which account for approximately 40 percent of total energy consumption.

In 2020, Honeywell launched Solstice E-Cooling, a breakthrough platform for liquid heat transfer agents that cool high-performance electronics more efficiently and effectively than traditional methods using air and water. As a world leader in the development, manufacturing, and supply of refrigerants, Honeywell is committed and well prepared to power the green and low-carbon transition of Chongqing's digitalized economy.

Part IV: Conclusion

The integrated development of smart manufacturing and smart logistics is key to increase the competitiveness of manufacturing in Chongqing and enhance cooperation between CCTCEC companies, thus contributing to the development of advanced manufacturing clusters. These clusters will become strong engines for CCTCEC's economic integration. Honeywell suggests the Chongqing municipal government take action in the following four areas:

1. *Enhance cooperation between Chongqing, Chengdu, and other CCTCEC cities to promote advanced manufacturing's coordinated development.*
2. *Build an advanced manufacturing ecosystem encompassing manufacturers, logistics service providers, universities, and research institutions for R&D and talent training.*
3. *Leverage Chongqing's comparative advantages and expand the manufacturing sector's opening-up in Chongqing and CCTCEC.*
4. *Upgrade traditional manufacturing sectors with integrated solutions for smart manufacturing and smart logistics, as well as streamline logistical processes to facilitate the emergence of new manufacturing powerhouses such as pharmaceuticals and consumer goods.*
5. *Accelerate green and low-carbon transitions in manufacturing and logistics with smart technologies.*

As a high-tech enterprise that has been deeply rooted in China for many years, Honeywell is committed to implementing its "East for East" and "East to Rest" strategies, leveraging smart technologies and IoT / SaaS-based solutions to innovate for advanced manufacturing's development in Chongqing and CCTCEC.

Industrial Digitalization and Rail Transit Digital Interconnection

Core Engine for the Chengdu-Chongqing Economic Circle

Xiao Song
Global Executive Vice President
President and CEO Siemens Greater China
Chairman, President and CEO Siemens Ltd., China

1. Introduction

As economic globalization and regional economic integration continue to be reinforced, urban competition is no longer the competition between individual cities within an administrative region. The city has been considered as a more extensive concept, and it will participate in globalization in a broader space and with more openness. The urbanization in China is accelerating and city clusters are booming, with cities sharing resources, opening markets mutually, and complementing each other to pursue common prosperity and sustainable development. *Key Tasks of New Urbanization Construction in 2019* issued by The National Development and Reform Commission specified that the Chengdu-Chongqing Economic Circle, as the only inland city cluster in western China, will keep pace with the Beijing-Tianjin-Hebei Region, the Yangtze River Delta, and the Guangdong-Hong Kong-Macao Greater Bay Area. In 2020, General Secretary Xi Jinping personally deployed and boosted the construction of the Chengdu-Chongqing Economic Circle.The major mission was given to Sichuan and Chongqing to foster a growth pole for high-quality development in Western China, an influential economic center, a scientific and technological innovation center, a new high ground for reform and opening up, and a location for the high-quality lifestyle. As a main city in the Chengdu-Chongqing Economic Circle, Chongqing shoulders the responsibility to create a key growth pole and new driving force for high-quality development across the country. At the same time, it is also provided with a historic opportunity for development.

"Actively serve the national major strategies, further promote the Chengdu-Chongqing Economic Circle Construction and the coordinated development of the metropolitan area and town clusters, accelerate the formation of a new territorial space protection and development pattern featuring obvious functions, complementary advantages, and high-quality development, and continue to release the optimization effect of regional economic development layout."

Digitization has become an important engine for the new technological revolution and industrial transformation, profoundly changing the way human beings live and work. It is

imperative to promote the overall transformation and upgrading of the urban economy and society through digital means. The development of the Chengdu-Chongqing Economic Circle is not equivalent to the simple superposition of that of individual cities. Organic linkages of intrinsic functions and division of industries are required to avoid unnecessary duplication of resources, give full play to complementary advantages, and maximize benefits. With these efforts, we can prevent the industrial structure from being identical, avoid homogeneous competition, uneven development, and other problems. Creating a digital ecosystem with Chongqing characteristics through digital means will not only facilitate Sichuan and Chongqing in coordinated and integrated development, but also give full play to Chongqing's differentiated core competitiveness in promoting the Chengdu-Chongqing Economic Circle construction. Based on the Chengdu-Chongqing Economic Circle construction and Chongqing's 14th Five-Year Plan, this report will analyze the global digital development trend and the current status of Chongqing's digital development as well as the challenges head-on. Fully considering the features of the Chongqing's market, accelerate the development of Chongqing’s industrial digitization and rail transit digitization by deepening the localization cooperation with Chongqing’s enterprises. Recommendations will be made for creating a digital ecosystem with Chongqing characteristics, thus contributing to the Chengdu-Chongqing Economic Circle construction and the high-quality development of Chongqing.

2. The Development Strategy and Vision of Chongqing in the Chengdu-Chongqing Economic Circle Construction

The Chengdu-Chongqing Economic Circle is located in the upper reach of the Yangtze River and of geographical advantages. It is bordered by the provinces of Hunan and Hubei to the east, Qinghai and Tibet to the West, Yunnan and Guizhou to the South, and Shaanxi and Gansu to the north. It is an area under urbanization with the highest development level and considerate development potential in western China. It's also a key part of the Yangtze Economic Belt and the Belt and Road Initiative strategies. Promoting the construction of the Chengdu-Chongqing Economic Circle is conducive to forming a regional economic layout with complementary advantages and high-quality development, expanding markets, and optimizing and stabilizing the industrial chain and supply chain. It is a major measure to foster a new development paradigm with domestic circulation as the mainstay and domestic and international circulations reinforcing each other.

As one of the central cities in Chengdu-Chongqing Economic circle, the only municipality in middle and western China, the significant strategic fulcrum of the large-scale development of the western region, and the junction of the Yangtze Economic Belt, Chongqing plays a unique and important role in regional development and opening up of our country.

- The regional GDP of Chongqing reached 2.5 trillion yuan, with an average annual growth rate of 7.2% over the five years. Per capita regional GDP exceeded US$10,000 in 2020.
- The industrial enterprises above the designated size achieved 6.4% year-on-year growth in added values.
- The high-tech industry contributed 37.9% to industrial growth.
- The strategic emerging industry contributed 55.7% to industrial growth.
- The added value of the digital economy accounted for about 25% of the total regional GDP.
- The R&D spending throughout society increased by 17.4% annually.
- The number of high-tech enterprises increased by 3.3 times.

During the 13th Five-Year Plan period, Chongqing has significantly improved its comprehensive strength, achieved new breakthroughs in innovative development, and formed a new pattern of coordinated development. Facing the sudden attack of the COVID-19 epidemic and the complicated international landscape, Chongqing has still maintained a positive growth momentum, with the economy shifting from high-speed growth to high-quality development, and the quality and effectiveness of development being improved.

During the 14th Five-Year Plan period, how to continuously consolidate the positive momentum of high-quality development? While promoting the Chengdu-Chongqing Economic Circle construction and fostering a key growth pole and new driving force for high-quality development across the country, what measures should be implemented to make Chongqing an influential economic center, a scientific and technological innovation center, and a new high ground for reform and opening up with its own characteristics and advantages? How can Chongqing play a supporting role in the large-scale development of the western region in the new era, and play a demonstrative role in driving the green development of the Yangtze Economic Belt? For the questions above, we believe that the establishment of a digital ecosystem is necessary. Digital transformation will facilitate Chongqing in promoting innovation and creating a new highland for the digital industry; building a national advanced manufacturing city with a complete chain group, mature environment, distinctive features, and remarkable quality and efficiency; fostering a dual-city economic circle with strength and uniqueness; and becoming an active growth pole and strong driving force with international influence.

3. The Global Digital Development Trend

In recent years, the wave of digitization has swept the world and governments have released corresponding strategies and policies one after another. Germany has successively introduced policies such as *ICT Strategy of the German Federal Government: Digital Germany 2015*, *Digital Agenda 2014-2017*, *Digital Strategy 2025,* and *High-Tech Strategy 2025*, continuously upgrading its high-tech strategy, actively implementing the strategy of Industry 4.0, and promoting the digital

transformation of industry. The European Union (EU) also set explicit goals in *Europe's Digital Decade: digital targets for 2030*: 75% of European enterprises will take up new technologies including cloud computing services, big data, and artificial intelligence; more than 90% of European SMEs will reach at least a basic level of digital intensity; the number of unicorns of cutting-edge digital technology will double to 250. In addition, the United Kingdom, Japan, and other countries have also consecutively formulated national development strategies to promote the digital economy in terms of smart manufacturing, talent training for digitalization, and other fields.

The importance of digitalization has become increasingly prominent worldwide. Digital transformation, with huge potential, is the only way to achieve high-quality and resilient development for all market economy, even including the socialist market economies. McKinsey predicted that potential productivity in major developed countries (the United States and Western European countries) could grow by at least 2% per year over the next decade, with about 60% of this being achieved through digitalization. For example, in industrial production, 60% of manufacturing tasks can be automated, thus improving productivity, quality, and safety; in infrastructure construction, where the operation takes up 80% of the life cycle cost, Internet of Things (IoT) solutions can optimize the design and operation phases, and increase energy efficiency by 30%; in congested developing cities, digital technologies can be adopted to expand traffic volume by 20% without the construction of additional infrastructure. Meanwhile, the outbreak of the COVID-19 epidemic has fundamentally changed the role of digitalization in society and the economy, renewed public perceptions, and accelerated its development.

In March 2017, the digital economy was included in the Chinese government work report for the first time. In 2020, the added value of China's digital economy reached 39.2 trillion yuan, accounting for 38.6% of GDP. At the same time, China's 14th Five-Year Plan specified the development strategy to "accelerate digitalization-based development and construct a digital China", regarding the proportion of digital economy to GDP as one of the major indicators of economic and social development in this period. The Plan also proposed the target of increasing the proportion of the added value of core digital economy industries to GDP from 7.5% in 2020 to 10% in 2025. In terms of application scenarios, ten types of digitalized application scenarios such as intelligent transportation, smart manufacturing, and smart energy were mentioned.

In this context, global cooperation has been deepened. Taking Siemens as an example, in the industrial field, Siemens has assisted hundreds of Chinese industrial enterprises in dozens of industries to implement digital transformation and upgrade, setting a benchmark for Chinese industrial digitalization; in the transportation field, Siemens has provided CRRC Zhuzhou Locomotive (CRRC ZELC) with the digital metro vehicle traction system to secure the order of the first fully automatic driverless light rail transit 3 (LRT3) project in Malaysia, thus facilitating

Chinese rail transit enterprises in "going global".

4. The Current Status of Chongqing's Digital Development and Challenges Head-on

4.1 The Current Situation and Challenges of Industrial Digitization

During the 13th Five-Year Plan period, Chongqing's total industrial output value above the designated size reached 2.27 trillion yuan, with an average annual growth rate of 8.1%. The integration of the digital economy and the real economy accelerated, and the transformation of the traditional economy continues. Data show that in 2019 alone, Chongqing implemented 1,280 smart renovation projects and built 140 digital workshops and smart factories. Currently, over 50,000 manufacturing companies in Chongqing are taking advantage of technologies such as 5G, big data, industrial Internet for intelligent production and optimized capacity allocation. The rapid headway of Chongqing's industry has laid a solid foundation for the digital transformation of enterprises during the 14th Five-Year Plan period. However, some traditional manufacturing companies are still hesitating over digital transformation, and are ill-prepared for the challenges below: who will lead the transformation; what is the goal of the transformation; how to transform; how to enhance corporate competitiveness through digital transformation?

Therefore, in promoting digital transformation of manufacturing enterprises, solving the following three problems is of particular significance: 1. how to empower enterprises and assist them in the process; 2. how to connect corporate internal data on the basis of the value chain and effectively improve the competitiveness of enterprises; 3. how to create demonstrative digital transformation projects and accelerate the promotion of new digital transformation models while there are extensive industries and numerous enterprises in Chongqing.

4.2 The Current Situation and Challenges of Rail Transit Digitization

In the period covered by the 13th Five-Year Plan, the "ring and radial" rail transit system has been formed in the central city of Chongqing. The total rail transit mileage has extended from 202 km to 370 km, rapidly completing the rail transit network. At the same time, the fifth phase rail transit construction plan and urban (suburban) railway construction plan have been actively propelled to form the "one-hour commuting circle" in the metropolitan area.

Chongqing has put forward the target of "high-quality infrastructure development" during the 14th Five-Year Plan period. In the construction of the Chengdu-Chongqing Economic Circle, considering the demand of Chongqing's rail transit multi-format integration and interconnection, it has become a primary challenge for Chongqing rail transit development to adopt new digital technologies such as Internet Plus, cloud computing, artificial intelligence, and 5G communication

to achieve the following goals: the integration of urban railways, municipal railways, and high-speed railways; the interconnection of information; the establishment of the rail transit data-sharing network.

5. Accelerate Industrial Digitization and Rail Transit Digitization in Chongqing and Create a Digital Ecosystem with Chongqing Characteristics

Facing the inevitable trend of digital transformation and considering the national major decisions and arrangements for promoting the Chengdu-Chongqing Economic Circle Construction, Chongqing set the goals of "promoting the deep integration of the digital economy and the real economy" and "promoting the high-quality development of infrastructure" in the 14th Five-Year Plan. Over the years, with the support of CPC Chongqing Municipal Committee and Chongqing Municipal People's Government, Siemens and Chongqing has cooperated deeply in industrial digitalization, rail transit digitalization, and the training of new talents, and jointly promoted the implementation of a number of demonstration projects. Based on the current development of Chongqing's industrial digitalization, Siemens suggests that Chongqing can establish the digital ecosystem with Chongqing characteristics in the following four aspects.

5.1 Promote the Digital Transformation of Manufacturing Enterprises and Consolidate the Data Foundation for Advanced Manufacturing

Empower enterprises through platforms to promote corporate digital transformation. The digital transformation of enterprises is a process during which industrial software, automation, Internet, communication, and IoT technologies integrate into industries, showing that the Internet economy is entering a higher and deeper level. Digital transformation can satisfy the diverse and rapidly-changing demands of industries, and assist enterprises in improving competitiveness and adapting to market changes. Given the high investment and intensive capital needed in digitalization, establishing the shared Intelligent Manufacturing Innovation Center and Public Service Platform at the regional level is effective for accelerating industrial innovation research and development, industrial incubation, and collaborative development. Specifically, based on the local industrial characteristics and service levels, the Intelligent Manufacturing Innovation Center and the Public Service Platform aims at utilizing the leading technologies and expert resources of the outstanding enterprises in the field of intelligent manufacturing and industrial Internet such as Siemens, thus jointly conducting innovative technology research and development for the common problems of local intelligent manufacturing; jointly building and fostering industrial Internet platforms and public service platforms serving the local manufacturing industry; jointly establishing a talent training platform with professional features. With these efforts, the level of intelligent manufacturing innovation and application of large enterprises can be improved, the promotion of industrial Internet applications can be accelerated and the threshold of applying

digital technology can be lowered for small and medium-sized enterprises, the convergence of regional upstream and downstream enterprises and the formation of industrial clusters can be promoted, thus advancing the transformation and upgrading of existing industries, the effective allocation of resources, and the sustainable economic development of urban agglomerations. The Siemens Intelligent Manufacturing (Chengdu) Innovation Center established in 2019 is one of the perfect examples. Through the construction of the model lines, innovative laboratories, and industrial R&D area, the center provides the most advanced and complete digital enterprise solutions for the manufacturing industry and provides services such as digital transformation, talent training in digitalization, and university-enterprise cooperation for regional enterprises. Since its launch, it has led and promoted the digital transformation and upgrading of many enterprises in Sichuan and all over China.

Establish a data platform for coordination across value chains. The improvement of enterprise management and operation often involves multiple links on different value chains. Through traditional digital means, it is difficult to achieve coordination between different value chains of the product life cycle, asset operation, and business performance. However, combined with the IoT connection technology, the data platform technology can make IT/OT data fully accessible, break the barriers between independent subsystems and data sources, and integrate complex and diverse heterogeneous data, to realize data fusion between the product value chain, asset operation value chain, and business performance value chain. The integrated semantic model of the platform can form the industrial knowledge map, analyze and accumulate all the data, provide high-quality digital service with quick response and lasting business, promote the value creation and enhancement in enterprise management and operation, and manage enterprise-level data assets effectively, thus consolidating the foundation for the fast and effective corporate digital transformation.

Create typical and demonstrative application scenarios of digital technology, and lead the industrial digitalization in Chongqing. The digital transformation of enterprises cannot be accomplished overnight or without the target and plan in mind. Based on Siemens' experience, digital transformation should be fully comprehensive, industry-oriented, and feasible. Facing such transformation challenges, based on the common problems encountered by Siemens in projects of different sizes around the world, Siemens divides the entire process of digital transformation into 3 stages: consultation, implementation, and optimization. The typical and demonstrative application scenarios are not only the practice of the vision and plan proposed in the stage of consultation, but also the object and data source in the stage of optimization. The digital transformation of enterprises can only be achieved through the deployment and implementation of the three stages as a whole.

5.2 Fully Utilize the Scientific and Educational Resources of the Dual-city Circle to Foster an Industrial Innovation and Talent Training Platform in Chongqing

The rapid development of advanced intelligent manufacturing technologies represented by digital and automatic technologies, as well as the comprehensive integration of cross-field technologies, has undoubtedly promoted the transformation and upgrading of the manufacturing industry. When digitalization and intellectualization are surging, a major dilemma faced by the manufacturing industry, especially by the enterprises eager to realize intelligent manufacturing, is the lack of talents in digitalization.

With the rapid economic development of the Sichuan-Chongqing Economic Circle, the gradual adjustment of industrial structure and the challenges in industrial upgrading both create higher demands for the quantity, structure, and quality of human resources. Then three main services of human resources are needed: the training and cultivating services, exchange and sharing services, and innovation and entrepreneurship services.

Therefore, Siemens believes that for talent training in Chongqing, a knowledge structure with automation and digitalization fully integrating with each other should be reconstructed, and a digital-oriented talent training system for key positions in the manufacturing industry should be built. We can focus on the key industries and fields in Chongqing and construct a comprehensive and professional talent center with production-education integration. Taking advantage of the construction of the talent and innovation base in Chongqing, with the principle of "focusing on industry, talent infrastructure, production-education linkage, the force of reform, and development coordination", the center will become a technical training base and technological innovation base with domestic and global influence and competitiveness, meeting the major strategic needs of industrial innovation and development. Through these measures, we can cultivate a group of high-skilled personnel; develop industrial frontiers and common key technologies; cultivate a batch of influential leading industrial enterprises; drive several technology-oriented small and medium-sized enterprises; create innovative industrial clusters with great potential and strong leading force that can promote industrial innovation and talent training in Chongqing for new leaps.

5.3 Build the Ecosystem of Digital Rail Transit Industry with Chongqing Characteristics

Digitalization is fundamentally changing the rail transit industry. In addition to improving the availability of vehicles and infrastructure, optimizing operations, reducing complexity, workload, and costs, it also helps rail transit operators adopt big data and artificial intelligence in operation, thus making the infrastructure intelligent, improving the passenger experience, ensuring reliability, and enhancing the sustainability of the assets throughout the lifecycle. At the same time, real-time decision-making should also be incorporated into the business process to realize the automation

based on artificial intelligence, making the operation more simple, efficient, and intelligent.

In recent years, as the only supplier with the whole industry chain of transportation globally, Siemens has provided digital services to more than 50 customers worldwide, including the 32-year services of intelligent operation and maintenance for the Rhine-Ruhr Express of Germany, and 20-year services of comprehensive intelligent maintenance for vehicles and rail infrastructure in the subway of Bangkok, Thailand. At present, Siemens Mobility China is assisting MTR and some domestic subway companies to establish digital and intelligent operation and maintenance systems.

Based on the Chengdu-Chongqing Economic Circle Construction and goals of the fourth round of construction planning, Siemens Mobility China gives full play to its strengths in rail transit and draws experience from the past successful cooperation with Chongqing in the construction of two lines (Line 1 and Line 6 Phase I) that are currently in operation. Siemens plans to set up a joint venture with Chongqing local state-owned enterprises, create a local digital center, and provide solutions from an open, interactive, and complete perspective to problems ahead. The center will combine professional rail industry knowledge and adopt the latest big-data analysis algorithm, making the entire operation and service process of vehicle equipment and relevant decisions more active, targeted, and data-supported, so that it can better meet the future development needs of Chongqing rail transit operators, improving efficiency, achieving sustainable development, and ensuring information security.

5.4 Set Standards for Information Security

The cornerstone of digitalization is the construction of an information security system. Information security is no longer a new topic, and has been a serious problem worldwide. Since China's *Cybersecurity Law* went into effect in June 2017, with the rapid development of "integration of industrialization and informatization", "Internet Plus advanced manufacturing industry", and network infrastructure construction, relevant laws and regulations have become more stringent and concrete.

A perfect information security protection system is impossible. Only security solutions that are developed based on the experience of massive practical application scenarios and can be continuously iterated can tackle risks with the highest efficiency. For providers of factory automation control products and network communication solutions who have deeply engaged in China's industrial field, because they have experienced various industrial site problems, they have unique insights and even mature solutions in this field that can be drawn upon as reference. Siemens' strategy of industrial information security, "defense in depth", is a good example. The "defense in depth" is a comprehensive defense consisting of plant security, network security, and system integrity. Plant security focuses on physical protection and security management for

automation systems, including security measures and electronic key cards, etc.; network security refers to the communication security in industrial networks, with the main aims of dividing different network areas according to targets, providing protection at the boundaries, and protecting automation networks against unauthorized access; system integrity emphasizes the use of authentication, user management, patch management, attack detection, and other security means to ensure that the underlying industrial system is consistent with the intention in the design.

Conclusion

As one of the central cities of the Chengdu-Chongqing Economic Circle, Chongqing bears the heavy responsibility of building the fourth pole of China's economic growth, which demands the self-development of Chongqing. Chongqing's large volume and favorable industrial foundation will provide extensive application scenarios and broad market space for the digital transformation and upgrading of the manufacturing industry and the development of new technologies, new industries, new business models, and new patterns, laying a solid foundation for building a national advanced manufacturing city and highlighting differentiated advantages. Digital rail transit will lead urban development and promote the construction of a multi-center, multi-level, and multi-node network city cluster. The advanced manufacturing industry as the core competitiveness and digital rail transit as the support will integrate into the entire process of Chengdu-Chongqing Economic Circle construction.

The leap of Chongqing's industrial digitalization and rail transit digitalization will effectively promote the construction of the Chengdu-Chongqing Economic Circle, and make this area become an important economic center and scientific and technological innovation center with national influence, thus making great contributions to creating an important growth pole and a new driving force for the high-quality development across the country. As a trustworthy partner, Siemens is willing to work hand in hand with Chongqing to accelerate the construction of the Chengdu-Chongqing Economic Circle.

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Powering Good for a Sustainable Energy Future of the Chengdu-Chongqing Economic Circle

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Abstract

This paper aims to highlight best practices from China and the world which the Chongqing and Chengdu municipal governments can take into consideration while leading development of the Chengdu-Chongqing Economic Circle, helping to ensure that the ambitious vision for the new urban agglomeration becomes a reality.

In particular, these insights are focused upon further illuminating how China's southwestern super-region can strengthen its competitive advantages by continuing to lead the development of a stronger, smarter and greener energy system that will provide the lifeblood for sustainable economic and social development, transforming the economic circle into a leading growth engine. The timing is also apt against the backdrop of the world's post-pandemic recovery efforts underway, China's push to achieve its ambitious carbon neutrality and heightened global efforts to address climate change, with the accelerated energy transition playing a pivotal role.

We conclude with several recommendations that emphasize the importance of leveraging technology, encouraging green investment, driving collaboration, and acting with a focused sense of purpose and urgency to address climate challenge and create a sustainable future for all.

1. Global context

Global warming, described by the United Nations as an "existential threat" to humanity, is unquestionably one of the defining issues facing us today.[78] The devastating impacts of climate change are now being felt in every corner of the planet – including heatwaves, wildfires, floods, droughts, rising sea levels, and more.

Most worrying, the climate change impact is intensifying, with global emissions reaching record levels and still showing no signs of peaking. A report by the World Meteorological Organization (WMO) showed that the last decade was the hottest on record, with the average global temperature 1.1°C higher than pre-industrial levels.[79] This means that we're far behind the curve in terms of meeting either the 1.5°C or 2°C targets called for by the landmark Paris

[78] Climate change: An 'existential threat' to humanity, UN chief warns global summit, UN News, May 15, 2018
[79] 2010-2019 confirmed as warmest decade in history, UN Regional Information Center for Western Europe, March 10, 2020

Agreement. Unless drastic action is taken, recovery may prove elusive as environmental calamities escalate and their consequences become irreversible.

But with the world now gradually emerging from the pandemic, it is clear that there are much more urgent calls for real action on the climate emergency. Globally, there is widespread recognition that fighting climate change is of paramount importance and one of the most urgent challenges of our times. In the autumn, we hope to see this momentum translate into hard results when world leaders gather first at the UN Biodiversity Conference in Kunming, China in October and then at COP26 in Glasgow, UK in November, to set new global frameworks for strengthening biodiversity and addressing climate change, respectively. The convergence of these two major environmental summits has led to 2021 being hailed as a "Super Year" for global environmental policy – and hopefully will mark a turning point in our efforts to save the planet and avoid future devastation for millions worldwide.

Climate change is not only firmly back on the international agenda but ranked right at the very top of world leaders' priorities. As countries rebuild their economies after the pandemic, positive signs are abound of their reinvigorated commitment to drive towards a more sustainable future for us all. Most importantly, numerous countries have introduced stimulus packages on a massive scale, with the aim of bringing jobs back, reviving economies and facilitating a green recovery. Many governments have seen the logic in placing sustainability at the heart of such efforts and ensuring that investments are being carried out in a smart and environmentally friendly manner. For example, the E.U. approved the largest green stimulus in history, earmarking nearly one-third of its 1.8 trillion euros (US$2 trillion) economic rescue deal for climate action – or 500 billion euros (US$572 billion).[80]

All over the world, there is now an enormous focus on accelerating the transition to more sustainable energy systems as a crucial driver of the global recovery and the biggest contributor to mitigating climate change. It is also increasingly realized that electricity will be the backbone of a carbon-neutral energy system. This also calls for a more flexible and interconnected power system, that is also resilient, reliable and efficient. In short, we will need power grids that are stronger, smarter and greener.

According to the IEA's 'Net Zero 2050' report, 'the path to new zero emissions is narrow' and staying on it requires increased investment in infrastructure, and specifically, an 'immediate and massive deployment of all available clean and efficient energy technologies.'[81] By 2030, the world economy is expected to be some 40 percent larger but consuming seven percent less energy

[80] European Commission welcomes agreement on €1.8 trillion package, EURAXESS, November 14, 2020
[81] Net Zero by 2050: A Roadmap for the Global Energy Sector, International Energy Agency, Revised version, May 2021

to be on track for net zero in 2050. By this time, 'the energy sector will be dominated by renewables' and 'electricity will account for almost 50 percent of the total global energy consumption' – up from about 20 percent today.

The forecasts all come to the same conclusion: the carbon-neutral world is electric. And three building blocks are stacking up to deliver this carbon-neutral electric future: connecting larger volumes of wind, solar and hydro to the grids; electrifying the world's transportation, building and industrial sectors; and, where direct electrification is either not efficient or viable, introducing complementary and sustainable energy carriers, such as green hydrogen. Combined, these blocks will give us the foundation upon which electricity will become the backbone of the entire energy system and on which sustainable societies can progress.

China, as one of the world's leading economic powerhouses, is well-placed to be at the forefront of that global charge towards the carbon-neutral energy system of the future, and has set out a long-term roadmap for decarbonization with its ambitious new goals to achieve peak carbon emissions by 2030 and carbon neutrality by 2060. This was well-received by the world – and the country is wholly committed to turning that vision into a reality.

2. The Chengdu-Chongqing Economic Circle – China's newest regional integration plan, aiming to power growth in the southwest and beyond

The Chengdu-Chongqing Economic Circle is poised to play an integral role in China's push to realize its 2030/2060 climate goals. Last autumn, the Political Bureau of the CPC Central Committee reviewed the master plan for the new super-region, China's fourth pillar for regional integration following the Yangtze River Delta region, the Guangdong-Hong Kong-Macao Greater Bay Area and the Beijing-Tianjin-Hebei region.[82] As the economic circle takes shape, the national strategy will transform China's two southwestern megalopolises into major new hubs for growth and help to drive high-quality, sustainable development nationwide. Under the master plan for its' development, China's leadership has called for the two cities to work closely together to create a high-standard market system, build a first-class business environment, and participate in the development of the Belt and Road Initiative (BRI). Deepening integration between the Chengdu and Chongqing economies and leveraging the respective strengths of each city will transform the economic circle into a major center for science and technology and a national leader for reform and linking up with the global economy.

For the economic circle to realize its full potential and become a global model, it will be important for the two mega-cities to deploy the strongest, smartest and greenest energy

[83] CPC leadership reviews master plan for Chengdu-Chongqing economic circle, CGTN, October 17, 2020

infrastructure and sustainable transportation solutions. As there is currently an imbalance between energy production and demand, ensuring sufficient energy supply for the region will be critical to facilitating integration between Sichuan province and Chongqing.[83] For instance, Chongqing's new electricity demand is expected to reach 25 GW by 2035, calling for an acceleration in the introduction of clean electricity into the giant city. So there is a clear need to further expand and diversify the sources (such as renewables) from which the new urban agglomeration derives its energy – both within the region and from across the country. To do so, Sichuan and Chongqing are focused on planning the integrated development of their power grid and power market, with an emphasis on achieving high-quality energy development. Fortunately, Sichuan holds unbelievably rich and diverse energy sources which will help to power the clean energy transition in China's southwest and far beyond.

3. Powering a strong economic circle

Having proved its resilience in China during these extraordinary times, a reliable and efficient power sector is crucial for continuing to drive the economic recovery, and it will play a pivotal role for the sustainable energy future of the economic circle. For Chengdu and Chongqing, clean electricity will be critical for the economic circle's long-term socioeconomic development. The most efficient, cleanest and cost-effective way to electrify the city cluster will be to harness Sichuan's vast renewable energy sources.

However, Chongqing and Chengdu are the end-users consuming the renewable energy transmitted to their consumers. We would therefore need to leverage ultrahigh-voltage (UHV) and high voltage (HV) technologies to integrate, transmit and interconnect Sichuan's abundant hydro, solar and wind power to the densely populated economic circle. In contrast to traditional grid networks, UHV transmission is significantly advantageous due to its ability to dramatically increase transmission capacity, conserve land resources, reduce transmission losses, and diminish project investments.

To enhance grid connectivity in the region, recommendations for the 14th Five-Year Plan for the Sichuan-Chongqing UHV Power Grid were submitted to the National Energy Administration earlier this year, proposing targets for the completion of various UHV projects: the 1000 kV Ganzi-Tianfu South-Chengdu East and Tianfu South-Tongliang UHV AC projects by 2023 and the Aba-Chengdu East UHV AC and Sichuan-Chongqing UHV projects by 2025.[84] During the 14th Five-Year Plan (FYP) (2021-2025) period, the development of these new UHV routes will provide vital infrastructure to help enhance the transmission of clean energy. By 2025, power transmission

[83] Greater efforts in Sichuan-Chongqing energy integration, IChongqing, April 9, 2020
[84] Plan for the Sichuan-Chongqing UHV AC power grid submitted to the National Energy Administration, proposing to upgrade Sichuan's main power network as soon as possible, China Smart Grid, March 2, 2021

capacity throughout the economic circle is expected to surge to 11 million kW, up from only 5.5 million in 2019, and carbon emissions will be reduced by more than 56 million tons.[85]

In Chongqing, ABB Chongqing Transformer Co., Ltd., has supported China's clean energy transition for over two decades.[86] Jointly established by Hitachi ABB Power Grids and Chongqing Transformer Co., Ltd., the company is one of the largest Hitachi ABB Power Grids transformer factories in the world. The advanced production facility has supported numerous UHV projects throughout China, including the Yangtze River Three Gorges Hydro Power Right Bank Substation, Northwest-Central China (Sichuan) Power Grid DC Interconnection Project, Beijing Chengbei Substation (one of the key projects for the 2008 Beijing Olympic Games), and the world's first ±1100 UHVDC transmission line. With growing business opportunities, this manufacturing base is also becoming a regional export hub.

At present, ABB Chongqing Transformer Co., Ltd. is in the process of being relocated from Jiulongpo District to Chongqing's Liangjiang New Area, where it will establish a world-leading transformer manufacturing base.[87] It is increasing important to realize that collaboration across stakeholders, sectors, and geographies will be critical to facilitating our long term vision and carbon neutrality ambitions. The ongoing relocation of this factory, in operation for over two decades, provides a powerful example of how dynamic collaboration efforts yield the best results. Requiring significant coordination among multiple stakeholders and government agencies, the project has been actively supported by the Chongqing municipal government, Liangjiang New Area, and Jiulongpo District, all of whom are working very closely together to ensure a successful relocation of the factory. Once completed, the facility will be one of Hitachi ABB Power Grids' most advanced manufacturing units in the world, and it will continue contributing to efforts aimed at accelerating the clean energy transition in the Chengdu-Chongqing Economic Circle and across China.

4. Powering a smart economic circle

Building a smart city cluster by deploying digitalization will be integral to the success of the Chengdu-Chongqing Economic Circle. Digitalization will help to unlock the growth that will drive even greater integration of the two cities' economies and foster the creation of a world-class business environment. In particular, accelerating and deepening the digitalization of the economic circle's energy system will help to provide greater flexibility, resilience, reliability and efficiency

[85] Chongqing: Construct an integrated Sichuan-Chongqing UHV power grid to accelerate deeper interconnections between Chengdu and Chongqing, Xinhua, March 26, 2021
[86] ABB Chongqing Transformer Co., Ltd., Hitachi ABB Power Grids
[87] ABB to build a world-class smart manufacturing base of transformers in Chongqing, July 26, 2019

across the power value chain. It will also contribute towards greater social, economic and environmental value supporting the super-region's sustainable energy future.

Leveraging widely deployed sensing technologies, vast amounts of data and advanced analytics as well as software-based asset management and optimization solutions are just some examples that can enable the convergence of operational (OT) and information technologies (IT). For instance, greater grid digitalization can enhance reliability by pre-empting events that may lead to failure; predicting when critical assets will fail; and swiftly guiding the right people to the right place, equipped with the right information to resolve issues. Across the world, entities who are investing in digitalization today are leveraging a clear and sustainable competitive advantage derived from increased flexibility and cost efficiency.

For super-regions like the Chengdu-Chongqing Economic Circle, deploying digital technologies can also elevate urban development to the next level and create a smarter energy system by improving efficiencies and enhancing supply and demand. Smart solutions are key, and the pandemic has significantly accelerated the smart transition globally, with many sectors now undergoing digital transformation – from renewable energy integration to asset intensive industries like mining & metals, oil & gas and across the transportation and infrastructure sectors.

As an example of the many benefits unleashed by digitalization, China Southern Power Grid's (CSG) first virtual power plant in Shenzhen, offers a good case study.[88] The city's operational grids were facing issues, not only due to varied supply sources but also as new demand loads were being connected to CSG's electrical operations (e.g. air conditioning systems, charging facilities for electric vehicles, energy storage, and distributed resources[89]). The challenge was how to effectively regulate and control the flexible power resources in Shenzhen without constructing new power plants given extremely limited land resources in such mega-cities.

CSG's new virtual power plant (VPP), developed with technical support from Hitachi ABB Power Grids, is playing an integral role in helping to do so. The state-of-the-art facility now forms part of China's extensive urban power grid and is supporting Shenzhen's drive to build a safe, reliable, sustainable and efficient energy system. Covering less than one square meter, the system is able to function like a large power plant in terms of peak load regulation and voltage control, operating via smart technologies that ensure stable operations of the grid. More than 20 MW of flexible power resources across several areas of Shenzhen will ultimately be connected to the virtual power plant, providing service for about 1,000 grid users. In future, these advanced systems

[88] Hitachi ABB Power Grids helps China Southern Power Grid build its first automated virtual power plant, November 23, 2020
[89] China's first automatic virtual power plant system begins trial operations, China Southern Power Grid, November 6, 2020

can be deployed further across China's vast urban landscape, empowering mega-cities to overcome severe land constraints.

5. Powering a green economic circle

As part of the energy transition and carbon neutrality commitments, governments around the world are preparing for a massive increase in renewable energy sources. This influx of renewables needs to be integrated and then transmitted and distributed to consumers often located far from the generation points – all in a timely, efficient and reliable way. The answer lies within the world's power networks, i.e. ensuring the right grid infrastructure – the Chengdu-Chongqing Economic Circle is no exception.

To leap forward in reducing the carbon dioxide intensity of the global energy system, it is critical to go beyond accessing the best green energy resources, which are often located in remote places, such as in Sichuan. To fulfill the vision of a sustainable Chengdu-Chongqing Economic Circle and support China's drive towards achieving its 2030/2060 climate goals, clean energy systems will need to be installed in Chengdu and Chongqing that act as the backbone for powering a green, high consumption cluster. The launch of mechanisms aimed at incentivizing the generation, transmission and usage of clean energy, as well as the establishment of trading platforms for such sustainable sources, can play a key role in driving that process forward.

For both domestic and foreign companies operating in the economic circle, internationally recognized green standards and certification can provide a competitive advantage, demonstrating to stakeholders their commitment to facilitating the sustainable energy transition. For instance, the I-REC Standard, which empowers energy buyers by facilitating reliable energy claims with Renewable Energy Certificate (REC) schemes, provides an example.[90] Currently being rolled out in a growing number of countries outside Europe and North America, I-REC offers companies an effective, market-based instrument to facilitate the integration of renewable energy into their global sustainability strategies, enabling them to document reductions in their greenhouse gas emissions and improve their sustainability ratings. In contrast to other Energy Attribute Certificates (EACs) which often focus on one particular form of energy, the I-REC Standard was designed to be energy neutral, or to enable reliable claims regardless of the specific type of energy that was used.[91] On the other hand, as accountability increases, companies may also face the risk of incurring penalties if they do not actively contribute to the energy transition.

[90] The International REC Standard
[91] Understanding EAC Schemes and Roadmaps for Their Development, The International REC Standard Foundation, September 2020

Countries and regions are also increasingly turning to carbon tax mechanisms as an effective tool for addressing climate change and reducing pollution levels while ensuring a level playing field. The Organization for Economic Co-operation and Development (OECD) defines carbon tax as "an instrument of environmental cost internalization. It is an excise tax on the producers of raw fossil fuels based on the relative carbon content of those fuels."[92] In Europe, the EU-ETS system of carbon pricing is a crucial tool for aligning market incentives to ensure an effective and efficient use of capital. The reduction, for instance, in UK coal usage in recent years is largely because of this system which has made coal uneconomical for power generation. The other positive impact of carbon taxes is the revenue to governments which can be used to push further decarbonization or to ensure carbon equality. Going forward, the world will likely see a system of border tax adjustments which will ensure that carbon intensive industries do not just move to a location with no carbon taxes.

Given the strong incentives for companies to go green, the global business community has started taking a leading role in driving the energy transition forward. For instance, State Grid Corporation of China plans to invest US$70 billion annually over the next five years to push projects that will help China's national electricity grid to make better use of low-carbon power sources, while China Southern Power Grid intends to expand its clean power capacity five-fold by 2030, aiming to add 100 GW of new energy capacity by 2025 and another 100 by 2030. European energy giant Equinor, like several others, is positioning itself to be a leading company in the energy transition, having set the goals of producing 10 times as much renewable energy by 2026 as today and becoming a net-zero company by 2050.[93] Demonstrating its commitment to renewables, the biggest industry project that Equinor currently has under development is not an oil platform but the world's largest wind farm off the UK coast – Doggers Bank. In fact, Hitachi ABB Power Grids has been selected to provide its pioneering HVDC technology to integrate wind energy for Doggers Bank A, B and C, the three projects awarded so far.

Earlier this year, Hitachi ABB Power Grids announced Sustainability 2030 – its own strategic plan for sustainability.[94] Through Sustainability 2030 the company has outlined its main commitments to act and drive business in a sustainable way. Based around four pillars – Planet, People, Peace and Partnerships – the strategy draws from the UN's Sustainable Development Goals (SDGs), where each pillar has corresponding targets that drive the business to contribute social, environmental and economic value. For example, targets relating to protecting the planet include becoming carbon-neutral in its own operations by 2030. As a first step, the business expects to have moved to 100 percent fossil-free electricity by the end of 2021. It has also

[92] OECD, Glossary of Statistical Terms, Carbon Tax
[93] Equinor's largest industry project today is not an oil platform, but an offshore wind farm, Equinor
[94] Hitachi ABB Power Grids announces Sustainability 2030, Hitachi ABB Power Grids, June 3, 2021

announced a target to halve CO2 emissions along the value chain by 2030 and is working closely with suppliers to achieve this.

Supporting the drive to a sustainable energy future, Hitachi ABB Power Grids is pioneering digital and energy platforms which help customers to overcome complexity, increase efficiency and accelerate the shift towards a carbon-neutral energy future. For instance, in April 2021 the company launched EconiQ™ – its eco-efficient portfolio of products, services and solutions which are sustainability-oriented in design and proven to deliver a superior environmental performance compared to conventional solutions.[95] Hitachi ABB Power Grids has been consistently investing to address the growing demand for eco-efficient solutions from its customers and partners, including in China.

As another example, Hitachi ABB Power Grids and King Long Motor Group, one of the largest bus and coach manufacturers in China and globally, have jointly developed a prototype e-bus with Hitachi ABB Power Grids' flash-charging technology – the world's fastest.[96] Charged in seconds at bus stops, the e-bus can stay on the road all day long which avoids the need to take the vehicle out of service for recharging every few hours or having a replacement bus ready, thereby minimizing the size of a city's fleet as well as parking lots. Hitachi ABB Power Grids' TOSA flash-charging system is already an established e-bus technology in Geneva, Switzerland, where it has operated for more than 500,000 kilometers, transported millions of passengers and saved more than 1,000 tons of carbon dioxide emissions.

What's more, non-energy sector players are also becoming heavily involved in the development of renewables. Google, having made its commitment to clean energy a cornerstone of its sustainability efforts, became the first company of its size to match its entire annual electricity consumption with renewable energy in 2017. Two years later, Google made the biggest corporate purchase of renewable energy ever, unveiling a 1,600 MW package of agreements, including 18 new energy deals, to expand its global portfolio of wind and solar agreements by over 40 percent to 5,500 MW.

6. Conclusion and recommendations

As the world addresses COVID-19 and prepares for the 'new norm,' we need to push for an accelerated energy transition – given the situation the world faces, with increasing climate driven natural disasters all over the world, there is no time to spare. Successfully doing so between now and 2030 is absolutely crucial to the wellbeing of humanity and the planet. As the preferred clean energy source, electricity will be the backbone of that transition. And as the central theme of the

[95] Hitachi ABB Power Grids' EconiQ
[96] ABB and China's King Long to develop e-bus with world's fastest flash-charger, Hitachi ABB Power Grids, September 5, 2019

electricity revolution, renewables will be the biggest contributor to the transition. Harnessing and deploying digital technologies will be vital for accommodating increasing amounts of renewable energy which in turn calls for adequate, resilient, efficient and flexible grids to integrate, transmit and distribute the power to consumers across the spectrum. This calls for a number of key enablers and catalysts such as adequate financing and technology deployment. It also requires the right policies and regulatory environment and appropriate business models, supported by collaboration across stakeholders.

For the Chengdu-Chongqing Economic Circle, it will be critical to deploy the appropriate energy, transport, industrial, building and digital infrastructure to attract investment and foster economic and social growth. This will power a sustainable future for China's massive new city cluster in the southwest – attracting even more domestic and multinational corporates to settle in the region and helping to ensure that the region emerges as a leading global model.

At this promising stage of the Chengdu-Chongqing Economic Circle's development, we offer the following suggestions to help unleash the full potential of the new super-region as a sustainable economic growth engine:

- **Leverage technology:** Technology has a key role to play in driving the pace and scale of the clean energy transition. In particular, accelerating the deployment of key technologies to integrate and manage renewables as well as digitalization to enable our grids to become more flexible and reliable. For instance, managing renewable energy variability in the Chengdu-Chongqing Economic Circle using the latest technology will help facilitate a more resilient grid.
- **Encourage green investment:** Chongqing and Chengdu already stand upon a robust ecological foundation, with expansive natural resources and clean energy at their fingertips. Further embedding sustainability at the heart of their development strategies will be critical to strengthening the economic circle's competitiveness in the future. Key steps include facilitating greater inflows of environmentally friendly investments and developing viable business models that reflect the Chinese economy's sustainable transition.

- **Drive collaboration:** Collaboration across stakeholders will be a key success factor in fostering a more sustainable energy future and realizing the economic circle's full potential. No player, no matter how good, can do it alone. In order to deliver effective solutions, we need to establish a dialogue and strong cooperation between the expert stakeholders and ensure a conducive policy and regulatory environment.

- **Act with a focused sense of purpose and urgency:** Now more than ever we all need to come together to address the colossal challenges facing global society. It is crucial that the

foundations needed to accelerate us towards a carbon-neutral energy system are laid as a foundation, particularly in super-regions like the Chengdu-Chongqing Economic Circle. We must not lose sight of the urgency. Speed and scale will be key success factors.

We hope that the above practices and learnings from China and across the world provide actionable suggestions that can help realize the Chengdu-Chongqing Economic Circle's vision of becoming a leading new economic engine – one which successfully drives sustainable growth and prosperity in China as well as the wider world.

Decarbonization in the Chengdu-Chongqing Economic Circle

With consideration of Japanese trends aiming at the achievement of carbon neutrality in 2050

SATO Yasuhiro
Chairman, Mizuho Financial Group

[Index]

Part 1: Introduction

In October 2020, the Political Bureau of the Communist Party of China (CPC) Central Committee reviewed the 'Master Plan for the Construction of the Chengdu-Chongqing Economic Circle' (hereinafter 'the Chengdu-Chongqing Economic Circle'). The Chengdu-Chongqing Economic Circle is a new economic zone centered around Chengdu, a city in Sichuan that sits upstream of the Yangtze River Economic Belt, and Chongqing, the only direct-controlled municipality in inland China. The Circle plays an important role of driving economic growth in inland China and it joins other economic zones like the Yangtze River Delta Area, the Guangdong-Hong Kong-Macao Greater Bay Area, and the Beijing-Tianjin-Hebei Area.

As the capital of Sichuan province, Chengdu has played a central role in the development of China's western regions since 2000. Chongqing has also played a key role connecting the western regions with China's east (an area traversed by the Yangtze golden waterway), with Chongqing's advantageous geographical location helping it to serve as a hub connecting the Yangtze basin, Southeast Asia, Central Asia and Europe. As a node in the 'One Belt One Road' and the 'Yangtze River Economic Belt,' the Chengdu-Chongqing Economic Circle will make a major contribution to the development of inland China.

The Chengdu-Chongqing Economic Circle will probably need to engage with 'decarbonization' in order to achieve sustainable development going forward. In September 2020, the Chinese government set a goal of hitting peak greenhouse gas (GHG) emissions by 2030 on the road to achieving net zero emissions by 2060, with China and its regions pursuing various initiatives to achieve this end.

This report will examine global carbon neutrality trends while introducing some cases from Japan. It will also look at initiatives, challenges and future possibilities when it comes to achieving carbon neutrality in key industries.

Part 2: Global trends in the area of carbon neutrality

The adoption of the Paris Agreement in 2015 provided impetus to moves to combat global warming and it led to a flurry of international initiatives aimed at cutting GHG emissions. The Paris Agreement set concrete goals, such as limiting the global temperature increase to 2 degrees Celsius[97] and achieving a balance between GHG emissions and absorption in the latter half of the 21st century. It also decided to establish a framework for GHG initiatives that encompasses developed and developing nations.

[97] International goal of keeping average global warming less than 2 degrees Celsius above pre-Industrial Revolution levels

In December 2019, the European Commission announced its new 'European Green Deal' growth strategy for Europe. This targets zero net GHG emissions by 2050 (carbon neutrality). Moves towards global carbon neutrality were also given a big boost at the United Nations General Assembly in September 2020 when China announced a goal of decarbonization by 2060, with Japan also announcing in October 2020 that it would target carbon neutrality by 2050. The US had withdrawn from the Paris Agreement following the inauguration of President Trump, but Joe Biden assumed the presidency in January 2021 and he had pledged to tackle climate change in his manifesto, with the US also now on board with the goal of carbon neutrality.

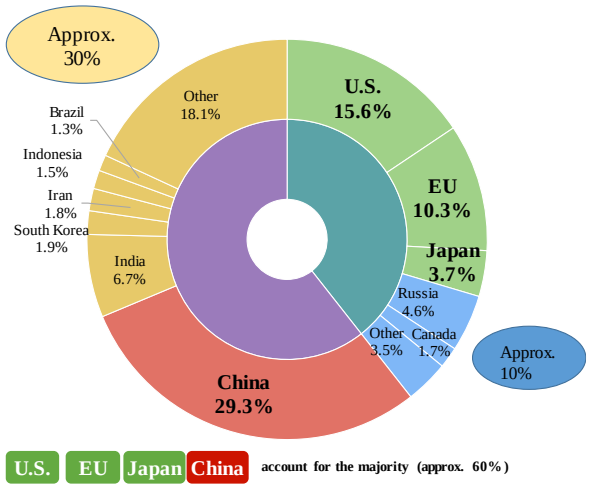
In addition to the aforementioned long-term goals, several countries and regions have also set new medium-term goals for GHG cuts by 2030 or have strengthened existing targets (Fig. 1). Europe, the US, China and Japan account for around 60% of all global CO2 emissions (Fig. 2), so it is very significant that they have all pledged to achieve carbon neutrality. As they seek to achieve this goal, governments are likely to promote the replacement of legacy assets while accelerating moves to encourage the take up of new technologies and demand across all industries. It is not just developed nations - emerging nations (excluding China) account for around 30% of emissions and they also have a key role to play in reducing GCGs. China has also stepped up to play a major role in tacking environmental problems, as evinced by the international pledge it made to reduce GHGs when it adopted the Paris Agreement. I would express by respect for the steps China is making as it strives to play a leading role in international moves to tackle global warming.

Fig.1: The targets of each country and region

	EU	Japan	The US	China
Long-term goals	Carbon neutrality by 2050	Carbon neutrality by 2050	Net zero emissions by 2050	Carbon neutrality by 2060
Medium-term goals	Cut emissions by at least 55% by 2030 (compared to 1990 levels; and a 44% cut compared to 2013 levels)	Cut emissions by 26% by FY2030 (compared to 2013) ⇒Cut emissions by 46% by FY2030 (compared to 2013)	Cut emissions by 26-28% by FY2025 (compared to 2005) ⇒Cut emissions by 50-52% by 2030 (compared to 2005)	Reach peak emissions by 2030. Reduce CO2 emissions per unit of GDP by 65% compared to 2005

Source: Prepared by Mizuho Bank's Industry Research Department from the UNFCCC GHG Data Interface and Ministry of Economy, Trade and Industry materials

Fig. 2: Share of CO2 emissions by country and region



Source: Prepared by Mizuho Bank's Industry Research Department from Ministry of Economy, Trade and Industry materials

Before examining trends in Japan, I would like to discuss trends in Europe and the US. In its 'Green Deal,' growth strategy, the EU announced a goal of carbon neutrality. In January 2020, the EU announced a plan to attract at least one trillion euros worth of public and private investment over the next decade. It is hoped that initiatives aimed at achieving carbon neutrality by 2050 will also help the economy to recover from the impact of Covid-19. At this moment in time, the EU is planning to spend at least 30% of the 1.8 trillion euros earmarked for its Long-term Budget for 2021-2027 and its Next Generation EU Fund on policies to tackle climate change. There are also initiatives that operate across several major sectors, including the EU Emissions Trading System (EU ETS), the Carbon Border Adjustment Mechanism (CBAM), the EU Taxonomy Regulation, the Industrial Policy, and the Just Transition Mechanism. The EU is investing huge sums on a variety of policies that tackle climate change while also helping to strengthen the competitiveness of EU firms.

In the US, in March 2021 the Biden administration announced 'the American Jobs Plan,' an infrastructure investment plan costing around $2.3 trillion. The plan includes a comprehensive range of environmental policies, including investment in transportation infrastructure, a $174 billion investment in EVs, and a $35 billion investment in strengthening climate change R&D, including the creation of the Advanced Research Projects Agency-Climate (ARPA-C), a federal government-wide research body, with the government planning to promote climate change policies by linking them with economic and industrial policies.

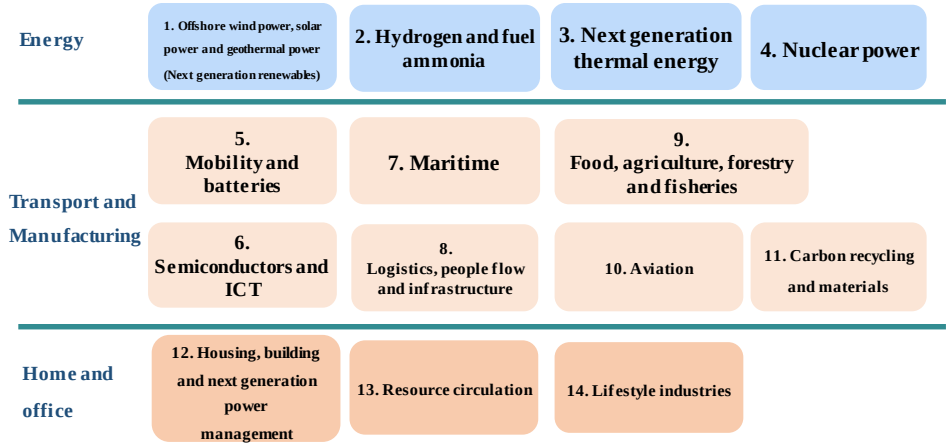
A glance at US and European moves in the area of carbon neutrality clearly reveals that Europe and the US see climate change policies not only as a way to achieve carbon neutrality but also as something that can play a central role in growth strategy for creating jobs and cutting-edge technology.

Part 3: Japanese moves to achieve carbon neutrality by 2050

Following its 2050 carbon neutrality pledge, Japan formulated the 'Green Growth Strategy Through Achieving Carbon Neutrality in 2050' in December 2020 with the aim of uncovering new green growth opportunities. As with the US and Europe, Japan believes its Green Growth Strategy can play a key role in its industrial strategy for building a 'positive cycle of economic growth and environmental protection.' Japan believes it is vital to build a framework under which initiatives to achieve carbon neutrality can also contribute to boosting the industrial competitiveness of the country and regions. I would now like to introduce three aspects of Japan's Green Growth Strategy.

Firstly, Japan has outlined 14 sectors targeted for growth (Fig. 3). These were selected for their growth prospects and also because they need to be included in the green strategy if Japan is to cut GCG emissions. Its action plans for these sectors include clear yearly targets and they prioritize regulatory reform and standardization, the creation of demand through financial markets, and cost reductions through an increase of private investment. When it comes to the key technologies that will drive growth, the strategy includes a progress chart for 2050 that is divided into four phases: the R&D phase, demonstration phase, scale-up phase, and commercial phase.

Fig. 3:14 sectors with strong growth prospects



Source: Prepared by Mizuho Bank's Industry Research Department from the Green Growth Strategy Through Achieving Carbon Neutrality in 2050

Secondly, Japan aims to cover around 50-60% of power generation using renewables (primarily solar).This is only a reference figure based on the major premise of power sector decarbonization and on estimates that demand for electricity in 2050 will be up 30–50% on current levels on the electrification of industry, transport and the household sector, but it still represents a quantitative target (see Part 4 for more details).

Thirdly, the policy will use the following five cross-sectoral policy tools to support ambitious

corporate investment in innovation.

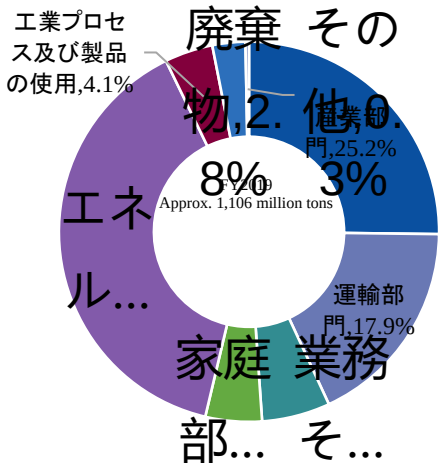
1 Budget: A 2 trillion yen ‘Green Innovation Fund’
2 Tax: Introduce the ‘Tax System to Promote Investment Towards Carbon Neutrality’ to stimulate 1.7 trillion yen worth of private investment over 10 years
3 Finance: Introduce an ‘Interest Subsidy Scheme’ to encourage investment in innovative technology related to decarbonization; improve the environmental for the utilization of transition finance; and promote enterprises’ disclosure of information on climate change
4 Regulatory reform and standardization: Promote international standardization for equipment involved in the international transportation of hydrogen; and relax/strengthen regulations to encourage the spread of new technologies including “carbon pricing” and other economic instruments that utilize market mechanisms
5 International collaboration: Promote collaboration with emerging economies in Asia and elsewhere in the areas of carbon recycling, hydrogen, offshore wind power, and carbon capture; and support the effective transition to a low-carbon economy in a way that suits the circumstances of each country

Given how support geared towards company needs has a vital role to play in encouraging corporate investment in innovation, the aforementioned policy tools will be used in the most appropriate way when implementing the four phases of the progress chart for 2050 (the R&D phase, demonstration phase, scale-up phase, and commercial phase).

Part 4: Initiatives and challenges in Japan’s clean energy sector

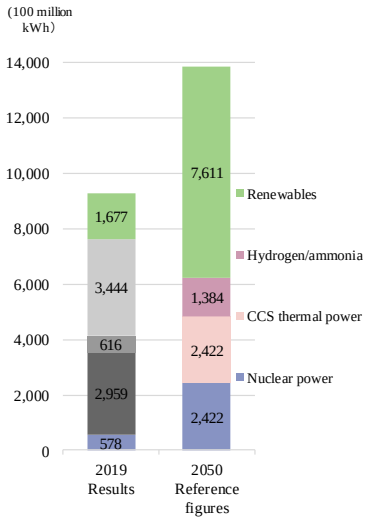
In Japan, energy consumption accounts for over 90% of all CO2 emissions, so the energy sector response has a very important role to play in realizing sharp cuts of CO2 emissions (Fig. 4). As mentioned in Part 3, the Japanese government has outlined its target energy mix for FY2050 (Fig. 5). To achieve this, Japan will need to promote the large-scale introduction of renewables in a manner that takes into account natural conditions and social restraints while also developing and establishing technologies in the area of hydrogen, ammonia and CCUS, for example. This section will examine Japanese initiatives and challenges in the area of hydrogen and CCUS.

Fig. 4: Breakdown of CO2 emissions in FY 2019



Source: Prepared by Mizuho Bank's Industry Research Department from National Institute for Environmental Studies materials

Fig. 5: 2050 energy mix



Source: Prepared by Mizuho Bank's Industry Research Department from Agency for Natural Resources and Energy materials

4-1. Initiatives and challenges related to the realization of a hydrogen society

Hydrogen is a clean energy that doesn't produce air pollutants or GHG emissions. It can also be produced from a diverse range of primary energy sources using various methods. Hydrogen can also be transported and stored as gas or liquid, and it is expected to play a central secondary energy role going forward.

The Japanese government has positioned 'hydrogen and fuel ammonia' as one of the 14 sectors with strong growth prospects in its Green Growth Strategy. It has also outlined a direction and vision for 2050 to be shared among the public and private sector. This includes a target of introducing up to 3 million tons of hydrogen in 2030 and around 20 million tons in 2050. The introduction of more hydrogen will lower the cost of hydrogen production from around 100 yen/Nm3 at present to 30 yen/Nm3 in 2030 and below 20yen/Nm3 in 2050. This will bring hydrogen power generation costs below thermal power generation costs. The plan is also to develop technologies before any other country and then roll these out internationally, particularly with regards to technologies like hydrogen power turbines, fuel cells, trucks and other commercial vehicles, and hydrogen reduction steelmaking. The Japanese government's goal is for hydrogen and fuel ammonia to account for around 10% of total electricity output. It is also aiming to use hydrogen to respond to heating demand in sectors such as non-power industries, transportation, commerce and residential.

Many trials are underway with the aim of expanding hydrogen energy utilization. This section will examine some of Japan's trials in the area of hydrogen energy supply chains. Rather than tinkering with some supply chains, the achievement of carbon neutrality will require structural changes across all processes. In particular, as a country with few fossil fuel resources, Japan is aiming to build a hydrogen-based society. As such, there is a growing need to pursue integrated initiatives to construct hydrogen supply chains by producing hydrogen from unused resources overseas and then shipping it to Japan. In order to establish a system to ensure a stable, low-cost supply of hydrogen, since 2015 the Japanese government has been carrying out two world-leading trials to construct hydrogen supply chains that utilize unused resources from overseas.

The first is the 'Hydrogen Energy Supply Chain (Victoria).' Running since 2018, this public/private Japan-Australia trial project involves the establishment of an international hydrogen supply chain via the export of CO2-free liquid hydrogen to Japan. Development on the Australian side is being carried out by a consortium of five Japanese firms and one Australian firm, with the total Japan-Australia budget running to around 500 million Australian dollars. Development on the Japanese side is centered around an R&D organization established by Royal Dutch Shell and six Japanese firms (with some overlapping) involved in heavy electricity manufacturing and so on. The mining site in the Australian state of Victoria has energy reserves equivalent to 240 years of electric power generation in Japan, particularly reserves of low-grade coal (lignite) with a price one-tenth that of regular coal. Kawasaki Heavy Industries has developed commercial technology capable of extracting hydrogen from lignite. Furthermore, the CO2 released during the production process is being buried in the ground and kept out of the atmosphere using CCS technology. The produced hydrogen is cooled to -253 degrees, with hydrogen converted from gas to liquid. The volume of liquid hydrogen is 800 times smaller than gas hydrogen, so this process significantly boosts transport efficiency. This project has succeeded in bringing hydrogen production costs down to one-third the cost of hydrogen sold at hydrogen filling stations within Japan, with hydrogen usage expected to expand into a wide range of sectors, including cars, power generation and industrial materials. The first phase of this project involved a year-long trial and it succeeded in establishing a completely integrated hydrogen supply chain between Japan and Australia. Japan finished building port facilities to liquefy and store hydrogen in July 2020 (Kobe), with Australian port facilities completed in August 2020 (Hastings). Furthermore, the world's first liquefied hydrogen carrier 'Suiso Frontier' successfully launched in seas close to Japan in October 2020. Operations are expected to commence in earnest in the second phase from 2021. In February 2021, J-Power announced it had begun manufacturing hydrogen, with the production of high-grade hydrogen also a possibility. The aim is to move into the commercial phase in the 2030s based on the results of the pilot phase, the approval of the regulatory authorities, feedback from communities, hydrogen demand trends, and the level of development of CCS technology, for example.

The second trial involves the organic chemical hydride method, which utilizes toluene as the hydrogen carrier. This method is used to produce hydrogen from gas from a natural gas liquefaction plant in Brunei, with this hydrogen then shipped to Japan. The project target for the initial phase was successfully completed in December 2020. The project is being led by an R&D organization comprising an engineering firm and three other private firms, with support provided by the Japanese government. Hydrogen has a low energy density, so transportation presents a challenge, but the organic chemical hydride method enables hydrogen to be stored and transported at regular temperature and pressure as liquid methylcyclohexane (MCH; with a compressed volume of approximately one 500th of hydrogen), which is produced from a reaction between toluene and hydrogen procured from commodity-producing nations. Furthermore, the toluene and hydrogen can be separated again in the demand country, with the hydrogen supplied to consumers and the toluene sent back to Brunei to be used in the transport of hydrogen again. The project began in 2017 with the construction of a trial plant, for example. The MCH arrived on Japan's shores for the first time in December 2019, with hydrogen then extracted from the MCH and supplied domestically. In June 2020, meanwhile, toluene was transported back to Brunei and recombined with hydrogen, thus marking the successful completion and safe usage of a hydrogen supply chain comprising a series of processes. The project succeeded in supplying over 100 tons of hydrogen over a 10-month period. It was a world first when it came to the safe and secure transportation of large volumes of hydrogen between two countries. The trial confirmed that it would be possible for hydrogen supply chains using MCH technology to be scaled up to commercial level. Japan is seeking to promote the early establishment of a hydrogen society. To this end, (pre-commercial) trials will commence in the early 2020s with the aim of lowering costs further by scaling up to meet expanding demand and pursuing more technological improvements. The goal is to help Japan and other countries achieve carbon neutrality by 2050 using green technologies developed in Japan.

Japan's Green Growth Strategy aims to realize a 'hydrogen society.' To this end, several technological and economic challenges will need to be resolved in the areas of 'supply,' 'demand' and 'usage.' Japan will need to tackle several challenges in order to obtain a supply of around 20 million tons of 'clean hydrogen' (hydrogen produced from fossil fuels + CCUS, renewables, etc.) by 2050. These include (1) securing renewable electric power output when manufacturing hydrogen from renewables within Japan, (2) securing CO2 storage areas when producing hydrogen using fossil fuels + CCS in Japan, and (3) scaling up carrier ships when importing liquefied hydrogen. The Green Growth Strategy also faces several technological challenges regarding the use of hydrogen in each industry, such as the commercialization of fuel cell trucks and so on, the verification of stable combustion in power generation, the establishment of technologies for 100% hydrogen reduction steelmaking, the expansion of a commercial vehicle liquid hydrogen transport network, and the lowering of manufacturing costs for hydrogen-derived plastics. Other challenges include the establishment of CO2 circulation (chemistry) and the fact that hydrogen conversion

will only be viable in a few temperature zones (heat demand), with innovation and technological development required in these areas too.

4-2. Initiatives and challenges related to CCUS

CCUS is the general name for new technologies that capture, use and store CO2 generated by power plants, refineries, ironworks, etc. before it enters the atmosphere. It broadly involves two processes: Carbon Capture Storage (CCS) and Carbon Capture Utilization (CCU).

The Japanese government's Green Growth Strategy calls for the maximum introduction of renewables. The government has said that thermal power generation will be utilized while making maximum use of carbon capture, so CCS-based thermal power generation will become essential in the run up to 2050. It seems CCUS will also be actively utilized in other sectors besides power generation, with CCUS set to be a vital technology as Japan strives to achieve carbon neutrality.

I would now like to examine the R&D and trials that have been undertaken with the support of the Japanese government with the aim of making CCS and CCU viable. When it comes to CCS, a large nine-year trial was held in Tomakomai from FY2012 to FY2020. Facilities for separating and capturing CO2 were designed and built in the four years from FY2012 to FY2015. From 2016, 100,000 tons of CO2 were injected per annum, with a total of 300,000 tons injected in 2019. From here on, the plan is to monitor the behavior of injected CO2 in the earth around the reservoir. The trial facilities will also be used in a 'Carbon Recycling Trial Project' that aims to synthesize methanol from separated/captured CO2.

With regards to CCU, technology is being developed to reduce the amount of CO2 generated in cement manufacturing. The current trial aims to develop technology that enables captured CO2 to be reused as raw materials for cement or as construction material. The project is being pursued under the aegis of the Ministry of Economy, Trade and Industry with the aim of introducing the technology in domestic factories by FY2030. When non-energy-originated CO2 emissions are added to the equation, the Japanese cement industry is the third largest emitter of CO2 behind the power and steel industries, so policies targeting this sector will be very important. The 'Progressive Environment Innovation Strategy' (formulated in January 2020) positions 'establishing processes for manufacturing cement using CO2' as one of 39 themes capable of contributing substantially to Japan's technological capacities. It is estimated that this could cut global CO2 emissions by around 4.3 billion tons by 2050, leading to high expectations

With CCS, Japan needs to focus on cutting 'separation/capture costs' and securing transportation means (Japan's reservoirs will probably lie offshore and will thus require liquid transportation), with a further challenge posed by the lack of potential large-scale transportation

storage sites. In comparison to CCS, it is difficult to process large amounts of CO2 using current CCU technology, but profits could be generated from the manufacture of chemicals and fuel, for example, so CCU could be said to have an economic advantage. When it comes to facilitating the practical application of CCU, the government will need to set time targets for technological development and its initiatives should also focus on areas where core technologies already exist and existing products could be replaced to achieve lower costs.

Part 5: Initiatives and challenges in major Japanese industries

I would now like to look at Japan's key industries and the initiatives and challenges that exist on the road to carbon neutrality. In the wake of recent trends towards carbon neutrality, Japanese firms will need to examine strategies with targets for 2030 and so on that conform with an overall goal of carbon neutrality in 2050. Firstly, firms will need to surmount current cost increases by expanding existing business or 'low-carbon' business while pouring energy into building up organizational strength and improving structures ahead of a structural shift to fully-fledged 'decarbonization' business. Furthermore, many sectors are expected to see significant changes (tougher regulations or technological innovation, etc.) from 2030 onwards. In order to respond to these changes, firms should be fully aware that they may need to apply managerial judgement earlier than expected. Based on the above, Japanese firms will need to do the following: (1) decarbonize existing business and secure business opportunities, (2) promote the development and utilization of innovative technologies, (3) review location and supply chain strategies, and (4) formulate long-term plans and develop financial and capital strategies to support these plans.

Outlined below are the sector-specific methods and strategies for achieving carbon neutrality.

Industry		Strategies to achieve carbon neutrality
1	Electricity	• Restructure traditional power-supply structures based around thermal power to focus on renewables instead (secure investment resources); decarbonize thermal power generation • Pursue important strategies that focuses on collaboration with operators inside and outside the industry when developing power sources and also when producing and supplying hydrogen made from surplus renewable energy • In the thermal power sector, attach importance to establishing technologies that promote decarbonization using ammonia and hydrogen, etc. and lowering the costs • Consider collaborations with other players in the electricity sector when it comes to the procurement of low-cost renewable fuels from overseas and the upgrading, improvement and replacement of existing facilities
2	Petroleum and gas	• The oil sector could diversify in the short to medium term by expanding electricity business and moving into non-energy businesses. • In the long-term, the sector will need to decarbonize fuel through the provision of hydrogen, biofuels and e-fuel. • In the short to medium term, the urban gas sector should capture fuel conversion demand as much as possible while pursuing low carbonization by diversifying through the expansion of lifestyle services and by providing carbon neutral gas to urban areas. • In the long term, the sectors will need to decarbonize fuel through the utilization of methanation and the supply of hydrogen.
3	Steel	• Promote the maximum utilization of domestically-produced scrap as fuel for electric furnaces • Use hydrogen as a reducing agent instead of coke • Develop low-carbon steelmaking technology rapidly and use this business model to capture engineering business overseas
4	Chemicals	• Boost the proportion of decarbonization business in corporate portfolios ahead of 2030; CCUS technology is likely to come into commercial use from 2030 so, as a rough direction, firms should use the technology to create business opportunities and cut emissions. • Though the situation differs for each country and region, firms should increase the proportion of natural gas and renewables in their energy mixes while working to ensure emissions do not rise above current levels.
5	Electronics	• Finished product manufacturers: Cut CO2 emissions across entire supply chains (including intermediate goods, transportation and manufacturing processes) and reform business models (extend the life cycles of existing hard equipment and pursue reform in non-hard domains) • Semiconductor manufacturers: The horizontal specialization system could be approaching a turning point; cluster semiconductor factories and develop industrial clusters to cut CO2 emissions from mobility and supplementary operations; partial vertical integration is also progressing, coupled with package differentiation trends; firms also need to pursue discontinuous initiatives related to the overarching reform of manufacturing processes.
6	Automobiles	• Japanese OEMs will need to construct BEV-centered structures with an eye on 2035 and beyond. While developing business strategies to boost BEC profitability, firms will also need to respond to the environmental situation by cutting emissions using LCA. To this end, firms should generate cash through technologically superior HEV in anticipation of a certain amount of market growth. They should also supplement their BEV strategies by promoting the efficiency of ICE (a shrinking market).
7	Transport (passenger)	• Firms involved in passenger transportation will need to continue engaging with MaaS. • However, the hurdle of changing passenger behavior will need to be overcome in order to promote the switch to more energy-efficient transportation modes. In addition to the promotion of Maas and the improvement of convenience, operators will need to examine transportation policies, including MaaS (based on the Helsinki example), as part of initiatives to pursue carbon neutrality. • The aviation sector will be difficult to achieve zero emissions when it comes to flying itself, but the sector will be expected to participate in (1) the supply of replacement fuels (biofuels, etc.) and (2) businesses that contribute to credit generation.
8	Transport (freight)	• Logistics companies still need to pursue low carbonization by raising their productivity as operators. • Given the long-term trend of logistics operations commoditization, the survival of logistics firms could depend less on simply contracting 'operations' and more on how well they can engage with shipper companies' logistics 'strategies'. In the wake of the recent carbon neutrality declaration, it will become more important to engage with logistics strategies that also include CO2 reductions.
9	Real estate	• The real-estate sector still needs to pursue low carbonization through energy saving, etc. While striking a balance between investment and profitability, firms will need to continue investing in renewables while boosting energy-saving capacities as much as possible. • Property owners and users encompass a wide spectrum, from individuals to large corporations. One issue is how to ensure initiatives in the real-estate sector spread across to surrounding areas, so the design of incentives and regulations could be crucial going forward.
10	Retail	• The sector needs to prepare for decarbonization while overcoming industry problems such as store oversupply and low productivity. • For now, firms will need to pursue energy saving, cut green electricity introduction costs, and renovate stores to make them more energy efficient. One long-term issue will be the cost burden of purchasing Scope 3 credits across entire supply chains. • In the medium to long term, the retail sector might expand based on initiatives pursued by stores and large retailers and could use further decarbonization to explore the best ways to go forward.
11	Food	• The food industry should use decarbonization to explore new ways to deliver value. • For the food industry, decarbonization could provide an opportunity to diversify food value. This could be a chance for food manufacturers to change their brand portfolios by investing in food-tech (future foods) such as replacement protein. • When it comes to reducing food loss, trading companies and wholesalers might play an even more important role with regards to streamlining food value chains.

Part 6: Conclusion

So far, we have examined global trends in the area of carbon neutrality. We have also looked at Japan's Green Growth Strategy and initiatives and challenges in each clean energy sector and major industry ahead of the achievement of carbon neutrality in Japan by 2050.

Governments, companies and investors are actively working together on initiatives to solve social problems, as epitomized by the adoption of SDGs[98] by the UN in 2015. In order to achieve sustainable growth, China will need to respond thoroughly to the demands of environmentally-conscious overseas investors and various other stakeholders. China is likely to see rising demand for electricity and it will need to meet this demand while pursuing initiatives to cut GHG emissions.

Hydrogen-related technologies (fuel cells, hydrogen turbines, hydrogen reduction steelmaking, etc.) and CCUS are areas where Japan and China could work together on R&D and trials in a way that utilizes each country's strengths. Japan is also pursuing initiatives related to the construction of hydrogen supply chains. China's rich coal resources could be utilized in this area, for example. Japan and China could also work together to build hydrogen supply chains as an effective approach to meet substantial increases in demand for hydrogen in China.

Chongqing city already released 'Guidelines on the Development the Hydrogen Fuel Cell Automobile Industry in Chongqing City' in March 2020, with Sichuan province then releasing the 'Hydrogen Energy Industry Development Plan (2021–25)' in September 2020. As mentioned in Part 1, the area could utilize its advantageous geographical location to attract hydrogen industry clusters.

Finally, Japanese and Chinese joint ventures aimed at other Asian countries could contribute to sustainable development in China while strengthening Sino-Japanese economic cooperation and contributing significantly to sustainable development across the whole of Asia. Furthermore, joint initiatives with other Asian countries could also serve as sustainable growth strategies for Asia. I hope Japan and China will pursue more clean energy initiatives going forward as the two countries play a leading role in green energy in Asia and across the world.

[98] Sustainable Development Goals

A Brief Analysis of the Chengdu-Chongqing Twin-City Economic Circle in the Post-Epidemic Era - Public Health Development Strategy

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Table of Contents

A Brief Analysis of the Chengdu-Chongqing Twin-City Economic Circle in the Post-Epidemic Era - Public Health Development Strategy

It is a great honor for MSD to be a member of Chongqing Mayor's International Economic Advisory Council, and MSD would like to express its deep appreciation for the opportunity to participate in the 16th Annual Conference and provide constructive comments on the theme of "Twin Cities" and "Economic Circle": Opportunities and Challenges.

As an industrial leader in providing innovative medical solutions to markets in over 140 countries, MSD has made great contributions to human health: In 1987, MSD donated 3.4 billion doses of Ivermectin tablets to over 30 countries and regions for free to help 300 million patients suffering from River Blindness, benefiting over 80 million people each year up to present. By joining hands in close collaboration with global partners, the initiative has been described as the "Most Successful Public Private Partnership in the World".

MSD is deeply aware of the important role of international collaboration in supporting scientific and technological innovation, and we are proud of our long history of deep involvement in China. In September 1989, MSD and the Chinese government signed an agreement for the technology transfer for producing the genetically engineered hepatitis B vaccine, in which MSD promised not to charge any royalties or seek for any profits from China or to sell MSD's hepatitis B vaccine in China. With the vision and commitment to rooting in China, MSD established its first manufacturing plant in Hangzhou in 1994 and its Global Clinical Data Center in China in 2005, which is now one of the three MSD global centers. In 2005, MSD signed a partnership agreement with the Ministry of Health of China for the comprehensive prevention and treatment of HIV. In 2011, MSD established its China R&D Center. Over the past 30 years since the entry into China, the Company has introduced more than 40 innovative drugs and vaccines, with a focus not only on high-incidence diseases such as oncology and diabetes, but also on diseases that threaten the public health security of China, such as hepatitis C and HIV, which not only demonstrates MSD's ongoing efforts to improve the accessibility and affordability of healthcare for Chinese patients, but also highlights our commitment to support the Chinese government in achieving the strategic goal of "Healthy China 2030".

In 2017, MSD renewed the distribution and promotion cooperation agreement with Chongqing Zhifei Biological Products Co., Ltd., as the exclusive distributor of MSD's Human Papillomavirus Quadrivalent Vaccine (Saccharomyces cerevisiae) in China, providing health protection for women of appropriate age between 20-45 years old in China. In 2018, MSD signed a supplemental distribution agreement with Zhifei Biological for the Human Papillomavirus 9-

valent Vaccine (Saccharomyces cerevisiae), providing health protection for women of the age from 16 to 26 years old in China. In 2000, MSD signed a supply, distribution and co-promotion agreement with Zhifei Biological, which primarily aimed to adjust and renew the base purchase amount of five vaccine products for which MSD has obtained marketing licenses in the Chinese Mainland, and to strengthen the close cooperation with Zhifei Biological.

MSD highly values this opportunity and is willing to leverage our international experience and expertise to support the development of a high-quality public health innovation ecosystem in Chengdu and Chongqing based on close collaboration with the Chongqing Municipal People's Government.

Abstract

The Chengdu-Chongqing Twin-City Economic Circle has become the fourth pole of urban agglomerations in China as well as an important economic zone for high-quality development in the western part of China. Especially during the epidemic prevention and control in 2020, the Chengdu-Chongqing Economic Circle has engaged in fruitful collaboration and mutual assistance with staged results in epidemic prevention and control, boosting the development of public health in the Chengdu-Chongqing Twin-City Economic Circle. In this post-epidemic era, based on the favorable development foundation of the bio-industry in the Chengdu-Chongqing region, and from the perspective of the national pharmaceutical industry, we would like to propose two aspects to be focused on in the development of the public health bio-medical industry:(1) The development of biopharmaceuticals should be benchmarked against international-level industry clusters, and the innovative business cooperation model of MSD and Zhifei Biological should be promoted to enhance the comprehensive development of local enterprises towards the international market. In addition, by leveraging the complementary resources of the Chengdu-Chongqing Bio-pharmaceutical Industry Chain, efforts are expected to create an internationally competitive vaccine layout for R&D, production, digital IoT, etc. in Chongqing, and to enhance the strategic position of the Twin-City Economic Circle in the Chengdu-Chongqing region. (2) Improve the emergency supplies reserve system and optimize supply security. Accelerate the building of emergency supplies reserve system in Chengdu-Chongqing Economic Circle, improve the mechanisms and emergency plans, further enhance the safety reserve of emergency rescue drugs, optimize the access restrictions of medical insurance policies on emergency rescue drugs, and establish the production and reserve capacities for urban emergency products in collaboration with enterprises.

Keywords: Chengdu-Chongqing Twin-City Economic Circle; Post-Epidemic Era; Public Health; Pharmaceutical Industry Layout

1. Introduction

The development and advancement of a nation is fulfilled by the productivity of human-centered labor. And the public health efforts with the mission of improving the quality of healthy life are being increasingly valued by the government, society and the public. Therefore, public health has become an inevitable requirement to promote the overall development of human beings, the basic condition for economic and social development, an important symbol of national prosperity and national strength, as well as the common pursuit of the general public. In the historical process of achieving the "Two Centenary Goals" of China, the development of healthcare industry has always been and will always be in a fundamental position that is closely linked to the overall national strategy and plays an important supporting role. In the new era, the coordinated development of city clusters will also serve as a new model for regional development as well as a power source to propel the region in leading high-quality development.

Throughout the history of China, the Chengdu-Chongqing region has been of pivotal importance both in terms of strategic location and regional development. Since the approval of the regional planning for the Chengdu-Chongqing Economic Circle by the State Council in 2011, the construction of the economic circle in the Chengdu-Chongqing region has been listed and expedited on the agenda.

The Chengdu-Chongqing region has witnessed significant achievements in fields of economy, culture, education, health, etc. In 2020 when the epidemic was raging, the twin cities of Chengdu and Chongqing have joined hands in collaboration, joint prevention and control, and precise efforts to promote the overall controllable situation in regional epidemic prevention and control, while also innovating the practices of regional joint prevention and control of public health events, thereby providing plenty of experience to promote the coordinated development of the Chengdu-Chongqing Economic Circle and the layout of the public health industry.

2. Importance of responding to regional joint prevention and control of public health events

Based on the experience of epidemic prevention in China, it can be found that for the COVID-19, joint regional prevention and control is one of the most effective means to prevent and control the spread of the virus by strictly controlling the movement of people. Chengdu-Chongqing Central City Cluster features high population density and economic activities, as well as close ties and frequent interactions between both cities, making the epidemic prevention and control a major issue that affects the overall system. However, by leveraging the achievements of the construction of Chengdu-Chongqing Twin-City Economic Circle, both cities have efficiently collaborated to ensure a satisfactory stage victory in the blockade battle of epidemic prevention and control

through reasonable deployment of resources, precise alignment of prevention and control, scientific early warning and monitoring, etc.

3. Major domestic cross-regional joint prevention and control experience

3.1 Chengdu-Chongqing Twin-City Economic Circle

In the face of the epidemic, the Chongqing Municipal People's Government and the People's Government of Sichuan Province responded quickly, interacted actively, and jointly formulated a memorandum for the joint prevention and control of the epidemic, including real-time sharing of the epidemic prevention and control updates in the Chengdu-Chongqing Metropolitan Area, transportation coordination of epidemic prevention and control materials, interchange and mutual recognition of health information of both cities, and joint management of transportation guarantees between both cities. Through a series of long-term cooperation mechanisms, orderly and efficient prevention and control in the Chengdu-Chongqing Metropolitan Area has been ensured throughout the epidemic period.

3.2 Beijing-Tianjin-Hebei City Cluster

After the outbreak of the epidemic, as the most central zone in China, the Beijing-Tianjin-Hebei City Cluster promptly established a joint prevention and control working mechanism for the epidemic, with precise collaboration in various aspects such as information exchange, population movement and material guarantee, and formulated a list of 38 epidemic prevention rules and tasks in 10 areas. Meanwhile, to guarantee the resumption of production and work, the Beijing-Tianjin-Hebei region has established an epidemic data sharing platform, which adopts uniform technical standards to ensure the interoperability and mutual recognition of epidemic data. Finally, vigorous efforts have been made to promote the resumption of work and production in key industries in the region, thereby enabling rapid recovery of the regional economy.

3.3 Guangdong-Hong Kong-Macao Greater Bay Area City Cluster

The epidemic prevention and control in the Guangdong-Hong Kong-Macao Greater Bay Area is upgraded based on the cooperation mechanism on SARS in 2003. Pursuant to the Cooperation Agreement on Emergencies in Public Health signed by Guangdong, Hong Kong and Macao, joint meetings on epidemic prevention and control have been held to regularly discuss epidemic measures across the region to inform respective epidemic prevention and control situations and jointly develop epidemic prevention and control measures.

3.4 Yangtze River Delta City Cluster

For the joint epidemic prevention in the Yangtze River Delta region, the first step is to establish a joint working mechanism with the vice provincial governors/mayors as the main leaders,

convene joint prevention and control video conferences in a timely manner, and develop a system for sharing information on infected patients, informing isolated personnel, borrowing from each other on prevention and control initiatives, assisting each other with medical supplies, sharing treatment plans with each other, etc. Following the alleviation of the epidemic situation, measures such as interoperability and mutual recognition of health codes, mutual cooperation in resumption of production and work, and reciprocity in transportation access have been developed, and transportation departments have been coordinated to organize dedicated vehicles, transport lines and planes to ensure the healthy and safe return of migrant workers to their work places, which has accelerated the economic recovery of the Yangtze River Delta region.

4. Public health development strategies for Chengdu-Chongqing Twin-City Economic Circle in the post-epidemic era

4.1 Important historical opportunity for the construction of Chengdu-Chongqing Economic Circle

Over the past 30 years, the global development of pharmaceutical has been on the rise, with growth rates constantly superior to other industrial sectors. Along with the advent of rapid aging, the implementation of universal health insurance and medical reform policies, as well as the increasing living standards and health demands of the people, have all contributed to the development of the biopharmaceutical industry. The upcoming decade is believed to be “Golden Decade” for the development of China's biopharmaceutical industry. Chongqing has a relatively well-established industrial base in the pharmaceutical industry itself. As early as in 2011, Chongqing had built a biopharmaceutical industrial park in the Maliu Riverside Development Zone to promote the accelerated development of the biopharmaceutical industry in Chongqing, and the industrial pattern featuring “Five Parks, Two Belts and Seven Bases” has been formed. Relying on the national strategic opportunity for the construction of the Chengdu-Chongqing Economic Circle, the pharmaceutical and biological industries in Chongqing will inevitably usher in the historical opportunity for great leaps and bounds and become a first-class biomedical industry base in the western part and even across the country.

4.2 Strengths of collaborative public health in the Chengdu-Chongqing Economic Circle

The strengths of collaborative public health in the Chengdu-Chongqing Economic Circle generally lie in two aspects:

On one hand, based on the successful joint epidemic prevention and control in the Chengdu-Chongqing Economic Circle, medical cooperation has been further intensified. As of the end of December 2020, a total of 5,182 medical institutions in Sichuan and Chongqing have been designated for direct settlement of inpatient expenses, of which 1,887 have been accessible in

Chongqing, and all eligible inpatient medical institutions in the city have been connected to the national platform. Presently, 10,399 medical institutions have been designated for direct outpatient calculations in Sichuan and Chongqing, of which 5,109 have been accessible in Chongqing.

On the other hand, after almost 10 years of development, Chongqing Biomedical Industrial Park has taken shape with the output value to a certain level. Presently, continuously focusing on the theme of "Intelligence and Green", Chongqing is mainly engaged in the development of the four aspects of modern TCM, biomedicine, medical devices, medical trade and logistics, and focusing on building a pharmaceutical industry gathering area in the Three Gorges Reservoir area as well as the national and municipal level "green factory". Chengdu-Chongqing Economic Circle is coordinating the development of public health and vigorously promoting the development of biopharmaceutical industry in Chongqing, which will definitely be of great and far-reaching significance to cultivate and strengthen the pharmaceutical and health industry in the Three Gorges Reservoir Area, guard the "Clean Water in the River, Green Mountains on the Banks", extend and solidify the road of "industrial ecologization and ecological industrialization", and assist in poverty alleviation and rural revitalization in the Three Gorges Reservoir Area.

4.3 Recommendations on public health layout in the Chengdu-Chongqing Economic Circle

4.3.1 Innovate new business cooperation models, assist local enterprises in upgrading international competitiveness

In addition to introducing foreign-funded enterprises in biopharmaceuticals, etc. to invest and settle in the Chengdu-Chongqing Economic Circle, reference may also be made to the model of cooperation between MSD and Zhifei Biological to introduce international innovative biopharmaceutical enterprises to cooperate with local enterprises so as to accelerate the introduction of innovative products and improve the accessibility to patients. Meanwhile, through long-term strategic cooperation, efforts are expected to promote the all-round development of local enterprises in terms of compliance, business operation, professional training, project cooperation, etc. and enhance their overall competitiveness. On the other hand, efforts are also expected to introduce international first-class biopharmaceutical R&D enterprises to cooperate with local enterprises, and further leverage the established experience of foreign biopharmaceutical enterprises in overseas registration system and WHO pre-certification so as to assist local enterprises to go global.

4.3.2 Explore new developments in government-enterprise cooperation, encourage product development and innovation in public health

Explore the cooperation between government and enterprises for building an innovation ecological chain of public health system, and build a future-oriented and modernized public health

system, with the focus to be shifted from the treatment of diseases to the promotion of the People-Centered Integrated Care. It is recommended to focus on developing smart health management systems for infectious diseases, chronic hypertension, diabetes, tumors, etc., intensify financial investment in public health technology and product innovation, accelerate vaccine R&D and innovation, and provide certain support and subsidies for the R&D, clinical trials and registration of major innovative vaccines, multiplexed and multivalent vaccines and other new vaccines.

4.3.3 Industrialization layout of biopharmaceuticals under the new situation, acceleration of vaccine R&D and transformation of achievements

On the basis of encouraging innovation in pharmaceutical products, further enhance the support to promote the realization of innovative achievements in industrialization. In case of drugs and medical devices registered under the jurisdiction of Chongqing, with independent legal personality of the drug registration applicants to submit applications for registration, after obtaining the approval number of drugs and medical devices and achieving manufacturing in Chongqing, a certain amount of incentives or subsidies may be granted. For new APIs that have obtained registration numbers, after the associated formulations have been approved for the first time on the market or for the first time associated with the listed formulation varieties through the associated review, incentives may be granted.

Promote the organic linkage of vaccine R&D and industrialization chains, expedite the establishment of an industrialization system with enterprises as the main body and combining industry, academia and research in vaccine innovation and R&D, and focus on the transformation of achievements, so as to be well prepared for the possible normalized prevention and control work. It is recommended that the government take initiatives to build a resource platform for the biopharmaceutical industry ecosystem in the “Five Districts, Two Belts and Seven Bases”, integrate the sharing of industry advantageous resources, strengthen the linkage of vaccine technology, R&D, production expansion, material reserve, and supply chain construction, realize the synergistic development of Chengdu-Chongqing Economic Circle, achieve complementary advantageous resources, and make Chongqing a new highland for vaccine R&D, production and IoT+ digital technology. Assist local enterprises in playing a benchmarking and leading role in the biopharmaceutical industry.

4.3.4 Construct a new system of public health, strengthen the emergency supplies reserve system

It is recommended to construct a medical emergency supplies reserve system in the Chengdu-Chongqing Economic Circle and collaborate to establish a production capacity reserve of emergency products for public health events so as to respond to public health events such as epidemic prevention, disaster relief, emergencies and foreign aid. Improve the unified emergency

material guarantee system, improve related working mechanisms and emergency plans. Public health emergency products mainly include products for protection, prevention, treatment, etc. The storage cycles of disposable protective and therapeutic products are insufficient, and no universal preventive vaccines are available to be physically reserved, therefore, the capacity reserve of public health emergency products can be performed to keep the production lines of both places "readily available". Compensate enterprises appropriately for their R&D investment for supporting emergency supplies reserves; establish special emergency expropriation funds and improve the requisition system so that enterprises that contribute to emergency response are fully financially protected. In addition, the practices of some developed countries can also be referenced, for example, the government allocates special funds each year for medical emergency supply R&D reserves.

4.3.5 Capture new heights of academic R&D and accelerate the creation of public health innovation platforms

In accordance with the principle of "Synergic Development, Market-oriented Operation" and by means of internal divestiture, merging and integration as well as external introduction, build new high-end R&D institutions with high synergy among industry, academia and research, and open cooperation at home and abroad, grant financial supports for special projects of high-end platform cultivation, high-end talent team introduction and high-tech R&D implemented in Chongqing. Encourage the introduction of well-known institutions at home and abroad to establish new high-end R&D institutions in Chongqing, grant special support for R&D and related funding for four consecutive years from the year following the establishment of the institution, based on its talent team, R&D investment, construction scale, etc. upon assessment and certification. Attract third-party R&D service platforms, professional testing institutions as well as other key innovation environment improvement platforms in Chongqing to increase the scale of investment. In terms of policy, adopt the principle of "Exclusive Consultation for Specific Issue", and support the key core platform projects of special importance from the government level.

5. Conclusion

In 2020, Chengdu Municipal Health Commission and Chongqing Municipal Healthcare Commission signed the *Cooperation Agreement on Promoting the Integrated Development of Health Care in Chengdu and Chongqing by Building the Chengdu-Chongqing Twin-City Economic Circle (2020-2025)*, under which both parties officially established partnership and will actively promote the integrated development of health care in the Chengdu-Chongqing Twin-City Economic Circle. Therefore, it is believed that, in the future, with the in-depth promotion of the national strategy of synergistic development of Chengdu-Chongqing Economic Circle, the health care resources of both cities will be further shared and their advantages will become increasingly

complementary, so that the people of both cities can really enjoy more convenient and better quality medical and health care services, effectively enhancing the accessibility to medical care for the people of both cities, fully demonstrating the advantages of high-quality livability, and contributing to the accelerated establishment of a twin-city economic circle with strong strength and distinctive features in the Chengdu-Chongqing region.

We appreciate the trust and opportunity given to us by the Chongqing Municipal People's Government so that we can support and advise on the high-quality development of the Chengdu-Chongqing Twin Cities Economic Circle, and we look forward to further discussions and exchanges on this topic in the future.

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Current Conditions, Issues, and Potential of the Inland Chinese Healthcare Market

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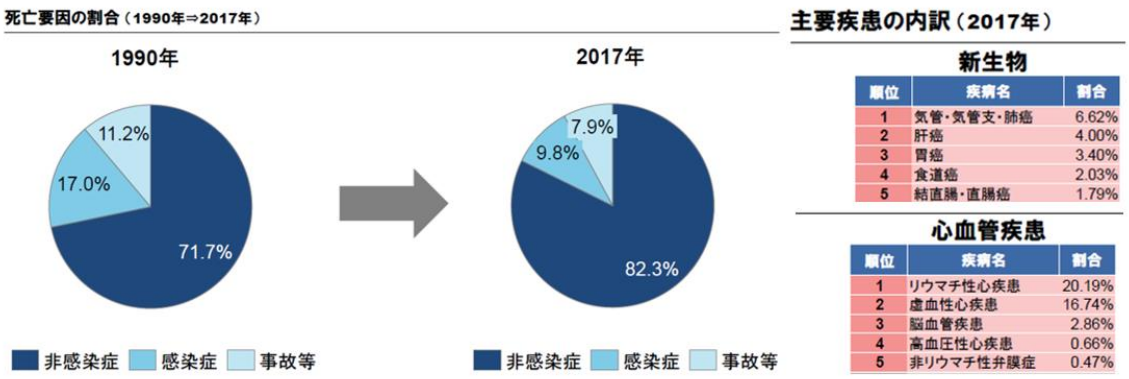
1. Macro-environment of the Chinese Healthcare Market

With the rapid economic development in China over the past several decades, the health levels of its citizens and its medical and hygienic environment have greatly improved. Indicators, including average lifespan, infant mortality rate, mortality rate of children under five, and maternal mortality rate have all improved to levels of developed countries. For example, China's average lifespan increased from 69 in 1990 to 77.4 in 2020, approaching the levels of Japan (84.2) and the US (78.5).

With improvements in the medical and hygienic environment, the disease patterns in China is transitioning to that of developed countries. Comparing the causes of death in 1990 and 2017, the percentage of infectious diseases fell from 17.0% to 9.8% while the percentage of non-infectious diseases (chronic diseases) increased. The two most prevalent non-infectious diseases – cardiovascular diseases (rheumatic heart disease, ischemic heart disease, etc.) and cancer – make up 65% of all diseases. An increase in lifestyle-related diseases with an aging population and changing lifestyles is part of the reason for the change in disease patterns. In addition to these kinds of structural changes surrounding the medical environment, demands for more sophisticated medical services associated with increasing income and greater health consciousness are creating new issues and potential in the Chinese healthcare industry.

In October 2016, the Chinese Communist Party and government announced the outline of the Healthy China 2030 plan, the country's first medium- to long-term national plan in the health field. Under the policy of building a "Healthy China", the plan set out a series of targets including increasing the average lifespan to 79 by 2030. In July 2019, China released an action plan, the Healthy China Program (2019-2030). The 14th Five-Year Plan (2021-2025) announced in March 2021 promotes initiatives to further improve the level of its citizens' health, including expanding high-quality medical resources and balancing their distribution among regions, building a national medical science center and regional medical science centers, and strengthening organic collaboration among prevention, treatment, nursing care, and rehabilitation.



Source: METI “International Medical Care Development: China Edition” (March 2021)

2. Current Conditions and Issues in the Inland Chinese Healthcare Market

The cities of Chongqing and Chengdu, Sichuan, play central roles in the healthcare field in inland China. According to the latest edition of the Chinese hospital ranking published annually by the Hospital Management Institute of Fudan University, among the top 100 hospitals, five were in Chongqing, and four in Chengdu. In particular, West China Hospital of Sichuan University in Chengdu ranked second nationwide, behind the Chinese Academy of Medical Sciences and Peking Union Medical College in Beijing. Medical service users from other cities in Sichuan and neighboring provinces and autonomous regions, including Qinghai and the Tibet Autonomous Region, come to Chongqing and Chengdu for their relatively advanced healthcare system in inland China. For example, of the more than 160 million people who received medical services in Chengdu in 2019, one third were Chengdu residents, one third were from areas outside Chengdu in Sichuan, and one third were from outside Sichuan.

		単位	中国全体	北京	上海	重慶	成都
経済指標	GDP	億元	1,015,986	36,103	38,701	25,003	17,717
	1人当たりGDP	万元	7.2	16.5	15.6	7.8	8.5
	人口	百万人	1,411.8	21.9	24.9	32.1	20.9
	65歳以上	百万人	190.6	2.9	4.0	5.5	2.9
	高齢化率(65歳以上)	%	13.5	13.3	16.3	17.1	13.6
医療指標	平均余命	歳	77.3	82.2	83.6	77.9	80.5
	上位100病院の数	病院	100	22	17	5	4
	三級甲レベル病院数	病院	1,516	78	66	27	29
	人口百万人当たり	病院	1.1	3.6	2.7	0.8	1.4
	病床数	千床	8,524	114	127	193	127
	医療費	億元	65,841	2,501	2,302	1,374	-
	対GDP比	%	6.7	7.6	6.4	6.4	-

(注)平均余命は全国が2020年・各都市が2018年、三級甲等病院数は2019年、
病床数は全国が2020年・各都市が2017年、医療費と医療費対GDP比は全国が2019年・各都市が2018年
その他は全て2020年、四川省の医療費は3253億元、対GDP比は7.6%
(出所)国家統計局、国家衛生健康委員会

Many of the issues in the healthcare market in inland China overlap with nationwide issues, but there are some specific issues to inland China. Below, we will discuss three of the main issues.

1) Increasing healthcare burden caused by the aging population and rise in related healthcare needs

China's population is rapidly aging, and the percentage of elderly (people 65 and older as a percentage of total population) rose from 5.6% in 1990 to 13.5% in 2020. While this percentage is smaller than that of Japan (28.4% in 2020) and the US (16.6% in 2020), the pace of aging is expected to accelerate. According to the latest edition of the UN's World Population Prospects, in 2040, the percentage of elderly is expected to rise to 23.7% in China, exceeding the forecast for the US (21.6%).

The population is aging especially quickly in Chongqing, even compared to the rest of China. The percentage of elderly was 17.1% in 2020, much higher than the national average. The figure was the second highest among China's 31 provinces, direct-controlled municipalities, and autonomous regions, behind Liaoning (17.4%). At 13.6%, Chengdu is about the same as the national average, but overall, Sichuan at 16.9% ranks third, demonstrating the speed of aging in regional cities within the province outside of Chengdu. In Chongqing and Sichuan, the increase in local job opportunities with economic development has led to a decrease in residents moving to coastal regions to earn a living. However, many young workers are still leaving for other regions, increasing the percentage of elderly in the region.

A progressively aging society leads to increased healthcare and nursing care costs. According to China's National Health Commission, in 2019, total healthcare costs in China were 6.58 trillion yuan, or 6.7% of GDP. While this is lower than the US (16.9% in 2018) and Japan (10.8% in 2018), healthcare and nursing care costs are expected to pressure national and regional finances, as they have in Japan and other countries. In terms of the prevention and presymptomatic disease treatment measures that hold the key to controlling increasing healthcare and nursing care costs, greater and more sophisticated health screening and improved rehabilitation facilities are required.

The declining birthrate in China is also creating new healthcare needs. At its Politburo meeting in May 2021, the Chinese Communist Party set a policy allowing couples to have three children, accelerating its measures aimed at resolving declining birthrate. Going forward, as countermeasures on declining birthrate take shape in China, the creation of the environment in which couples can have and raise children comfortably will become a pressing issue, and there will be increasing needs for maternity and pediatric departments that provide high-quality medical services.

2) Uneven distribution of healthcare resources

China faces a structural problem of healthcare resources and patients being concentrated in certain major cities and large-scale general hospitals. In September 2015, the State Council released its Guiding Opinion to Promote the Building of a Tiered Medical Examination System. The guideline clarifies the division of roles among tertiary hospitals, secondary hospitals, provincial hospitals, and primary medical institutions. Thereafter, some progress was seen in the tiered medical system, but serious issues remain, such as patients concentrated in top-level public hospitals called Tertiary A hospitals (1,516 nationwide), forming long lines from early morning to receive medical examinations. There is also an issue with illegal brokers charging fees for medical examinations.

While Chongqing and Chengdu have a relatively advanced healthcare system in inland China, the number of Tertiary A hospitals for every 10,000 people is not so high, with 0.8 in Chongqing and 1.4 in Chengdu, while the number is 3.6 in Beijing and 2.7 in Shanghai. Furthermore, as mentioned above, healthcare service users come for healthcare to Chongqing and Chengdu from outside of the cities and the province, making the problem of unevenly distributed healthcare resources worse.

The Committee on Cooperative Development for Integrated Health and Hygiene, announced by Chongqing and Chengdu in December 2020, and the Creation of a Remote Medical System in Chongqing and Chengdu, one of the committee's initiatives, are important in correcting the uneven distribution of healthcare resources and improving the quality of healthcare services. Through this cooperation, main hospitals, including West China Hospital of Sichuan University (Chengdu) and the Army Medical University-affiliated hospitals (Chongqing) are jointly building a remote healthcare system, with plans to provide online appointments, medical examinations, and health management services to patients of both hospitals. Chongqing and Chengdu are building a digital healthcare platform that encourages cooperation among hospitals, individuals, and government organizations. If the initiative can provide high-quality healthcare services to not only those two cities, but also to neighboring cities, provinces, and autonomous regions, it will contribute to correcting the uneven distribution of healthcare resources in inland China.

3) Insufficient supply of high-quality specialized hospitals

Healthcare service demand is becoming more sophisticated in China with higher levels of income and health consciousness, but there is a shortage of specialized hospitals. At public general hospitals, patients can receive a certain level of healthcare services at a relatively low cost, with health insurance. However, there are problems including 1) appointments are generally hard to get, 2) the hospitals place little effort into services that would improve patient satisfaction, and 3) there

are cases where patients are unable to receive specialized treatment in specialty fields. The number of specialized public hospitals is limited, and there are still very few private specialized hospitals. In fields such as dentistry (implants, braces, etc.), maternity (pain-free delivery, etc.), health examinations (gastroendoscopies, etc.), and plastic surgery, there is a mismatch between demand and supply in healthcare services provided by specialized hospitals. These problems are more pronounced in inland China, making it a promising market for foreign-capitalized, specialized hospitals and medical examination service providers.

While economic progress has been made in Chongqing and Chengdu compared to China overall, income levels are not as high as in major coastal cities such as Beijing and Shanghai. 2019 GDP per capita in Chongqing and Chengdu was 78,000 yuan (approximately US$11,000) and 103,000 yuan, respectively, which was 50-70% of the levels in Beijing (165,000 yuan) and Shanghai (156,000 yuan). Meanwhile, approximately 800,000 foreigners live in Shanghai, and 250,000 in Beijing, compared to 10,000-20,000 in Chongqing and Chengdu. The figures show that Chongqing and Chengdu do not have the market growth prospects in healthcare and examination services for the affluent and foreigners like Shanghai and Beijing do, and the challenge is how to capture the local upper middle-income earners as hospital customers.

3. Bringing the experiences and services of Japan to inland China (To China)

1) Trend toward "wellness" in presymptomatic and prevention services and individual health management

As healthcare costs continue to rise in Asia, a new age of wellness is expected to arrive, in which individuals, rather than hospitals, will become the leading players, choose their own healthcare, and manage their own health. From patients to everyday people, there is a trend away from treatment and to presymptomatic approaches and prevention. Digital technology is creating a rapid wave of transformation that is driving this trend, and presymptomatic and preventive measures are expected in this context in inland China.

For example, in November 2020 in Japan, a stop-smoking app became the first digital therapeutics to be approved as a pharmaceutical and to be covered by health insurance. The difference between this therapeutics and an online examination is that it intervenes in the patient's everyday life outside of an examination setting, with the app acting as a patient escort in a way that healthcare practitioners cannot. For patients addicted to nicotine, the app can be used to encourage patients not to smoke in the periods between stop-smoking treatments where patients tend to relapse (in between examinations). Patients can receive videos explaining tobacco addiction and pharmaceutical treatments as well as automated advice. Expectations are also rising for digital therapeutics including treatment apps for alcohol and drug dependence and insomnia.

Additionally, Allm, an investee of Mitsui & Co., provides the MySOS health support app. Health examination results can be entered into a smartphone, and examination results and prescriptions can be registered. The app can also gauge the risk of illness through data analysis, supporting individual everyday health management and the treatment of illness. Allm's services allow individual and families to understand and use health examination results, hospital examination records, medications, and lifestyle data received through wearable devices. This helps in creating personal health records (PHR) to improve lifestyles and promote health and could contribute to improving healthcare in inland China.

Furthermore, in the age in which individuals manage their own health, Mitsui & Co. is focused on preventing lifestyle-related illnesses using oral care. In 2019, Mitsui & Co. concluded an inter-organizational open innovation agreement with Tokyo Medical and Dental University to advance joint research into possible applications of cutting-edge IT technology in the dental field. Recent medical research has shown a cause-and-effect relationship between systemic illnesses such as diabetes and periodontal disease. Through the dental field, we will make contributions to lifestyle-related illness prevention.

Given current relations between Japan and China, contributions could be made with Japanese-developed OTC pharmaceuticals. In the COVID-19 pandemic, when movement was limited, against the backdrop of declining inbound demand, multiple Japanese OTC manufacturers promoted new initiatives in the Chinese market, such as partnering with major Chinese pharmaceutical companies with sales routes to pharmacies, and opening stores on cross-border EC sites. In the age of personal health management, there are increasing expectations for safe, high-quality Japanese OTC drugs.

2) Allm is eliminating the uneven distribution of medical resources with its remote healthcare platform

We believe that the services provided by Allm, an investee of Mitsui & Co., will contribute to healthcare cooperation both within Chongqing and Chengdu, and with areas outside of the cities and the province.

Allm is the provider of its doctor-to-doctor remote medical platform app called Join, which is covered by Japan's public insurance (the equivalent of Chinese medical insurance) as a medical device program. Join allows medical imaging such as MRIs and CTs to be read through a smartphone. Even in regional hospitals where there are no specialists, doctors can consult and discuss examination results with other doctors through online chats, video calls, and the exchange of medical imaging. Join is also used as a communication tool for coordination among multiple hospitals in building regional healthcare systems. Within one hospital, Join is used for the staff

responsible for the care of COVID-19 patients to share test imaging and patient data with all the staff, as well as the meeting minutes. These functions provided by Join are also expected to contribute to the building of the tiered medical examination system and medical association being developed by the Chinese government.

The convenience of using the smartphone to share records has led Join to be introduced at approximately 300 facilities in Japan (including more than 40 university hospitals), and the business has expanded to 20 countries overseas. For example, in Peru, where doctors are concentrated in central Lima, there are strong expectations for the effective capabilities of Join in addressing the uneven distribution of medical resources in the suburban areas with fewer doctors. In Brazil, Join has already been introduced at 16 hospitals, with planned introduction to 40 more. The plan is to introduce an online support system for local doctors where Japanese doctors share the basic knowledge that they have acquired in Japan for difficult symptoms.

3) Contributing to high-quality healthcare service

One high-quality healthcare service that Japan has pursued for many years is the early discovery and treatment of cancer. We believe that this field can contribute to the healthcare issues in Chongqing and Chengdu.

Since 1981, cancer has been the leading cause of death in Japan, affecting roughly half the population during their lifetimes, and remains one of the most important issues to the lives and health of Japanese citizens. Based on its Basic Plan to Promote Cancer Control Programs, Japan's Ministry of Health, Labour and Welfare recommends cancer screenings, promotes cancer genome medicine, and provides support in balancing cancer treatments and work. In recent years, by studying the types and quantities of micro-RNA in the blood, the early detection of cancers such as lung cancer and breast cancer became possible. It is anticipated that this will become a new diagnostic marker, and there is a focus on the verification testing being conducted in Japan.

Amid this trend, Mitsui Bussan Chemicals has provided support for the overseas marketing of drugs made by Stella Pharma used in first-of-its-kind boron neutron capture therapy (BNCT) being developed jointly by Stella Pharma and accelerator manufacturers such as Sumitomo Heavy Industries. BNCT is one kind of cancer radiation therapy. Cancer patients are administered with the boron drug used in BNCT (made by Stella Pharma) including the boron particles (boron-10) that are specifically drawn into the cancer cells. After the drug has accumulated in the cancer cells, the boron compound is irradiated with a low energy neutron beam created in an accelerator. The boron drug and the low energy neutrons collide and the alpha-rays, one type of particle beam produced by nuclear fission, destroys the cancer cells. BNCT does not damage healthy cells, and sufficient benefit can be gained from one radiation treatment. There are hopes for BNCT as a new

treatment option for locally unresectable recurrent or unresectable advanced head and neck cancer.

As for high-quality healthcare services other than those for cancer, DaVita Care, an investee of Mitsui & Co., has contributed to dialysis patients in Asia. DaVita Healthcare Partners, DaVita Care's parent company, operates 3,150 dialysis clinics in the US and other countries, reliably providing high-quality dialysis treatment. Using this operational know-how, DaVita Care aims to expand its China business further, while contributing to both the improved quality and efficiency of healthcare. Furthermore, in the drug discovery industry, which has been developed mainly in Europe, the US, and Japan, it is believed that China will become a key player going forward. As an investor in European, US, and Japanese drug discovery companies, Mitsui & Co. is interested in this development.

4. Bringing Chinese-developed healthcare DX to Japan (From China)

The Chinese government is focused on healthcare DX (using healthcare data and AI) as a common solution to the issues in the Chinese healthcare field, including 1) the rapid increase in lifestyle-related diseases, 2) delays in creating systems to provide medical care, including the uneven distribution of healthcare resources, and 3) the emergence of ballooning healthcare costs. In its Healthy China 2030 plan announced in October 2016, the Chinese government mentioned the application of big data in the healthcare field. In September 2018, the National Health Commission created detailed guidelines to promote online medical consultation, remote healthcare management, and the integration of healthcare data.

In addition to the policy response, corporate initiatives are also gaining steam. Healthcare DX is being promoted at corporate levels to resolve issues in the healthcare field by introducing and using digital technology. In China, where it is easy to collect and use personal data, the focus is on how to utilize in the healthcare field the personal data of hundreds of millions of people owned by big tech companies. The ability to access a large amount of personal demographic data, including genetics, in addition to lifestyle data including behavior patterns, activity levels, sleep data, and voice data, is important when considering the healthcare service business. Such data will be useful in providing individualized healthcare services in each stage from treatment to preemptive healthcare for presymptomatic conditions to prognosis management. It is also seen as extremely effective in future drug development for pharmaceutical manufacturing companies. In Japan, Europe, and the US, there are high hurdles in using lifestyle data for drug creation from the standpoint of protecting personal information. Backed by ample AI development personnel, Chinese companies are creating new added value from their ability to use an enormous amount of personal data.

Ping An Insurance, a leading Chinese healthcare DX company, applied for the 8th largest

number of international patents in 2019, many of which were for AI and blockchain technology. Ping An Good Doctor, a spinoff from Ping An Insurance, has achieved a \1.4 trillion market capitalization based on this technology. Healthcare DX is a business field that the US GAFA is eager to capture. There are many things for Japanese companies to learn from Chinese companies, and there is great potential for collaboration in this field.

Mitsui & Co., which is committed to contributing to solve the ever-rising healthcare costs in Asia, must rapidly pursue innovation in the healthcare DX field and is advancing initiatives in partnership with Chinese companies.

1) Mitsui & Co. affiliate NOBORI and Alibaba work together to fight COVID-19

On February 15, 2020, Alibaba's subsidiary Alibaba Health and its research group DAMO Academy announced that they had developed an AI diagnosis technology that can screen for lung inflammation from COVID-19 within 20 seconds, at 96% accuracy, using CT scanning. This technology was provided to hospitals within China starting with Henan Province, and the AI algorithm was provided overseas free of charge. On March 30, 2020, Alibaba, in partnership with Mitsui & Co. affiliate NOBORI, began the trial provision of the technology for research purposes to hospitals throughout Japan free of charge. In June 2020, approval was gained from the Pharmaceuticals and Medical Devices Agency, and services were provided through a three-company partnership among M3, Alibaba, and NOBORI. Thereafter, the technology received funding support from SONY, SMFG, and Pfizer to support COVID-19 treatments, with the service provided free of charge for a set period to more than 100 medical facilities, which led to the paid adoption of the system at some facilities. Japan's CT scanner penetration rate is approximately 100 machines per million people, which is roughly four times that of the OECD average and one of the highest in the world. In that sense, this is a good example of collaboration that applies to the unique qualities of Japanese healthcare infrastructure.

2) Mitsui & Co. affiliate PHC and MGI collaborate to contribute to cutting-edge genome healthcare research

PHC Corporation, a subsidiary of PHC Holdings, acquired the Japanese sales rights for the next-generation sequencers manufactured and developed by MGI (the manufacturing division of BGI, China's largest company in the genetic analysis field) and began sales in July 2021.

Based on genetic analysis technology, MGI is working to advance healthcare technology in the fields of both treatment and prevention. There is strong interest in illness risk prediction for cancer and leukemia using genetic analysis, a service that many Chinese venture companies provide. Technological innovation has progressed for genetic analysis equipment, with the time and money required for the analysis of one person reduced from 12 years and US$3 billion for

first-generation equipment to 6 months and US$100,000 for second-generation equipment, to one day and US$100 for third-generation equipment.

In recent years in Japan, the government has promoted initiatives to spread genome healthcare for the screening and treatment of cancer, diabetes, and cardiovascular diseases. Cancer genome treatment suited to the constitution and pathology of individual patients based on genetic analysis results requires applied tools using cutting-edge genome analysis technology with next-generation sequencers such as cancer genetics panel testing (comprehensive testing for genetic changes related to cancer). MGI's next generation sequencers are a solution realizing the efficient and economically viable analysis of highly precise genetic information data, and PHC is supporting Japanese researchers and healthcare practitioners in the genetic information analysis field.

Improving International Influence with Joint Efforts on Sports Events

Ruling Zhang Blein
Chairman & CEO of Sodefinance

Chongqing and Chengdu have been the two most important cities in Southwestern China since ancient times, and the competition between the two has never stopped in the economic, transportation, cultural and touristic sectors. By competing in the same domains, the two cities do not express their own talents, and it also affects their sustainable development in the future. Therefore, in January 2020, the Chinese Government made momentous decisions and arrangements to promote the construction of the Chengdu-Chongqing Economic Circle, which has a far-reaching impact on the development of Sichuan and Chongqing.

By understanding the progress made in the construction of the Chengdu-Chongqing Economic Circle, we are pleased to see that under the strategy of adhering to an integrated planning and a joint deployment, the construction of the Economic Circle has formed a good trend, and remarkable achievements have been made in infrastructure, industrial development, environmental protection, and the cooperation in public service.

Economic construction cannot be separated from exchanges and cooperation with the world. As the most well-known tourist cities in the Southwest, Chongqing and Chengdu attract more and more domestic and foreign tourists especially after their frequent appearance in films and TV series in recent years. But there is still a long way for Chongqing to go before becoming a real international metropolis. Past experience at home and abroad has proved that holding international sports events is of great help to increase visibility, influence and boost the regional economy. Therefore, we believe that Chongqing will enhance the world's understanding and attention to the two cities and efficiently improve the construction of the Economic Circle through joint efforts with Chengdu in holding international sports events.

I. Current conditions and advantages

First of all, Chongqing and Chengdu are about 340 kilometers apart. The close distance and the well-developed traffic network make it conducive to the organization and long-term operation of the events. According to the *Comprehensive Transport Development Plan for the Chengdu-Chongqing Dual-city Economic Circle* issued by the National Development and Reform Commission and the Ministry of Transport in June this year, Chengdu-Chongqing will basically be on track by 2025 to build a "dual-city Economic Circle ". At that time, the total scale of rail transit in Chengdu and Chongqing will reach more than 10,000 kilometers, of which the railway

network will reach more than 9,000 kilometers. Around this goal, in the next few years, both cities will try to strengthen the connection between their metropolitan areas in terms of rail transit, road traffic and bus lines, and finally achieve the aim of reaching major regional cities and node cities within one hour, and the one-hour bus-oriented commuters service in Chongqing's and Chengdu's metropolitan areas.

Chengdu-Chongqing Expressway
Resource: Sichuan Provincial Department of Transport

Secondly, Sichuan and Chongqing have successfully held many important games and have rich experience in conducting sports events. Chongqing has hosted the ISU Grand Prix of Figure Skating and the Sino-EU Basketball Champion Cup. Chongqing International Marathon is the first international full marathon in Southwest China. Chengdu is also actively building itself into a

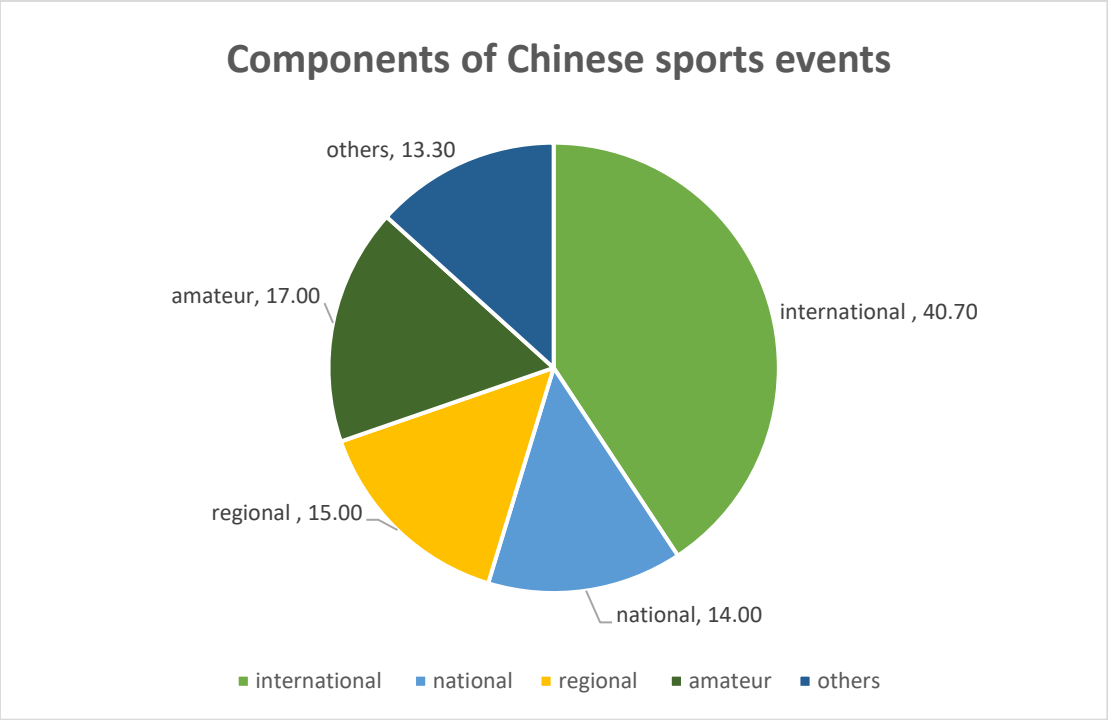
major international sports events city, and has successfully bid for the 2021 summer Universiade, the 2022 World Table Tennis Championship, the 2023 AFC Asian Cup, the Thomas Cup and the Uber Cup in 2024, and the World Games 2025.

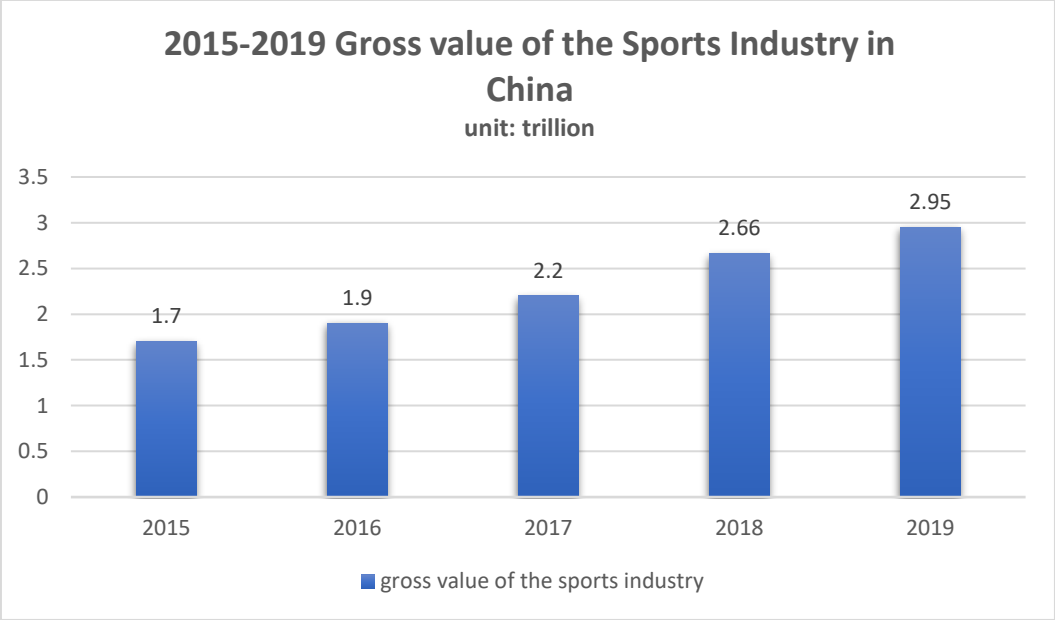
During the 14th Five-Year Plan period, Chongqing will build a number of sports venues that meet international standards, such as the Olympic Sports Center, Longxing Professional Football Stadium and Dadukou International Small Ball Sports Center. With the continuous improvement on various sports infrastructure and the capability of holding big sports events, there is no need to invest much more money in bidding for or holding the events in the future. As mentioned above, Chengdu will hold the 2023 AFC Asian Cup, and one of the venues is arranged at Chongqing Longxing Football Stadium. This fully reflects the advantage of the integration that one single event will have double support from two cities.

II. Selection and incubation of sports IP

In general, sports events are divided into three categories: comprehensive, mass and professional. Comprehensive sports events are mainly the Olympic Games, the Asian Games, etc., most of which are at the national level so they are not discussed in this article. Mass sports events such as fitness running, citizens' sports meetings and dragon boat races, are widely welcomed because they are easy to practice by the public. Professional sports events include various professional leagues, such as the NBA, football leagues, ATP tours, etc., and are most popular for their commercial value, participation and international influence.

With the enhancement of the public awareness of a healthy life and the Government's strong advocacy for nationwide fitness, the sports industry has been developing rapidly in China in recent years and has become an important component of the national economy. More and more sports agencies have emerged in China and are promoting the exchange and integration between Chinese sports and international sports events.





Characterized by their geographic locations, first-class sports venues and supporting facilities, Chengdu and Chongqing are ideal cities to carry out sports events. Therefore, their cooperation on sports events should be on selecting and incubating sports IP. IP refers to “intellectual property”, and sports IP, including patents, trademarks, broadcasting rights and related derivatives, is the core product of the sports industry. With China's increasing attention to the development of the sports industry in recent years, a large amount of capital has flooded into the sports market, and sports IP

has become a "resource" contested by various companies.

When selecting or incubating sports IP we shall take the users' participation frequency as an important reference. NBA teams play at least 82 games in a single regular season. The seasons of the five major European football leagues last from August or September to May of the following year. There are about 16 Formula One Grand Prix every year around the world, usually starting in March and ending in October. A sport itself needs a high frequency of exposure to generate continuous interaction, so as to establish stickiness and loyalty among the audience and fans. Although road running competitions have been very popular all over China in recent years, It is difficult to accumulate loyal participants and fans because many cities hold such competitions only once or twice a year and similar events can be found everywhere in China. When selecting or incubating sports IP, we suggest that the City Government should focus on the sports whose competition systems are of a higher frequency. There are other measures to improve the exposure and influence of a sport event by increasing the number of games, matching the main event with smaller-sized games, or organizing training camps before the event.

In addition, a successful sports event needs a strong profitability to keep its vitality. China's sports events are mainly profitable from tickets, derivatives revenue, sponsorship and broadcasting rights transfer, of which sponsorship revenue accounts for the major part, while more mature international sports events usually rely mainly on tickets, derivatives revenue and broadcasting rights transfer. The profit model of the latter reflects that these sports events are more market-oriented, more widely participated and of stronger advertising effect. Therefore, Chongqing and Chengdu should pay attention to the leveraging of these profit channels when building up sports IP, so as to provide policy support and services to stimulate the market.

III. Experience from France

France has the world's most popular tourist destination and hosts many international events, such as the "Tour de France" and the ATP French Open, as well as major football, sailing, bicycle racing, equestrian sports events, etc. These events have a long history in France and attract many audiences.

Take the "Tour de France" as an example. With more than 3,000 kilometers, this summer event course lasts up to three weeks, and attracts hundreds of millions of viewers around the world every year. Hundreds of media and thousands of journalists report on the race, and it is broadcasted live in nearly 200 countries and regions. The route changes every year and sometimes goes abroad, however, the end of the race is always on the Champs Elysees in Paris.

For centuries, the other parts of France have always been obscured by the reputation of Paris, but through the organization of the Tour de France, more and more beautiful towns have become well known and have greatly developed tourism in various places. Brittany, the Grand Départ of this year's Tour de France, is a frontier area in Northwestern France. Being always on the route for the Tour de France, Brittany has attracted many bicycle enthusiasts to train and stay there for fun. It is now the most popular tourist destination in Northern France.

We believe that this is very useful experience for Chongqing. As a famous mountainous city, Chongqing has rugged roads, developed transportation network and the magnificent natural landscape that make it an ideal city for promoting outdoor sports such as bicycle racing, marathons and rock climbing. In addition, as China's largest municipality under the direct administration of the Central Government, Chongqing has more than 260 A-level scenic spots, most of which are located in vast and magnificent suburban counties. Due to the lack of popularity, many spots haven't attracted enough tourists from home and abroad. Through holding sports events, these areas and attractions can be better known by the world, and they might develop more sports-related industries like Brittany.

France has a population of more than 66 million, about half of which maintain regular exercise, and the total output value of the sports industry accounts for more than 1% of GDP, making it the second largest consumer market for sports goods in Europe. The French government firmly believes that sport is not only a means to increase the influence of the country, but also an important economic growth factor. In order to improve the overall level of sports in France, in addition to formulating rules and policies on the development of sports, the French Government is constantly upgrading public sports institutions, strengthening the practice at school and amateur training, restructuring sports colleges, etc. In addition, the French government has set goals for sports diplomacy, including holding international sports events to enhance international attractiveness and helping French companies enter overseas markets.

In 2019, the State Council issued *the Opinions on Promoting National Fitness and Sports Consumption to Promote the High-quality Development of the Sports Industry*, which details the measures and directions for ten aspects, which have a very positive and profound impact on the whole society. We believe that the government's function should be more to help the economic development in sports industry with macro policy supports, and to encourage and guide the integration of sports and economy.

IV. Significance

Thanks to the holding of international events, urban planning and public infrastructure have been extensively improved and upgraded. The vigorous development of the sports industry also promotes the development of tourism, cultural brand incubation and other related industries, which greatly contributes to the economic restructuring of cities. At the same time, the concept of national fitness is deeply rooted in the hearts of the people, and the spiritual outlook and physical quality of citizens have been better improved.

Sports, like arts and music, transcend linguistic, racial, religious and age barriers and connect the world. Whether the contestants or hundreds of millions of viewers, they can learn about a city and a country through sports events, thus deepening their understanding of the world and the different nationalities and cultures.

President Xi Jinping has repeated his expectation on the external propaganda of telling good Chinese stories. We think it's better to see for oneself than to hear for times. Holding international sports events in China is to give foreign people a good opportunity to better know the country. It will be the most convincing propaganda if they can see for themselves the standard of living and the mental richness of the Chinese people. Chongqing and Chengdu have every reason to shoulder this responsibility as they are the only two inland Chinese cities with the highest level of economic development and internationalization. We look forward to more and more important sports events jointly organized by the two cities through the construction of the dual-core Economic Circle, which not only helps cultivate a good sports atmosphere in the two cities, but also shows the world an equal, liberal and industrious China.

Optimization of Production Layout, the Fostering of Globally Competitive Advanced Manufacturing Clusters, and the Promotion of High Quality Development in Manufacturing

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1. Introduction

Achieving high quality is essential for products to become globally competitive. For this purpose, it is effective to construct an advanced manufacturing cluster in which several companies, universities, etc. with expertise in specialized fields come together with the strong support of the local government. This paper describes an advanced manufacturing cluster based on intelligent machines including intelligent robots and collaborative robots, and smart manufacturing using IoT and various types of AI.

2. Promotion of high quality development in manufacturing

High quality is one of the essential elements for products to satisfy customers and increase international competitiveness. In order to manufacture high-quality products, advanced manufacturing technologies such as high-precision machining and high-precision assembly are required, and skilled workers play an important role. In many industrial countries, the number of skilled workers is decreasing drastically due to the declining birthrate, aging population, and higher education levels. However, as described below, intelligent robots, collaborative robots, IoT, and AI are making it possible to manufacture high-quality products even without skilled workers.

2.1 Intelligent robots equipped with vision and force sensors

Figure 1 shows an example of a robot assembling a robot arm's wrist. In the past, such high-precision assembly could only be done by skilled workers. However, an intelligent robot equipped with a vision sensor and a force sensor has made it possible to automate this kind of high-precision assembly.

2.2 Collaborative Robots

When trying to automate the manufacturing of high quality products, there are inevitably difficult tasks that can only be done manually. Collaborative robots are equipped with safety functions, such as immediately stopping when they come into contact with a person, to enable collaborative work with humans in the same work area, eliminating the need for the yellow safety fence that has separated humans and robots until now. The collaborative robot can be highly

automated if it is equipped with a vision sensor and a force sensor as described above, but only for advanced and difficult

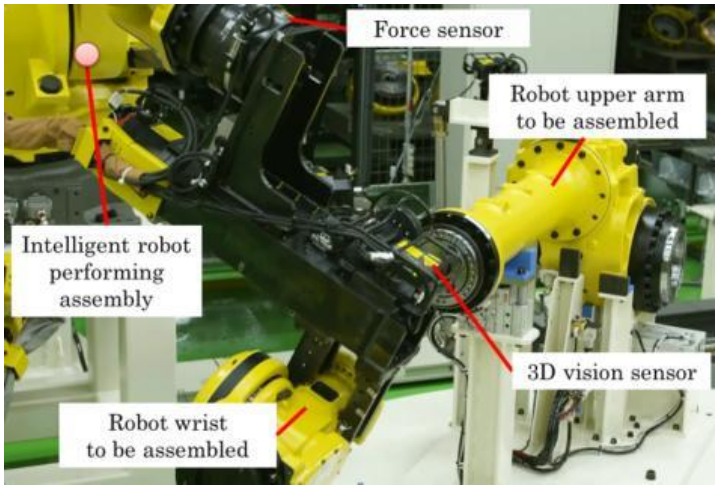

Figure 1 Assembly of a robot by a robot (Robot Assembly Factory at FANUC)

tasks that absolutely require human intervention would a human perform the task in the same work area as the robot. This enables an optimal division of work between humans and robots. In other words, the collaborative robot can automate most of the tasks, while the human can perform the difficult tasks that can only be done by a human. In addition, both the human and the cooperative robot perform different tasks during the time when they are not working together, which allows for a more efficient division of work. Figure 2 shows FANUC's latest collaborative robot CRX. The screen of the teaching tablet shows the latest timeline programming, which enables complex programming by simply arranging icons.

Figure 2 FANUC's latest collaborative robot CRX

2.3 IoT

Figure 3 shows the concept of an IoT open platform, to which various devices, such as machine tools and robots operating in a factory are connected, and the operating data is collected, analyzed and interpreted to obtain a variety of useful information. Figure 4 shows an example of failure prediction by a maintenance and diagnostic system called Zero Down Time (ZDT). With ZDT, robot parts such as reducers and motors that are likely to fail can be identified from the vast amount of data obtained during robot operation, and the parts can be replaced with new ones during regular inspection and maintenance during scheduled production shutdown. This can prevent major damage caused by sudden factory shutdowns.

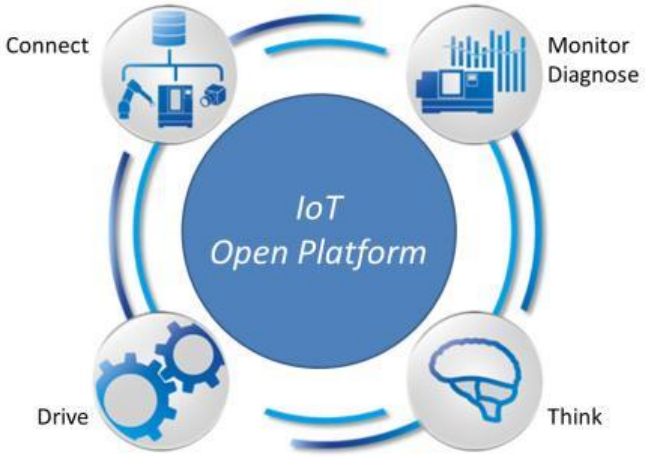

Figure 3 Concept of the IoT open platform

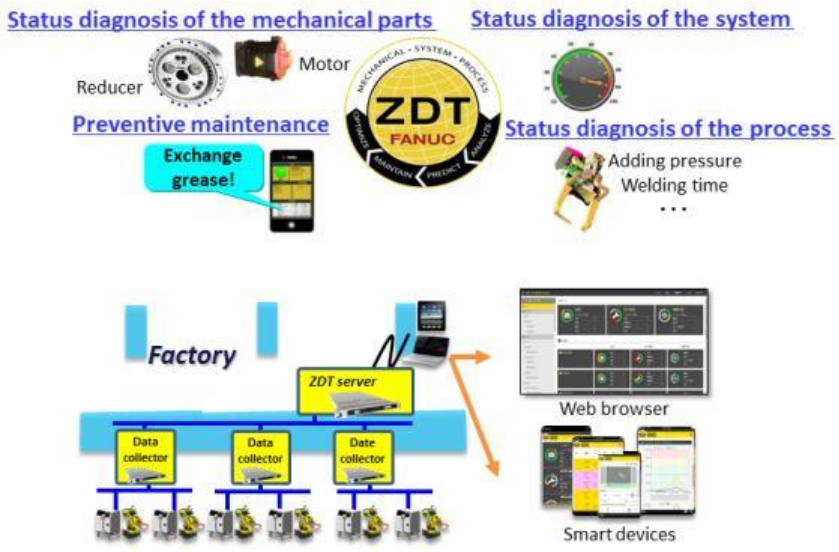

Figure 4 Maintenance and diagnostic system ZDT

2.4 AI

Artificial intelligence (AI) technology is progressing at an ever-increasing pace thanks to advancements in computing power, including algorithms such as deep learning and AI-specific chips. The following illustrates an example of an AI application at FANUC.

Figure 5 shows an example of the AI function of a robot (AI good/bad judgment). In the example shown in the figure, by simply registering an example where a nut is assembled onto the product (Pass) and an example where no nut is present (Fail), the AI automatically learns how to determine whether a nut is present or not, and can automatically determine whether the product is OK or not good.

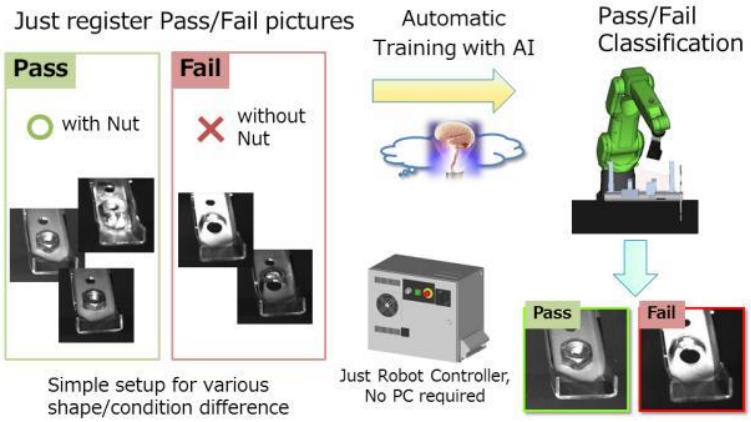

Figure 5 AI Pass/Fail Judgment

Figure 6 is an example of thermal displacement compensation of a machine tool by AI. The complex relationship between the temperature change and thermal displacement of a machine tool is modeled by machine learning, and the thermal displacement is compensated with high accuracy from the thermal displacement model and temperature.

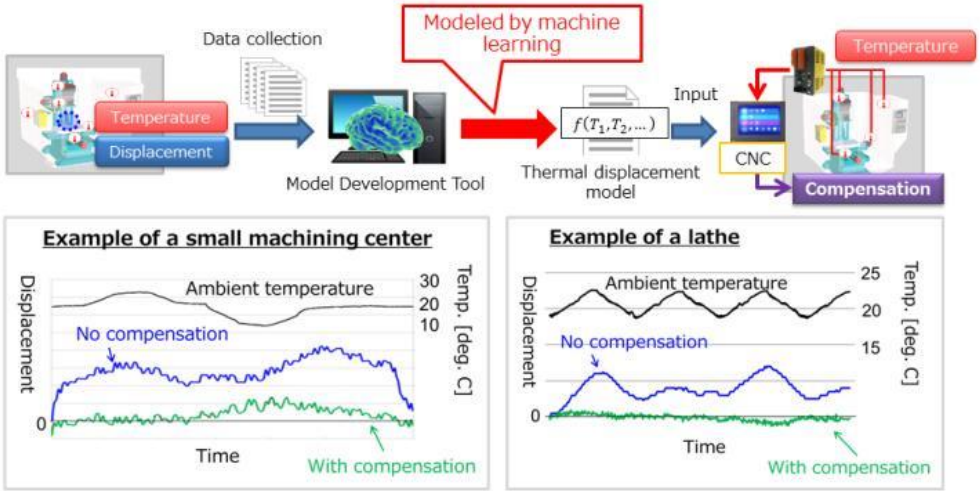

Figure 6 AI-based thermal displacement compensation for machine tools

3. Production Layout Optimization

3.1 What is optimization?

The concept of optimization is becoming more important to effectively use limited operational resources. Optimization is often performed on a digital twin configured in cyberspace based on the concept of Cyber-Physical Systems (CPS), which is then implemented in the real world. In order to optimize a production system, it is necessary to consider first what to optimize and then the scope of optimization.

1) ***What should be optimized?***

The items to be optimized include energy consumption, productivity (cycle time, etc.), and equipment lifetime. Figure 7 shows an example of a robot layout where the energy consumption of the robot is minimized by applying an optimization algorithm.

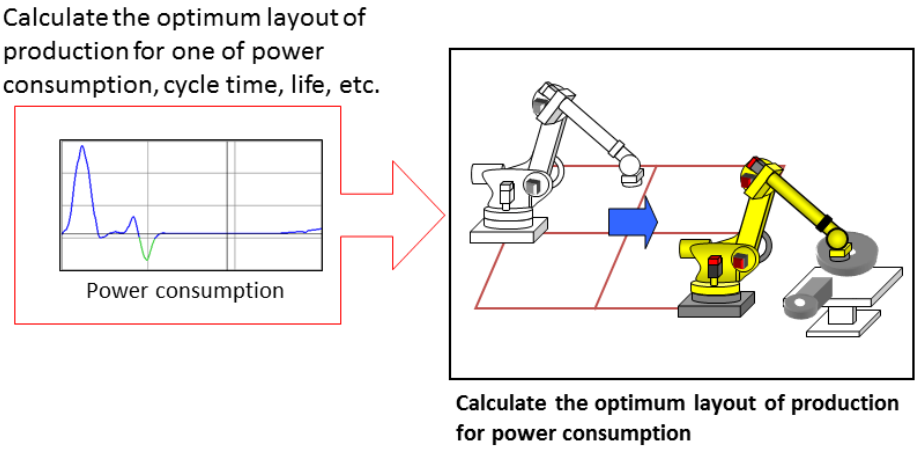

Figure 7 Optimal layout of a robot

2) Scope of Optimization

The solution to the optimization depends on the overall scope. The scope may range from narrow to wide depending on which range is considered to be the CPS:

(1) individual equipment such as machine tools and robots, (2) manufacturing cells and production systems, (3) entire factories, and (4) entire towns including factories

4. Fostering globally competitive advanced manufacturing clusters

4.1 What is a cluster?

Globally competitive manufacturing clusters are formed in communities where a group of

innovative companies in a specialized field cooperate with each other. According to M. Porter [1], a "cluster" is a geographically concentrated group of related firms, specialized suppliers, service providers, firms in related industries, and related institutions (universities, standards bodies, industry associations, etc.) in a particular field, competing and cooperating at the same time. A cluster is a geographically proximate group of companies and institutions that belong to a particular field and are interrelated. These companies and institutions are linked by commonalities and complementary characteristics. Clusters can be as small as a single city, an entire country, or a network of several neighboring countries.

The main reason why the cluster perspective is important is that it is a convenient way to think about the nature of competition and the sources of competitive advantage. Clusters are broader than industries, and offer a spillover effect able to capture important linkages and complementary relationships among firms and industries, as well as technologies, skills, information, marketing, and customer needs. These linkages can be fundamental to competition and productivity, especially in the formation of new businesses, and to the direction and pace of innovation.

Clusters create a forum for constructive and efficient communication between relevant companies, suppliers, local governments, and other key institutions. Public and private investments to improve the condition of clusters will benefit many companies.

4.2 Advanced Clusters

Figure 8 shows an example of a smart factory. Production is carried out by robots and other intelligent machines, and their operating data is collected on an IoT open platform to be analyzed and interpreted to obtain useful information.

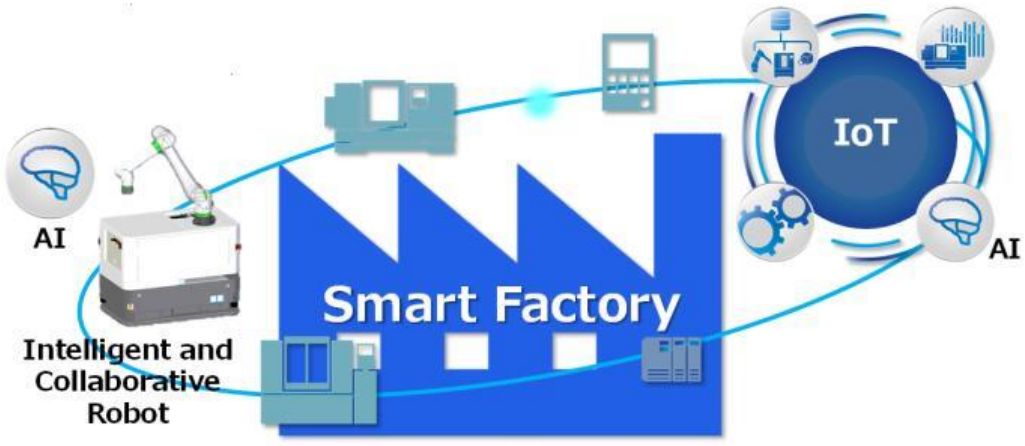

Figure 8 Smart factory

Figure 9 shows an example of several companies with the above-mentioned smart factories, which constitute an advanced manufacturing cluster that is internationally competitive as a whole, while at the same time demonstrating their individual characteristics. Each company, university, local government, etc. has the IoT open platform to share detailed data, including the entire concept of the products to be jointly developed. After optimizing the overall quality in cyberspace and making use of their respective features, the products may be implemented in the real world.

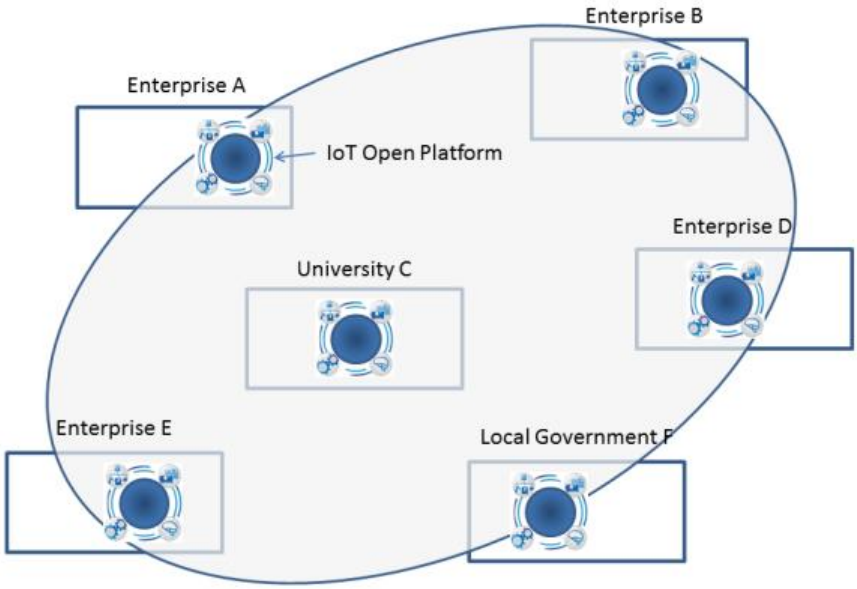

Figure 9 Configuration example of advanced manufacturing cluster

5. Conclusion

Improving the quality of products is increasingly important for driving global competitiveness. In recent years, smart manufacturing is emerging through the use of intelligent robots, collaborative robots, IoT, and AI, which enable unskilled workers to manufacture high-quality products. This paper described an advanced manufacturing cluster where companies, universities, and local governments with expertise in smart manufacturing can come together and share data through a common IoT open platform to achieve total optimization. I would like to express my sincere gratitude to Mr. Tang Liangzhi, the Mayor of Chongqing City for giving me the opportunity to write this paper, which will hopefully benefit many readers in the future.

References

[1] Michael E. Porter: “Clusters and the new economics of competition,” Harvard Business Review, Vol.76, pp.77-90, 1998.