

Chapter 2

Report on the Green Transformative Development of Industries in China's Special Economic Zones



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In order to promote the ecological civilization construction of industries, carry out the spirit of the Fifth Plenary Session of the 18th Central Committee of the Communist Party of China and the five major development philosophies, including innovation, coordination, greenness, openness and sharing, it is necessary to resolutely boost green development and push forward industrial transformation and upgrading. As China is entering the era of green transformation and development, the five major special economic zones are actively putting in practice the important path of green development, transformative development, innovative development, harmonious development which have produced preliminary effects.

2.1 Basic Trends of the Green Upgrading of Industries in the Special Economic Zones

2.1.1 *Build a Modern Industrial System, Promote the Green Transformation of Industries*

Building a modern industrial system, continuously optimizing the industrial structure, speeding up industrialization, increasing the proportion of the tertiary

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industry, decreasing the proportion of the industries with high energy consumption and high carbon emissions in the GDP is one of the main ways of achieving the green transformation of industries.

1. Shenzhen

Shenzhen's GDP was 1750.3 billion yuan in 2015, up 8.9%—the tertiary industry rapidly developed—its annual added value was 1,029,180 million yuan, up 10.2%, accounting for 58.8% of Shenzhen's GDP, up 1.5 percentage points compared with the previous year; the modern service industries delivered added value amounting to 713,447 million yuan, up 11.6%, accounting for 69.32% of the tertiary industry, up 1.72 percentage points; the real estate industry grew the most rapidly among the modern service industries, its annual added value was 162,777 million yuan, up 16.8%; the financial industry witnessed a relatively rapid growth, its annual added value was 254,282 million yuan, up 15.9%; as one of the four pillar industries, including the financial industry, cultural industry, and new and high-tech industry in Shenzhen, the logistics industry delivered an annual added value amounting to 178,270 million yuan, up 9.4%. The development of the service industry is one of the comprehensive indicators which reflect the comprehensive strength and the degree of a city's modernization. Compared with industry, the modern service industries consume fewer resources and energy and emit less pollution; they are environmentally friendly, thus accelerating the development of the modern service industries is the inevitable choice for achieving the green transformation of industries. The sustained growth of Shenzhen's modern service industries is conducive to promoting a profound integration of industrialization and informatization, sharpening the competitive edge of industrial enterprises, and expediting the development of the Internet and consumption platform so as to push forward the green transformation of industries.

Shenzhen's secondary industry brought about added value amounting to 720,553 million yuan in 2015, up 7.3%, accounting for 41.2% of Shenzhen's GDP, down 1.5 percentage points—the high-technology manufacturing industry in the secondary industry delivered added value amounting to 449,136 million yuan, up 9.7%, with its growth rate being 2 percentage points higher than that of the industries above the designated size in Shenzhen, accounting for 66.2% of the added value of the industries above the designated size in Shenzhen, up 3 percentage points. The advanced manufacturing industry generated added value amounting to 516,557 million yuan, up 11.5%, 3.8 percentage points higher than the growth rate of the industries above the designated size in Shenzhen, accounting for 76.13% of the added value from the industries above the designated size, up 1.93 percentage points. Currently, Shenzhen's intelligent equipment manufacturing industry is delivering an annual output value equivalent to about 500 billion yuan; it provides support for intelligent industrial manufacturing and has become the frontrunner in China. Shenzhen's marine industry realized an added value at an average annual growth rate of 20%, Shenzhen has become the national pilot city for developing the marine industry. In 2015, not only large enterprises including Huawei, ZTE Corporation, BYD, China Star Optoelectronics Technology and major projects grew rapidly, but also small and medium-sized enterprises such as DJI-Innovations (drone), BGI (the world-leading

genomics center), Ubtech (Alpha humanoid robot) and Royole (the world's thinnest (0.01 mm) flexible screen) swiftly rose; a large number of new-type enterprises led the direction of the emerging industries and sub-industries and stimulated the manufacturing industry to move towards the high end. Moreover, Shenzhen focused on developing seven major strategic emerging industries, including biology, the Internet, new energy, new generation information technology, new materials, cultural creativity, energy conservation and environmental protection; their annual added value increased by 12.4, 19.3, 10.1, 19.1, 11.3, 13.1 and 12%, respectively compared with the previous year, apparently higher than the growth rate of the industries above the designated size in Shenzhen and have become the new growth point of a low-carbon economy. The vigorous development of the advanced manufacturing industry and the strategic emerging industries helped continuously optimize Shenzhen's industrial structure, constantly improved the economic quality and promoted the green transformation of industries.

2. Zhuhai

In 2015, Zhuhai's GDP was 202,498 million yuan, up 10.0%, the highest growth rate in Guangdong Province—the secondary industry delivered added value amounting to 100,601 million yuan, up 10.2%, the highest growth rate in the five major special economic zones; the tertiary industry generated added value equivalent to 97,234 million yuan, up 10.0%, accounting for 48% of Zhuhai's GDP, up 1.2 percentage points. The industrial structure was optimized and upgraded. The high-end manufacturing industry, new and high-tech industry, high-end service industry, characteristic marine economy and ecological agriculture continuously developed; Zhuhai saw the formation of a new industrial system with a high technological content, high added value, low energy consumption and low pollution, and energetically pushed ahead with the green transformative development of industries. In 2015, the advanced manufacturing industry and the high-technology manufacturing industry grew by 20.5 and 18.6%, respectively, much higher than the growth rate (9.6%) of the industries above the designated size in Zhuhai. The modern service industries delivered added value amounting to 56,286 million yuan, up 10.1%, accounting for 57.89% of the tertiary industry, up 0.29 percentage points. The financial, convention and exhibition, headquarters economy industries, developed rapidly—the added value from the financial industry grew by 14.8%; the number of exhibitions, exhibition areas and the number of participants grew by 167, 183 and 105%, respectively; with strong support from preferential policies and fiscal funds, the potential of the headquarters economy was changed into actual developmental strength, many enterprises were headquartered in Zhuhai, especially in the Hengqin New Area. With the implementation of “Blue Zhuhai, Scientific Rise” strategy, the marine economy was identified as an important pole of Zhuhai's industrial system covering the high-end manufacturing industry, new and high-tech industry, high-end service industry, characteristic marine economy and ecological agriculture; the annual output value from the marine industry hit 70 billion yuan, up 27%, accounting for about 34% of Zhuhai's GDP, which made outstanding contributions to Zhuhai's economic growth. Doumen Ecological Agricultural Park includes 14 national and provincial agricultural standardized

demonstration bases and 18 bases for the production of agricultural products; it is listed among the second batch of the national food safety demonstration zones and the fifth batch of national agricultural science and technology parks, the first national demonstration zone for modern urban agriculture and the first national estuarine fishery demonstration zone.

3. Shantou

In 2015, Shantou's GDP was 185,001 million yuan, up 8.4%, 1.5 and 0.4 percentage points higher than the national GDP and Guangdong's GDP, respectively; Zhuhai's economy developed steadily and rapidly—the secondary industry delivered added value amounting to 95,669 million yuan, up 7.4%; the tertiary industry generated added value equivalent to 79,601 million yuan, up 10.4%; the growth rate of Zhuhai's tertiary industry was the highest among the five special economic zones; the three-industry structure was adjusted to 5.3:51.7:43.0; the proportion of the added value from the service industry increased by 1 percentage point compared with the previous year, and the industrial structure continued its process of optimization. The modern service industries delivered an annual added value amounting to 31,788 million yuan, up 12.6%, accounting for 39.9% of the tertiary industry, up 0.9 percentage points. As the Internet finance policy was implemented and capital market was brisk, the added value from the financial industry grew by 13.8%, 3.4 percentage points higher than the growth rate of the added value from the tertiary industry. With the impetus from 4G mobile phones, the Internet, relevant industries and other emerging business types, the added value from the information transmission, computer services and software industries grew by 13.2%, 2.8 percentage points higher than the growth rate of the added value from the tertiary industry. With the rapid development of industrial production and the service industry and the swift growth of modern logistics, the express business volume ranked No. 6 in Guangdong Province.¹ The annual industrial added value was 87,248 million yuan, up 7.1%—the advanced manufacturing industry delivered an added value amounting to 9662 million yuan, up 8.9%; the high-technology manufacturing industry brought about an added value amounting to 3.6 billion yuan, up 6.6%.

4. Xiamen

In 2015, Xiamen's industrial structure was continuously optimized; Xiamen's three-industry structure was adjusted to 0.7:43.5:55.8, the annual added value from the secondary industry was 150,899 million yuan, up 7.9%; the tertiary industry delivered an added value amounting to 193,308 million yuan, up 6.5%; the proportion of the added value from the service industry increased by 2.3 percentage points, the service industry became the most important pillar for economic growth. In 2015, the Xiamen Ocean Gate Container Terminal was put into operation; it is the first fourth-generation automatic terminal in China; it has greatly enhanced the international shipping capacity. In 2015, the annual port cargo throughput reached 210

¹An Analysis of City-wide Economic Operations in 2015, Shantou Statistical Information Online.

million tons, up 2.5%; the container throughput reached 9,183,000 TEUs, up 7.1%. E-commerce retail sales became a new point of growth; the annual total retail sales of consumer goods amounted to 116.84 billion yuan, up 8.9%. The tourism, conference and exhibition industry also continued to maintain a good momentum of development. Xiamen was listed among the first batch of China's model cities for leisure tourism. The annual tourism income totaled 83.24 billion yuan, up 15.3%. A total of 1.35 million people participated in meetings, up 57.6%. Xiamen was given the Asia Outstanding Exhibition Award. The industries grew rapidly. The total output value from the industries above the designated size in Xiamen was 503.08 billion yuan in 2015, up 8.1%, while the added value was 125,406 million yuan, up 7.9%. The advanced manufacturing industry developed in a concentrated way; in 2015, the new and high-tech enterprises delivered an output value amounting to 331.59 billion yuan, accounting for 65.9% of the total output value from the industries above the designated size. The panel display industry chain generated an output value amounting to 115.3 billion yuan; it was the first industrial chain of manufacturing which hit 100 billion yuan in Xiamen. The computer and communications equipment industrial chain delivered an output value equivalent to 70.92 billion yuan. A number of enterprises, including Taiwan United Microelectronics Corporation and Tsinghua Unigroup, settled in Xiamen, making Xiamen the national base for the integrated circuit industry. The biological and new medical industrial chain delivered an output value amounting to 9.47 billion yuan. Haicang Biopharmaceutical Park has become the characteristic industrial base under the China Torch Program. The Torch High-tech Zone is the only industrial cluster for pilot photoelectric display in China.

5. Hainan

In 2015, Hainan's GDP was 370.28 billion yuan, up 7.8%—the added value from the secondary industry was 87,513 million yuan, up 6.5%; the added value from the tertiary industry was 197,181 million yuan, up 9.6%; the three-industry structure was adjusted to 23.1:23.6:53.3; the industrial structure was further optimized; the proportion of the added value from the service industry increased by 1.4 percentage points from the previous period; the added value from the service industry accounted for more than half of the GDP and increased its contributions to economic growth. The development of the modern service industries was an important way to promote the transformation and upgrading of the service industry. In 2015, there was a rapid growth in the financial, information transmission, software and information technology service, tourism and express industries. The added value from the financial industry was 24,701 million yuan in 2015, up 19.6%; the information transmission industry and the software and information technology service industry reversed the decrease which had occurred in the previous year and delivered an operating revenue amounting to 12.09 billion yuan in 2015, up 11.9%, accounting for 14.6% of the service industries above the designated size in Guangdong Province, up 1.9 percentage points. Travel agencies, relevant service industries, park and scenic spot management, literary and artistic creation, performance and amusement parks generated an operating revenue equivalent to 6.23 billion yuan in 2015, up 12.4%, accounting for 7.5% of the service industries above the designated size in Guangdong Province.

With the driving effect from fast-growing e-commerce, the express industry delivered an operating revenue amounting to 360 million yuan in 2015, up 57.4%. Hainan's industries developed late, so leveraging Hainan's resource advantages to develop the emerging strategic marine industries is an important way to speed up industrialization and high-end development of industries.

2.1.2 Derive Driving Forces from Scientific and Technological Innovation, Enhance the Capability for Green Transformation

The transformative development of industries must rely on the support from strong green science and technology. It is necessary to intensify scientific and technological innovation, improve the capability for scientific and technological innovation and the efficiency of resource utilization, transform the extensive economic pattern of development into an intensive economic pattern of development in order to fundamentally change the driving forces for economic development and enhance the capability for the green transformation of industries.

1. Shenzhen

Shenzhen's R&D input accounted for 4.05% of the GDP in 2015, up 0.03 percentage points compared with the previous year. In 2015, only Huawei dedicated more than 100 billion yuan to research, development and market services. There were more than 1,353,000 professionals and technicians, up 5.6%, including 415,000 professionals and technicians at and above the intermediate technical title, up 4.4%. Shenzhen filed 13,300 PCT (Patent Cooperation Treaty) international patent applications in 2015, up 1700, accounting for 46% of the PCT international patent applications across the country, ranking Shenzhen No. 1 in China for 12 consecutive years; Shenzhen surpassed a number of countries, including the UK and France to be at the forefront of the world in innovation capability for 4G technology, metamaterial, gene sequencing, new energy automobiles, 3D displays and drones. There were 105,400 domestic patent applications and 72,100 domestic patent authorizations in 2015, up 28.2 and 34.3%, respectively. As of late 2015, Shenzhen was home to 1283 innovation vehicles, including key national, provincial and municipal laboratories, engineering laboratories, engineering (technology) research centers and enterprise technology centers. Thanks to the strong impetus provided by the vehicles of innovation Shenzhen was given 4 technical invention awards and 9 scientific and technological progress awards in the appraisal and selection of national, scientific and technological awards, 34 awards including 5 first awards, 16 second awards and 13 third awards in the appraisal and selection of scientific and technological awards in Guangdong Province. With the support from innovation carriers, incubation carriers and investment funds, Shenzhen is gradually fostering an innovation and entrepreneurial environment with a virtuous cycle. Shenzhen has made a flying-geese innovative

business arrangement for the common development of small, medium-sized and large enterprises, and has reached the national advanced level in the capability for original innovation and core technology innovation, Shenzhen is actively promoting the green transformation and upgrading of industries.

With scientific and technological innovation, many enterprises have grown into global leaders of the industry; for example, as the largest telecommunication equipment provider in the world, Huawei delivered an annual global sales revenue amounting to 395 billion yuan, up 37%. As the largest gene sequencing institution in the world, BGI applies a number of frontier scientific research achievements in such fields as medical health, agricultural breeding and resource conservation, and is pushing forward the transformation of genetic scientific and technological achievements; it was given two provincial awards for natural science in 2015. DJI-Innovations has become the leading global small-drone enterprise in several years and enjoys more than 50% of the global market share. TP-Link has ranked No.1 in the world on the wireless device market for five consecutive years.

2. Zhuhai

In 2015, Zhuhai's R&D input accounted for 2.7% of the GDP; it ranked No. 2 in Guangdong Province, only second to Shenzhen. The coverage rate of research and development institutions at the industrial enterprises above the designated size reached 20%, and ranked No. 1 in Guangdong Province. There were 2711 invention patent applications per one million people per year and every 10,000 people owned 22.5 invention patents. Zhuhai ranked No. 2 in Guangdong Province in both indicators. New and high-tech enterprises accounted for 40% of the total industrial enterprises above the designated size; the output value of new and high-tech products made up 55% of the total output value of the enterprises above the designated size, Zhuhai ranked No. 3 in Guangdong Province in both indicators. In 2015, Zhuhai unveiled the *Three-Year Action Plan of Zhuhai for Innovation-driven Development (2015–2017)*, *Several Policies and Measures of Zhuhai for Accelerating Scientific and Technological Innovation* and 18 core policies for innovation-driven development gradually shaped the innovation ecology of Blue Zhuhai. In 2015, significant innovation achievements were made; Livzon Pharmaceutical's project for research, development and commercialization of the original new drug Ilaprazole was granted the national second award for scientific and technological progress; nine projects, including Gree Electric Appliances' two-stage permanent-magnetic synchronous frequency-convertible centrifugal chiller, Livzon Pharmaceutical's research and commercialization of major generic and key technologies in the upgrading of the injection products for traditional Chinese medicine were given scientific and technological awards of Guangdong Province, among which three projects were granted the first award of Guangdong Province for science and technology, ranking Zhuhai No. 3 in Guangdong Province in the number of the first awards, only second to Guangzhou and Shenzhen. As of late 2015, there were 16 recognized innovative research and development institutions, including Zhuhai Innovation Center of Tsinghua University and Zhuhai Modern Industry Research Institute of South China University of Technology, and Gree Research Institute was chosen as the key national laboratory. Innovations

were also made to the operational mechanisms for the public testing service platform similar to South Software Product Testing Center; a government-led operational mechanism consistent with market needs was built; full scope was given to the role of public innovation service platforms in exerting influence on others and the innovation capability of small and medium-sized enterprises was improved.

The effect of putting scientific research achievements in practice was very significant. In 2015, a number of innovative enterprises made improvement in both output value and technology; take Oceanalpha as an example, as an enterprise established by the youngest expert under China's Recruitment Program of Global Experts six years ago, it achieved an explosive growth of output value and extended industrial development to the upstream—research and development of new materials, the downstream—testing and technical service, and it represented the explosive growth of innovative enterprises and improvement in both output value and technology. Meizu delivered an output value which hit 20 billion yuan, up more than 300%. CNOOC Deep Sea Development Co., Ltd. generated 10 billion yuan in output value, up more than 100%. A host of enterprises, including Hailong Biological, Enpower, CNR and Emerson, grew by more than 50%.

3. Shantou

In 2015, with the driving effect of municipal science and technology programs, Shantou's social R&D input significantly improved; an amount of 30,354 million yuan was invested in industrial technical renovation, up 61.7%. A total of 9827 patent applications were newly filed, up 8.0%; 7651 patent authorizations were granted, up 18.3%. There were 14 state-owned independent research and development institutions, scientific research information and literature institutions at and above the county level; 46 scientific and technological awards and 5 provincial awards for scientific and technological progress were given. As of late 2015, Shantou had established a cooperative relationship with more than 40 colleges and universities, including Wuhan University, and more than 20 scientific research institutes; it had built a number of industry-university-research demonstration bases, including a functional film research and development base, green packaging, digital printing and an alliance for industrial technical innovation; it had provided policy and capital support in order to cultivate a group of national and provincial innovative enterprises; it was home to 150 enterprises provincially identified as new and high-tech enterprises, all of which reached national new and high-tech enterprise standards, up 13.6%. A total of 92% of the 25 listed enterprises in Zhuhai were technology enterprises; the business incubation center of the hi-tech zone was successfully identified as the national incubator for technology enterprises.

4. Xiamen

In 2015, Xiamen's R&D input was 10,342 million yuan, accounting for 3% of the GDP; the full-time equivalent of research and development personnel per 10,000 workers was 128 man-years; Xiamen ranked No. 1 in Fujian Province in both indicators. As of late 2015, there were 14.38 effective invention patents per 10,000 people,

3.1 times the average number in Fujian Province; in this regard, Xiamen ranked No. 1 in Fujian Province. Xiamen actively promoted popular entrepreneurship and innovation; there were 1000 new and high-tech enterprises in Xiamen, accounting for about 50% of the new and high-tech enterprises in Fujian Province. In 2015, the new and high-tech industries delivered an annual added value amounting to 113,782 million yuan, accounting for 75.4% of the added value from the secondary industry; the new and high-tech enterprises above the designated size brought about an added value equivalent to 33.57 billion yuan, up 34.2%; it ranked No. 1 in Fujian Province in total quantity, proportion and speed of growth. In 2015, Xiamen introduced more than 400 national science and technology projects, and obtained funds worth about 390 million yuan; the effect of scientific and technological input was significant; a range of products and technologies—including the first hepatitis E vaccine in the world, the world's third and China's first cervical cancer vaccine, the immune diagnostic reagent for the Middle East respiratory syndrome corona virus—became world-class. As of late 2015, 51 provincial innovative enterprises were cumulatively cultivated, including 6 national innovative enterprises and 7 national pilot innovative enterprises. Furthermore, in the Xiamen Torch Hi-tech Zone, as one of the four national hi-tech zones named “torch” in China, the industrial enterprises above the designated size delivered an annual output value and an added value amounting to 57,204 million yuan and 14,659 million yuan, respectively.

5. Hainan

In 2015, Hainan's fund expenditure in scientific and technological activities reached 1.67 billion yuan, up 3.7%; 36,309 people were employed, up 1.9%. A total of 3125 patent applications were accepted and handled, up 29.3%; 2060 patents were authorized, up 29%; there were 2111 effective invention patents, up 17.8%; 2.34 effective invention patents were owned per 10,000 people. Moreover, the establishment of Hainan's first key national laboratory within enterprises (AVIC Special Glass Technology Co., Ltd. got approval to build a key national laboratory for special glass) means that great strides have been made in the system of technical innovations. In 2015, 10 key laboratories and engineering and technological research centers were newly added; 34 enterprises were newly identified as new and high-tech enterprises; 33 projects and products were newly identified as new and high-tech projects and products. In 2015, in Hainan, nearly 500,000 *Stichopus variegates* were bred, with the output value of nearly one million yuan, making the first breakthrough in artificial breeding of *Stichopus variegates* in South China; scientific and technological achievements promoted the development of efficient featured agriculture. In Hainan, special projects for boosting marine development through science and technology were launched; major scientific and technological projects relating to the ocean were carried out, and active efforts were made to apply for provincial-ministerial joint construction of a key national laboratory for the utilization of marine resources from the South China Sea.

2.1.3 Improve the Environmental Protection System and Mechanism, Promote the Green Transformation of Industries

Catering to the needs of the development in the era, fostering the philosophy of environmental protection, making laws to build the institutional environment and incentive system for green transformation, seizing the important opportunities from supply-side structural reform for shoring up the weak links in the ecological environment are the important forces for boosting the green transformation of the industries.

1. Shenzhen

In 2015, Shenzhen's energy consumption per 10,000 yuan GDP was 0.398 tce/10,000 yuan, down 3%, its level of energy consumption was the lowest in China; water consumption per 10,000 yuan GDP was 11.37 m³/10,000 yuan, down 6% the advanced level among large and medium-sized cities across China; the average annual PM2.5 concentration was 29.8 μg/m³, down 11.3%, making Shenzhen the large city with the best quality of air in China. In 2015, the ambient air quality index (AQI) was good and excellent on 340 days which accounted for 96.3% of the annual effective monitoring days (353 days).

In 2015, Shenzhen's environmental protection department carried out the new *Environmental Protection Law*, intensified the environmental protection law enforcement, carried out the actions of the Environmental Law Enforcement Year, special law enforcement actions in key fields and objects, and cracked down on the acts of violating environmental laws. In 2015, Shenzhen imposed administrative penalties on 1248 acts of violating environmental laws; these penalties hit 91,518,000 yuan. In 2015, Shenzhen became the first to initiate carbon emissions permit trading; Shenzhen was listed among the first batch of national pilot low-carbon cities; Shenzhen was at the national advanced level in carbon emissions per 10,000 yuan GDP; Shenzhen came out in front among national pilot low-carbon cities. As China V gasoline was applied in an all-round way, about 132,000 yellow-label cars and old cars were phased out; about 600 enterprises underwent exhaust gas control and treatment, 263 automobile repair enterprises experienced water paint renovation. Shenzhen was the first to control pollution from ships in ports with the adoption of low-sulphur fuel in 619 smaller ships.

2. Zhuhai

In 2015, Zhuhai's energy consumption per 10,000 yuan GDP decreased by 2.8%; energy consumption per 10,000 yuan industrial added value declined by 1.88%; electric power consumption per 10,000 yuan regional GDP decreased by 1.61%.² The annual daily average PM2.5 concentration was 31 μg/m³, down 8.8%, the air quality was relatively good; Zhuhai ranked No. 9 among 74 cities nationwide in the quality of air. In 2015, the ambient air quality index (AQI) was good and excellent

²http://www.gdstats.gov.cn/tjzl/tjgb/201605/t20160509_327753.html.

on 323 days which accounted for 89.97% of the annual effective monitoring days (359 days). The quality of the water environment was very good, the quality of the water at the drinking water source fully complied with the standard in 2015. The amount of 14,537 million kWh of electric power was consumed in 2015, up 8.2%—8828 million kWh of electric power was consumed by industry, up 4.9%. Waste gas emissions from industrial enterprises increased by 0.48%; the discharge of industrial wastewater decreased by 14.53%, and solid wastes from industrial enterprises increased by 3.34%.

3. Shantou

In 2015, Shantou's energy consumption per 10,000 yuan GDP decreased by 6.81%; the energy consumption per 10,000 yuan industrial added value declined by 16%; the consumption of electric power per 10,000 yuan regional GDP decreased by 5.78%.³ The annual daily average PM_{2.5} concentration was 33 $\mu\text{g}/\text{m}^3$, down 17.5%, the quality of the air was relatively good. In 2015, the ambient air quality index (AQI) was good and excellent on 342 days, which accounted for 94% of the annual effective monitoring days (364 days). The quality of the water at its source was good, and the quality of the water fully complied with the standard. The amount of 17,801 million kWh of electric power was consumed in 2015, up 2.2%—11,412 million kWh of electric power was consumed by industry, up 1.9%. The consumption of electric power in modern service industries soared—the consumption of electric power in the computer service and software industry surged by 41.5%, that in the telecommunications and other transmission service industries increased by 8.2% and that in the financial industry rose by 7.4%; they were 39.3, 6 and 5.2 percentage points higher than the growth rate of the total consumption of electric power, respectively.

In 2015, Shantou intensified its environmental supervision, environmental law enforcement and environmental rule of law; Shantou expanded the limitation on the accessible areas, increased the incentive and subsidy standard for phase-out and enhanced law enforcement on roads to phase out yellow-label cars; 235,000 marks of environmental conformity were verified and issued; 17,000 yellow-label cars were phased out, and the testing lines of nine environmental testing bodies were renovated.

4. Xiamen

In 2015, Xiamen's energy consumption per 10,000 yuan GDP was 0.437 tce/10,000 yuan, down 8.33%; the energy consumption per unit of the industrial added value decreased by 16.81%; the consumption of electric power per unit of GDP declined by 6.32%.⁴ The annual daily average PM_{2.5} concentration was 29.4 $\mu\text{g}/\text{m}^3$, down 19.01%; Xiamen ranked No. 2 among 74 cities nationwide in the quality of the air. In 2015, the ambient air quality index (AQI) was good and excellent on 362 days, which accounted for 99.2% of the annual effective monitoring days (365 days). The quality of the water at the source of drinking water fully complied with the standard; 93.4% of the municipal sewage was treated in a centralized way.

³See Footnote 2.

⁴<http://xmec.xmsme.gov.cn/2016-3/20163894448.htm>.

In 2015, according to 9 tasks and 42 work priorities specified in *Xiamen's Action Plan for Clean Air (2014–2017)*, Xiamen took active clean air actions to promote low-carbon urban construction, carry out 50 major energy conservation projects and save an amount of energy equivalent to 45,800 tce. A total of 16,456 yellow-label cars were phased out; marine shore power facilities started to be built at the wharfs; oil and gas pollution was controlled at 118 gas stations and 7 oil depots; roads were cleaned, greening, maintenance and spraying were carried out to reduce flying dust; 43 concentrated areas for catering were built; 9346 illegal barbecues were banned.

5. Hainan

In 2015, Hainan's energy consumption per unit of industrial added value was 2.4 tce/10,000 yuan, down 0.56%; the annual daily average PM_{2.5} concentration was 20 $\mu\text{g}/\text{m}^3$, which complied with the national Grade II standard for ambient air quality. The quality of Hainan's air was good and excellent on 97.9% of the days—it was excellent on 73.5% of the days and good on 24.4% of the days. The quality of the water at the centralized domestic drinking water sources fully complied with the standard and national requirements for the quality of water at the centralized drinking water sources. In 2015, industrial waste gas emissions totaled 233.87 billion m^3 , down 11.4%; sulfur dioxide emissions were 32,000 t, down 3.0%; nitric oxide emissions were 89,000 t, down 6.3%; soot and dust emissions were 20,000 t, down 13.0%.

Hainan relies on unique environmental resource advantages to seek development and utilizes its great advantages to build a green, ecological special economic zone. This is Hainan's absolute advantage. In 2015, 2.84 billion yuan were invested in environmental protection. In late 2015, there were 20 environmental monitoring stations in Hainan. Technical renovation relating to emission reduction was made in the No. 4 and No. 5 units at the Haikou Power Plant, the No. 1 unit at the Dongfang Power Plant and the No. 3 boiler at the Jinhai Pulp & Paper. China V gasoline was adopted in an all-round way, and about 30,000 yellow-label cars were phased out.

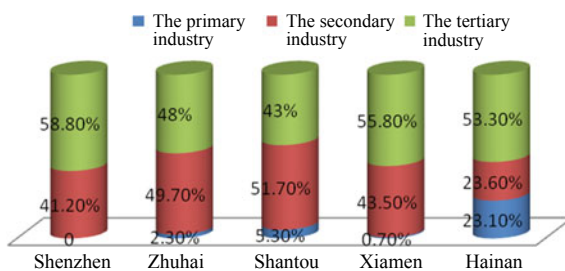
2.2 Analysis of the Capability of the Special Economic Zones for the Green Transformation of Industries

2.2.1 Comparison of the Levels of Structural Conversion

1. Comparison of the levels of industrial structural conversion in the special economic zones

Regarding the three-industry structure, the secondary industry receded, the tertiary industry advanced and the proportion of the primary industry changed slightly in the five major special economic zones in 2015—the proportions of the tertiary industry

Fig. 2.1 Comparison of the three-industry structure in the five major special economic zones in 2015



in Shenzhen, Zhuhai, Shantou, Xiamen and Hainan increased by 1.5, 1.2, 0.7, 2.3 and 1.4 percentage points, respectively compared with 2014; accordingly, the proportion of the secondary industry declined to some extent.

In 2015, the proportion of the tertiary industry exceeded 50%, but that of the primary industry was lower than 1% in Shenzhen and Xiamen; both cities were at the advanced stage of industrial evolution. The proportion of the secondary industry reached about 50%, but that of the primary industry was lower than 10% in Zhuhai and Shantou; both cities were at the stage of industrial evolution characterized by the intensification of industrialization. The proportion of the tertiary industry exceeded 50%, but that of the primary industry was basically the same as that of the secondary industry in Hainan; this was closely related to Hainan's unique resource and environmental endowment conditions; an industrial structural evolutionary path suitable for Hainan was experimented in line with Hainan's advantages (see Fig. 2.1).

2. Analysis of the transformation of the service industries in the special economic zones

In 2015, tertiary industry grew rapidly and its proportion increased to some extent in the five special economic zones. The increasing proportion of the service industries, especially the modern service industries, is conducive to boosting the green transformative development of industries. The high value-added modern service industries, including the financial, marine and modern logistics industries, and the annual cumulative completed investment amount in the tertiary industry in the special economic zones are compared and analyzed below.

In 2015, the financial industry grew rapidly in the five major special economic zones; the added value from Shenzhen's financial industry hit more than 250 billion yuan (see Fig. 2.2). The added value from the financial industry in Shenzhen, Zhuhai, Shantou, Xiamen and Hainan grew by 15.9, 14.8, 13.8, 14.7 and 19.6%, respectively, compared with 2014, which were 5.7, 4.8, 3.4, 8.2 and 10 percentage points higher than the growth rate of the added value from the tertiary industry in these special economic zones.

As the 17th National Congress of the Communist Party of China was convened, the marine industry had developed faster and it had increasingly become an important growth pole for the country or regions; the five major special economic zones have made breakthroughs in developing the marine industry thanks to their location,

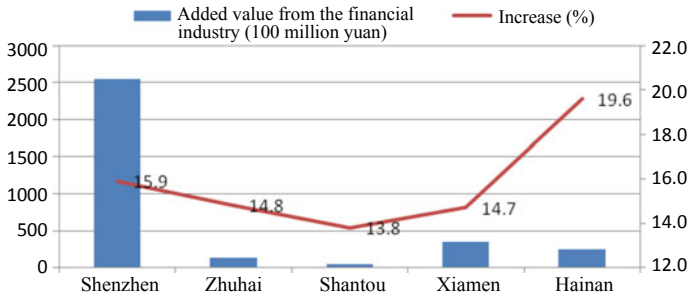


Fig. 2.2 Added value from the financial industry and its growth rates in the five major special economic zones in 2015

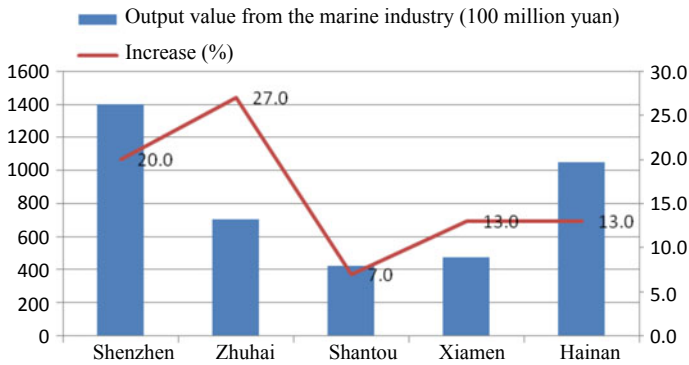


Fig. 2.3 Output value from the marine industry and its growth rates in the five major special economic zones in 2015

resources and institutional advantages. In 2015, the output value from Shenzhen’s marine industry was about 140 billion yuan, that from Hainan’s marine industry hit 100 billion yuan and that from Zhuhai’s marine industry exceeded 70 billion yuan; the output value from the marine industry grew rapidly (see Fig. 2.3). Moreover, Shenzhen, Zhuhai and Hainan have put the development of the characteristic marine industry in an important strategic position, while the launch of high-end projects, the increase of R&D input and the introduction of scientific research talents will further boost the development of the marine industry.

The rapid development of new-generation information technology and the Internet stimulated the growth of e-commerce and the modern logistics industry. The added value from Shenzhen’s logistics industry was 178.3 billion yuan in 2015, up 9.4%; the added value from Xiamen’s logistics industry exceeded 30 billion yuan; Hainan’s logistics industry grew by more than 50%; the development of the modern logistics industry injected vigor into cities. Meanwhile, the growth of the software and information technology service industry was also fairly optimistic. Thanks to the leading enterprises, including Huawei and Tencent, Shenzhen’s software and infor-

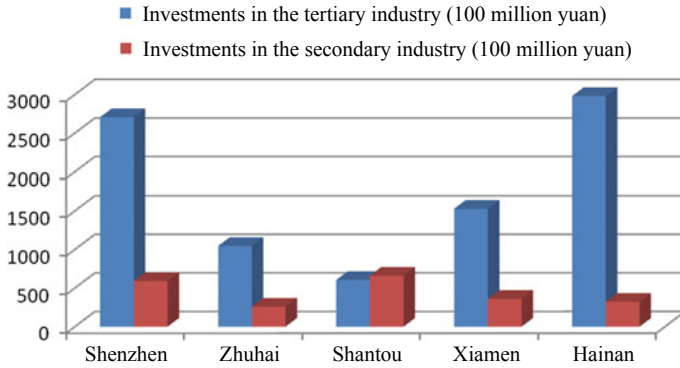


Fig. 2.4 Amount of investments in the secondary and tertiary industries in the five major special economic zones in 2015

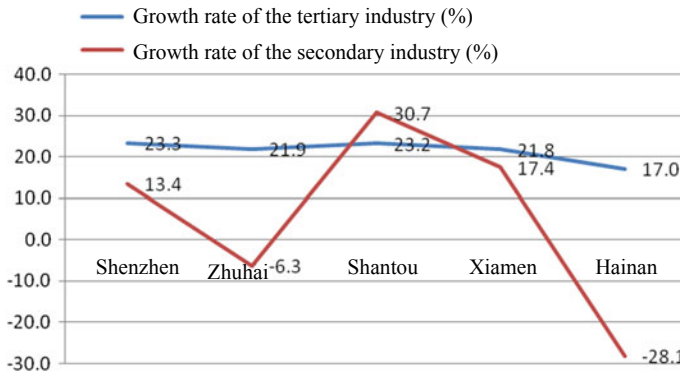


Fig. 2.5 Growth rates of investments in the secondary and tertiary industries in the five major special economic zones in 2015

mation technology service industry grew rapidly, ranking Shenzhen No. 2 in China. The added value from the information transmission, computer services and software industries in Shantou and Hainan grew by 13.2 and 11.9%, respectively, in 2015.

The direction of fixed asset investments reflected the direction of the regional industrial development to some extent. In 2015, the amount of investments in the tertiary industry was much higher than that in the secondary industry and was about five times that in the secondary industry in the five major special economic zones, including Shenzhen, but not Shantou (see Fig. 2.4); the amount of investments in the tertiary industry in Shenzhen, Zhuhai, Xiamen and Hainan grew by 23.3, 21.9, 21.8 and 17%, respectively, which was, respectively 9.9, 28.2, 4.4 and 45.1 percentage points higher than the growth rates of the amount of investments in the secondary industry in the special economic zones (see Fig. 2.5). This indicates that the tertiary industry was the development priority in the special economic zones and its proportion may further increase.

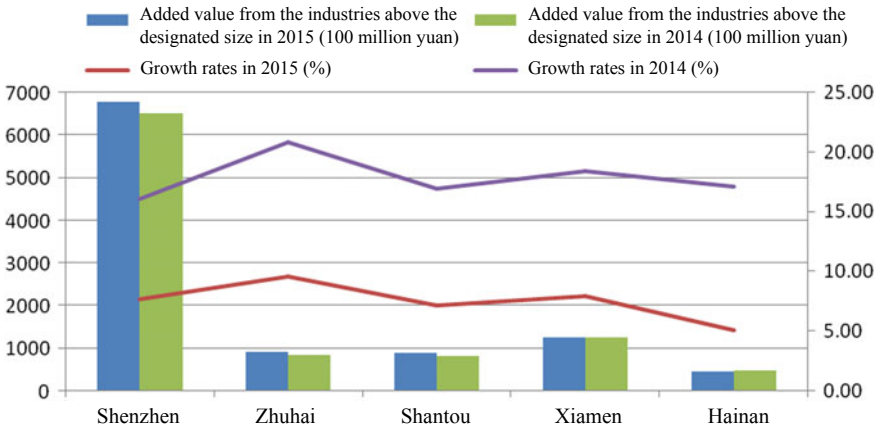


Fig. 2.6 Added value from the industries above the designated size and its growth rates in the five major special economic zones in 2014 and 2015

3. Analysis of the transformation within the industries in the special economic zones

In 2015, the industrial added value from the enterprises above the designated size in Shenzhen, Zhuhai, Shantou, Xiamen and Hainan was 678.5, 90.8, 87.25, 125.41 and 44.9 billion yuan, respectively, up 7.7, 9.6, 7.1, 7.9 and 5.1%. The growth rates of the industrial added value from the enterprises above the designated size in the five major special economic zones in 2015 were lower than they were in 2014 (see Fig. 2.6). The industrial added value from the enterprises above the designated size in Shenzhen was 7.5, 7.8, 5.4 and 15.1 times higher than what it was in Zhuhai, Shantou, Xiamen and Hainan. This suggests that the industrialization in the special economic zones had entered the stage of intensification, and the growth rates had declined slightly.

The advanced manufacturing industry is the resource-saving, environmentally-friendly efficient manufacturing industry and serves as an important path for the transformation and upgrading of the manufacturing industry and for the green transformation of industries. The advanced manufacturing industry grew by 11.5, 20.5 and 8.9%, respectively in Shenzhen, Zhuhai and Shantou in 2015, apparently higher than the growth rates of the added value from the industrial enterprises above the designated size in 2015 (see Fig. 2.7). This shows that the industries in the special economic zones were transforming and developing towards the resource-saving, environmentally-friendly advanced manufacturing industry.

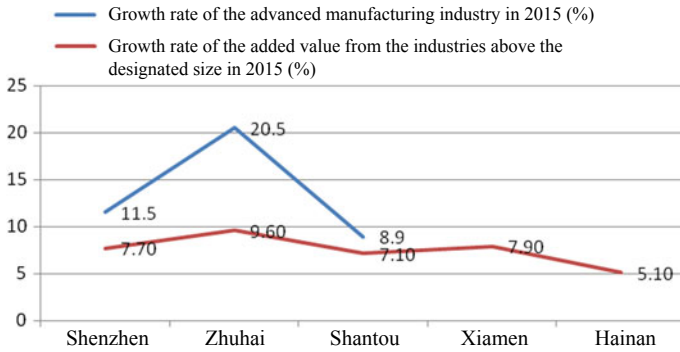


Fig. 2.7 Growth rate of the added value from the industries above the designated size and that of the advanced manufacturing industry in the five major special economic zones in 2015

2.2.2 Comparison of the Levels of Innovation Impetus

In 2015, the proportion of all R&D input in GDP in the special economic zones was obviously higher than the level of the national average (see Fig. 2.8); in particular, that in Shenzhen reached 4.05%, equivalent to that in South Korea which ranked No. 2 in the world, much higher than that in other special economic zones.

In 2015, the number of scientific research achievements soared in the special economic zones. The number of domestic patent applications and domestic patent authorizations grew by more than 28% in Shenzhen and Hainan, while the growth rates of domestic patent applications and domestic patent authorizations in Shantou were relatively low—8 and 18.3% respectively (see Fig. 2.9). In addition, the number of PCT international patent applications reached 13,300 in Shenzhen, ranking Shenzhen No. 1 in China for 12 consecutive years and surpassing such countries as the UK and France.

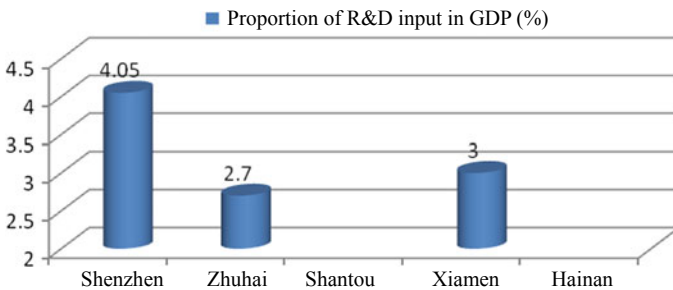


Fig. 2.8 Proportion of R&D input in GDP in the five major special economic zones in 2015

2.2.3 Comparison of Ecological Environmental Protection

In 2015, the consumption of energy per 10,000 yuan GDP in Shenzhen, Zhuhai, Shantou, Xiamen and Hainan decreased by 3, 2.8, 6.81, 8.33 and 1.27%, respectively. The consumption of electric power in Hainan per 10,000 yuan GDP grew slightly, while that in Shenzhen, Zhuhai, Shantou and Xiamen decreased by 5.52, 1.61, 5.78 and 6.32%, respectively (see Fig. 2.10). This indicates that the special economic zones were transforming towards the pattern of intensive growth.

Regarding the quality of the air in the special economic zones, the average annual PM_{2.5} concentrations in Shenzhen, Zhuhai, Shantou, Xiamen and Hainan were 29.8, 31, 33, 29.4 and 20 $\mu\text{g}/\text{m}^3$ in 2015 (see Fig. 2.11), respectively, much lower than they were in the previous year, reaching the national Grade II air quality standard (average annual 35 $\mu\text{g}/\text{m}^3$); all of these special economic zones were low-ranking

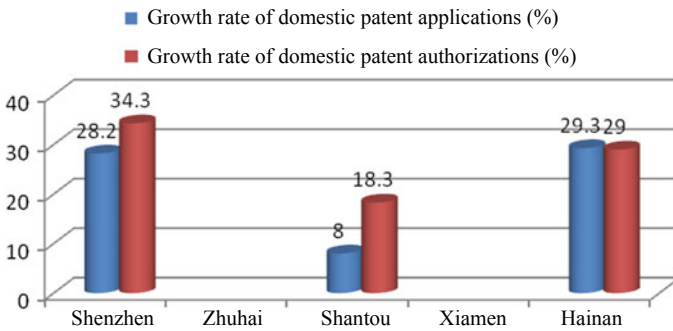


Fig. 2.9 Growth rates of domestic patent applications and domestic patent authorizations in the five major special economic zones in 2015

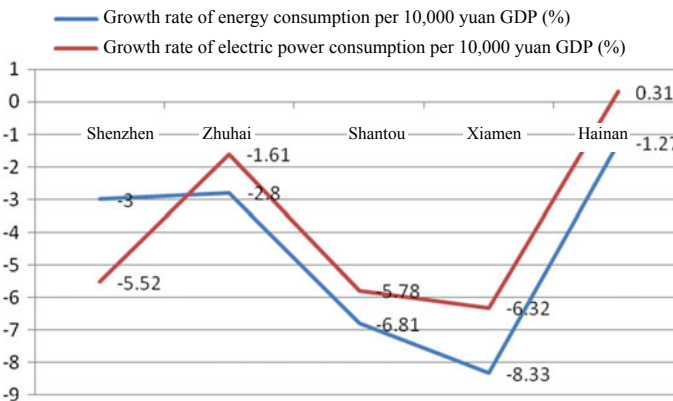


Fig. 2.10 Growth rates of energy consumption and electric power consumption per 10,000 yuan GDP in the five major special economic zones in 2015

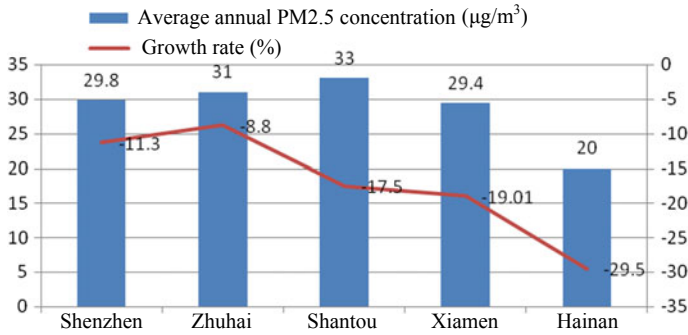


Fig. 2.11 Average annual PM2.5 concentration and growth rate in the five major special economic zones in 2015

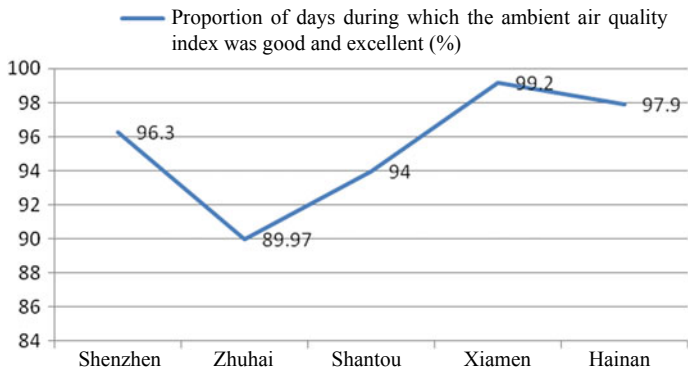


Fig. 2.12 Proportion of days during which the ambient air quality index was good and excellent in the five major special economic zones in 2015

in this regard among 360 Chinese cities whose air quality monitoring data were released. The ambient air quality index in all of the special economic zones, except Shantou, was good and excellent on more than 94% of the days (see Fig. 2.12). This indicates that the special economic zones were relatively good among the major cities in China in terms of air quality and this produced certain effects on the green transformation of industries.

2.3 Evaluation of the Capability of the Special Economic Zones for the Green Transformation of Industries

2.3.1 The Line of Thought Regarding Evaluation

With respect to the green transformation of industries, currently the academic community is mainly focusing on the research in the evaluation of green industries (see Table 2.1). Unlike the research on the evaluation of green industrial development, the evaluation of the capability for green transformative development of industries stresses not only the capability for penetration of green philosophy and technologies in the industrial transformation, but also the level of integration between the industrial transformation and green development. The research on the capability for the green transformative development of industries mainly addresses the industrial transformation, research perspective and greening in the industrial transformation. A green industry is a concept based on environmental protection and mainly relies on a green environmental system. A green industry is a global concept. Regarding the connotation and denotation of the academic research, both involve the integration between green development and industrial development, but they are different in focus. When it comes to the building of a method of evaluation and a system of indicators, and the integration between green development and industrial development, both indicators can be mutually used for reference within a certain scope.

Based on the system of indicators, the line of thought regarding the building developed by such scholars as Zhu et al. (2014), Gu et al. (2013), given the subject of evaluation—the capability of the special economic zones for the green transformative development of industries—this paper proposes taking the input-output process of the industrial development as the logical observation point for the design of the indicators, and developing the system of indicators from the perspectives of green input, green production, green control, green benefits and green environment, and adopting the entropy method to conduct a quantitative evaluation of the capability of the special economic zones for the green industrial transformative development.

2.3.2 Design of the Evaluation Indicator System and Data Source

1. Design of the evaluation indicator system

Based on the above line of thought regarding evaluation, the analysis of relevant domestic and foreign literature, and given the availability of indicator data and the operability of the evaluation scheme, the evaluation system for the capability of the special economic zones for the green transformative development of industries which includes the following 13 indicators is ultimately determined (see Table 2.2).

Table 2.1 Research progress in the evaluation of the existing green industrial development

Author	Research subject	Evaluation method	System of indicators	Brief comment
Zhu et al. (2014)	Evaluation research on green industrial development	Grey situation decision-making model improved by entropy weight	Build the evaluation system from the perspectives of green benefits, green utilization, green manufacturing, green control and green management	The system of primary indicators is highly enlightening, but it is difficult to obtain a number of indicators in the system of secondary indicators, and evaluation focuses on green industries, while insufficient attention is paid to transformation
Gu et al. (2013)	Research on the system of indicators for green industry evaluation	R cluster-grey correlation analysis method	Choose 22 indicators from the perspectives of green production, green consumption and green environment to build the system of indicators	It focuses on the production and consumption process in green industries; the evaluation subject is different from the green transformative development of industries. This paper focuses on building the system of indicators and does not involve an empirical process; many indicators are inoperable in the empirical process
Zhou et al. (2016)	Building a model of a system of indicators for green industry evaluation, and empirical research	R cluster-factor analysis method	Choose 26 indicators from the perspectives of green production, green consumption and green environment to build the system of indicators	There is no rigorous logic for classifying sub-indicators; the subject of evaluation is different from the subject involving the green transformative development of industries. Green consumption does not fall within the evaluation field involving the green transformation of industries

(continued)

Table 2.1 (continued)

Author	Research subject	Evaluation method	System of indicators	Brief comment
Zhu and Ma (2011)	Evaluation research on the effects of green industrial development	Factor analysis method	Choose 26 indicators from economic indicators, ecological environmental indicators and social evaluation indicators to build the system of indicators	The system of indicators is highly operable, but the subject of evaluation is green industry and is different from the subject involving the green transformative development of industries

The average annual concentration of inhalable particles in central urban areas is a negative indicator—its size is negatively related to the capability of the special economic zones to carry out green industrial transformation. All of the remaining 12 indicators are positive indicators—their size is positively related to the capability of the special economic zones to carry out green industrial transformation.

2. Data source

The textual and graphical data from the statistics bureaus and environmental protection departments of China’s five major special economic zones are used to generate the basic data for evaluating the capability of China’s five major special economic zones to carry out green industrial transformation in 2015, as shown in Table 2.3.

2.3.3 Evaluation Process

The entropy method is adopted to evaluate the capability of the five major special economic zones to carry out the green transformation of industries, as below. The entropy method is an objective weighting evaluation method. Its evaluation process covers the following steps.

1. Standardized processing of raw data

The definitions and measurement units of the evaluation indicators in the evaluation system for the capability of special economic zones to carry out the green transformation of industries are different, thus it is necessary to classify the above indicators into two categories for dimensionless processing in order to facilitate a unified comparison. The positive indicators undergo standardized processing according to the following processing method:

$$x'_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \quad (0 \leq x'_{ij} \leq 1)$$

Table 2.2 The evaluation system for the capability of the special economic zones to carry out green transformation

Evaluation objectives	Primary indicator	Secondary indicator	Indicator type
Evaluation of the capability of the special economic zones to carry out green transformation	Green input	Proportion of R&D fund expenditure in GDP	Positive
		Proportion of personnel above the junior college degree	Positive
		Growth rate of fixed asset investments	Positive
	Green production	Change value of the three-industry structure	Positive
		Growth rate of the output value from new and high-tech industries	Positive
		Growth rate of the added value from the modern service industries	Positive
	Green control	Proportion of reduction of energy consumption per unit of GDP	Positive
		Proportion of reduction of the consumption of electric power per unit of GDP	Positive
	Green benefits	GDP per unit of land area	Positive
		Per capita GDP	Positive
	Green environment	The number of days during which the quality of the air reaches the national Grade I standard	Positive
		Per capita park green land area	Positive
		Average annual concentration of inhalable particles in central urban areas	Negative

Table 2.3 Basic data for evaluating the capability of China's five major special economic zones to carry out green industrial transformation in 2015

Secondary indicator	Shenzhen	Shantou	Zhuhai	Xiamen	Hainan
Proportion of R&D fund expenditure in GDP	4.05%	0.94%	2.70%	3%	0.48%
Proportion of personnel above the junior college degree	17.18%	4.16%	18.39%	17.80%	7.77%
Growth rate of fixed asset investments	21.40%	27.10%	15.00%	20.60%	10.40%
Change value of the three-industry structure	3.00	1.40	2.40	4.60	2.80
Growth rate of the output value from new and high-tech industries ^a	9.70%	18.60%	6.60%	11.20%	15.60%
Growth rate of the added value from the modern service industries	10.20%	10.00%	10.40%	6.50%	9.60%
Proportion of reduction of energy consumption per unit of GDP	3%	6.81%	2.80%	8.33%	1.27%
Proportion of reduction of the consumption of electric power per unit of GDP	5.52%	5.78%	1.61%	6.32%	-0.31%
GDP per unit of land area	8.66	0.98	1.10	2.21	0.11
Per capita GDP	157,985	33,406	124,700	90,378	40,818
The number of days during which the quality of the air reaches the national Grade I standard	340	342	323	362	357
Per capita park green land area	16.91	14.41	19.5	11.4	12.11
Average annual concentration of inhalable particles in central urban areas	29.8	33	31	29.4	20

^aXiamen and Hainan's 2015 statistical communiqués do not show the growth rate of the output value from new and high-tech industries. Xiamen's growth rate of the output value from new and high-tech industries chosen here is the data covering January–October, 2015. Hainan's growth rate of the output value from new and high-tech industries is the data covering the first half of 2015. The basis for replacement is the sound growth rates of the leading industries supporting the development of Xiamen and Hainan's new and high-tech industries in the second half of the year. Hainan's economic growth rate in the second half of the year was 0.2 percentage points higher than that in the first half of the year

The negative indicators undergo standardized processing according to the following processing method:

$$x'_{ij} = \frac{\max x_{ij} - x_{ij}}{\max x_{ij} - \min x_{ij}} \quad (0 \leq x'_{ij} \leq 1)$$

Table 2.4 Standardized data concerning the indicators for evaluating the capability of the five major special economic zones to carry out green industrial transformation in 2015

Secondary indicator	Shenzhen	Shantou	Zhuhai	Xiamen	Hainan
Proportion of R&D fund expenditure in GDP	0.8061	0.1714	0.5306	0.5918	0.0776
Proportion of personnel above the junior college degree	0.8338	0.0684	0.9052	0.8706	0.2805
Growth rate of fixed asset investments	0.5700	0.8550	0.2500	0.5300	0.0200
Change value of the three-industry structure	0.5000	0.1000	0.3500	0.9000	0.4500
Growth rate of the output value from new and high-tech industries ^a	0.3133	0.9067	0.1067	0.4133	0.7067
Growth rate of the added value from the modern service industries	0.5200	0.5000	0.5400	0.1500	0.4600
Proportion of reduction of energy consumption per unit of GDP	0.3000	0.6810	0.2800	0.8330	0.1270
Proportion of reduction of the consumption of electric power per unit of GDP	0.5927	0.6164	0.2373	0.6655	0.0627
GDP per unit of land area	0.8665	0.0981	0.1096	0.2215	0.0109
Per capita GDP	0.9845	0.0262	0.7285	0.4644	0.0832
The number of days during which the quality of the air reaches the national Grade I standard	0.6154	0.6462	0.3538	0.9538	0.8769
Per capita park green land area	0.6910	0.4410	0.9500	0.1400	0.2110
Average annual concentration of inhalable particles in central urban areas	0.2600	0.1000	0.2000	0.2800	0.7500

^aXiamen and Hainan's 2015 statistical communiqués do not show the growth rate of the output value from new and high-tech industries. Xiamen's growth rate of the output value from new and high-tech industries chosen here is the data covering January–October, 2015. Hainan's growth rate of the output value from new and high-tech industries is the data covering the first half of 2015. The basis for replacement is the sound growth rates of the leading industries supporting the development of Xiamen and Hainan's new and high-tech industries in the second half of the year. Hainan's economic growth rate in the second half of the year was 0.2 percentage points higher than that in the first half of the year

The maximum and minimum values of the indicators are determined according to the empirical values of recent years. According to the above calculation formula, the raw data in Table 2.3 can be put into dimensionless processing, as shown in Table 2.4.

2. Calculation of the entropy, difference coefficient and weight

First, determine the proportions of the indicator values of the evaluation units under each indicator; the calculation formula is shown below:

$$p_{ij} = \frac{x'_{ij}}{\sum_{i=1}^n x'_{ij}}$$

And then calculate the entropy of each indicator:

$$e_j = -k \sum_{i=1}^n p_{ij} \ln p_{ij}, \text{ where } k = \frac{1}{\ln n}.$$

Define the difference coefficient: $g_j = 1 - e_j$, calculate the weight according to the difference coefficient:

$$a_j = \frac{g_j}{\sum_{i=1}^m g_j}$$

Calculate the entropy, difference coefficient and weight according to the above formula, as shown in Table 2.5.

3. Evaluation results

Calculate the comprehensive evaluation value according to the entropy, difference coefficient and weight:

$$v_i = \sum_{j=1}^n a_j p_{ij}$$

Substitute the data to obtain the scores of the primary and secondary evaluation factors involving the capability of the five major special economic zones to carry out the green transformative development of industries, as shown in Tables 2.6 and 2.7.

2.3.4 Analysis of the Results of the Evaluation

As shown in Table 2.8, Shenzhen ranked No. 1 among the five major special economic zones in the capability for the green transformation of industries and obtained the highest sum of factor scores in five aspects, followed by Xiamen, Zhuhai, Shantou and Hainan.

According to the results of the evaluation obtained after continuously tracking the capability of the five major special economic zones for industrial transformation in recent years, the results of the evaluation concerning the capability for the green transformation in industrial development is greatly different from that related to the capability for pure industrial transformation. From 2012 to 2014, Shenzhen ranked No. 1 among the five major special economic zones in the capability for industrial

Table 2.5 Entropy, difference coefficient and weight of evaluation indicators

Secondary indicator	Entropy	Difference coefficient	Weight
Proportion of R&D fund expenditure in GDP	0.8605	0.1395	0.0761
Proportion of personnel above the junior college degree	0.8635	0.1365	0.0744
Growth rate of fixed asset investments	0.8364	0.1636	0.0892
Change value of the three-industry structure	0.8953	0.1047	0.0571
Growth rate of the output value from new and high-tech industries ^a	0.8865	0.1135	0.0619
Growth rate of the added value from the modern service industries	0.9570	0.0430	0.0234
Proportion of reduction of energy consumption per unit of GDP	0.8856	0.1144	0.0624
Proportion of reduction of the consumption of electric power per unit of GDP	0.8811	0.1189	0.0649
GDP per unit of land area	0.6310	0.3690	0.2012
Per capita GDP	0.7597	0.2403	0.1310
The number of days during which the quality of the air reaches the national Grade I standard	0.9687	0.0313	0.0171
Per capita park green land area	0.8765	0.1235	0.0674
Average annual concentration of inhalable particles in central urban areas	0.8644	0.1356	0.0740

^aXiamen and Hainan's 2015 statistical communiqués do not show the growth rate of the output value from new and high-tech industries. Xiamen's growth rate of the output value from new and high-tech industries chosen here is the data covering January–October, 2015. Hainan's growth rate of the output value from new and high-tech industries is the data covering the first half of 2015. The basis for replacement is the sound growth rates of the leading industries supporting the development of Xiamen and Hainan's new and high-tech industries in the second half of the year. Hainan's economic growth rate in the second half of the year was 0.2 percentage points higher than that in the first half of the year

transformation and firmly secured that position. The other four special economic zones changed a lot in ranking—Zhuhai and Hainan have gradually improved their capability for industrial transformation recently, while Xiamen and Shantou have seen a certain decrease in their capability for transformation in recent years.

When the evaluation and observation of the capability for industrial transformation of the five major special economic zones from the green perspective is added, a new perspective of analysis is provided for the current transformation of the special economic zones.

Table 2.6 The scores of the secondary evaluation factors involving the capability of the five major special economic zones to carry out the green transformation of industries in 2015

Secondary indicator	Shenzhen	Shantou	Zhuhai	Xiamen	Hainan
Proportion of R&D fund expenditure in GDP	0.0282	0.0060	0.0185	0.0207	0.0027
Proportion of personnel above the junior college degree	0.0210	0.0017	0.0228	0.0219	0.0071
Growth rate of fixed asset investments	0.0229	0.0343	0.0100	0.0213	0.0008
Change value of the three-industry structure	0.0124	0.0025	0.0087	0.0223	0.0112
Growth rate of the output value from new and high-tech industries ^a	0.0079	0.0229	0.0027	0.0105	0.0179
Growth rate of the added value from the modern service industries	0.0056	0.0054	0.0058	0.0016	0.0050
Proportion of reduction of energy consumption per unit of GDP	0.0084	0.0191	0.0079	0.0234	0.0036
Proportion of reduction of the consumption of electric power per unit of GDP	0.0177	0.0184	0.0071	0.0198	0.0019
GDP per unit of land area	0.1334	0.0151	0.0169	0.0341	0.0017
Per capita GDP	0.0564	0.0015	0.0417	0.0266	0.0048
The number of days during which the quality of the air reaches the national Grade I standard	0.0031	0.0032	0.0018	0.0047	0.0043
Per capita park green land area	0.0191	0.0122	0.0263	0.0039	0.0058
Average annual concentration of inhalable particles in central urban areas	0.0121	0.0047	0.0093	0.0130	0.0349

^aXiamen and Hainan's 2015 statistical communiques do not show the growth rate of the output value from new and high-tech industries. Xiamen's growth rate of the output value from new and high-tech industries chosen here are the data covering January–October, 2015. Hainan's growth rate of the output value from new and high-tech industries are the data covering the first half of 2015. The basis for replacement is the sound growth rates of the leading industries supporting the development of Xiamen and Hainan's new and high-tech industries in the second half of the year. Hainan's economic growth rate in the second half of the year was 0.2 percentage points higher than that in the first half of the year

From the perspective of the green transformation of industries, thanks to prominent green input and green benefits, Shenzhen ranked No. 1 among the five major special economic zones in the capability for the green transformation of industries. The score obtained by Shenzhen in green input was nearly 7 times Hainan's score, while Shenzhen's score in green benefits was nearly 30 times and 11 times Hainan's score and Shantou's score, respectively. Although Shenzhen still enjoyed certain advantages in the production and control process, it lagged behind, to some extent, Hainan, Xiamen and Shantou in the scores concerning the growth rate of the output value from new and high-tech industries and the added value from the modern ser-

Table 2.7 The final evaluation results concerning the capability of the five major special economic zones to carry out the green transformation of industries in 2015

Primary indicator	Shenzhen	Shantou	Zhuhai	Xiamen	Hainan
Green input	0.0720	0.0420	0.0513	0.0638	0.0106
Green production	0.0260	0.0308	0.0172	0.0344	0.0340
Green control	0.0261	0.0375	0.0149	0.0432	0.0054
Green benefits	0.1898	0.0166	0.0586	0.0607	0.0064
Green environment	0.0343	0.0201	0.0374	0.0216	0.0451
Total	0.3482	0.1470	0.1795	0.2238	0.1015
Ranking	1	4	3	2	5

Table 2.8 Analysis of the ranking in evaluating the capability of the five major special economic zones for industrial transformation, 2012–2014

Year	Shenzhen	Shantou	Zhuhai	Xiamen	Hainan
2012	1	3	4	2	5
2013	1	2	4	3	5
2014	1	2	5	4	3

The results of the evaluation concerning the industrial transformation capability of the five major special economic zones from 2012 to 2014 is shown in the Report on Transformative Development of Industries in China’s Special Economic Zones prepared by Yuan Yiming, Yan Zhenkun and Guo Hongyi, from the *Annual Report on the Development of China’s Special Economic Zones (2015)* edited by Tao Yitao, Social Sciences Academic Press, 2015, p. 24

vice industries which constituted the scores concerning green production. This was mainly because those special economic zones were mostly in the industrialization or post-industrialization process; the advantages of the scale of new and high-tech and service industries had yet been fully tapped, and it was difficult for Shenzhen to maintain rapid growth on a large scale after many years of development; Shenzhen lagged behind Xiamen and Shantou in green control; Zhuhai was better than Shenzhen in green environment. As a relatively mature special zone at the developmental stage, Shenzhen should intensify its green control and improve its green environment in order to speed up the green transformation of its industries in the future.

In 2015, Xiamen ranked No. 2 among the five major special economic zones in the capability for the development of green transformative development of industries. This was mainly attributable to Xiamen’s outstanding advantages in green production and green control. According to the scores concerning both primary indicators, Xiamen ranked No. 1 among the five major special economic zones—Xiamen’s score concerning its capability for green production was 1.33 times that of Shenzhen, and Xiamen’s score for its capability for green control was 1.66 times that of Shenzhen. Its excellent scores concerning capability for green production and green control mainly resulted from the rapid adjustment of the industrial structure in Xiamen. From 2014 to 2015, Xiamen’s three-industry structure was rapidly adjusted from 0.7:45.8:53.5

to 0.7:43.5:55.8; the rapid increase in the proportion of the tertiary industry made Xiamen enjoy the highest score concerning the change value of the three-industry structure. With the rapid development of the service industry, the industrial structure was rapidly optimized and the consumption of energy and electric power decreased rapidly. Xiamen ranked No. 1 among the five major special economic zones in the rate of reduction in consumption of energy and electric power per unit of GDP, suggesting that the adjustment of the industrial structure was highly related to the green transformative development of industries in an area. Compared with Shenzhen's high capability for green transformation, Xiamen was defective in green input, green benefits and green environment, so accelerating the intensive development of industries and the development of the environmentally-friendly industries is still the top priority for Xiamen in its future green transformative development of industries.

Zhuhai ranked No. 3 among the five major special economic zones in the capability for green transformative development of industries in 2015. This was mainly attributable to its high score in green environment. Zhuhai ranked No. 2 among the five major special economic zones in the score concerning green environment, only second to Hainan and slightly higher than Shenzhen with the highest capability for green transformative development of industries. Zhuhai was advantaged in per capita park green land area among the three indicators which constituted the score concerning green environment, so Zhuhai's score in green environment covered its gap with Shenzhen in the quality of the air and PM2.5. It is noteworthy that Zhuhai still has great weaknesses in green production and green control. These weaknesses cause Zhuhai to have nearly a one-fold gap with Shenzhen in the overall score. In 2015, although Zhuhai enjoyed an advantage in green environment, that advantage was not firm so the other areas caught up with and surpassed it more rapidly. It is necessary for Zhuhai to make integrated efforts in green transformation by reinforcing its industries, narrowing the gap with Shenzhen and Xiamen in green transformative development of the industries in the future.

Shantou ranked No. 4 among the five major special economic zones in the capability for green transformative development of the industries in 2015. As a special economic zone with a relatively low level of per capita GDP and an accelerated intensification of industrial development, Shantou performed very well in the scores concerning green production and green control; in particular, Shantou's scores were higher than those of Shenzhen in the ratio of reduction in consumption of energy and electric power per unit of GDP. Both scores in green production and green control constituted 46.48% of Shantou's competitiveness. However, it should be noted that Shantou had a large gap with Shenzhen, Xiamen and Zhuhai in green benefits, green input and green environment. It is essential for Shantou to make breakthroughs in speeding up the green transformation of its industries and the transformation of their industrial structure, strengthening input and environmental improvement in the future.

Hainan ranked No. 5 among the five major special economic zones in the capability for green transformative development of industries in 2015. Hainan's poor performance in green transformative development among the five major special economic zones mainly resulted from a disconnection between Hainan's green development

and industrial development. Regarding the scores in five aspects, Hainan took the first place in the score concerning the green environment, but had nearly a several-fold, even a 10–20-fold gap with the other special economic zones in green input, green production, green control and green benefits. Noteworthily, although Hainan has made great progress in promoting optimization and adjustment of the industrial structure in recent years, the introduction of petrochemical and smelting projects has greatly undermined the green development of its industries. In Hainan, the tourism industry, Hainan's pillar industry, is less related to the modern manufacturing and modern service industries, and the industrial chain is short. Given these striking problems, there was a long way to go and heavy responsibilities for Hainan in the transformative development of its industries. How to consolidate the industrial foundation in accelerating the green transformative development of industries will remain a great challenge for Hainan in the future.

2.4 Policy Suggestions for the Green Transformative Development of Industries in the Special Economic Zones

2.4.1 Foster the Philosophy of Green Transformative Development, Promote Profound Transformation of Industries in the Special Economic Zones

Over the 30 years of reform and opening up, China's special economic zones have witnessed splendor since China's reform and opening up, and have also become the first in China to face huge challenges in adjusting their economic growth pattern under resource and environmental constraints. Against the general background of the current increasing resource and environmental constraints, in order to intensify transformation in the future, it is essential for the special economic zones to more rapidly build a market-oriented industrial structure with high technological content, low resource consumption and less environmental pollution. However, the green transformative development of industries is not merely the development of the environmental protection industry or an emerging energy-saving industry; on the contrary, it means that it is necessary to make changes in various aspects, from value concepts to production modes, and these changes involve not only technologies and capital, but also the people's mindsets and standard procedures. Therefore, speeding up the green transformative development of industries is a profound change in the current industrial development of the special economic zones, even of China itself. As the forefront of China's reform and opening up, China's special economic zones should undertake new missions during the new historical stage of development and strive to seek new paths for boosting the green transformative development of industries.

2.4.2 Eliminate the Weaknesses in the Green Transformation of Industries, Enhance the Capability of the Special Economic Zones for Green Transformation

According to the evaluation of the capability of the five major special economic zones for the green transformative development of industries, these special economic zones were different in developmental level and greatly differed in the stage of the industrial transformative development and the weak links in the green transformation of industries. Thus it is necessary for the five major special economic zones to make well-targeted efforts to address their developmental weaknesses according to their own conditions in the process of promoting the green transformation of industries. Specifically, although Shenzhen enjoys outstanding advantages in green input and green benefits, and high technical strength in boosting the green transformation of industries, there is a need for intensifying efforts in green control, cultivation of green industries and environmental protection. Xiamen and Shenzhen complement each other to some extent in pushing forward the green transformation of industries. Xiamen should take targeted actions to increase the green input and promote green technologies in the future. Only when innovation-driven development is strengthened can the green benefits from industrial development gradually become apparent. Zhuhai, Shantou and Hainan enjoy certain advantages in some fields relating to green input, green production, green control, green benefits and green environment, but they have a great gap with Shenzhen and Xiamen in the overall score. In order to narrow the gap more rapidly with Shenzhen and Xiamen in key links, it is necessary for them to take comprehensive measures to further develop green industries, optimize their industrial structure, increase their technical level and extend their industrial chain.

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