

# INDUSTRIAL SYMBIOSIS: PRACTICES IN CHINA'S INDUSTRIAL PARKS

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Panoramic view of Suzhou Industrial Park

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Administered by the State-owned Assets Supervision and Administration Commission of the State Council, the China Association of Circular Economy (CACE) is a nationwide organization, whose role is to formulate both strategic planning for government on the development of the circular economy and development and implementation programs for industries, as well as promoting the development of the circular economy in accordance with the relevant laws and regulations.

As an important driver for regional economic development, industrial parks are not only a zoned area consuming resources and energy while generating pollution, but also an excellent tool to improve the ecological environment and achieve high-quality development. Industrial symbiosis refers to the cooperation between different companies to achieve resource sharing or complementarity, and directly or indirectly enhance resource allocation efficiency within or outside them. It helps foster synergistic developments among industries, efficient use of resources, continuous extension of the industrial chain, and further develop the industrial cycle, symbiosis or coupling.

## INTRODUCTION

Around 2000, China began to actively explore industrial symbiosis within industrial parks and adopted various policy measures promoting park circular transformation and demonstration eco-industrial park and green industrial park construction, aiming at symbiotic and sustainable development in industrial parks.

This article summarizes the policy measures taken, main focus and practical experiences in three areas – park circular transformation, demonstration eco-industrial park construction, and green industrial park construction – to explore the pathway to industrial symbiosis within industrial parks in China.

## POLICY MEASURES TAKEN TO PROMOTE INDUSTRIAL SYMBIOSIS IN INDUSTRIAL PARKS

### PARK CIRCULAR TRANSFORMATION

Issued in September 2005, «Several Opinions of the State Council on Speeding up the Development of the Circular Economy» proposed to carry out trial demonstration work on the circular economy in industrial parks, and to explore its effective development. Park circular transformation has been explicitly listed as a key project of the circular economy in the Outline of the 12<sup>th</sup> Five-Year Plan for the National Economic and Social Development of the People's Republic of China.

In 2011, Baiyin High-tech Industrial Development Zone in Gansu Province and other eight parks were approved to carry out the pioneering demonstration of park circular transformation; in 2012, the National Development and Reform Commission (NDRC) and the Ministry of Finance (MOF) issued the «Opinions on Promoting the Circular Transformation of Industrial Parks», proposing to develop 100 national demonstration parks and thus provide model for all kinds of industrial parks to achieve transformation by developing the circular economy.

In order to give full play to the leading role of the pioneering demonstration, NDRC, MOF and other relevant departments released “Administrative Measures for Mid-term Evaluation and End-of-term Acceptance Test of the Circular Transformation of Demonstration Industrial Parks”, strengthening mid- and late-stage supervision and gradually form a long-term mechanism of park circular transformation.

Policy measures regarding park circular transformation mainly focused on:

**Improving the efficiency of resource utilization.**

- By-products and waste could be fully utilized by extending the industry chain;
- Energy and resource efficiency could be ameliorated by conducting energy-saving transformation;
- Overall resource efficiency and output could be substantially improved by promoting utilization of waste heat and pressure, adopting graded, quality-based and cascaded use of water, and material exchange.

**Leading industrial transformation and upgrading.**

In accordance with the comprehensive requirements of «industrial clustering and integration, quantity control and quality improvement, energy conservation and emission reduction», industrial parks will optimize their industrial layout, complete the supporting facilities such as sewage



Hengqin Free Trade Zone, Zhuhai City, Guangdong Province, China



and solid waste treatment, eliminate backward production capacity and promote advanced technology. Traditional industries will be thus optimized and upgraded.

**Encouraging the green transformation of industrial parks.**

By building centralized energy supply centers to replace small coal-fired boilers, parks could optimize their energy structure with a shift towards green energy; by outsourcing waste management services and developing recycling systems, parks could reduce emissions and promote green development.

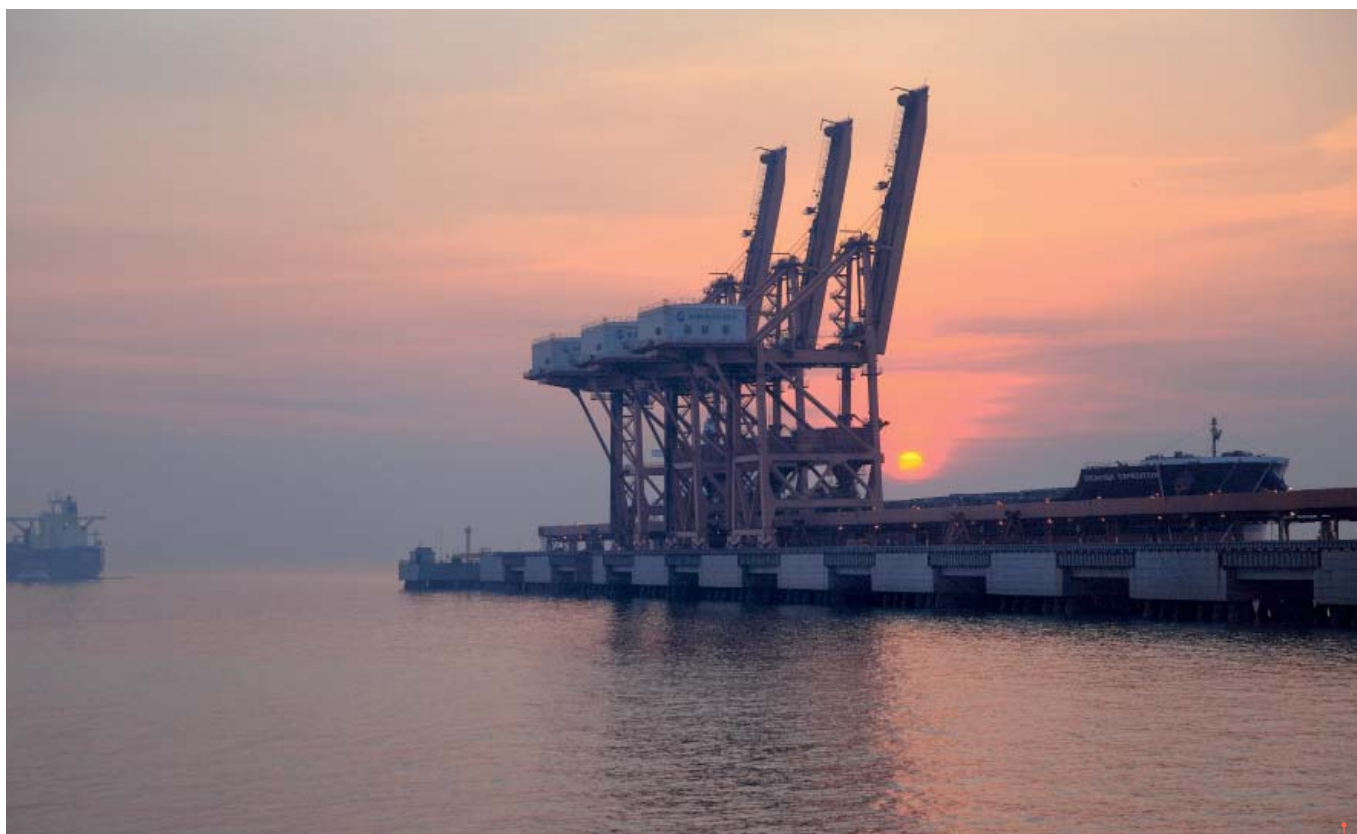
### CONSTRUCTION OF DEMONSTRATION ECO-INDUSTRIAL PARKS (EIPs)

In 2000, the State Environmental Protection Administration (SEPA, restructured and renamed the Ministry of Environmental Protection in 2008, then the Ministry of Ecology and Environment in 2018), started to implement EIPs in different regions for different industries, including sugar, aluminum, chemical and high-tech, for local authorities and companies.

*Industrial parks will adopt ecological transformation and reduce pollutant emissions to build an eco-industrial system with resource conservation, clean production and waste recycling*

In December 2003, SEPA issued the “Notice on the Issuance of the ‘Regulations on the Declaration, Naming and Management of National Demonstration EIPs (Trial)’ and other documents”, which clarified the main characteristics of demonstration EIPs, standardized procedures of declaration, naming and supervision, and formed the basic process of declaration, planning preparation, feasibility analysis, approval, naming, supervision and implementation. The Notice also established a supervision mechanism based on regular reporting, an annual summary and regular assessments.

To comprehensively boost EIP construction, relevant departments have issued several policies including “Guidance on Strengthening the Construction of National Demonstration EIPs”, “Management Measures for National Demonstration EIPs”, “Standards of National Demonstration EIPs”, “Notice on Strengthening the Development of the Low-Carbon Economy in National Demonstration EIPs”, “Notice on Review and Evaluation of National Demonstration EIPs”, etc. The policy documents encouraged the formation of a long-term mechanism for the construction and development of EIPs.



Sunrise at Caofeidian Industrial Dock

Policy measures regarding construction of demonstration eco-industrial parks mainly focused on:

**Promoting the construction of an ecological civilization within parks.**

Industrial parks will adopt ecological transformation and reduce pollutant emissions to build an eco-industrial system with resource conservation, clean production and waste recycling. Contributing to a resource-saving and environmentally friendly society, and to sustainable social and economic development in parks, these are essential requirements for the construction of ecological civilization.

**Optimizing economic development by complying with environmental requirements.**

Industrial parks will transform their concept of environmental management through scientific planning, reasonable industrial layout, raising the environmental access threshold, completing the environmental risk prevention mechanism, and strengthening environmental infrastructure. Environmental management could gradually extend from traditional end-of-pipe treatment to the whole process control, from production, circulation, consumption and trade to investment, etc. This will also help the integration of the environment and economy in industrial production in the region.

## CONSTRUCTION OF GREEN INDUSTRIAL PARKS

In September 2016, the Ministry of Industry and Information Technology (MIIT) issued the "Notice on the Construction of a Green Manufacturing System", proposing the construction of one hundred green parks with industrial clustering, green structure and ecological links by 2020, and specifying a green park evaluation system including green indicators covering six aspects: energy utilization, resource utilization, infrastructure, industry, ecological environment, and operation and management. MIIT has taken the lead in organizing the declaration and review of green parks and has established a long-term mechanism for the construction of green parks, which is a post-evaluation based on construction results.

Policy measures regarding construction of green industrial parks mainly focused on:

**Improving the level of green development of the park.** In accordance with the concept of green development, the park will continuously improve by completing infrastructure construction, creating a green industry chain, enhancing energy structure, increasing energy efficiency, optimizing industrial structure and boosting the technological progress of green industries.

**Encouraging the development of industrial clustering.** By centralizing promising industries, developing clusters, playing a driving role for promising industries and

companies, helping companies in the park to carry out collaborative support, and improving the industrial collaboration level, parks will develop a circular economy with a closed-loop industry chain. Relevant policy measures help effectively protect the environment, achieve economical, comprehensive and circular use of resources, and promote the transformation of industrial development. They also strengthen intensive and economical land use and strive to improve the comprehensive utilization efficiency of industrial land.

## PRACTICAL EXPERIENCE OF INDUSTRIAL SYMBIOSIS IN CHINA'S INDUSTRIAL PARKS

China has explored and practiced synergistic development among different industries by promoting park circular transformation, and eco-industrial park and green industrial park construction.

### CAOFEIDIAN INDUSTRIAL ZONE: INDUSTRIAL SYMBIOSIS BETWEEN STEEL AND SEAWATER DESALINATION

Located in Tangshan City, Hebei Province, Caofeidian Industrial Zone was approved for trial demonstration work on industrial park circular transformation in 2013. Caofeidian has gradually established a circular economy system covering the whole region and spreading to the surrounding areas by forming a circular economy industry chain, promoting the construction of key projects, improving the efficiency of resource and energy utilization, and cultivating strategic emerging industries. Thanks to circular transformation, the resource output rate of the park has increased by 162.2%, the comprehensive utilization rate of industrial solid waste has reached 97.5%, and the reuse rate of industrial water has reached 94.1%.

*The Caofeidian Industrial Zone achieved material recycling and graded use of energy within the steel industry and between related industries, creating a symbiosis between the steel industry and seawater desalination*

In accordance with the reduce-reuse-recycle principle, Caofeidian Industrial Zone introduced chain-supplementing and chain-extending projects and formed a relatively complete material and energy circular network in the steel industry. The iron slag in steelmaking slag and steel scrap from steelmaking and rolling are recycled as feedstock to achieve the recycling of iron elements. The zinc slag is returned to the smelter for remelting, and tar slag and biochemical treatment sludge are mixed into coking coal for reuse to achieve waste recycling. The reuse of high temperature exhaust gas in sintering circular cooler and dry quenching flue gas, the recycling of sensible heat during coke dry quenching, residual pressure at the top of blast furnace and extra blast furnace coal gas, marked the recycling of waste heat, waste pressure and waste gas resources. Waste heat steam,

exhaust steam of power generating units, and blast furnace slag water can be used as low-temperature heat sources to power low-temperature multi-effect seawater desalination devices, creating synergy between steel industry and seawater desalination projects.

The Caofeidian Industrial Zone achieved material recycling and graded use of energy within the steel industry and between related industries, creating a symbiosis between the steel industry and seawater desalination.

### **YEJI ECONOMIC DEVELOPMENT ZONE: INDUSTRIAL SYMBIOSIS BETWEEN BAMBOO PROCESSING AND BIOMASS POWER GENERATION**

Located in Lu'an City, Anhui Province, Yeji Economic Development Zone was approved for trial demonstration work on industrial park circular transformation in 2015. Aiming at becoming an industrial cluster, centralized market and future urban area, Yeji implemented circular transformation while focusing on investment attraction, infrastructure construction, project promotion and service improvement, which brought revitalized development to the Zone. Thanks to circular transformation, the park's resource output rate increased by 2.8% in 2017 compared to 2014, the comprehensive utilization rate of industrial solid waste increased by 60%, and the reuse rate of industrial water increased by 100%.

The Zone was closely tied into regional socio-economic factors. With limited resources and restricted environmental conditions, it actively promoted the adjustment of enterprise organization. Based on the basic development strategy of differentiation, cost reduction and recycling, the Zone formed a development mode mainly focused on differentiation and recycling. It has gradually established a sound operation mechanism with furniture and artificial board as flagship products, bamboo and rattan products and crafts, biomass fuel, activated carbon, bamboo charcoal, high value utilization of low-quality wood and targeted cultivation of forest resources as the new growth point. Yeji Economic Development Zone has gradually built several circular economy industry chains, such as the deep processing of raw bamboo and logs, the reuse of forest harvesting residues, the reuse of bamboo and wood processing residues and the recycling of waste wood and bamboo products. This not only extends the deep processing industry chain for the wood and bamboo industry, but also achieves 100% utilization of processing residues, harvesting residues and other waste generated from furniture and panel processing, forming a circular economy model of "make the best use of everything" for wood and bamboo processing and use.

### **GUIGANG NATIONAL ECO-INDUSTRIAL (SUGAR) DEMONSTRATION PARK: INDUSTRIAL SYMBIOSIS BETWEEN THE SUGAR, ALCOHOL AND PAPER INDUSTRIES**

Located in Guigang City, Guangxi Zhuang Autonomous Region, Guigang National Eco-Industrial (Sugar) Demonstration Park is the first national demonstration EIP in China, approved by SEPA in 2001, representing a milestone in the history of China's eco-industrial development.

Guigang National Eco-Industrial (Sugar) Demonstration Park actively carried out environmental management innovation, explored third-party pollution management, built an industrial chain for graded use of resources in the park, offered specialized services for applying clean production policies, norms and standards in the park, provided ongoing consultation and training on environmental protection and clean production, and improved comprehensive environmental management services and management in the park. Taking cane sugar production as its core activity, the Park formed an ecological industry chain to produce alcohol from waste molasses, produce paper from bagasse, and generate power from bagasse pith. The ecological industry chain covered six segments: cane field, sugar production, alcohol production, papermaking, cogeneration and comprehensive environmental treatment. The interdependence and symbiosis between segments positioned them mutually upstream and downstream in the ecological industry chain, and the «resources-products-re-resources» production process presented a cyclical material cycle.

### **SUZHOU INDUSTRIAL PARK: DIVERSIFIED INTEGRATION OF GREEN INDUSTRIES**

Located in Suzhou City, Jiangsu Province, Suzhou Industrial Park was approved for the first batch of trial demonstration work on a green park in 2017. The park insisted on implementing the national strategy of green development and ecological civilization construction, focused on the top-level design of green development, transformed the institutional mechanism for green development, built an ecological green development system, and strived to be a representative project of China's green development. In 2017, the park achieved a 7.2% year-on-year growth in gross regional product, a 2.1% year-on-year reduction in energy consumption per unit of GDP, a 91% industrial water reuse rate, and a comprehensive regional environmental quality index of 97.4. The park also realized a 2.47% year-on-year decrease in the comprehensive energy consumption of six high-energy-consuming industries, and a centralized sewage collection and treatment rate of about 98%.

Guided by ecological civilization construction, the Park focused on the transformation of economic development, acting in various fields including spatial layout, energy utilization, resource utilization, infrastructure, green industry, ecological environment and operation management, etc., and making use of the capacity-building

and management innovation system offered by green development. It also promoted the completion of high-level green parks with the delineation of an ecological red line, improvement of public transportation efficiency, rational layout of public service facilities, underground space utilization, ecological landscape and green space coverage, steady progress in construction of an Energy Internet Demonstration Park, resource recycling, centralized treatment of pollutants, green operation and management in various aspects such as guiding ideology, industrial structure, performance assessment and lifestyle.

## ROADMAP ANALYSIS ON HOW CHINA FOSTERS INDUSTRIAL SYMBIOSIS IN INDUSTRIAL PARKS

By reviewing the measures and practices implemented by China to foster industrial symbiosis in industrial parks, we may find that symbiosis is only achieved through space optimization, symbiosis planning, resource reutilization, integrated pollution treatment and shared infrastructure.

### SPACE OPTIMIZATION

Based on material and industrial connections in industrial parks, space design and planning are optimized to achieve industrial symbiosis and effective land use. For example, during the planning stage, industrial park A fully considered the industrial system in the park and adopted an integrated development model. Driven by the leading industry, industrial park A divided the park into areas based on different functions of the circular economy, including the harbor area, Lingang industrial area and Liaobin City Area. The regional circular economy is thus enhanced and supported by space planning.

### EFFECTIVE RESOURCE UTILIZATION

By promoting clean production in industrial parks, waste is reduced from the source. Industrial parks adopt clean and high-efficiency technology to replace old-fashioned energy and promote renewable energy consumption. Industrial parks promote the use of waste heat and pressure and encourage utilization of local-generated waste and wastewater in a bid to promote efficiency of the circular economy and boost industrial symbiosis. For example, industrial and municipal energy-saving are fast to develop in industrial parks. Resource utilization efficiency is promoted by enhancing recycling of water, by-products and waste gas.

### SYMBIOSIS PLANNING

Material loops can be achieved among projects, companies and industries. Along the industrial chain, by-products and waste can be traded as resources. For example, desulfured plaster, coal ashes and slag which is produced by power plants can be used by cement producers as raw materials. The steam and heat generated by cement producers can be used by brewers. Waste diatomite produced by brewers can be put into coals which are burned by power plants

and cement producers. Some of it can even be used as raw materials for cement plants. Wastewater generated by brewers can also be used as cooling water for power plants after treatment. Condensate water can be used as boiler water in power plants.

### INTEGRATED POLLUTION TREATMENT

Industrial parks boost the construction and upgrading of pollution treatment facilities. Professional waste treatment companies are built to treat pollution with an integrated approach. Environment management is enhanced and certified. An environment management system is adopted at the industrial park level, corporate level and product levels. Emissions are reduced to the maximum level. For example, industrial parks are equipped with wastewater and waste gas treatment facilities to achieve standard emissions. Building treatment facilities which are more connected reduces the operating cost.

### GRADED USE OF ENERGY

Water can be used by grades. For example, wastewater can be treated and reused as reclaimed water to save water resources and level up water use efficiency. Energy can also be used in the same way to promote energy efficiency. For example, an energy land can be built in an industrial park to distribute high, medium and low-pressure steam. It can ensure the graded use of energy. Waste heat can also be reused at the company level to promote energy efficiency. Waste heat boilers and supply networks can be built to provide heat for other users. Public heat and pressure pipeline construction are a preferred option to boost energy recycling.

### INFRASTRUCTURE SHARING

Infrastructure in industrial parks can be shared and optimized to promote efficiency and reduce costs, including environmental facilities - such as WWTPs, solid waste recycling centers, transportation, water/power supply, lighting, construction, warehouse and public networks. Integrated underground networks can enhance the use of underground space and overall city capacity. An integrated heat and water supply is also necessary.