

## A Summary of the Practice of Eco-Industrial Parks

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**Abstract:** Eco-industrial parks, with different names, diverse forms and rich contents, are developing continuously in practice. The construction of eco-industrial parks in developed countries started earlier and developed better, and each park has its own characteristics according to local conditions. Eco-industrial parks in developing countries are characterized by equal emphasis on planning and spontaneity, and high participation of residents.

### 1. Introduction

Industrial ecology has developed from the technical level of cleaner production to the phenomenon of "disconnection" between natural ecosystems and industrial systems. It has changed from the study of the production process of a single product to a systematic study [1]. Eco-industrial parks (EIPs) have become the theme of the development of world industrial parks. Cleaner production should be realized within the parks in order to reduce waste sources, and exchange of waste, energy and information among enterprises in order to achieve the best possible utilization of resources, material cycle and efficient utilization of energy, so as to make the waste discharge of the parks to the outside world tend to zero. At present, there are more than 60 eco-industrial parks in the world under planning or construction, most of which are in the West, such as Denmark, the United States, Japan, the Netherlands, France, the United Kingdom, and Italy and so on. Developing countries such as Egypt, Philippines, Thailand and India are also developing eco-industrial park projects, and countries have accumulated rich experience in specific practice.

### 2. Practice of Eco-industrial Parks in Developed Countries

#### 2.1 Kalundborg Industrial Park, Denmark

Although the term "circular economy" has not yet appeared in Danish legislation, it is one of the earliest countries in practice. Kalundborg, Denmark, is the most typical representative of industrial ecosystem operation in the world. The eco-industrial park consists of four main enterprises, Asnaesvaerket Thermal Power Plant, Statoil Refinery, Gyproc Gypsum Material Company and Novo Nordisk Bioengineering Company [2]. Taking these four enterprises as the core and using the waste and by-products produced in each other's production process through trade not only reduces waste production and treatment costs, but also produces better economic benefits, forming a virtuous cycle of economic development and environmental protection. The initiation of industrial symbiosis system in Kalundborg eco-industrial park has nothing to do with the environment and ecological protection, and is not driven by environmental protection, but formed by enterprises themselves to adapt to the economic environment. In order to compensate for or reduce the cost of sewage discharge, the government consciously carries out a series of technological innovations, which invisibly promotes the cooperation of quality and energy cycle, and makes Kalundborg industrial park gradually evolve into an ecological industrial park [3].

## **2.2 Eco-industrial Parks in the United States**

Since the 1970s, with the support of the Environmental Protection Agency (EPA) and the Presidential Commission for Sustainable Development (PCSD), the Eco-Industrial Park (EIP) project in the United States has emerged, involving the development of bioenergy, waste disposal, clean industry, solid and liquid waste recycling and other fields. At present, there are nearly 20 eco-industrial parks in the United States. These parks are often a regional system that includes many industrial enterprises, agriculture, residential areas and so on. In 1994, together with the EIP Task Force, EPA designated four communities, Fairfield, Cape Charles, Brownsville and Chattanooga, as demonstration sites for EIPs.

■ Fairfield Eco-Industrial Park in Maryland and Chattanooga Eco-Industrial Park in Tennessee are transformed eco-industrial parks, which exchange waste and energy within the region through appropriate technological transformation of existing industrial enterprises. The park takes DuPont's nylon thread recovery as the core to carry out the enterprise zero emission reform, which not only reduces pollution, but also promotes the development of environmental protection industry. All enterprises in the park use sustainable production mode to produce sustainable products, and develop new industrial space in the old industrial zone.

■ Cape Charles Sustainable Technology Park in Virginia is a new type of eco-industrial park. It mainly attracts enterprises with green manufacturing technology to enter the park, and creates some infrastructure to enable these enterprises to exchange wastewater, waste heat and so on.

■ The Brownsville Eco-Industrial Park in Texas is a typical virtual eco-industrial park. On the basis of the original members, the Industrial Park continuously increases new members to play the role of "supplementary chain network" in the industrial ecological chain, such as thermal power plants, waste oil, waste solvent recovery plants, etc. The Park does not strictly require its members to be in the same area. By establishing computer models and databases, it establishes material or energy connections among its members on the computer.

## **2.3 Portland Industrial Park and Burnsde Industrial Park, Canada**

The existing literature mentions that the main Canadian eco-industrial parks are Portland Industrial Park and Burnsde Industrial Park.

■ Since 1995, the Eco-Industrial Park project has been gradually launched in Portland, Toronto, Canada. Cleaner production and internal recycling of a single enterprise have certain limitations, because the production process will inevitably produce a part of waste and by-products that cannot be digested in the factory, so it is necessary to organize material recycling from outside the factory. Eco-industrial park is to implement the rule of circular economy in a wider scope, connecting different factories to form a symbiotic combination of industries sharing resources and exchanging by-products, making the waste gas, waste heat, waste water and waste become the raw materials and energy of another factory. Portland Industrial Zone currently brings together a wide range of manufacturing and service industries with waste and energy exchange potential.

■ In Burnsde Industrial Park, Canada, waste paper is recycled and shipped to other companies to produce liner boards. Another packaging company recycled the excess polystyrene from computer companies; it also owned various recycling and reuse companies, dealing with pigment boxes, ribbon re-inking, tire renovation and furniture renovation; it also used silver recovery system to recover silver from printing plants; at the same time, L9 chemical production and sales companies in the park jointly exchanged chemicals [4].

## **2.4 Fujisawa Eco-Industrial Park and Kitakyushu Eco-Industrial Park, Japan**

There are 23 eco-industrial parks approved by Japan. Fujisawa Eco-industrial Park and Kitakyushu Eco-industrial Park are the more stereotyped and mature eco-industrial parks.

■ Fujisawa Eco-Industrial Park [5] is independently invested and operated by EBARA. Although it cooperates with research institutes, the latter only provides information resources. The whole plan is proposed by the top managers of EBARA. EBARA's managers aim at zero emissions, promote

environmental technology by demonstrating its effectiveness, and improve its position in the market by building a green image and improving the environment, to gain a higher market share. They integrate the commercial facilities, industrial manufacturing areas and residential areas into a zero-emission eco-industrial park, which improves the environment and enhances its competitive position.

■ Kitakyushu Eco-Industrial Park was officially established in July 1997 with the approval of the state. The purpose is to recycle all kinds of garbage as raw materials for other industries, to achieve no garbage discharge (zero discharge) and build a resource-recycling society as far as possible. The specific content of the project is to focus on the Xiangtan area, focusing on the reuse of household appliances, automobiles, plastic bottles and other items. The region has gathered many research institutes to carry out garbage disposal and reuse technology jointly; make full use of the city's industrial infrastructure, cooperate with each other, and from the perspective of local cities, strive to realize the idea of environmental joint venture and promote the environmental protection activities of the whole industry in the city. Beijiuzhou Industrial Park is a typical eco-industrial park established by reducing waste emissions and seeking its optimal economic benefits.

## **2.5 Practice of Eco-industrial Parks in Other European Countries**

■ Londonderry Eco-Industrial Park in New Hampshire, UK, began to enter the construction stage. In addition, a sustainable development park [6] is planned to be developed in South York Town.

■ As one of the sponsors of the European Partnership for the Environment, OREE in France is working on its PALME project [7], which aims to provide technical support and specifications for the establishment of eco-industrial parks. By 1995, five industrial zones, Sophia and Esterel, had been accelerated under the guidance of PALME and had obtained the eco-certification mark of PALME.

■ Rotterdam, Netherlands, has built an eco-industrial park with petroleum industry, petrochemical industry and its supporting industries as its main component, which consists of 85 large and medium-sized enterprises.

■ In the Emilia-Romagna region of northern Italy, the cooperation among enterprises has taken shape and achieved good economic benefits. It has a good foundation for the development of ecological industry.

## **3. Practice of Eco-industrial Parks in Developing Countries**

### **3.1 Practice of Eco-industrial Parks in China**

China has always regarded sustainable development as a basic national policy, and has also carried out very useful positive practice and bold exploration in the construction of industrial parks. Economic and Technological Development Zone (ETDA) is a modern industrial and industrial park set up by China to implement the policy of reform and opening. In 1984, with the establishment of special coastal economic zones, China formally launched the work of economic development zones. State-level economic and technological development zones are economic and technological development zones approved by the State Council and occupy the highest position in the existing economic and technological development zones in China. As of September 2015, there are 219 national-level economic and technological development zones in China. Each province in the Mainland has its own distribution. Among them, Jiangsu Province has the largest number, with 26, followed by Zhejiang Province with 21 and Shandong Province with 15.

Industrial parks started early in China. In the 1990s, industrial parks developed vigorously, with "industrial agglomeration" as the main development mode. The development mode of "industrial agglomeration" played a positive role in promoting regional economic development, but it also brought problems such as unbalanced development, unreasonable allocation of resources, environmental pollution, lack of capital and technology. In order to solve these problems, the Ministry of Environmental Protection, together with the Ministry of Commerce and the Ministry of Science and Technology, organized and implemented the construction of the National Eco-Industrial

Demonstration Park. The Ministry of Industry and Information Technology and the Development and Reform Commission also implemented the construction of the National Low-Carbon Industrial Park.

In 2015, the Ministry of Environmental Protection, the Ministry of Commerce and the Ministry of Science and Technology promulgated the "Measures for the Management of National Eco-industrial Demonstration Zones" and the "Standards for National Eco-industrial Demonstration Zones". The government will focus on promoting national-level economic and Technological Development zones, national high-tech industrial development zones, provincial industrial parks with high development level or other characteristic parks, and actively carry out the establishment of eco-industrial demonstration parks. As of January 2017, the Office of the Leading Group of National Eco-industrial Demonstration Park Construction has organized experts to demonstrate and pass 48 national eco-industrial demonstration parks.

### **3.2 Practice of Eco-industrial Parks in Other Developing Countries**

■The Naroda Industrial Zone in India is one of the largest industrial parks in the world. It includes chemical, pharmaceutical, dyestuff and food manufacturing industries.

■Thailand invited the German Technical Cooperation Organization (GTZ) to select four industrial parks, namely, Bangpu Industrial Park and North Industrial Park, Matapu Industrial Park with petrochemical industry and East Coast Industrial Park with high and new technology as demonstration projects for the project of eco-industrial park, aiming at transforming national industrial parks into eco-industrial parks [8].

■Zabalin Resource Recovery Industrial Park in Cairo, Egypt, was implemented in 1981 and has created a more effective solid waste management system for Cairo for many years.

■The Eco-Industrial Network (EIN) served by five industrial parks in southern Manila, Philippines, is one of the earliest eco-industrial experiments in Asia. The EIN project, known as PRIME, was funded by the United Nations Development Programme.

## **4. Conclusion**

At present, the eco-industrial park has been widely practiced, and its theory has been expanded through practice. Eco-industrial parks are the third-generation industrial parks constructed under the guidance of the concept of circular economy, following the high-tech industrial parks. Through rational distribution of industrial enterprises, sharing public resources, effective utilization and disposal of waste, establishment of enterprise symbiosis system, clean production and other measures, the "win-win" of economic development and environmental protection of industrial parks can be realized.

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