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## Comparison and Analysis of Evaluation Indexes regarding China's Eco-industrial Parks

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# Comparison and Analysis of Evaluation Indexes regarding China's Eco-industrial Parks

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**Abstract.** The industrial park plays a significant role in fueling the economic growth, expanding the foreign trade and promoting the industry cluster. However, due to the blind investment attraction, and the poor perspectiveness and systematicness of the planning, the industrial park also becomes the centralized pollutant emission area. Chinese government has implemented many meaningful explorations in promoting the ecological development of the industrial parks, successively introduced the demonstration eco-industrial park, circular transformation of industrial park, and green park construction, and separately established the evaluation index system and policy guarantee system. This paper reviews the ecological greening development course of China's industrial parks, thoroughly introduces the evaluation index system of demonstration eco-industrial park, circular transformation index system of the industrial park, and the green park evaluation index system, and compares and analyzes the commonalities and differences of such three sets of index systems from the theoretical basis, target positioning, index requirements, index universality, evaluation methods and many other dimensions, based on which this paper proposes the policy suggestions regarding the ecological greening development of China's industrial parks.

## 1. Introduction

In order to attract the foreign investment and expand the opening-up, Chinese government approved to establish the first lot of 14 economic and technological development zones in 1984. As of the end of 2018, China has totally established 219 state-level economic and technological development zones and 168 state-level high-tech development zones. As shown in *Catalogue of China's Development Zones the Approval of Which is Announced* (2018 Version), the total number of development zones nationwide has increased from 1568 in 2006 to 2543, including 552 nos. of state-level development zones, and 1991 nos. of province-level development zones. The economic contribution rate of China's industrial parks has increased sharply. According to the statistics, the GDP of state-level economic and technological development zones and state-level high-tech development zones in 2017 accounted for 22.5% of the national GDP, while the GDP of province-level and above development zones accounted for 50% plus of the national GDP [1, 2]. China's development zones have already become the windows of economic development and experimental field of system reform and innovation. The industry cluster has greatly reduced the economic cost and achieved the remarkable economic scale benefit. However, the development zone not only becomes the economic development cluster, but also becomes the centralized pollutant emission area. There are many problems, such as the blind investment attraction, low industrial correlation, irrational production layout, excess load of ecological environment, and etc. China has explored many paths with regard to the greening development of industrial park, including the demonstration eco-industrial park, circular transformation of industrial



park, green park and etc., which has promoted the greening development course of industrial parks from variable perspectives.

## **2. Ecological Greening Development Course of Industrial Park**

Chinese Ministry of Environmental Protection has already started the construction pilot works of demonstration eco-industrial parks since the end of 1990s. The eco-industrial park is the new-style industrial organization designed as per the circular economy theory, industrial ecology principle, and the eco-industrial cluster, while its target is to minimize the waste amount and realize the "zero discharge" of waste in the park [3]. The Ministry of Environmental Protection has released the HJ 274-2009 *Standard for Sector-integrate Eco-industrial Parks*, HJ/T 273-2006 *Standard for Sector-specific Eco-industrial Parks (On trial)*, and HJ/T 275-2006 *Standard for Venous Industry Based Eco-industrial Parks (On trial)*, which are used as the criteria basis for creation and evaluation of demonstration eco-industrial parks. In 2015, the Ministry of Environmental Protection integrated the aforesaid three criteria into the HJ 274-2015 *Standard for National Demonstration Eco-industrial Parks*, which defines the national demonstration eco-industrial parks as the new-style industrial parks that pass the review as per the specified procedures and are granted with the relevant titles, as per the requirements of circular economy theory, industrial ecology principle, and clean production, and in conformity with this standard, *Measures for the Administration of National Eco-Industrial Demonstration Parks*, and other relevant requirements. As of the end of 2018, totally 93 demonstration eco-industrial parks were approved for establishment, among which, 48 demonstration eco-industrial parks have been accepted and named.

In 2011, the Chinese National Development and Reform Commission started the circular transformation and demonstration pilot works of the parks, mainly adopted the state-level or province-level economic & technological development zones, high-tech industrial development zones, key professional parks, or industrial clusters as the objects, and mainly supported the circular industrial chain linked or extended key projects, resources sharing facilities construction projects, materials closed-circuit circulation and utilization projects, by-products exchange & utilization, energy cascade use, and water classification using and recycling projects, and waste "zero discharge" or systematic construction projects. In 2012, the National Development and Reform Commission and the Ministry of Finance released the *Comments regarding Promoting the Circular Transformation of the Park*, which proposed that 50% plus of state-level development zones and 30% plus of province-level development zones had completed the circular transformation till 2015. In 2017, the *Initiative to Guide the Shift toward Circular Development* was released, which proposed that 75% of state-level parks and 50% province-level parks should implement the circular transformation till 2020. As of now, 129 parks have been approved to implement the circular transformation demonstration pilots.

In order to promote the industrial coupling and realize the near-zero-discharge, the *Made in China 2025* released in 2015, proposed to complete the construction of one hundred green demonstration parks in 2020. The green park refers to the industrial park that passes the review as per the specified procedures and is granted with the relevant title, in conformity with the green development concept and green manufacturing system requirements, and as per the *Green Park Evaluation Requirements* and other relevant requirements. The green park comprehensively applies the planning, standards, indexes, informationalization and many other tools and methods to promote the energy utilization greening, resources utilization greening, infrastructure greening, industrial greening, ecological environment greening and operation management greening, and realizes the continuous enhancement and development of the industrial park through the mechanism innovation. As of the end of 2018, the Ministry of Industry and Information Technology had already approved 79 parks as the green parks.

## **3. Ecological Green Park Evaluation Index System**

### *3.1 Demonstration Eco-industrial Park Evaluation Index System*

In 2015, Chinese Ministry of Environmental Protection released the HJ 274-2015 *Standard for*

*National Demonstration Eco-industrial Parks*, which constructed the demonstration eco-industrial park evaluation index system, mainly consisting of the economic development, industrial symbiosis, resources saving, environmental protection, information disclosure and other five major categories and 32 indexes, inclusive of 17 mandatory indexes and 15 optional indexes. With regard to the category, the economic development indexes include 4 indexes, namely, the proportion of total industrial output value of high-tech enterprises to that of the park, per-capita industrial added value, average annual growth rate of the park's industrial added value within three years, and the proportion of resources recycling industrial added value to the added value. The industrial symbiosis index includes 3 items, namely, the quantity of newly added and constructed eco-industrial chain projects after the implementation of construction planning, industrial solid waste comprehensive utilization rate, and repeated utilization rate of renewable resources. The resources saving index includes 9 items, namely, the industrial-added value per unit of industrial land area, average annual growth rate of the industrial-added value per unit of industrial land area within three years, comprehensive energy consumption elasticity coefficient, comprehensive energy consumption per unit of industrial added value, use ratio of renewable resources, fresh water consumption elasticity coefficient, fresh water consumption per unit of industrial added value, repeat rate of industrial water, and reclaimed water (intermediate water) reuse rate. The environmental protection index includes 13 items, namely, the key pollutants steady discharge up-to-standard conditions of the industrial park, the completion conditions of the national key pollutants total amount discharge control index of the industrial park and local particular pollutants total discharge amount control index, the number of especially important and important emergency environmental events occurred to the enterprises and public institutions within the industrial park, integrity level of environmental management capacity, clean production approval and implementation rate of key enterprises inside the industrial park, wastewater centralized treatment facilities, integrity level of environmental risk protection system construction within the industrial park, disposal rate of industrial solid waste (including the hazardous waste), major pollutants discharge elasticity coefficient, average annual reduction rate of carbon dioxide emissions per unit of industrial added value, wastewater discharge per unit of industrial added value, solid waste quantity per unit of industrial added value, and green cover rate. The information disclosure index includes 3 items, namely, the end enterprise environment information disclosure rate, eco-industrial information platform integrity level, and eco-industrial subject publicity activities. Such evaluation index system provides the requirements of each index, namely, index benchmark value.

In the national demonstration eco-industrial park evaluation index system, totally 23 items of indexes are involved in the calculation. Only when a park conforms to all requirements of 23 items of indexes involved in the calculation, it will be deemed as the national demonstration eco-industrial park. In order to reflect the difference of park development, such evaluation index system points out that when the output value of a given industry in the park accounts for more than 70% of the total industrial output value of the park, the values of industrial solid waste comprehensive utilization rate, comprehensive energy consumption per unit of industrial added value, fresh water consumption per unit of industrial added value, average annual reduction rate of carbon dioxide emissions per unit of industrial added value, wastewater discharge per unit of industrial added value, solid waste quantity per unit of industrial added value, green cover rate and other indexes, shall reach the first-grade level of clean production evaluation index system in such industry or recognized international advanced level. Besides, for the renewable resources circulation utilization rate index, the park that fails to conform to the standards may not select such index as the evaluation index.

### *3.2 Park Circular Transformation Evaluation Index System*

The park circular transformation reference indexes released by the National Development and Reform Commission include 6 categories, namely, the resources output index, resources consumption index, resources comprehensive utilization index, waste discharge index, and other indexes and special indexes. Among them, the resources output index includes 4 items, namely, the resources output rate, energy productivity rate, land output rate, and water productivity rate. The resources consumption

index includes 4 items, namely, the water intaking amount per unit of GDP, energy consumption per unit of GDP, major products per unit energy consumption, and major products per unit of water consumption. The resources comprehensive utilization index includes 3 items, namely, the industrial solid waste comprehensive utilization rate, industrial water repeat utilization rate, and waste resources comprehensive utilization amount (including import). The waste discharge index includes 7 items, namely, the sulfur dioxide emissions, chemical oxygen demand emissions, ammonia nitrogen emissions, nitrogen oxides emissions, carbon dioxide emissions per unit of local GDP, volume of industrial solid waste disposed, and amount of industrial wastewater discharged. Other indexes include 3 items, namely, the park circular economic industrial chain correlation, the proportion of non-fossil fuel to the primary energy consumption, and the proportion of renewable resources. The special indexes shall be independently determined by the park as per its own features. Such index system is mainly used for each park to prepare the park circular transformation implementation scheme.

### *3.3 Green Park Evaluation Index System*

China has many industrial parks, which have the differences with regard to the industrial base, economic scale, resources endowments, industrial structure, energy structure, development stage and etc. It is required to follow the principles as shown below, so as to establish a set of green park evaluation index system that is relatively fair to each level and category of parks: Firstly, it is required to try to select the relative indexes with the horizontal comparability, such as the use ratio of renewable resources. Secondly, it is required to classify the indexes into the mandatory indexes and optional indexes, grant the flexibility of park index selection, and conform to the features of parks with the variable categories and industrial types. For instance, the venous industry park may select the renewable resources recovery & utilization rate index. Thirdly, it is required to follow the evaluation principle of the combination of basic requirements and goal leading. The basic requirements are the threshold requirements, while it is firstly required to ensure that the park shall conform to the requirements of laws & regulations, pollutant emission standards, environmental quality standards, park management and others, and also judge the degree of each index in the park reaching the goal leading value on this basis. Fourthly, it is required to consider the data acquisition cost and index redundancy [4], and establish the comparable park green indexes that may measure the park's green connotation, and use the finite index to facilitate the calculation, so as to realize the horizontal and vertical comparability of the park's green indexes.

Based on the aforesaid principles, China has established the green park evaluation index system, including 6 categories and 31 items of indexes, namely, energy utilization greening index (EG), resources utilization greening index (RG), infrastructure greening index (IG), industrial greening index (CG), ecological environment greening index (HG) and operation management greening index (MG), inclusive of 18 mandatory indexes and 13 optional indexes. The energy utilization greening index includes 3 items, namely, the energy productivity rate, renewable energy use rate, clean energy use ratio. The resources utilization greening index includes 8 items, namely, the water productivity rate, land output rate, industrial solid waste comprehensive utilization rate, industrial water repeat utilization rate, intermediate water reuse rate, waste heat recovery and utilization rate, waste gas resources recovery and utilization rate, renewable resources recovery and utilization rate. The infrastructure greening index includes 5 items, namely, the wastewater centralized treatment facilities, the proportion of green buildings to the newly built industrial buildings, cover rate of bus stations (within the 500m service scope), the proportion of energy saving and new energy buses. The industrial greening index includes 4 items, namely, the proportion of production value of high-tech industry to the total production value of park industry, the proportion of green industry added value to the park industry added value, per capita industrial added value and the proportion of modern service industry. The ecological environment greening includes 8 items, namely, the industrial solid waste (including the hazardous waste) treatment and utilization rate, carbon emission reduction rate of industrial added value in ten thousand yuan, wastewater discharge quantity per unit of industrial added value, main pollutant elasticity coefficient, park air quality excellence rate, green cover rate, proportion of road

shade, proportion of open-parking ground shade. The operation management greening index includes 3 items, namely, integrity degree of green park standard system, preparation of green park development planning and integrity degree of green park information platform.

#### **4. Comparison & Analysis of Evaluation Indexes**

##### *4.1 Index Commonality Analysis*

The demonstration eco-industrial park, park circular transformation and green park evaluation index systems involve the resources and energy utilization, environmental protection and other relevant categories of indexes, while the almost same indexes include 8 items, namely, the use ratio of renewable resources, land output rate, energy productivity rate (comprehensive energy consumption per unit of industrial added value), fresh water consumption per unit of industrial added value (water output rate), comprehensive utilization rate of industrial solid waste, repeat utilization rate of industrial water, recovery & utilization rate of renewable resources, and industrial solid waste (including the hazardous waste) treatment and utilization rate. Therefore, such 3 sets of index systems have its own emphasis, while the common indexes account for little proportion. For the demonstration eco-industrial park and green park index systems mutually adopting the comprehensive evaluation methods, both of them share 14 items of almost same indexes, namely, energy productivity rate, renewable resources use ratio, water productivity rate, land output rate, industrial solid waste comprehensive utilization rate, industrial water repeat utilization rate, intermediate water reuse rate, renewable resources recovery & utilization rate, wastewater centralized treatment facilities, proportion of production value of high-tech industry to the total production value of park industry, per capita industrial added value, industrial solid waste (including the hazardous waste) treatment and utilization rate, carbon emission reduction rate of industrial added value in ten thousand yuan, and main pollutant elasticity coefficient, which accounts for 40% of the respective indexes. Therefore, although such two indexes share some commonalities, they still have greater differences.

##### *4.2 Index Difference Analysis*

The Ministry of Ecology and Environment, National Development and Reform Commission, and Ministry of Industry and Information Technology construct three sets of evaluation index systems, namely, the demonstration eco-industrial park, park circular transformation and green park evaluation index systems, which have the differences at many aspects and many dimensions, as shown in Table 1. Firstly, with regard to the target positioning, the starting point and objective of the eco-industrial park is to minimize the production and emissions of pollutants, which belongs to the scope of environmental protection and governance. It is mainly based on the industrial ecology theory. The park circular transformation mainly intends to enhance the park resources utilization efficiency, which belongs to the scope of resources saving and intensive utilization. It is mainly based on the circular economy theory. Compared with the demonstration eco-industrial park and park circular transformation, the green park has more systematicness, intersectionality, integration and dynamics, while its main target is the green industry cultivation, infrastructure green sharing and minimum environmental impact, which belongs to the scope of green economy. It is mainly based on the green economy theory.

Secondly, with regard to the index benchmark setting, the demonstration eco-industrial park gives the index threshold value, namely, such index requirements must be completely satisfied. The park circular transformation does not provide the benchmark value of each index, while the evaluation is mainly used for reference purpose upon the preparation of circular transformation scheme made by each park. The green park provides the target leading value of each index, namely, only when a given proportion of each index is reached, it will be deemed as the green park. The green park gives the target leading value, while the demonstration eco-industrial park gives the threshold value. Therefore, for the same index, the benchmark value of the former is higher than that of the latter.

Thirdly, with regard to the index universality, considering the variable regional difference, type,

industrial structure and development basis of the park, it is required to implement the difference and flexibility treatment of the indexes. In this regard, both the demonstration eco-industrial park and green park classify the indexes into the mandatory indexes and optional indexes. The so-called mandatory index refers to the index selected by variable parks for evaluation purpose, while the optional index refers to the index independently selected by variable parks as per its own features. The park circular transformation considers the index significance, while the index will be divided into the mandatory indexes and optional indexes. Therefore, a certain handling is made for such three sets of indexes, but the index properties considered may be different.

Fourthly, with regard to the index evaluation method, the demonstration eco-industrial park adopts the conformity evaluation method, namely, if all index requirements are satisfied, it will be deemed as the demonstration eco-industrial park. The green park intends to construct the green index model of the industrial park based on the evaluation index system. In order to reflect the principle of appropriate incentives, the maximum score of each index will be set as no higher than 120, namely, the maximum value of green index will be 120. However, the park circular transformation does not give the specific evaluation methods.

The demonstration eco-industrial park evaluation index system has been implemented since 2009, and modified in 2015. At present, totally 48 nos. of demonstration eco-industrial parks are evaluated as per such set of index. The park circular transformation evaluation index system has been implemented since 2013 and modified in 2017. At present, totally 129 nos. of park circular transformation demonstration pilots are approved to carry out the works. The green park evaluation index system has been released and implemented since 2016, while 79 nos. of green parks are evaluated and identified. Compared with the 2543 nos. of province-level and above development zones, the identified quantity of such three types of parks still accounts for very small proportion, namely, only 10% without the elimination of repeated parks.

Table 1. Comparison & analysis of evaluation indexes for demonstration eco-industrial park, park circular transformation and green park

Index category	Demonstration eco-industrial park evaluation index system	Park circular transformation evaluation index system	Green park evaluation index system
Theory basis	Industrial ecology theory	Circular economy theory	Green economy theory
Target positioning	Indexes focusing on the environmental protection and governance	Indexes focusing on the resources saving and intensive utilization	Indexes focusing on the green industrial cultivation, and infrastructure green sharing
Index Quantity	32 items of indexes	21 items of indexes	31 items of indexes
Identified parks quantity	48 nos. of parks	129 nos. of parks	79 nos. of parks
Index requirements	Provide the index threshold value	Not provide the index benchmark value	Give the target leading value of the index
Index universality	Consider the park difference and classify the indexes into the mandatory and optional indexes	Consider the significant differences of the indexes, and classify the indexes into the mandatory and optional indexes	Consider the park difference and classify the indexes into the mandatory and optional indexes
Evaluation methods	Conform to all requirements and adopt the conformity evaluation method	Take the indexes for reference, but not give the evaluation method	Circular economy index and target leading evaluation
Competent authority	Ministry of Ecology and Environment	National Development and Reform Commission	Ministry of Industry and Information Technology
Implementation year	Implemented in 2009 and modified in 2015	Implemented in 2013 and modified in 2017	Released and implemented in 2016. At present, the national standard <i>Green Park Evaluation Specification</i> is being prepared.

## 5. Conclusions & Suggestions

Chinese government attaches great significance to the greening transformation and construction of the industrial parks, successively promotes the construction of demonstration eco-industrial parks, park circular transformation demonstration pilots and green parks, and establishes a lot of benchmarks and examples of green development, which plays the significant role in promoting the green development of 2543 nos. of development zones. After the comparison and analysis of the evaluation index systems of such three types of parks, it is found as follows. Firstly, each sort of index system has its own features, focuses and theories basis. Secondly, each sort of index system considers the index or park development difference, and makes the property classification of the indexes, for instance, both the demonstration eco-industrial park and green park classify the indexes into the mandatory and optional indexes. Thirdly, due to the variable starting points and objectives, such three sorts of index systems adopt the variable evaluation methods, for instance, the demonstration eco-industrial park adopts the index conformity evaluation method, while the green park adopts the green index comprehensive evaluation method. Finally, the index benchmark setting methods of such three sorts of index systems have the differences, namely, the demonstration eco-industrial park gives the index threshold benchmark value, while the green park gives the index target leading value, and the park circular transformation does not give the index benchmark values, which are determined by the specific evaluation methods. However, it is found in this study that the quantity of industrial parks evaluated and identified as per such three sets of standard systems is only 256 nos. of parks, which accounts for only 10% of the province-level and above development zones. Therefore, it is still a long way to go for the green development of China's industrial parks.

Based on the aforesaid analysis conclusions and problems, it is advised that the Chinese relevant government agencies shall further optimize the greening development works of the parks as follows: Firstly, it is required to construct the unified ecological green park evaluation index system, establish the unified evaluation method, and accelerate the preparation of ecological green park evaluation national standards. Secondly, it is required to summarize and form one lot of typical model cases of park green development, force more industrial parks to attach greater importance to the greening development through publicity and promotion, and accelerate the promotion of park ecological transformation, so as to gradually enhance the proportion of ecological green parks.

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