Research on Construction of Industrial Ecosystem Based on Sustainable Development

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Abstract: The establishment of industrial ecosystem is the key to realize the economical sustainable development. This article analyses the related literatures of industry ecosystem, and points out the industry ecosystem's hierarchy. Then on the basis of theoretical analysis, the article proposes the building strategy of the industry ecosystem, from three aspects of the microcosmic, the intermediate and the macroscopic perspective. And finally, the paper provides some suggestions of the building strategy implementation of industrial ecosystem.

Keywords: Sustainable development, Industrial ecosystem, Building strategy

1 Introduction

With the development of science and technology and the social productive forces, people’s living standard is rapidly enhancing, but it also has caused the massive resources waste, and the natural ecological environment is worsening day by day. The non-ecological development of the economy has aroused people's high attention. It is the key to reasonably adjust the regional industrial structure and the spatial pattern to promote the coordinated evolution of local society, economy and ecological environment, finally to realize the sustainable development. With the application of industrial ecology principle, building a regional industrial ecosystem is a new way to solve the related ecological environment problems and it needs to explore thoroughly.

2 Literatures of Industrial Ecosystem

Industrial ecosystem is a network-based eco-economic system with efficient economic process and harmonious ecological functions, based on principles of ecological economics and knowledge-based rules. Its original research began in the developed countries. In 1970's, the Kalundborg industrial park of Danish opened up a new waste management approach using “industrial symbiosis”. The system about efficient use of resources is considered the beginning of the industrial ecological system ideas. In 1989, Robert Frosch and Gallopoulos for the first time put forward the industrial ecosystem (IES) in the paper of "sustainable industrial development strategy". In 1991, the U.S. National Academy of Sciences and the Bell Labs co-organized a special seminar about "industrial ecology". With the continuous deepening of the research, the content of industrial ecosystem constantly expands. Deschers, Andrews and other scholars proposed industrial symbiosis, and extended the study from ecological industrial park to the trans-region and cross-sector. IEEE in the report "White Paper on Industrial Ecology and Sustainable Development" states: "Industrial Ecology is a cross-disciplinary research of exploring industrial systems, economic systems and the relationship with the natural system, including energy supply and use, new materials, new technology, basic science, law, management science and social science " and it is a "sustainability science." This definition expanded the industrial ecosystem to the scope of political, economic, ecological, environmental and other fields. With the progress of the study, some scholars promoted the concept of industrial ecosystem to a larger area, proposing Business Ecosystem (referred to as BES). Heriberto Cabezas, who conducted a simulated ecological and technological experiment, pointed out that the industrial ecosystem is a complex of sustainable system, industry, agriculture and natural biology, which constituted a "extended food webs", and the industrial ecology system should follow the objective laws in the ecological sense. JouniKorhonen and Juha-Pkka Snakin analyzed the practice of the industrial ecosystem and evolutionary issues from biological evolution, and stressed that industrial ecology and industrial evolutionary theory would play a significant role for the industrial and
economic development in the future. In addition, Arun J. Basu, Dirk JA van Z also further integrated industrial ecology and cleaner production, and pointed out that the extent of cleaner production depended on the degree of industrial ecosystem. In the whole, the industrial ecology theory is limited to a particular enterprise or a region. The study about the construction and of trans-regional, cross-sector, cross-sector industrial eco-system is less.

3 A Building Strategy of Industrial Ecosystem Based on Sustainable Development

Taking the instruction of the sustainable development to realize the coordinated development of society, economy and environment, requests the superiority industry to obtain quick development. And it also needs the construction of ecology adjustment ability and environment governing to overcome the restraint of ecological environment. Therefore, we should utilize the industry ecology's principle to analyze material circulation and external environment to enhance the sustainable development.

3.1 Hierarchy of industry ecosystem construction

The industry ecosystem can be build in the interior of an enterprise or organization through the waste exchange, also between the enterprises in an industrial park, and even in a wider range. Therefore, it is hierarchical. The industry ecosystem can build different level's industrial ecology chain through simulating natural ecosystem's ecology position food chain. The industrial chain in each level may be regarded as a relatively independent open system, simultaneously as a subsystem. For the industrial ecosystem, through establishing multi-level, three-dimensional transformation network, it can promote the flow of material and energy. To achieve this target, it needs to adopt certain methods to integrate functions of the system, such as: longitudinal closed, transverse coupling and system integration. Longitudinal closed refers to carrying on the effective engagement of product life cycle to realize recycling and circulation. The transverse coupling is to form a network system to make full use of waste. The system integration is to link different levels to realize the circulation of material and energy.

3.2 Strategic level model of industry ecosystem construction

The industry ecosystem construction mainly includes: enterprise ecosystem in microcosmic, industrial park system in the intermediate region and cross-region industry ecosystem in macroscopical, as shown in figure 1.

![Figure 1 IES construction strategy level model](image)

3.2.1 Microcosmic—simulating natural ecology to build enterprises’ industrial ecosystem
The industry ecosystem theory believed that the enterprise operation essentially is to realize the value increasing of the material in the processing or switching process, but this activity must go through the
material flow, energy flow and information flow to realize. Moreover, enterprises inevitably produce some surplus. The business operation is a series of flow activity. Therefore, enterprises can simulate the natural ecosystem to construct their core flow system—“value-added system” and make every effort to realize the full transformation and use of the material and energy in enterprises and reduce even eliminate waste and pollution as far as possible. Thus, enterprises must establish a relatively independent subsystem with the core value chain linking to use the surplus resources effectively. The subsystem and core value chain may be a closed loop, which depends on the technological means.

3.2.2 Intermediate—building an industry ecosystem in the industrial park

The industry ecosystem is an industry coordinated system based on the local natural environment and it is the gathering of enterprises in a region. Therefore, it can make an ecology transformation to construct the region industry ecosystem in the industrial park. The construction of ecology industrial park refers to based on the circulation economy idea and the industry ecology principle producing an ecology chain and closed circuit to control pollution and realize clean production. We can build an industry ecology chain in order to realize “zero emissions”. The ecology industrial park can embody the industry ecosystem theory and this construction pattern will possibly become the leading economic type in the developing process of regional economy in the future.

3.2.3 Macroscopical—building an cross region industrial ecosystem

In the cross region industry ecology, there exists many problems such as benefit division among related enterprises, infrastructure and sharing mechanism of industrial ecology chain, industrial ecology chain management, industrial ecology knowledge sharing and knowledge transformation in network environment, coordination of different regional government and enterprises and so on. It is impossible to resolve these problems only depending on enterprises. And it must depend upon the cooperation of cross-regional enterprises, inter-government and the fundamental research organizations. Only in this way, can it create a cooperative affection. Therefore, it needs to construct a cross region industry ecosystem from the macroscopic point, and make a good macroscopic environment for the development of the intermediate and microscopic industry ecosystem.

In the whole, the construction of industry ecosystem needs to pass through different levels, and under the instruction of sustainable development theory to determine a correct developing strategy plan to instruct the sustainable development.

4 Implementation of Industry Ecosystem Construction Strategy

The construction and development of industry ecosystem is an engineering system and needs a comprehensive support. Therefore, to promote its smooth and comprehensive development, it needs to build a coordinated unified platform of the industry ecosystem.

4.1 Macroscopical—building an industry ecosystem supporting platform

The industry ecosystem is a complex and giant system with the characteristics of openness, non-balance and multiplication. And its construction needs the support from all levels of government department, R&D facilities, enterprises as well as other social organizations. Meanwhile, it also needs experts with rich experience, high-level management teams and modern information technology. Therefore, the industry ecosystem platform's construction needs to profit from the methodology system of complicated questions. Meanwhile it must rely on industrial ecology, operation management science and environment resources, as well as all kinds of social resources, as shown in figure 2.

The industry ecosystem platform provides a way of communication to realize the ecological and sustainable development for enterprises, and can help enterprises to obtain information about policy and related organization departments and feedback. Through the platform, it may synthesize enterprises’ basic information, environment information, macro economy, technical information and spatial information and so on. Thus it can establish a corresponding database to analyze the dynamic trend of industrial technology and pollutant discharge, and provide the decision information basis for the control section. It can carry on an optimized analysis for the region waste transaction and circulation and provide an automatic appraisal and optimized analysis to the industrial ecology chain and ecology.
network, then to find an organic and unified way for the economy, technology and environment. This is the final perfect condition. But to achieve the goal, it needs the coordinated cooperation of various departments, including the central government, as well as other related departments.

4.2 Intermediate—speeding up region industry ecology reforming supported by innovation system
The industry ecosystem's construction relies on the development and progress of science and technology. The ecological transformation of traditional industry must build on the advanced technology. And innovation is the key for the technology progress. Therefore, to promote the building and fast development of industry ecosystem, we must take innovation system's construction and development as the foundation and take innovating technology and ideas as the instruction, as shown in figure 3.

The supplier, producer, seller and resource recovery businesses constitute a regional industry chain, which transforms the natural resources into commodity through production and operating activities, following the waste and influence to the environment. Based on the innovation system and the evolution rule of industrial ecology, the innovation system platform can speed up the optimization of industrial chain's ecology integration, form an industrial ecology chain and long-term competitive advantage and also provide an essential technology base for industrial chain's ecology reforming. At the same time, enterprises such as supplier, producer and seller gather in an area and easily form an industrial cluster and establish an industrial paragenesis network, which is more advantageous to the region innovation system's establishment and development. With the supporting of innovation system and industrial cluster, the industry structure in the region is more stable and can resist the disturbance from the outside.
Meanwhile, when the industry ecosystem is disturbed by the extraneous factors, it can rapidly restore, even rise gradually to a more superior condition to speed up ecology reforming of the region industry.

4.3 Microcosmic—using ecology technology to reform traditional industrial production way

The ecology technology takes information technology as a core, which is a coordinated new technology system of person, nature and society. Based on the industrial ecology principle, using modern ecology technology and cleaner production technology can reform traditional industry and raise the availability of resources. It can reduce the quantification, detoxification and other negative effects to environment to the greatest degree. And finally it may realize the ecological transformation of the traditional industry. At the same time, with the adjustment of industrial structure and spreading of ISO14000, enterprises in heavy industry such as chemical, machinery, building materials and so on, may realize cleaner production and change from the terminal pollution government to an entire process control. In addition, it should strengthen the government of traditional industrial pollution, through strict control, including registration dynamic management and pollution emission permit and so on. Those enterprises with backward technology, inferior quality and serious pollution should be eliminated. And the new and renewable sources of energy should be enhanced.

5 Conclusion

The industrial ecosystem is a network-based ecological economy system under the ecology principle and economic laws. With the development of effective economy process and harmonious ecology, the industrial ecosystem has the layered characteristic. The industrial ecosystem's construction needs a diverse cooperation, namely realizing the traditional industry ecology technological transformations in microscopic; integrating region industrial park based on the innovation system in the intermediate perspective; building an industrial ecosystem platform macroscopically to create a good macroscopic environment for the industry ecosystem's construction and development. Only in this way, it may realize the sustainable development.

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References