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IMPLEMENTATION OF THE CIRCULAR ECONOMIC MODEL IN THE CHINESE PRACTICE

Анотація. Циркулярна економічна модель (СЕ) — це новітня парадигма людства, яка здається неминучою для створення сталого управління ресурсами для нашого майбутнього в усіх секторах економіки, особливо в промисловому виробництві. Такі дисципліни, як промислова екологія, вже пролили світло на важливість відтворення або адаптації природних екосистем у промислових зонах та парках, прикладом чого є екопромислові парки, що поширюються у всьому світі. У багатьох частинах світу циркулярна економіка не тільки виникає як теоретична концепція, але також інтегрується в процеси формування політики та практику. Циркулярна економіка також може бути альтернативою традиційним – лінійним – економічним системам у глобальному масштабі. Європейський Союз робить рішучий крок у цьому напрямку, як і багато інших країн, включаючи Сполучені Штати та Китай. Китай є одним із найвідданіших промоутерів цієї концепції, де ми можемо говорити про політичне впровадження циркулярної економічної моделі з 1990-х років. У країні експоненціально зростає кількість пілотних проектів циркулярної економіки. Впроваджуючи модель циркулярної економіки, Китай розмірковує над складними проблемами дуже швидкої індустріалізації та економічного зростання. Надзвичайно централізований політичний режим Китаю, використовує методи «зверху вниз», які, неможливо реалізувати ні в ЄС, ні в США, але потрібно вивчати скоріше системне мислення кругообігу, а не конкретні плани та кроки. Ця стаття має на меті проаналізувати, чому циркулярна економіка є вигідним підходом для промислових об'єктів, чому ми можемо стверджувати, що китайська практика є дуже унікальною та специфічною у глобальному порівнянні, і які можуть бути потенційні уроки чи моделі, які інші країни чи регіони можуть вивчити та імплементувати у власну економіку. Методологія, яка використовувалась під час досліджень, базується на огляді останньої міжнародної літератури та наукових досліджень, щодо найкращої практики циркулярної економіки, а також на конкретних прикладах і статистичних даних Китаю.

Ключові слова: циркулярна економіка, екоіндустріальні парки, Китай, пілотні проекти, планування, стале промислове виробництво.

JEL Classification: E17, E69, F40.

Absztrakt. A körkörös gazdasági modell az emberiség által újonnan (újra) felfedezett paradigmája, amely elkerülhetetlennek tűnik jövőnk fenntartható erőforrás-gazdálkodásának megteremtéséhez, a gazdaság minden szektorában, különösen az ipari termelésben. Az olyan tudományágak, mint az ipari környezetvédelem, már rávilágítottak a természet alapú ökoszisztémák másolásának vagy adaptálásának fontosságára az ipari övezetekben, parkokban, lásd például a világszerte terjedő ökoipari parkokat. A világ számos részén a körkörös gazdaság nemcsak elméleti fogalomként jelenik meg, hanem a politikaalkotási folyamatokba és a gyakorlatba is beépül. A körkörös gazdaság globális szinten is alternatívája lehet a hagyományos – lineáris – gazdasági rendszereknek. Az Európai Unió erőteljes lépést tesz ebbe az irányba, akárcsak sok más ország, köztük az Egyesült Államok és Kína. Kína ennek a koncepciónak az egyik legelkötelezettebb hirdetője, ahol a körkörös gazdasági modell 1990-es évektől kezdődő politikai mainstreamingjéről beszélhetünk. Az országban exponenciálisan növekszik a körkörös gazdasági kísérleti projektek száma. Kína a körkörös gazdasági modell megvalósításával a nagyon gyors iparosodás és a gazdasági növekedés összetett problémáira reflektál. Egy olyan szélsőségesen centralizált politikai rezsim, mint Kína, felülről lefelé irányuló



módszereket alkalmaz, amelyek megvalósítása az EU-ban és az USA-ban lehetséges lenne, hanem inkább a rendszerszintű körforgás mikéntjét kell tanulmányozni a konkrét tervekkel és lépésekkel ellentétben. Ennek a cikknek az a célja, hogy elemezze, miért előnyös a körkörös gazdaság az ipari telephelyeken, miért állíthatjuk, hogy a kínai gyakorlat globális összehasonlításban nagyon egyedi és specifikus, és mik lehetnek azok a lehetséges tanulságok vagy minták, amelyeket más országok vagy régiók tanulmányozhatnának és implementálhatnak. A szerző által alkalmazott módszertan a körkörös gazdaság legjobb gyakorlataival foglalkozó legújabb nemzetközi szakirodalom áttekintésén, valamint konkrét esettanulmányokon és Kínából származó statisztikai adatokon alapul. A már meglévő és publikált modellek alapján vitathatatlanul megállapítható, hogy a kínai gyakorlat nagyon progresszív, azonban a kísérleti és demonstrációs projekteknek több gyenge pontja is van, elsősorban az érintettek bevonásának alacsony szintje valamint a kooperációs hálózat terhelése miatt.

Kulcsszavak: körkörös gazdaság, ökoipari parkok, Kína, kísérleti projektek, tervezés, fenntartható ipari termelés.

Abstract. *The circular economic model is a newly (re)discovered paradigm by the humanity which seems to be inevitable in order to create a sustainable resource management for our future, in all sectors of the economy, especially in industrial production. Disciplines such as industrial ecology have already shed the light on the importance of copying or adapting nature-based ecosystems in industrial zones, parks, see e.g., the worldwide spreading eco-industrial parks. In many parts of the world, the circular economic is not only emerging as a theoretical concept, but is also being integrated into policy-making processes and practice. The circular economy can also be an alternative to traditional – linear – economic systems on a global scale. The European Union is making a strong move in this direction, as are many other countries, including the United States and China. China is one of the most committed promoters of this concept, where we can talk about the political mainstreaming of the circular economic model since the 1990s. The country is having an exponentially increasing number of pilot projects for circular economic. By implementing the circular economic model, China is reflecting on the complex problems of the very rapid industrialization and economic growth. An extremely centralised political regime like China is using top-down methods which may not be possible to implement neither in the EU nor in the US, but it is rather the system-level thinking of circularity which must be studied, not the concrete plans and steps. This article aims to analyse why circular economy is a beneficial approach to industrial sites, why we may state that the Chinese practice is very unique and specific in a global comparison, and what might be the potential lessons or patterns other countries or regions could study and interpret. The methodology applied by the author is based on the review of recent international literature available on the best practices of circular economic, as well as concrete case studies and statistical data from China. Based on the already existing and published models, it is undebated that the Chinese practice is progressive in quantitative terms, however, there are several weak points of the pilot and demonstration projects, mainly regarding the low level of involvement of stakeholders (park management and business actors) and the density of cooperation networks.*

Keywords: circular economy, eco-industrial parks, China, pilot projects, planning, sustainable industrial production.

Introduction. The model of circular economy is an important paradigm for sustainable development and at the same time development policy, which seeks to achieve a closed chain and cyclicity of material and resource flows and to extend the useful life of products. The key elements of the model are resource efficiency, a low-carbon economy and sustainable waste management, production and consumption systems [19, pp. 76-91].

In many parts of the world, the CE is not only emerging as a theoretical concept, but is also being integrated into policy-making processes and practice. The circular economy can also be an alternative to traditional – linear – economic systems on a

global scale. The European Union is making a strong move in this direction, as are many other countries, including the United States and China [3, pp. 5-9].

The most important features of the CE model are the life-cycle approach, resource efficiency, the use of renewable energies, recycling and sustainable waste management [11, p.59]. The life-cycle approach set out in the circular economy model means much more than the purely material recycling of a product, as the aim here is to keep the added value and quality of the product for as long as possible, only then recycling it into its material and then converting it into energy (e.g., generating thermal energy through incineration) and finally landfilling [5, pp. 759-761]. As a result, the time spent in the economic cycle can be significantly increased, which can result in a vast amount of resource savings. A further aim of the CE concept is to promote social and economic sustainability in addition to the environmental dimension. The most important gains and benefits in the three areas can be summarized as follows [10, pp. 809-823]:

- environmental dimension: reduced use of raw materials; less waste generated; lower emissions; higher resource efficiency through re-use and the use of renewable energies.

- economic dimension: energy cost savings; the creation of new economic activities and forms of employment; lower waste management costs; saving on pollution costs; reduction of impairment.

- social dimension: increased networking within communities; encouraging participation in community processes; the development and transmission of conscious consumer attitudes; growth of social capital.

Literature Review. While examining the implementation possibilities of the circular economic model, we can find a very well-developed argument that the general upscaling, application and development of the CE concept can be very effectively supported by industrial ecology, and the two can strengthen and complement each other both theoretically and practically. These correlations are discussed in detail in a number of related literatures, including the work [1]. The extremely extensive literature on industrial ecology and industrial symbiosis has been evidence since the second half of the 1980s that modeling and copying natural material and resource flows and waste-free operating processes in industry is an opportunity and a necessity so that we can prevent the overexploitation of our finite resources and pollution, and create the conditions for sustainable development – see, among others, the classic works, such as [4, pp.1-10] and [6, pp. 144-152].

The laws of industrial ecology are based on the analogy of mutually beneficial resource exchanges and shares that can be discovered everywhere in nature [8, pp. 29-38], and from this we can deduce the solutions that serve to create and maintain the cycle. Industrial ecosystems can be promoters and tools for the application of the circular economic model, and the close logical links between the two concepts are well illustrated e.g., by the research [1, p. 170]. Their study is based on a systematic literature review which aimed to examine the co-occurrence of the concepts of symbioses, industrial ecosystems and eco-industrial parks in the case of articles and studies published up to 2016. A complex bibliographic analysis of about 110 matches confirms the correlations, and the co-occurrence of the above concepts and the very large number of cross-references also show that industrial ecology provides very serious theoretical added value to the CE model. Another important finding of the



research is that it has shown that the most common case studies on CE and IS are related to China, with the incidence of Chinese case studies being extremely high, significantly higher than in any other country [1, p. 170].

The so-called industrial parks which have developed and spread all over the world in recent decades, can be an excellent empirical field for the joint study of environmental, economic and social sustainability and the practical feasibility of the circular economic model. The analysis of the industrial parks operation from a sustainable development and environmental point of view can provide important experience and scientific results, as they focus not only on the production structure of the individual companies present, but also on spatial planning, networking, local/regional government actors and even the aspects of the population.

The term 'eco-industrial park' (EIP) has been used since the 1990s. This concept refers to a facility that is created and operated on the basis of innovation, innovative environmental solutions and concepts, thus contributing to the renewal of traditional industrial sectors and creating high added value in both the economic and social dimensions with sustainability in mind. In the case of eco-industrial parks, site selection is a complex process: in addition to good accessibility and obvious consideration of transport infrastructures, aspects such as environmental and resource management or the protection of ecosystems also emerge. Based on all this, it can be said that the concept of eco-industrial parks can be interpreted essentially as part of (or in response to) sustainable spatial planning, and in all its elements it carries the most important objectives of the circular economic model [2, pp. 331-349].

Purpose of the study. The main purpose of this study is to analyse why circular economy can be a beneficial approach to industrial sites, why we may state that the Chinese practice is very unique and specific in a global comparison, and what might be the potential lessons or patterns other countries or regions could study and interpret. The methodology applied by the author is based on the review of recent international literature available on the best practices of CE, as well as concrete case studies and statistical data from China.

Research results and discussions.

A global leader in CE - The case of China. The Chinese circular economy model generally takes a broader perspective, focusing on the complexity of pollution, encompassing many other dimensions in addition to waste and resource issues, reflecting on the complex problems of very rapid industrialization and economic growth. In China, the political mainstreaming of the circular economic model since the 1990s has made the country's economy growing steadily and at a very rapid pace, and the new model would alleviate the severe and growing environmental burden it causes [14, p. 832].

The application of the circular economic model in the case of China also has a very relevant urban-rural division dimension, as one of the biggest challenges for the country is the increasing extent of urban and industrial areas. This issue is also relevant in Europe or the US, but it does not go as far as Chinese metropolitan areas with a population of more than ten million. Also, in terms of spatiality, there are numerous samples or pilot settlements in China, with the so-called eco-industrial parks, etc. where CE is sought to be implemented in a homogeneous form, within a given well-defined geographical or economic unit [9]. Of course, there are many similar initiatives in Europe, but the way they are implemented is less well-structured

and systemic than in China – even if there are Member States that are at the forefront of implementing the circular model and often demonstrate their good practices through successful pilot projects.

The case of China is special in many respects by the planned management system operating in the country, in which the so-called five-year plans set the standards to be met by the economy, including, of course, even CE implementation targets and indicators. In 2015, the National Statistical Office developed an indicator system specifically related to the circular economy, which includes e.g., sulfur dioxide emissions or water use per unit of GDP [20, pp. 163-173].

In their 2016 article, John A. Matthews and Hao Tan [12, pp. 440-442] emphasize that China is now the number one polluter on a global scale, while also leading the way in innovative management of environmental problems and the application of new technologies. This duality has defined the Chinese interpretative framework for sustainable development since the early 2000s. Statistics of 2011 highlight the huge gap in raw material consumption between China and its successor OECD countries: the country's raw material demand is higher than that of the other 34 OECD countries combined.

Both the use of raw materials and the amount of industrial waste generated testify to significant waste and inadequate energy efficiency. Of course, this phenomenon poses a huge environmental threat, as e.g., landfill is in many cases almost mountainous in size and can cause natural disaster. The central government has adopted a wealth of system-wide reforms, new rules, and measures over the past 15-20 years to improve the energy efficiency and sustainability of the Chinese economy [21, pp. 187-202].

It is important to note that the already strong spatial concentration of industrial activity (more than half of the production takes place in industrial parks and zones) has a positive effect on the transformation, as the developments focus specifically on these units. China's industrial parks are entities of such size and importance as potential symbiosis of thousands of companies through which circular economic packages or eco-industrial developments can indeed generate significant change. Matthews and Han [12, pp. 440-442] argue that such dimensions do not appear anywhere else in the world, nor do complex, systemic environmental-economic ambitions like in China.

In the case of China, the CE model and the pursuit of environmental sustainability have been an integral part of public economic and industrial development strategies since the beginning of the 2000s, so the literature reviewed here serves to analyze policy at the national level. In any case, China's industrial parks can be said to be key elements in the country's exponentially growing economic and production performance. Data for 2013 reported about three hundred industrial parks in China. Of course, not all three hundred facilities function as eco-industrial parks, but most of them are operating as so-called pilot or demonstration projects already mentioned above. The number of parks where some complex transformation process has started towards the implementation of the EIP is approaching one hundred, and these projects also serve as an extremely important platform for innovation and design as well as an empirical 'experimental base'. Case studies show that significant improvements have been achieved in the use of water and raw materials as well as waste emissions in the industrial parks studied [17, pp. 6325-6331].



Over the past decade, the Chinese government has also clearly recognized and assessed that the application and implementation of the circular economic model as a national strategy is the only alternative for China – with a strong focus on the dominant element of the country’s economic performance, manufacturing. The creation of the strategy also meant the establishment of a hierarchy of measures and interventions, the first step of which is the development of the recycling of raw materials within the individual companies. The second element is about improving the resource efficiency of companies operating in different industries, and thus specifically about the more sustainable operation of industrial parks. In this phase, the strengthening of inter-industrial relations, the support of networking, and the active involvement and participation of local and regional government actors are very important goals.

Figure 1 shows the increasing trends in the field of energy efficiency in Chinese demonstration eco-industrial parks between 2006 and 2016. The statistical data refer to freshwater and energy consumption of the parks (as the two most important fields for industrial production), as well as the industrial value added per unit of industrial land area.

As we can see based on the data presented on Figure 1, the freshwater and comprehensive energy consumption per unit of industrial value added has been showing a significantly decreasing trend between 2006 and 2015, confirming the improving energy efficiency performance of the eco-industrial parks operating in China. Concerning industrial value added per unit of industrial land area, we can notice a growth of nearly 250% within a decade.

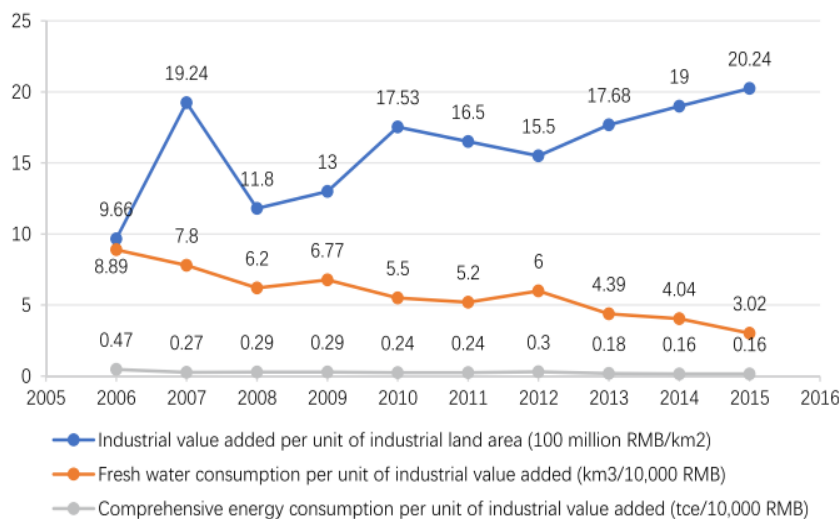


Figure 1. Energy efficiency in national demonstration eco-industrial parks in China, between 2006 and 2015.

Source: Ministry of Ecology and Environment China (2017) [13].

Figure 2 shows the spatial distribution of national demonstration eco-industrial parks accredited and established by localities.

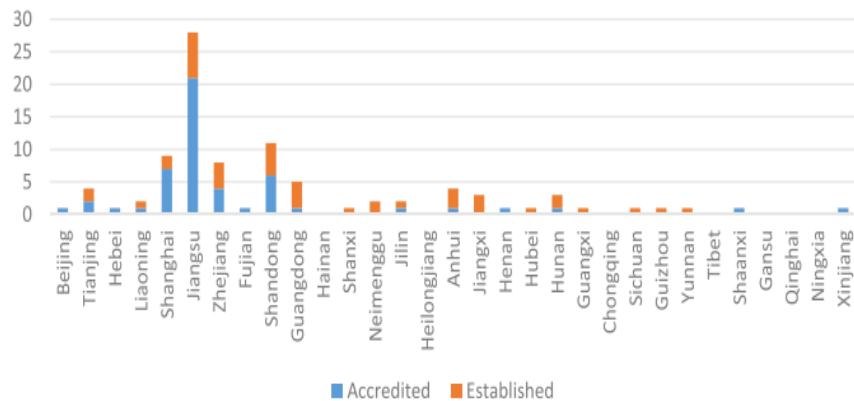


Figure 2. Number of national demonstration eco-industrial parks accredited and established by localities

Source: Ministry of Ecology and Environment China (2017) [13].

Figure 2 presents the geographical distribution of national demonstration EIPs across China, underlining that Jiangsu, Shandong and Shanghai are the three most important locations when it comes to the accreditation and establishment of new facilities.

Pilots and good practices – Current trends of creating eco-industrial parks in China. Between 2010 and 2015, the Chinese government launched one hundred CE pilot projects across the country in various industrial parks, primarily to gather empirical data and information. Parks participating in the projects will receive both central and local budget support, which can be used for non-profit infrastructure, capacity, knowledge and technology development. As for the top of the hierarchy, the third level: this is already the practice of the circular economy in urban or even larger territorial units and preassumes a complex socio-economic transformation, with the coordination of local governments. In doing so, a production and supply chain or cycle can be created that organically connects the primary, secondary and tertiary sectors, while the attitudes of the population are completely transformed. Although the legal and regulatory background for the creation of a circular economy is very extensive, its practical implementation is often hampered by the lack of enforceability and binding force. Another serious impediment is the very significant regional and territorial development inequality in China, which in many cases makes the success of a centrally managed and regulated environmental policy impossible [15].

According to Geng et al. (2009) [7, p. 13] and the categorization applied by the Chinese Ministry of Environment, we can distinguish three types of eco-industrial parks in China based on the sectoral affiliation of the settled firms. The first category is the so-called sector-specific EIP where we can observe the symbiotic coexistence and cooperation of e.g., chemical, metallurgical and other companies. The second category is the sector-integrated industrial park which operates along a broader concept, organizing principle, see e.g. high-tech industrial parks or complex economic development zones. Finally, we can talk about parks that deal specifically with the reuse of industrial solid waste.



An eco-industrial pilot project – The case of Gujiao Eco-Industrial Park. Gujiao Eco-industrial Park is located near Taiyuan in Shanxi Province in northeastern China. It was established in 2012 and covers an area of about 20 km². The investment had a very significant budget of 15 billion yuan (nearly 2 billion euros). There are mining companies in the EIP area, so it is a sector-specific facility. The region is one of the most important centers in China's iron and steel, heavy machinery and chemical industries, meaning the release of waste and pollutants is a particular environmental and social problem. It is no coincidence, then, that the Gujiao Industrial Park has become one of the flagship projects for government development and eco-investment. The park has an annual industrial output of more than 17 billion yuan and has become the most dynamically developing economic area in the Northeast since 2016. Gujiao ÖIP is China's largest coal and tar industry industrial park with a presence of 38 companies [18, p. 193].

It is important to emphasize that the development of symbiosis and eco-development is still taking place in this industrial park, it is not a mature and completed project. Geng et al. (2009) [7, p. 13] used social network analysis (SNA), a methodology known and frequently used in sociology, economics, and many other social sciences and natural sciences, to examine the symbiotic relationship system established in Gujiao Industrial Park. This quantitative methodological approach is intended to show the nature and density of social interactions e.g., through the number of commercial transactions or communications. The most important, central elements of the networks are the so-called nodes that can be assigned to any actor, institution, person, company, etc. The lines connecting these nodes symbolize the connections and interactions within the network. The system is called can be represented on a sociogram [16].

Using the model, Geng et al. (2009) [7, p. 13] were able to depict not only which companies developed symbiotic relationships, but which ones are more important, which companies dominate the symbiosis developed in the eco-industrial park. The research, which was carried out on the basis of a survey involving 38 companies and the data obtained from them, clearly showed that the wastewater treatment plant in the park is the dominant actor, as the wastewater of 29 other companies is treated. In a similar way, the authors analyzed the flow of waste within the symbiosis, and companies that were able to take over and use the waste of at least 15 other companies were given a key role. Further empirical research has also found that the density of waste exchange networks and connections within the industrial park is not yet sufficient, comparing the values with other international good practices and examples. The study also formulates policy proposals for future development directions and opportunities. As emphasized in the case studies analyzed in the international literature, the authors draw attention to the need to support the flow and sharing of information in order to expand and deepen symbiotic relations. This requires the active involvement of the EIP's management. In addition to the development of information platforms, the role of economic / financial incentives is also essential, especially with regard to commodity prices. As long as companies have cheaper access to raw materials from the markets than if they used recycled, recycled raw material from a secondary source or waste taken from a partner, they would not be really forced to act and build and maintain symbiosis.

Conclusion and recommendations. The literature analysis of the currently existing circular economy practices worldwide shows that the case of China is definitely worth studying. Based on the extensive literature on the Chinese implementation of the CE model especially in the industrial zones, it becomes possible to draw some important and relevant general conclusions about the mainstreaming and upscaling process of circularity in industrial production. As it has become obvious during the last decade, China is a great economic power which has discovered the potential in closing the loop of resource and energy flows, taking significant advantage of its newly constructed and redefined eco-industrial sites countrywide. The volume of change is incomparable to any other parts of the world, but the question is rather the quality and long-term sustainability. Europe and the US, constantly competing with China's innovations need to analyse the systematic approach China has been following, however, they must take into consideration the political and institutional environment as well in order to not just copy but smartly adopt the successful and good practices. An extremely centralised political regime like China is using top-down methods which may not be possible to implement neither in the EU nor in the US, but it is rather the system-level thinking of circularity which must be studied, not the concrete plans and steps. Based on the already existing and published models, it is undebated that the Chinese practice is progressive in quantitative terms (see the number of projects and the volume of financial investments), however, there are several weak points of the pilot and demonstration projects, mainly regarding the low level of involvement of stakeholders (park management and business actors) and the density of cooperation networks.

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