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Review of the development of China's Eco-industrial Park standard system

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ABSTRACT

Eco-industrial Parks (EIP) have become a central element in China's industrial strategy to combine industrial development while minimizing environmental impacts and improving resource efficiency. National standard system has been developed as a main tool for assessing EIPs. This paper provides a review of the development of China's EIP standard system. The focus of the analysis is the new national demonstration EIP standard (HJ/T274-2015), including a review of calculation methods for some key indicators. The analysis also provides a comparison with previous standards to identify the main changes and improvements in the assessment of EIPs. Comparison findings illustrate that the new standard provides a more consistent indicator system by providing a consolidated standard system, and offering more comprehensive and quantitative indicators. Moreover, the new standard aims to better manage environmental issues by supplementing more comprehensive environmental indicators. The standard also strengthens the emphasis of the industrial symbiosis dimension in the evaluation of EIPs. By offering optional indicators and giving distinct targets based on contextual conditions for a number of indicators, the flexibility and rationality of the EIP assessments are also enhanced. Although many positive changes have been identified, there are still some shortcomings exist in the new EIP standard. The paper proposes a number of recommendations based on analyzing shortcomings, for instance further improving of the industrial symbiosis indicators, offering social benefit evaluation indicators, and strengthening the reduction action evaluation. China's experience of setting EIP standards and indicators may provide lessons for other countries' attempts to develop industrial estate indicators. In order to observe and effectively promote industrial estates at the global range, several remaining research questions that need further exploration are put forward in this study.

1. Introduction

With the aim of responding to environmental pollution and global warming, many countries are seeking innovative ways to relieve these problems. Establishing Eco-industrial Parks (EIPs) is considered as one effective way for coordinating environmental pollution and economic development (Lai, 2013; UNEP, 1997; Zhang et al., 2010; Song and Shen, 2015). Though being a policy-concept which is infused with different meanings depending on political, socio-economic and cultural context (Boons et al., 2017), EIP is usually proposed as a community of manufacturing and service businesses seeking enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues (Lowe, 1997; Valenzuela-Venegas et al., 2016).

Practically, a precursor to EIP is the regional industrial symbiosis[1] at Kalundborg in Denmark, uncovered in 1990 (Ehrenfeld and Gertler, 1997; Chertow, 2000). Other eco-innovation park cases were also initiated and investigated, such as in the US (Chertow, 2000), Canada

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[1] Industrial symbiosis is a subset of industrial ecology, which is usually happened in EIPs. Industrial symbiosis engages traditional separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water and by-products. The key to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity (Chertow, 2000).

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(Cote and Cohen-Rosenthal, 1998; Fleig, 2000), Korea (Kim and Powell, 2008; Park et al., 2008, 2016), Japan (Van Berkel et al., 2009; Geng et al., 2010), European countries (Massard et al., 2014) and Australia (Roberts, 2004; Van Berkel, 2007; Van Beers et al., 2007). China began to facilitate the EIP strategy in early 2000s and actively promoted it with the enactment of both cleaner production promotion law and circular economy promotion law (Geng and Cote, 2003; Geng et al., 2009, 2013, 2016; Chiu, 2001; Fang et al., 2007; Shi et al., 2012a, 2012b; McDowall et al., 2017). The first reported EIP case in China is the Guitang sugar-making complex approved by the State Environmental Protection Administration (SEPA)[2] (Zhu and Cote, 2004; Zhu et al., 2007). China developed large amount of EIP networks since then.

Although EIP can be developed and promoted in different forms, setting of standards and guidelines is found helpful for promoting EIP development in China (Shi et al., 2012a, 2012b). Several regions also designed their own EIP criteria, including Port of Cape Charles in the US, Virginia in the US, Thailand, and the Eco-star criteria in Devens, Massachusetts (Cote and Liu, 2016). Yet only China designed a national EIP standard that is applied in large number of parks, and there is no internationally accepted standard for EIP. Several studies discussed about the EIP evaluation standard system in China. Geng et al. (2008) argued that some of the criteria in EIP standard released by SEPA in 2006 are vague and difficult to evaluate. Meanwhile, the standard is criticized having not considered the principles of eco-industrial development and local realities (Geng et al., 2009). Yu et al. (2014) and Liu et al. (2007) reviewed the EIP performance according to the Chinese EIP standards, and found indicators such as reuse rate of reclaimed water, recycling rate of solid waste are usually challenging for industrial parks to execute.

As mentioned, China has become a major player in EIP experimentation in the last decade, and use EIP standardas a main management tool to promote the EIP development. Reflection on the experience indicates that the development of practical quantitative assessment indicators for EIPs has been a crucial factor for the ongoing success of China's national demonstration EIP program (Shi et al., 2012a, 2012b). The performance of environmental pollutant emission and energy consumption intensity in certified EIPs is discovered much better than the average level of ordinary industrial parks (Tian et al., 2014). In this sense, a review of the EIP standard system is crucial in understanding how it has evolved over time adapting to both criticism from academia and needs from business. EIP standards in China have already experienced several rounds of revision since the first standards were established in 2006. In 2015, MEP (Ministry of Environmental Protection) released the new standard for national demonstration EIP (HJ/T274-2015) to replace the previous standards. Our literature review reveals that although several articles discussed the Chinese EIP standard system released in 2006 and 2009, no research has yet been undertaken to investigate the 2015 standard and assess progress. In order to fill this research gap, this paper will carry out an analysis of the newly released EIP standard. We will try to identify the primary changes and key improvements of the new version of EIP standard system. Furthermore, we will try to explore what are the shortcomings still existing in the new standard.

2. Research framework and methodology

2.1. Research framework

This study will first give a review of Chinese EIP standards development. The newest 2015 version of standard is illustrated in the manuscript, while the 2006 and 2009 versions are presented in our supplement material. Meanwhile, the enforcement and management mechanisms of EIPs in China are described. As the next step, the main changes among the series of EIP standards will be identified, and reasons of the modifications are discussed. Furthermore, shortcomings of the existing standard and outlook of EIP standard development in China are analyzed.

2.2. Methodology

Several approaches are conducted to collect materials and information in this study, including literature and report review, stakeholder interview and informal meetings. (1) The review of the EIP standard development was based on the released EIP standard documents. (2) Reasons of the several rounds' modifications were collected by interview and informal meetings with EIP standard designers from China Environmental Science Research Institute. (3) Critical analysis including the shortcomings of the current EIP standard and outlook of the EIP standard development is conduced based on interviews and informal meetings with EIP standard designers, EIP administrative office members and researchers within the EIP field.

3. China's EIP development

3.1. EIP and standards development

There are many types of industrial parks in China. In fact, it needs to be recognized that a significant share of China's manufacturing is being managed through those parks, much larger than e.g. in OECD countries (Mathews and Tan, 2016). In order to better manage these industrial parks, SEPA categorized these industrial parks into three groups, namely the sector-integrated group, the venous[3] group and the sector-specific group. The sector-integrated group refers to those parks with multiple industrial sectors, especially the development zones, which are the main form of Chinese industrial park. The venous industrial park particularly refers to those resource recovery parks where environmental technology companies and firms making "green products" coexist. The sector-specific group refers to parks with primarily one main sector or correlated sectors (Geng et al., 2009).

Before 2006, the sector-specific EIP accounted for the largest percentage among the three kinds of industrial parks, including steel industry, cement industry and paper industry. In 2006, the award of EIP for Qingdao New World venous industry park[4] indicated that the venous industry become a new type of EIP in China. By the end of 2008, 30 national demonstration EIPs construction plan had been endorsed by MEP, including 20 sector-integrated EIPs, 9 sector-specific EIPs and 1 venous industry EIP. The development of sector-integrated EIP grew rapidly from 2006 to 2009, with even higher expanding rate after 2010 (Yu, 2015). By the end of 2015, there are already 126 national EIPs demonstration plans being endorsed, including 109 sector-integrated EIPs, 14 sector-specific EIPs and 3 venous industry EIPs (see Fig. 1).

Alongside with EIP development, the EIP standards also experienced several rounds of evolution. The development process of standard systems for Chinese EIPs is summarized in Table 1(MEP, 2016).

The new EIP standard (HJ/T274-2015) has already been enforced since 2016, while those already approved EIP_S are required to implement this new standard from January 1, 2019. In order to better understand the new EIP standard (HJ/T274-2015), the whole indicators

[2] State Environmental Protection Administration (SEPA) changed to Ministry of Environmental Protection (MEP) in 2008.

[3] The term "venous industry" (*静脉产业*) is widely used in China and Japan, and refers to resource recovery or secondary material industries. This is by analogy with the circulatory system: arteries carry oxygen-rich blood to the body, while veins return blood that has had its oxygen used up. The term 'venous' thus refers to secondary cycles of materials and energy, while 'arterial' industries are those engaged in primary flows of virgin materials.

[4] Due to environmental illegalty, Qingdao New World venous industry park was punished and removed the title of demonstration EIP in 2016. http://www.zhb.gov.cn/gkml/hbb/bgth/201612/t20161212_368966.htm