Front. Eng. Manag. 2019, 6(4): 584–586
https://doi.org/10.1007/s42524-019-0076-6

COMMENTS

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The linkage mechanism between urban intelligence and low carbon innovation

With the acceleration of global urbanization and the rapid increase in urban population, many cities face pressures and challenges related to energy, water resources, and the environment. Promoting urban function and management intelligence and developing low-carbon industries have become the only path for modern cities to achieve sustainable development. Urban intelligence or the concept of a "smart city" is based on the city's informatization in conjunction with emerging technologies such as the Internet of Things, cloud computing, and e-government. Its purpose is to promote knowledge sharing and innovation and improve the overall operation of the city (Zhang et al., 2011). The concept of a "low-carbon city" puts higher requirements on sustainable development from the perspective of ecology and energy consumption. Developing a low-carbon economy and achieving low-carbon innovation are the main approaches to build low-carbon cities (Ci, 2012). As the main development direction of the city's future, there is an inseparable relationship and interaction between urban intelligence and low-carbon innovation. An accurate grasp of the connotation and linkage relationship between the two will help to clarify the dominant factors in the process of urban sustainable development. Specific tasks guide the practices of urban construction and management.

At present, the concept and connotation of urban intelligence are still evolving and developing. The evolution from urban informatization to urban intelligence has become a topic of general concern in academia and industry. In 2008, IBM proposed the "Smart Planet" strategy, which uses smart government and smart power, smart medical applications, intelligent transportation, intelligent supply chain, and intelligent banking as the main application fields. Some scholars have decomposed smart cities into perception layers. The network layer and the application layer have three levels and the smart city is considered to be a collection of intelligent applications based on the Internet of Things. Research has been conducted on the relationship between smart cities and industrial innovation. A knowledge-based smart city development model has been proposed and the successful experience of Melbourne's knowledge city construction has been reported. These studies reflect a common connotation, that is, urban intelligence is not only a simple application of intelligent technology but also a comprehensive theoretical system that integrates information networks, industrial innovation, and social services.

Low-carbon innovation is a key issue in developing a low-carbon economy and building an eco-city. Low-carbon innovation can be defined as a series of innovative activities to promote the development of a low-carbon economy (He, 2014). Specifically, the low-carbon innovation connotation includes the following three aspects: (1) Technological innovation. Low-carbon technology innovation refers to breakthroughs and developments in key technologies related to energy supply and industrial energy conservation. The key technologies of low carbon are development and utilization of clean energy such as nuclear energy, solar energy, wind power, water power, and single/polycrystalline silicon photovoltaic cells; transportation energy-saving technologies such as automobile fuel, electric vehicles, fuel cell vehicles, and new rail transit; energy-saving technologies for buildings such as geothermal energy utilization; industrial energy-saving technologies such as process energy conservation, industrial thermal power utilization, carbon capture and storage, and energy-saving materials research and development (He, 2014). (2) Industrial innovation. The low-carbon industry refers to an emerging industry that targets the low-carbon economy model and low-carbon technology. The

Received September 12, 2019

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goal of low-carbon industry innovation is to achieve the cluster development of low-carbon industries and the improvement of the overall competitiveness of the industry. Important tasks of industrial innovation include establishing a university-enterprise-government tripartite innovation system, exploring low-carbon industry development models, building low-carbon innovation platforms and public knowledge bases, supporting low-carbon key technology research, development, transformation and utilization, deepening low-carbon demand, establishing low-carbon product quality standards, promoting low-carbon market innovation, building and developing regional low-carbon industrial clusters, promoting complementarity and cooperation among enterprises within the cluster, and forming a complete low-carbon industrial chain with multi-level low-carbon products. The adjustment of industrial structure focuses on the development of the service industry and tertiary industry (Zhu et al., 2016). (3) Cultural innovation. Developing a low-carbon culture is one of the important links of low-carbon innovation. Low-carbon culture innovation refers to promoting the development of low-carbon concepts in the society and establishing a social culture of energy conservation, environmental protection, and ecological harmony. The low carbon culture innovation approach includes the clarification of the carbon responsibility and carbon obligations of enterprises and citizens, promoting the "carbon footprint" certification of enterprise products, promoting the monetization of forest carbon sinks, building a carbon trading market, promoting enterprises to take the road of low carbon sustainable development, placing an emphasis on education, encouraging innovations, meeting the knowledge environment and human resources needed for low-carbon industries, promoting low-carbon life concepts, and cultivating low-carbon consumption and environmentally friendly living habits.

Urban intelligence and low-carbon innovation are two important paths to achieve sustainable urban development. Urban intelligence focuses on the improvement in the level of urban informatization, achieves knowledge sharing, promotes innovation on the basis of interconnection, and improves the overall operational efficiency and productivity of the city. Low-carbon innovation focuses on promoting industrial and technological development related to reducing carbon emissions and creating a green and energy-saving eco-city development model. What they have in common is that urban sustainable development is their common goal and technological innovation is their fundamental driving force. During urban development, there is a synergistic relationship between urban intelligence and low-carbon innovation, i.e., interdependent and mutually reinforcing with mutual purpose and mutual means. This concept has been compared to the structure of DNA in molecular biology—the double helix model has been used to describe the development process that is both interlocking and relatively independent.

The double-helical model characterizes the basic principle of the linkage between urban intelligence and low-carbon innovation. However, each city has a unique historical connotation and economic and cultural foundation, and it is necessary to explore a development path that suits its own characteristics. Based on the double-helical relationship, there are three basic development models of modern cities. Urban decision-makers can flexibly adapt these models to specific situations and form different development strategies (He, 2016). These three basic models include: (1) A collaborative evolution model of urban intelligence and low-carbon innovation. This model is characterized by the same emphasis on urban intelligent construction and low-carbon innovation when formulating urban development strategies and investing in development factors of the same scale. In the implementation, we should promote that the two to go hand in hand and strengthen the linkage. In this way, the synergy effect of the collaboration can be maximized and the two can develop together. This model is suitable for cities with relatively balanced industrial structure, a good information industry foundation, and ecological transformation. Representative cities in China that are suitable for this model are Guangzhou, Shenzhen, and Tianjin. (2) The city's intelligence is considered the leading factor and drives the development model of low-carbon innovation. The characteristic of this model is that in the urban development strategy, intelligent construction is the dominant factor and low-carbon innovation is regarded as a link in the urban intelligent strategy. In the implementation, urban intelligentization is the main driving force and the city will focus on investing, rapidly improving the level of intelligence and knowledge, and indirectly promoting the development of low-carbon technologies and low-carbon industries. This model is suitable for cities with a good information industry foundation or low environmental pressure. Representative cities in China are Taipei, Hong Kong, and Hangzhou. (3) Low-carbon innovation is the dominant factor driving the development model of urban intelligence. This model is characterized by low carbon development as the core strategy of urban development and urban intelligence is a service link of the urban low carbon development strategy. In the implementation, the main force will be used for the cultivation of low-carbon industrial clusters and the low-carbon transformation of traditional industries; the gradual development of urban intelligence will be promoted through low-carbon innovation. This model is suitable for cities with a high degree of industrialization, and high carbon emission levels, energy demand, and environmental pressure. Representative cities in China are Taiyuan, Shijiazhuang, and Shenyang.

Many problems have to be solved in order to promote high-quality development of cities. It is necessary to cultivate new kinetic energy for urban development, embrace a new round of technological revolution, and accelerate the intelligent construction of cities. This

represents new kinetic energy for the high-quality development of our cities. We should also optimize the industrial structure, improve energy efficiency, reduce energy consumption, reduce emissions, explore new ideas based on ecological priority and green development, and promote green and low-carbon development. Low-carbon innovation is the industrial foundation and source of energy power for urban intelligent development. The two should promote each other, support each other, and develop together.

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