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Approach and practices of district energy planning to achieve low carbon outcomes in China

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HIGHLIGHTS

- A general framework for district energy planning is proposed.
- A case study of a low carbon energy plan for a new district is carried out.
- District energy planning should be standardized as soon as possible.
- The most suitable spatial scale for energy planning is at the municipal level.

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ABSTRACT

District energy planning is an important methodology to assist in realizing a lower carbon target. However, district energy planning has not yet been incorporated into the statutory planning system in China, primarily because there are no clear standards and specifications for these plans. In this paper, we propose a general framework and low carbon estimation method for district energy planning, which is based on evaluating the low carbon energy planning practices of several new districts in China. In addition, several key points of concern in the planning process are extracted and discussed: overall infrastructure planning; co-operation between city planning and other special low carbon eco-planning; investment, financing and profitable operation; planning management mechanisms; and the management of the construction of the energy system to coincide with the project schedule. We carried out a case study of a low carbon energy plan for a new district of Beijing to evaluate our framework. Finally, we conclude that to realize the low carbon target, regional energy planning covering technologies, the market and management should be standardized as soon as possible.

1. Introduction

Prior to the Copenhagen conference, the China State Council conference proposed that CO_2 emissions per Gross Domestic Product (GDP) will be decreased by 40–45% by 2020 compared with the 2005 levels (Zhuang and Zhang, 2010). Since China is still a developing country undergoing rapid industrialization and urbanization, energy demand continues to grow, and the pressure to mitigate greenhouse gas emissions increases.

We first introduce recent energy policy directions in China. Between 2006 and 2008, financial support was provided for renewable energy demonstration projects for a single building or a village. In the following two years funding was available for renewable energy demonstration projects at the city level. At the same time, photovoltaic subsidies were provided. Since 2010, low carbon ecological cities and green town demonstration projects have been implemented, and energy management contracting (EMC) subsidies have been provided. From the above we can see that the energy policy trend in China is moving from a single building to a regional level and from single technologies to integrated ones.

Energy infrastructure is established during urban construction, and once established is impossible to be changed. Thus, good energy planning is very important, especially for a new district. What we learn from the practices adopted in domestic and foreign low carbon eco-cities (Liu et al., 2010) is that, constructing a good energy system is not to solve a single technology problem, but to balance and integrate related technologies, as well as to respect localization characteristics and carry out scientific and quantitative management.

Zheng et al. (2008) and Fu et al. (2008) proposed an urban

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energy planning method, and developed a simulation tool for urban energy planning that incorporated dynamic space distribution over time. The macro-energy planning method has been applied to several fields, such as for a regional integrated energy plan (Ramachandra, 2009; Brookshire and Kaza, 2013; Contreras et al., 1997), urban energy demand and security (Jones, 1991), community energy planning (Long, 2008), and an energy consumption simulation of the building sector (Yamaguchi et al., 2007; Shimoda et al., 2004; Heiple and Sailor, 2008; Sadegh, 2007). However, this macro-energy planning method is more appropriate for the level of states or national regions. At the urban or local levels it is necessary to consider more engineering application factors.

Nowadays, there is a growing trend to implement energy planning models in smaller systems (Mavrotas et al., 2003). The most suitable spatial scale for energy planning is at the municipal level requiring short-term perspectives (Pasimeni et al., 2014). Furthermore, the exploitation of renewable energy sources has played a very important role in the last few years. In contrast to traditional energy sources, the environmental impacts of renewable energy facilities are rather localized, including extensive land use, landscape alteration, visual change of rural life, noise, etc. (Mourmouris and Potolias, 2013). For example, in Denmark, Sperling et al. (2011) suggested that the role of municipalities as energy planning authorities need to be outlined more clearly, and this required the state to provide municipalities with the necessary planning instruments and establish a corresponding planning framework.

However, district energy planning has not yet been incorporated into the statutory planning system in China, primarily because there are no clear standards and specifications for these plans. In this paper, we propose a general framework and low carbon assessment method for district energy planning, which is based on evaluating the low carbon energy planning practices of several new districts in China, and several key points of concern in the planning process are distilled and discussed. Moreover, a case study of low carbon energy planning for a new district of Beijing is carried out.

2. Methods

2.1. Low carbon strategies

By summarizing the low-carbon cases of new districts at home and abroad, and engineering practices such as the low-carbon planning for the Future Technology City in Beijing, our planning team proposes a CLEAR system for district low-carbon planning.

The CLEAR system summarizes five pathways for changing the development mode from high carbon emission to implementing green, sustainable and healthy development strategies with low energy consumption, low pollution and low emissions. The five pathways include: (1) reducing energy demand and improving energy efficiency ('Efficient'); (2) using alternative renewable energy ('Renewable'); (3) recycling energy resources ('Loop'); (4) taking greening and other measures to capture carbon dioxide ('Capture and storage'); (5) developing low-carbon industries for

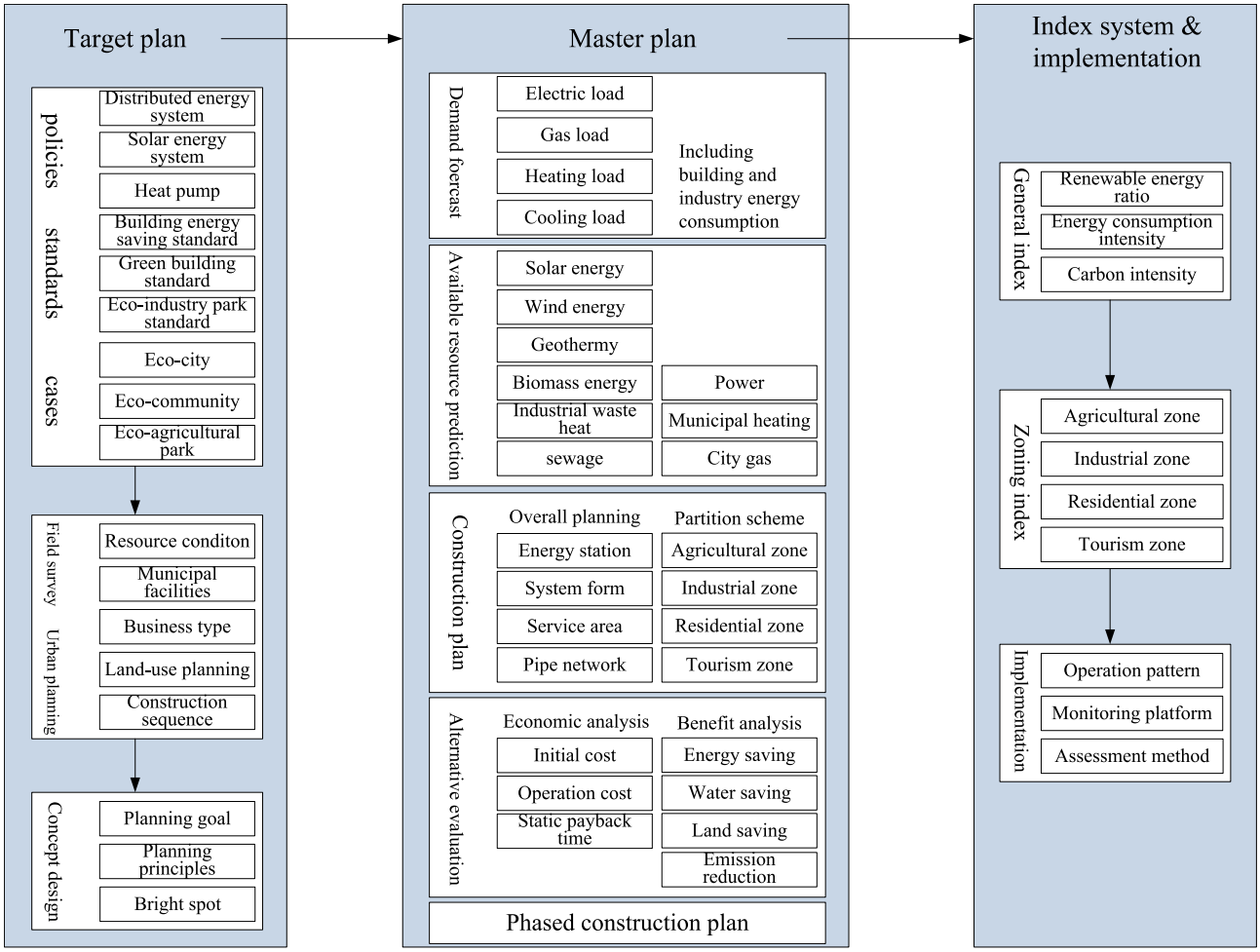

Fig. 1. The integrated framework of regional energy planning.