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Quantifying the Coordination of Energy Development and Environmental Protection: a Case Study of China

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Abstract

Today, balancing energy development with the desire to protect the environment remains a challenge in the world, especially in developing countries such as China. To make public policy for the balancing of alternative futures, quantification of the coordination between energy development and environmental protection is required. To achieve this end, we firstly establish the index system of energy-environment comprehensive development. Then we calculate the coordination degree of energy development and environment protection by means of principal component analysis and membership function of fuzzy mathematics. The resulting coordination of energy and environment systems in China during 2000-2012 is low with an average coordination degree of 0.6301. In 5 years, energy and environment systems are in the status of incoordination to different extents. To further improve the coordinated status, based on phenomenon analyses and economic theoretical interpretation on the reasons behind, some helpful policies are suggested, including establishment of a policy guarantee system for a coordinated development, implementation of energy green insurance and standardization of new energy market etc..

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1. Introduction

The concept of coordination has been widely applied to the modern science and culture. The coordination of a compound system is the mutual dependency, mutual restraints, harmonious coexistence

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among the respective systems under the influence of self-organization in the internal system and management activities from the outside. In the development process, respective systems coexist in harmony with each other showing multiple relations of cooperation, complementation and synchronization etc., which reflects the ordered structure and status of the compound system.

However, many contradictions and conflicts exist in the development process between energy system and environment system. For example, the traditional energy structure with the coal and petroleum as the dominance decides the large amount of pollutants such as waste gas and water discharged in the process of energy production and consumption, which caused the deterioration of environmental quality. Environmental factors such as environmental capacity also create apparent restrictions on the energy development. What's more, energy departments of many countries have to pay high development costs due to the international performance. In this context, thorough and deep research on the coordinated status of the “two systems” of energy development and environmental protection has great significance for governments to deepen its understanding of “two systems”, contribute to solving contradictions of “two systems”, and draw up the scientific development planning for promoting healthy and sustainable development of the society.

To determine relations between energy and environment systems, Pearson and Peter [1] mainly quantified environmental effects of energy production and transformation. Sinton et al. [2] focused on shared environmental responsibilities of the respective countries concerning the global climate change from the perspective of energy policy. Lorna and Steve [3] designed coordinated energy and environmental policies by means of multi-criteria decision-making (MCDM) methods. Vahid et al. [4] employed a simultaneous equations system to find out interactions between energy and environment on long and short timescales in Iran during the period 1974-2012. According to his studies, per capita CO₂ emissions and energy consumption exhibit the strongest relationships and elasticities in the equations system as a whole on long timescale. Energy consumption should be reduced to decrease environmental pollution and improve the level of system coordination. In China, many studies also center on energy development and its relations with environment. Li Zhuoya [5] pointed out that China's industrialized economy brings the growth of energy production and consumption demand, but the unreasonable energy structure and low efficiency of the energy utilization cause the imbalance between China's environmental pollution and ecological system. The author put forward measures such as building green energy consumption pattern for the enhancement of coordination between energy and environment. Generally speaking, certain limitations still exist for the relevant research. For example, the evaluation system and the measuring methodologies with general guidance have not been formed to convert two different systems into a unified system. In addition, policy studies considering the coordinated status of energy and environment in a specific country are still limited, especially for developing countries. These limited studies did not provide adequately targeted policies according to internal contradictions between systems and the reasons behind. Energy policy studies are often lack of full interaction and integration with environmental policy research. The main originality of this paper is that by building a comprehensive evaluation index system and applying membership function of fuzzy mathematics, it clarifies the current coordinated status of energy and environment systems in China. Meanwhile it conducts phenomenon analyses and economic theoretical interpretation on those incoordinations. This paper also tries to provide some creative suggestions on future government policies aiming at promoting the coordinated development of energy and environment.

2. Design of the index system

The two-dimensional index system of the comprehensive development level of energy and environment is established: one dimension is the energy and environment index, measured with the index

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