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On Spatial Distribution and Determinants of Urban Photovoltaic Utilization in China

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Abstract

In recent years, many countries, including China, have been actively promoting the construction of 'new energy cities'. China's solar radiation resources are good in general, moreover, photovoltaic utilization had a rapid development these years. This paper studies the spatial distribution characteristics of urban photovoltaic utilization basing on the analysis of the current situation of the application of urban photovoltaic projects in China. The influencing factors of spatial distribution difference is analyzed by SPSS software, which include four aspects: the solar radiation resource, the economic environment of cities, government policy and regional difference of photovoltaic enterprises. The results show that the spatial distribution difference of China's urban photovoltaic utilization is spatial non-uniformity. The most important influencing factor of spatial distribution is policy from government, followed by market environment and urban economic development conditions, which all show a strong positive correlation. This paper aims at providing a reference for the comprehensive evaluation and policy making of China's urban photovoltaic utilization in the future, which is based on the statistical research and analysis of the data.

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Keywords: Urban photovoltaic utilization; Spatial distribution; Temporal distribution; Influence factors; SPSS

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1. Introduction

To deal with the fossil energy crisis, many cities in China are competing to build 'solar city' [1]. The pattern of photovoltaic utilization in China can be divided into two types: centralized photovoltaic utilization and distributed photovoltaic utilization. Distributed photovoltaic utilization is more widely used in Chinese cities due to the specific properties of urban construction land. Distributed photovoltaic utilization is the photovoltaic power generation facilities constructed in or near the user's location, which has the characteristics of the users mainly generate electricity for self-use, the excess electricity will be connected to the state grid, and balance the electricity in the distribution network system [2]. The application of distributed photovoltaic utilization avoids site restrictions for concentrated construction, and is suitable for widely use in 'solar city' [3] for its flexible construction characteristics.

Up to now, some European countries have been systematically building the 'Solar City' from theory to practice on urban scale [4], getting its application deep into the city's space structure, building structure and public space which links closely to the city's municipal infrastructure. Different theories and models are proposed to quantify the spatial and temporal distribution of the renewable energy [5,6,7]. Although China's photovoltaic installed capacity ranks first in the world [8], there's no research on the spatial distribution and regional differences of the photovoltaic industry from the perspective of urban scale, researches on the macro photovoltaic industry focus on the market, technology, finance, talents [9] and policy [10].

Differences in the macroeconomic and policy conditions of urban areas led to diversities in the use of distributed photovoltaic utilization [11]. Research on the spatial distribution and its formation from urban scale can effectively improve the utilization rate of solar radiation and meet the energy demand of different areas and construction lands in the city.

At present, the China government proposes to build distributed photovoltaic systems in industrial and commercial enterprises and industrial parks in priority where the electricity prices are higher. Furthermore, the government encourages all the power users, investment enterprises, professional energy service companies, and individuals to invest in the construction of distributed photovoltaic project [12]. Therefore, this paper provides a reference for the comprehensive evaluation and policies proposal on the future of photovoltaic utilization in China, which is based on the statistical research analysis of urban photovoltaic utilization in China.

2. Methodology

The data used in this paper include two parts: urban photovoltaic utilization data in China and influencing factors data. Urban photovoltaic utilization data are obtained through the literature review method and spot investigation, then the project locations are calibrated and verified through Google Earth. This paper statistically studies a total of 246 urban photovoltaic utilization projects from 25 provinces, municipalities and autonomous regions in China. Among the influencing factors data, the total annual solar radiation and sunshine hours are acquired from China Meteorological Data Service Center (CMDC). The gross domestic product, population and per capita disposable income are derived from the annual statistical yearbook of 2015, the national statistical yearbook and the sixth census data. Photovoltaic enterprises data are from the energy industry annual report. Policy data are the scores assignments in accordance with supporting efforts of government policy to urban photovoltaic projects. This paper summarizes a total of 386 photovoltaic enterprises which are mainly engaged in urban photovoltaic utilization (as of December 31st, 2016), photovoltaic technology institute, solar module manufacturers, integrated system manufacturers and builders are included.

In this paper, correlation analysis for each influencing factors and the number of urban photovoltaic projects are analyzed by IBM SPSS statistical analysis software 19. SPSS (Statistic Package for Social Science) is a widely used program for statistical analysis in social science. In addition to statistical analysis, data management (case selection, file reshaping, creating derived data) and data documentation (a metadata dictionary was stored in the data file) are features of the base software. Statistics included in the base software are following 4 aspects. Descriptive statistics: cross tabulation, frequencies, descriptive, explore, descriptive ratio statistics. Bivariate statistics: means, t-test, ANOVA, correlation (bivariate, partial, distances), nonparametric tests. Prediction for numerical outcomes: linear regression. Prediction for identifying groups: factor analysis, cluster analysis (two-step, K-means, hierarchical), discriminant. SPSS statistics places constraints on internal file structure, data types, data processing, and matching