Empirical Analysis and Research on Urban Energy Efficiency Measurement Based on Computer Technology and Total Factor Framework

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Abstract. The utilization rate of energy can reflect the economic development quality and technical level of a country and a region, which directly affects the sustainable economic development. With the rapid progress of China's urbanization, the total energy consumption is constantly rising, among which the urban energy consumption accounts for more than two thirds of the total energy consumption. Therefore, the urban energy utilization efficiency largely determines the overall level of China's energy utilization. The results show that the growth rate of energy efficiency and the growth rate of energy use technology efficiency decrease under the constraint of environment. At the same time, due to the neglect of energy emission reduction technologies, the growth rate of technological progress in energy use decreases. As is known to all, carbon dioxide emitted by energy consumption causes a surge in greenhouse gases, leading to global climate anomalies, and China's carbon dioxide emissions have now surpassed the United States as the number one carbon dioxide emitter. Energy efficiency is an important "energy source ". Drew Warren (1982) regards energy efficiency as the" fifth energy source "alongside coal, oil, natural gas and electricity. Energy efficiency needs to play a major role as a "source of energy" as it can reduce reliance on energy. Based on the analysis of the urban energy research framework, the article of urban energy efficiency measures are divided into broad sense and narrow sense two aspects, combined with domestic and foreign research results, respectively, the energy efficiency at home and abroad to use comparative evaluation index, energy consumption data acquisition method, from two aspects of theory and practical application discusses the applicable scope of different measure methods and its advantages and limitations in the urban energy efficiency analysis, and points out how to enhance the applicability of the overseas related research methods and clear policy boundary scope of relevant research conclusion.

Keywords: Computer, Total Factor, City Energy Efficiency

1. Urban energy efficiency division and spatial scope definition
As the center of human social and economic activities, cities are not only the concentrated area of
energy consumption but also the powerful driving force and influence of resource adjustment. Therefore, cities are also the key platform for the development of low-carbon economy and have the status of "low-carbon leadership". As an important part of regional economy, the sustainable development of resource-based cities has great influence and significance on national economy and society. At present, the study of urban energy efficiency measurement is relatively backward, which is mainly caused by two core problems. One is how to divide the measure of urban energy efficiency, and the other is how to define the boundary of urban space. Combined with the characteristics of resource-based cities, the input and output factors of energy efficiency in resource-based cities under the total factor framework were analyzed. On this basis, the models were built and the energy efficiency under environmental constraints and energy efficiency without environmental constraints were measured respectively, and the Malmquist productivity index was used for decomposition. Studying changes in energy intensity over time in the end-use sector provides a better understanding of changes in energy efficiency. Various energy intensity measurement methods have been developed, and they are constantly improved to accurately decompose the overall energy intensity of the economic system into the actual energy intensity change effect and structural change effect within the department. Yang Hong liang analyzed the energy efficiency of various regions in China with single factor index, and Stan analyzed the energy efficiency of various regions in China with total factor energy efficiency index. Through comparison, it was found that the total factor energy efficiency index could better reflect the current situation of energy production and consumption in various regions in China.

Table 1. Average energy efficiency of resource-based cities by urban development stage.

| Stage of Development | 2008  | 2009  | 2010  | 2011  | 2012  | 2013  | 2014  | Average | Sort |
|----------------------|-------|-------|-------|-------|-------|-------|-------|---------|------|
| Grow up              | 0.598 | 0.634 | 0.644 | 0.598 | 0.643 | 0.573 | 0.607 | 0.613   | 1    |
| Mature               | 0.461 | 0.450 | 0.424 | 0.445 | 0.472 | 0.456 | 0.443 | 0.451   | 3    |
| Recession            | 0.343 | 0.350 | 0.375 | 0.401 | 0.404 | 0.399 | 0.394 | 0.381   | 4    |
| Regeneration         | 0.549 | 0.662 | 0.528 | 0.620 | 0.590 | 0.540 | 0.505 | 0.571   | 2    |

2. Measurement method of urban energy consumption

The research on total factor energy efficiency under spatial statistical analysis can be generally divided into spatial correlation analysis, spatial influence mechanism research and spatial measurement analysis method research. In the analysis of spatial correlation, most domestic scholars use the exploratory spatial data analysis method (ESDA) to investigate the spatial distribution and inter-regional spatial correlation of energy efficiency among provinces, cities and key regions. Theil index was originally used to analyze the income gap between countries [1]. The larger the value, the greater the income gap between countries. The index can also be used to measure other regional differences, such as the difference of energy consumption intensity between regions, in a certain variable form according to its idea.

\[ T(I) = \sum iy_i1n(I_i) \]

The first order decomposition of Theil index can be used to decompose the overall national differences according to different zones.

\[ T(I) = TB(I) + TW(I) = \sum i = 1 3 y_i 1nI_i + \sum i = 1 3 y_i [y_i 1nI_i/i] \]
3. Measurement of urban energy efficiency in a narrow sense
Under normal circumstances, the application of computer software testing technology is mainly to timely understand the problems in the system, record the test results data and information, carry out comprehensive evaluation, and form a good test working mode [2]. In order to highlight the analysis of energy efficiency in resource-based cities under environmental constraints, this paper makes a comparative study without considering environmental factors. In order to scientifically measure the energy efficiency of resource-based cities, input factors and output factors need to be analyzed. Calculating "energy efficiency", as the name implies, calculates how many units of economic output a unit of input can get. This is the energy efficiency of the single-factor framework, which only considers the influence of the single factor of energy on economic output [3]. The energy efficiency calculated in this paper is based on the total factor framework and the Malmquist index decomposition of total factor energy efficiency. In 1998, China began to adopt the international index of r & d investment intensity, and the r& d investment increased from 128.98 billion yuan to 1029.84 billion yuan in 2012. The investment and government support enable enterprises to actively carry out innovation and make rapid scientific and technological progress, so as to realize positive growth of total factor energy efficiency. On the other hand, in the past 16 years, China has gone through three five-year plans, each of which focuses on energy conservation and emission reduction, which has restrained the development of energy-intensive industries. Energy-oriented industries have been strongly supported by the government and promoted the improvement of total factor energy efficiency [4]. With urban energy consumption and related issues on the agenda, the International Energy Agency (IEA) has for the first time proposed a global urban energy consumption estimation model in response to the lack of worldwide urban energy consumption data [5]. He made a bold attempt to estimate the energy consumption of different cities around the world, and provided a model for calculating the energy consumption of different cities in different countries. But the usefulness of the model in estimating urban energy consumption data has proved limited, Due to the significant imbalance of economic and technological development in China's three regions, in terms of energy technology level. The central and western regions are far behind the developed eastern coastal regions, so the reference technology frontier of the central and western regions is far lower than that of the eastern regions. Therefore, the total factor energy efficiency under the regional frontier is far higher than the total factor energy efficiency under the common frontier. Therefore, there are significant differences in the measurement results under the two frontiers [6].

4. Analysis of the existing energy efficiency detection methods in China
Among the factors affecting energy efficiency, such as industrial structure, market openness and energy price, some scholars consider that China's energy price is not in line with the international energy market, so they start to study from the perspective of energy price difference. The difference
between cities of different scale and grade. Cities above the prefectural level can be divided into different scale levels according to the size of the city to further investigate the differences in total factor energy efficiency of cities at different scale levels. The above definition of energy efficiency is based on the broad concept of energy efficiency, while many scholars have also studied the narrow evaluation index of energy efficiency. The narrow sense of urban energy efficiency mainly refers to the energy efficiency of urban residents. Although people interpret energy efficiency of urban residents from different perspectives in practice, they generally follow the very important concept of "energy service", which means that the use of energy is not the end of itself but a kind of input to provide services to meet people's needs. According to the Asia Pacific Energy Research Center (APERC), the basic task of the energy efficiency index is to assess the consequences of the relative situation of the target in the same group. The energy efficiency index can be evaluated for different energy policies and projects\(^7\). By comparing the past and future trends, we can obtain effective energy-saving technologies and methods, and analyze their relative improvement capabilities by comparing similar energy consumption processes. The third category is questionnaire data. In the process of collecting such data, it is generally conscious to define housing structure, housing ownership, use preference, demographic characteristics and other driving factors related to energy consumption. It also has access to reliable energy bills and other energy consumption information that residents can choose from. Such data are significantly better than macro statistics, but are also limited by the difficulty and cost of acquisition, subjective judgment of respondents, seasonal temperature factors during the survey period, and the representativeness of selected samples, etc.

5. Conclusion
The utilization rate of energy can reflect the economic development quality and technical level of a country and a region, which directly affects the sustainable economic development. The measure of urban energy efficiency built with computer technology and total factor framework can accurately obtain the data we need. Furthermore, it has great influence on the sustainable development of resource-based cities and national economy and society. How to improve energy efficiency has become an urgent task for resource-based cities to realize efficient and low pollution green economy. To understand the current situation, differences and changing trends of energy efficiency in cities at and above the prefectural level will lay a good foundation for the subsequent analysis of the effect decomposition and influencing factors of energy efficiency in cities, and also provide an objective basis for the formulation of reasonable urban energy policies.

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