International Conference on Applied Energy 2019
Aug 12-15, 2019, Västerås, Sweden
Paper ID: 0262

BASED ON CITESPACE'S 1998-2018 ENERGY ECONOMIC RESEARCH TRACK AND FUTURE FORECAST

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ABSTRACT

There is a unity of opposites between energy and economy. In order to comprehensively consider the relationship of energy economy, this paper is based on the literature visualization analysis software CITESPACE for co-citation analysis, co-word analysis, cluster analysis, etc. The material of its operation is 2964 articles on energy economic research included in the core of web of science. (From 1998 to 2018) The results show that the results of energy economic research have risen sharply since 2015, and technology and energy are the core of the energy economy; Long-term concerns such as “sustainability”, “innovation”, “efficiency”, “climate change”, “carbon dioxide emissions” and “economic growth” need to be further implemented； Development paths such as “turning”, “replacement”, “co-integration”, “renewable energy” and “elasticity” will continue to be research hotspots; In the process of analyzing the energy economy, tools such as “cge model”,” penal data”, and “data envelopment analysis” will continue to be hot topics in the study of energy economic equilibrium.

Keywords: Energy economy; research hotspot; CITESPACE; Forecast

1. INTRODUCTION

Economic growth depends on the support of energy, and limited energy has a contradiction with economic growth. The choice brought by this contradiction is the object of economics research. For the study of energy and economy, many scholars around the world have discussed it, mainly divided into the following categories. First, based on a review of a branch of energy economy, such as Kallis, G made a review of petroleum economics[1]. The second is based on the discussion of a specific region. For example, Kousar, S discussed the economic effects of the China-Pakistan Economic Corridor (CPEC) project[2]. The third is based on a specific object discussion. For example, Biresselioglu, ME studied the dynamics and obstacles of electric vehicle diffusion through three levels of decision-making[3]. The fourth is based on a specific perspective analysis. For example, Mamrayeva, D used an innovative perspective to discuss the innovative development and innovation activities of typical companies in every economic sector worldwide[4]. The fifth is to summarize the relationship between economy and energy through a certain measure. For example, Rye, CD reviewed the energy economic model that includes the EROEI indicator[5]. However, due to the large amount of information in knowledge, there is a multi-angle and multi-dimensional analysis of a phenomenon. Scholars have no panoramic map analysis of the research trajectory of energy economy. This paper analyzes the trajectory of energy economic research in 1998-2018 with CITESPACE. Excavate the current research hotspots of the energy economy and forecast future research trends.

2. METHODOLOGY

2.1 *Introduction to CITESPACE*

CITESPACE is a citation visualization analysis software. It uses scientific knowledge as a material for measurement and research, and it can express the development process and structural relationship of scientific knowledge. This software uses mathematical equations to demonstrate the law of scientific development. It adopts citation analysis method and information visualization technology. By adopting curves, maps and other forms, the scientific development law is drawn into an intuitive two-dimensional and three-dimensional knowledge map. The final purpose is to find

Selection and peer-review under responsibility of the scientific committee of the 11th Int. Conf. on Applied Energy (ICAE2019).

each Field research hotspots and research trajectories[6].

2.2 Material

This study selected data from the core set of Web of science. The selection method is citation search, and the "energy economy" is used as the key word for searching. The search time period is set from 1998 to 2018. A total of 22,456 journal articles were retrieved (as of May 10, 2019). The study removed editorial material, data paper, correction, reprint, biographical item, letter. The research selected article, proceedings paper, review, book review, book chapter, retracted publication, ews item, meeting abstract and other types of materials, so that the final effective number of documents is 22,258. The study classified the material by subject, including Energy Fuels (6819), Environmental Sciences (4444), Economics (2964), Environmental Studies (2805), Green Sustainable Science Technology (2530), Engineering Electrical Electronic (1940), Engineering Environmental (1741) and so on. This paper uses 2,964 articles of Economics as samples for analysis. The study will record 2,964 documents in full text and reference in plain text format, and then name the file as a file starting with the download_ word and put it into the newly created data folder. The data is finally loaded into CiteSpace.

2.3 Calculation and accuracy judgment

Through CiteSpace, first set the analysis time span to 1998-2018, then select the time slice as 1 and set the node type to keyword, so that the key time co-occurrence timeline knowledge map for renewable energy research is finally obtained.

The two parameter values visualized by CiteSpace can judge the rationality of the knowledge map, which are module parameter Q (Modularity Q) and average contour value S (Mean Silhouette). Among them: the larger the Q value, the clearer and more significant the structure of the clustering. In the interval of (0,1), when the Q value is >0.3, the structure is clearly clear and has a credible value; when the S value is >0.5, the cluster is generally considered to be reasonable[7]. The Q value of this clustering result is 0.3533, and the S value is 0.5146. Therefore, it can be considered that the clustering operation result is reasonable and effective.

3. RESULTS AND DISCUSSION

3.1 Number of documents

Through the statistics on the issue of energy economy from 1998 to 2018 (Figure 1), it can be seen that the total number of documents has been increasing from 1998 to 2018. The change from the curve can be divided into two stages: from 1998 to 2014, energy economic research is in a steady upward phase; from 2015 to 2018, the number of publications has increased significantly.

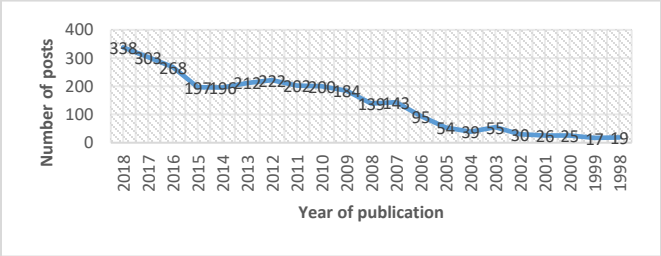

Fig 1 Analysis of the number of energy economic publications between 1998 and 2018

3.2 Keyword co-occurrence analysis

After the operation, N=211 and E=1440 are obtained, which indicates that a total of 211 subject nodes are generated by the keyword co-occurrence map, and a total of 1440 connecting lines are generated. After all the nodes are marked, the label items will be seriously overlapped, and the text information cannot be obtained. Therefore, the node labels with lower co-occurrence frequency are filtered out, and the simplified version of the energy economic keyword common knowledge map is derived. (Figure 2). The basic principle

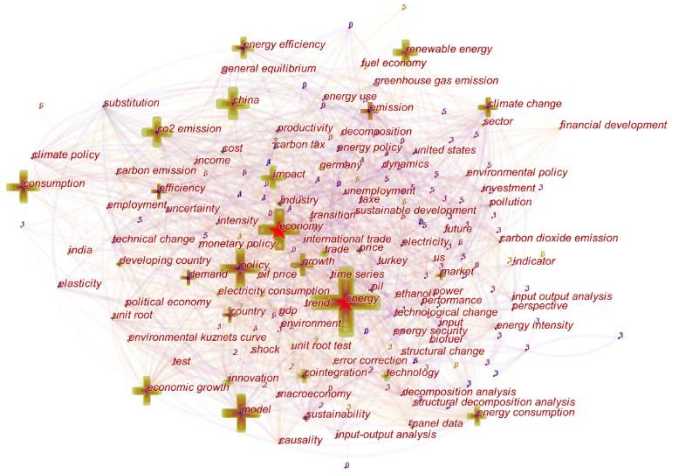

Fig 2 simplified version of the energy economic keyword common knowledge map

of co-occurrence of keywords is to count the frequency of occurrence of each group of words in the same group of documents, and to analyze the relationship between words and words by the number of co-occurrences[8].

Under certain conditions, the degree of co-occurrence of frequency and keywords is positively correlated with the hotspots of scholars at that time. The size of the nodes in the visualization map represents the number of occurrences of the keyword. The larger the diameter of the node, the more the number of representations.

Figure 2 shows that in addition to the two key words of energy and economy, policy, model, and consumption appear most frequently. Extract the information of the three keywords separately (Figure 3-5). The following content can be found: First of all, policy is highly relevant to international trade, competition, and investment and strategy. In the global specialization, a Global Value Chain (GVC) has been formed across economies. Countries are trying to improve the position of manufacturing in GVC to alleviate environmental constraints they faced[9]. This reflects the relationship between energy and economy is the availability of energy and its interaction with economic activities. Second, it is highly correlated with climate change and environmental protection. This reflects the energy economic function is the use of

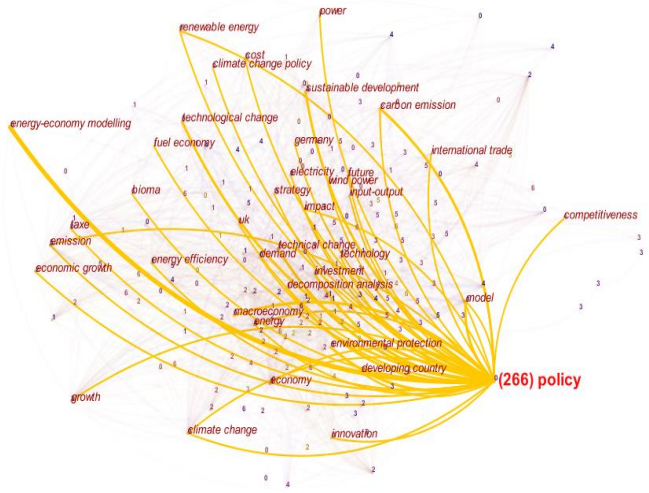

Fig3 "policy" keyword co-occurrence knowledge map

energy and the economic environment problems solved by it. Third, it is highly correlated with energy and sustainable development, especially renewable energy such as wind energy and biomass energy. This system is a trade-off between the energy economy and the limited energy resources. The fourth is highly related to technology and model, especially decomposition analysis. For example, SDA and IDA have been used to analyze changes in indicators such as energy use, CO2-emissions, labor demand and value added. The changes in these variables are decomposed into determinants such as technological, demand, and structural effects[10]. This shows that the energy economy is the way energy is used in the production and life of human society. Model is mainly related to dynamics, flexibility, technological change, demand, double dividend, substitution, general equilibrium, and uncertainty. This part is the support of energy and technology. Consumption is mainly related to input and output analysis, efficiency, rebound effect, co-integration, energy density, ecological footprint, and structural decomposition analysis. This shows that the energy economy is the process of conversion and substitution in the process of energy resource allocation in the economic process of social production and consumption.

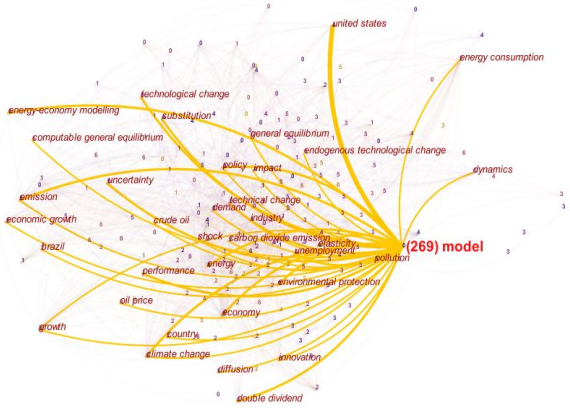

Fig 4 "model" keyword co-occurrence knowledge map

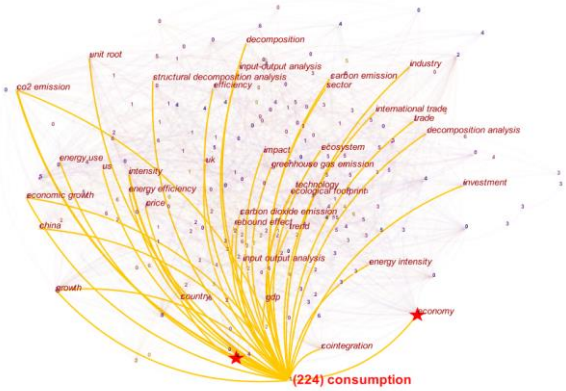

Fig 5 "consumption" keyword co-occurrence knowledge map

3.3 Keyword convexity analysis

The keyword emulation degree can reflect the research field with relatively large influence in a period of time. After the CITESPACE software cluster analysis of the relevant literature from 1998 to 2018, the first 25

emergent words were obtained (Figure 6). In terms of the degree of emergence, the "technological change" has an emissivity of 10.556, the degradation analysis has a degree of emergence of 9.015, and the energy has an emissivity of 7.5093. The outstanding values of these words are all over 7. The citation burst of the words are strong, which indicate that the research of these keywords has important value in the field of energy economy. It also shows that technology and energy are the core of the energy economy.

From the analysis of the sudden decline period, the “substitution” “sustainable development” emerged for

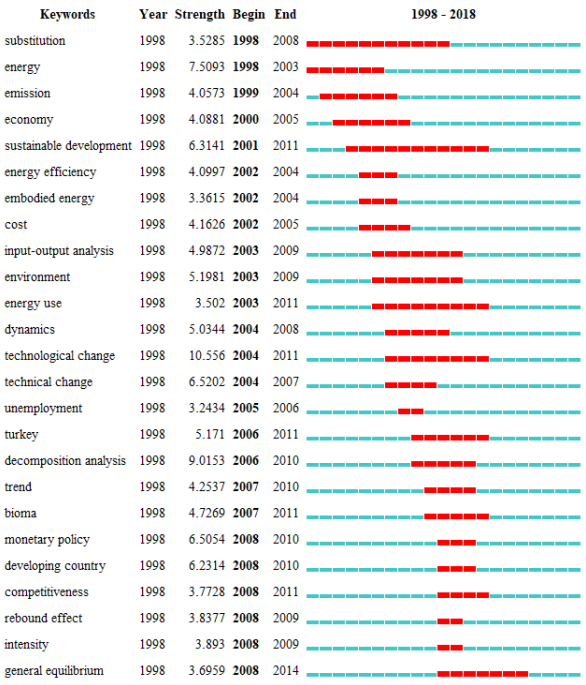

Fig 6 Top 25 words with the strongest citation bursts

11 years. This shows that the growth mode of transforming the economy, that is, developing in a sustainable way is a long-term development of the energy economy.

4. CONCLUSIONS

According to the key knowledge of the key words in the field of energy and economy in 2015-2018 Figure 7-10) and the research hotspots in the past 20 years, the future energy economic research should pay attention to the following aspects.

Long-term concerns such as “sustainability”, “innovation”, “efficiency”, “climate change”, “carbon dioxide emissions” and “economic growth” need to be further implemented.

These long-term developments are closely related to the structure and content of the energy economy. The speed

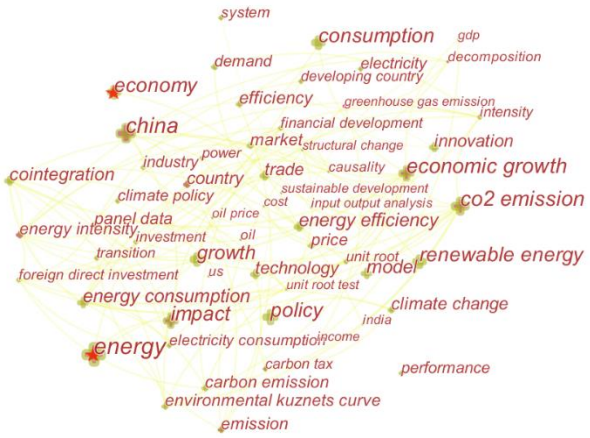

Fig 7 2018 Energy Economics Keyword Co-occurrence Knowledge Map

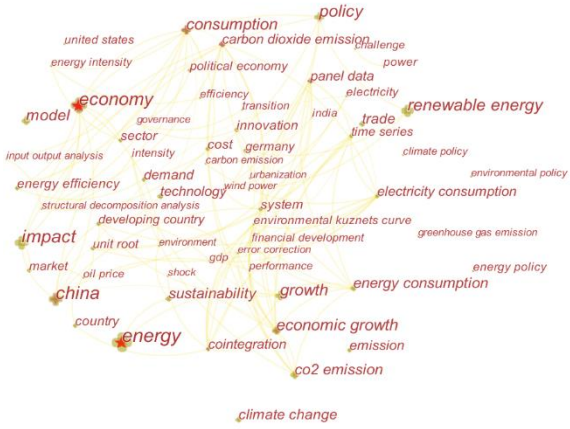

Fig 8 2017 Energy Economics Keyword Co-occurrence Knowledge Map

and quality of economic growth need to be balanced with the ecological environment and energy development. Therefore, this kind of research direction will be one of the hot research topics of urban economics.

Explore development paths such as “turning”, “replacement”, “co-integration”, “renewable energy”, and “elasticity”. The transformation of energy-free use is the direction of energy development. Every country in the world is exploring a clean development approach. The development of renewable energy can reduce dependence on fossil energy and safeguard national social and economic security. Renewable energy systems are promoted and developed notably due to their low environmental footprint[11]. A new alternative

development approach to energy can open up new areas of economic growth, integrate energy resources, and promote economic transformation. In recent years, research on energy elasticity, steering, substitution, and co-integration will continue to be hot spots.

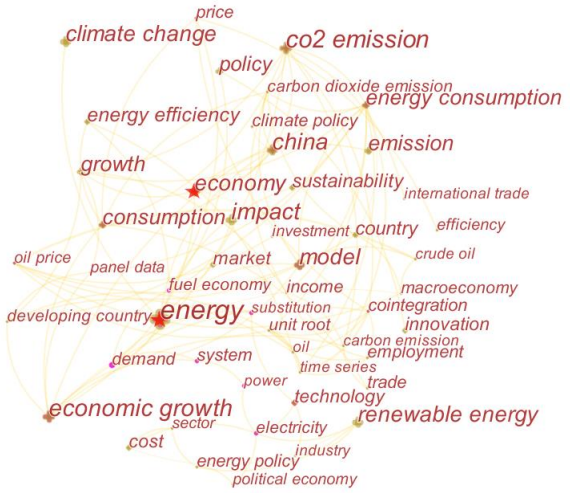

Fig 9 2016 Energy Economics Keyword Co-occurrence Knowledge Map

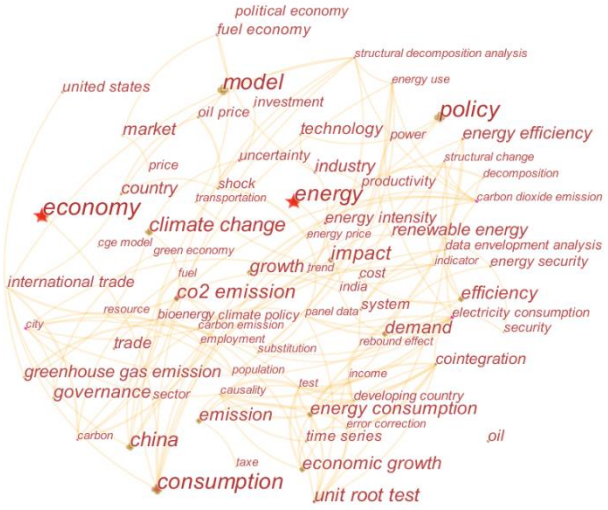

Fig 10 2015 Energy Economics Keyword Co-occurrence Knowledge Map

Explore the application of technologies and methods such as “cge model”, “penal data” and “data envelopment analysis” in energy economics. On the one hand, the energy economy changes according to changes in the world and regional energy patterns, and on the one hand has the foundation of economics. In the process of analyzing the energy economy, the data model is used to explore the content of energy economic equilibrium. In the process of analysis, "cge model", "penal data", and "data envelopment analysis" have become the hotspots of research.

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