The Discussion on Hot Spot and Frontier of Energy Research in Smart Cities

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Abstract. Taking the journal documents published between 2008 and 2019 in the core collection of web of science as samples, using citespace software, a visual analysis of the research literature in the energy field in smart cities from the three dimensions of research evolution path, research hotspot, and research frontier. The results show that smart city energy research has gone through three stages: the initial exploration of theoretical concepts, the growth period of technology application, and the coordinated industrial development period. The research hotspots mainly focus on the demand research of energy construction in smart cities, the research of energy intelligent construction and the energy of smart cities Construct three aspects of related industry research; the frontiers of research mainly include energy internet, smart energy and big data.

1. Introduction
The development of smart cities is inseparable from energy. Energy, like blood, is the basic guarantee for the functioning of urban organisms and an important driving force for urban economic construction and social development. As the main body of energy consumption, cities also determine the pattern and direction of future energy development. The problem of energy construction in the construction of smart cities is a complex system, involving many factors and complex issues, resulting in current research showing the inherent chaos and disorder of research in emerging fields, which makes the grasp of future research trends change Difficult. This paper uses citespace software to visually analyze the relevant literature included in the web of science, sorts out the research evolution path of energy issues in smart cities, tracks research hot topics, research priorities and frontier trends, and predicts development trends, so as to further clarify The key issues and key links faced by energy construction in smart cities, and dig out the key points and difficulties in the process of urban energy development, in order to better guide scholars to conduct targeted research and provide theoretical basis and practice for the practice of smart cities in my country guide.

2. Data sources and research tools
The data source uses the web of science database as the document data source, and the search condition is TS=(smart city) AND (energy); document type=article; time span=2008-2019, 911 related documents were retrieved.

This paper adopts the mainstream method in current literature research-bibliometric analysis to analyze the hot spots and development trends of energy research in smart cities, and uses citespace
software to visualize and analyze the literature data. The CiteseerX software is designed on the basis of the JAVA language, which can capture the corresponding detailed matrix relationships between different individuals and express the results visually.

3. **Keyword co-occurrence map analysis**

The keyword co-occurrence is used to analyze the research focus of the energy field in smart cities and the correlation of related fields, so as to grasp the overall characteristics of the energy field in smart cities. Use the visual analysis function of keyword co-occurrence in the CiteseerX software to obtain the knowledge graph of keyword co-occurrence at home and abroad (Figure 2). The results found that: "Smart City" has the largest focus circle, representing the most research centered on Smart City. Co-occurring keywords include "Smart Grid", "Internet of Things", "Energy", "Energy Management", and "Wireless Sensors" "", "Architecture" and other content, the number of branch agglomeration circles is relatively abundant, but the area of the agglomeration circles is small and the distribution is relatively scattered.

![Figure 1. Co-occurrence knowledge map of energy research keywords in smart cities](image1)

![Figure 2. Knowledge map of research evolution path Knowledge map of research evolution path at home and abroad](image2)
smart cities from the perspective of time development by using the characteristics of time views at home and abroad. Through the evolution path map of the energy problem research of smart cities (Figure 3), the development of this problem research is divided into three stages: The first stage is the initial exploration of theoretical concepts, and the time span is from 2008 to 2012. At this stage, both the research on smart cities and the research on smart energy issues are in the preliminary exploration stage, and there are few relevant documents and theoretical research is the main. The second stage is the growth period of technology application, and the time span is from 2013 to 2016. At this stage, the focus of research is mainly on the research of smart energy construction technology carried out around ICT (information and communication technology), which is characterized by related technology research and practical application as the guidance, focusing on the technical level to promote the construction and development of smart cities. The third stage is the period of industrial coordinated development, and the time span is 2017 to present. At this stage, research on smart energy is no longer limited to individual research on energy systems, but from a macro perspective of industrial development, studying energy construction issues in smart cities from an overall perspective, focusing on the energy industry and other related industries. Coordinated development between the two.

5. Visual analysis of research content
Select LLR algorithm clustering in citespace, and use keywords to identify the clusters, and use the cluster explorer function in citespace to obtain specific cluster citations, and combine cluster identifiers and cluster citations to summarize the main content of the research. Get the clustering knowledge graph of Figure 4. The value of Modularity Q abroad is 0.3481 and the value of mean silhouette is 0.6045, indicating that the clustering profile is good. The classification of cluster identification is divided into three categories: smart city development direction, smart energy direction and related industry direction.

5.1. Research direction of energy construction demand for smart cities
The research direction of smart city energy construction needs, the keywords involved mainly include smart city, green development, sustainable development, resource allocation, low-carbon development, urban data system, smart grid, energy management system, etc. Scholars have studied the construction planning of smart cities. Although the construction models are different, they all involve the demand for intelligent energy construction, which are mainly divided into the following three aspects: First, the demand for low-carbon green development in smart cities. The framework of smart city and green ecological development are mutually integrated. The combination of smart city and green ecological development jointly supports the social and economic development of the city. The intersection of the three constitutes the future development direction of the city. Second, the demand for energy data in the informatization of smart cities. Data on environment, energy, transportation, etc. is an important part of the establishment of a scientific city data system and the basis for building a smart city public information platform. Third, the demand for energy infrastructure in smart cities. Electricity is a city energy source, and the intelligent development of its main carrier power grid plays an extremely important role in the construction of smart cities. In the construction of smart cities, the development of smart cities driven by smart grids has been raised to the strategic height of overall urban planning [1].

5.2. Research direction of smart city energy intelligent construction
The development of smart city energy intelligence has brought a transformational opportunity for the traditional energy industry. The integration of technologies such as the Internet of Things and cloud computing with the energy industry is a revolution in primary energy technology. The research on the concept and connotation of smart energy is To promote the foundation and prerequisites for its follow-up development, there are basically three consensuses on the development of smart energy: 1) Smart energy can effectively solve the energy and environmental problems faced by cities. 2) Smart energy can guarantee the energy security needs of cities. 3) Smart energy can promote the coordination and complementation of regional energy resources and optimize the allocation to improve energy efficiency.
There are many problems in the process of smart energy construction. For example, the construction of smart infrastructure is not perfect, government supervision system and methods are relatively backward, etc. Therefore, research is also focused on several key issues: 1) Overall planning and top-level planning of smart energy construction Design issues. 2) The issue of construction funds. The construction of smart energy is a very complex giant system that requires support from multiple parties and sufficient funds. 3) A new regulatory framework compatible with smart energy.

In the related literature on smart city energy issues, the most aggregated keyword is "smart grid", but the research topics and construction goals of smart grids vary from country to country. The United States focuses on research on the formulation of relevant standards, Europe and Japan focus on research on new energy, distributed energy, and microgrids, while South Korea focuses on the development of new energy vehicles and smart meters relying on its own industrial characteristics.

5.3. Research direction of smart city energy-related industries

There are clusters of the construction industry and the transportation industry in domestic and foreign literature studies, indicating that the construction of energy in the construction of smart cities is inseparable from the construction of buildings and transportation.

In the transportation industry, the keywords involved include electric vehicles, smart street lights, smart charging stations, electric energy substitution, fuel cell technology, and operation plans. According to statistics, one-third of the energy consumed in the world comes from the field of transportation, so research on energy cannot be separated from related research in the field of smart transportation. On the one hand, research on electric energy substitution. On the other hand, it is about the integration between the transportation network and the energy network.

In the construction industry, it mainly focuses on the research on energy consumption in buildings, such as building energy conservation, energy consumption monitoring, and electricity consumption information collection systems. Compared with ordinary buildings, smart buildings can reduce energy use by 50% on average. In addition, in order to realize energy-saving management, smart buildings propose the integrated development of Internet of Things technology and smart building energy management, and build a public energy-saving management platform, which is of great significance to energy demand-side management.

![Figure 3. Keyword clustering knowledge map of smart city energy problem research](image)

6. Visual tracking of research frontiers

In citospace, the algorithm proposed by Kleinberg, J. in 2002 is used for detection, and "emerging subject terms" can be obtained to track the research frontiers of the subject, using citospace software to detect a total of 13 prominent words, which can be roughly classified. It is divided into four categories. One is related to green and smart cities, including climate and energy efficiency. It focuses on energy and emphasizes the impact of energy use on the urban environment. The second is the related issues of technology and hardware support, including cloud computing, smart grid, and smart meter. It can be
seen from related technologies that energy construction in smart cities mainly depends on the development of information construction. The third is related to the integration and development of other related industries. The key word involved is traffic. The energy subsystem of the smart city is not an independent subsystem. With the gradual development of the smart city, the correlation research between the various subsystems is also will gradually become a hot topic of research. The fourth is other prominent words. The key words involved are protocol. The construction of a smart city is a huge engineering project that requires multiple parties to collaborate. Therefore, in research, agreements between different parties have also become a hot issue in current research.

7. Conclusions and reflections

Through bibliometric analysis of energy issues in smart cities, it is not difficult to see the following problems in related research:

First, the research subject is single. The construction of smart energy involves many interdisciplinary subjects and departments, so the main body of research should not be limited to power companies. Second, the research content is highly fragmented. For an emerging field, it is not surprising that research content is highly fragmented. Under this circumstance, it is necessary to consider the construction of smart energy in smart cities as a whole, from a system perspective, to carefully sort out the important and difficult issues in this research field, and to point out the direction for follow-up research. This is the purpose of this article. Finally, the practical application of key technologies is not yet mature. From the perspective of research fronts, the research of big data, cloud computing and other related technologies belong to the research fronts of this field. The application of these technologies is still in the pilot stage, indicating that there is still a long way to go to the large-scale application of these frontier technologies. Need to do more in-depth research.

In short, in a smart city, the construction of smart energy is a systematic and long-term process. In theory, the research on this issue belongs to the field of interdisciplinary research and requires the cooperation of experts from various disciplines. In practice, it involves multiple subjects in society and requires the coordination of all sectors to create favorable environment and conditions for construction from multiple aspects such as policy, capital, and technology, and jointly promote the achievement of smart energy construction goals. Judging from the current research, the development of the energy field in smart cities has just started, and the construction of smart energy has not yet reached the requirements of smart cities for the development of smart energy. There is still a long way to go in the construction of smart energy, but the future of this field the development prospects of the company are still very broad.

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