Application of hydrogen energy in low carbon cities

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Abstract. Hydrogen energy, as a new clean energy, has attracted wide attention all over the world because of its own advantages, and China is also one of the hydrogen energy plans in some countries. But most of the investment and energy of hydrogen energy are in other fields, such as transportation. Low carbon cities are the development model to deal with environmental deterioration and climate change in recent years. They introduce low carbon clean energy, introduce low carbon energy in small towns and construction life cycle, and establish low carbon operation system. For hydrogen valley or hydrogen energy town model to provide reference. Through the analysis and comparison of the initial utilization of hydrogen energy and other energy sources at home and abroad and the literature of energy towns, and according to the development experience at home and abroad, the feasibility and operation mode of hydrogen energy in low carbon towns are summarized.

1. Introduction

1.1 Research background
Because of the rapid development of human society before, it has caused some pollution and destruction to the environment and natural ecology, caused the global climate change, and began to affect its own normal life. Among them, a large amount of carbon emissions is one of the reasons for the natural ecological environment problems. China is the country with the most carbon emissions and energy consumption, while the construction industry is an area with more energy consumption, accounting for about 34 percent. So countries and the construction industry need new energy to reduce carbon emissions and energy consumption. Low-carbon cities are urban models for addressing climate change and improving people's quality of life, introducing clean energy to form systems involving various industries and fields to reduce carbon emissions. Hydrogen energy is a new and clean energy source in recent years. Some countries, including China, have begun to develop hydrogen energy plans. Although most of the investment and energy of hydrogen energy is in the field of transportation, the technical means and applications of hydrogen energy need to be improved. However, some studies at home and abroad have introduced hydrogen energy into other fields, such as construction, for related research and transformation. By searching hydrogen energy and building keywords in knowledge network and web of science, it can be found that the literature of hydrogen energy has increased rapidly in the past two years and involves many fields.
1.2 Purpose and significance of the study

Through the study of hydrogen energy and the research of buildings and low-carbon cities, the hydrogen energy is introduced into the field of architecture, coupled to sum up the combination points and strategies of the two, and the initial application literature of other energy sources is studied. Analogy the way and method of combining hydrogen energy with architecture. Reduce energy consumption and carbon emissions in the construction field, and timely corresponding national policies and trends, make their own changes and responses, but also for the future promotion and application of hydrogen energy and other new energy to provide their own ideas, methods and strategies.

2. Literature review on hydrogen energy applications and low carbon cities

2.1. Application Prospect of Hydrogen Energy

Hydrogen is the lightest gas and has no taste color. It can be obtained by electrolytic water, solar hydrogen production and other ways. It has the advantages of high efficiency, low carbon, no pollution and wide application. It has become one of the important energy sources to improve energy structure in many countries, including China, and make different hydrogen energy plans according to its own national conditions. Fu Guanwen summed up the hydrogen energy models of Germany, Japan and the United States, their purpose and model of hydrogen energy development are also different, Japan's hydrogen energy industry, Germany's energy transformation, the United States is to achieve their own independent energy route, although the purpose and national conditions are different, but for China's hydrogen energy development model brought some inspiration. It can be seen that the development of hydrogen energy in most countries is focused on the field of transportation and the development of hydrogen energy fuel cell vehicles. Meng Xiangyu studied the future of China's hydrogen energy development industry. In addition to a large number of policies and measures introduced by the state to vigorously invest it in the field of transportation, due to China's large iron and steel production, the pressure on coal emissions and the potential of hydrogen in international trade, the development prospects in metallurgy, coal chemical industry and international commodity trade are analyzed. The application of hydrogen energy can also penetrate into various industries. At the same time, Yao Chunni introduced hydrogen energy into the construction field, carried out preliminary application exploration and research of hydrogen energy in the construction field, analyzed the current situation and development of the main stages of hydrogen energy preparation, storage, transportation and application, and connected hydrogen energy with the building in the form of other energy sources such as electric energy, light energy and heat energy. Because the combination of hydrogen energy and architecture is still in the initial stage, it can also bring some enlightenment to hydrogen energy building by studying some other scholars' early application literature, and can also integrate hydrogen energy with HVAC and other systems inside the building.

2.2. Low-carbon urban model

Because of the rapid development of urbanization before, the scope and degree of urbanization have...
been improved, which has become the largest area of carbon emission. Ju Xiang elaborated the concept of low-carbon city and low-carbon town, and compared with domestic and foreign case studies, which provided some enlightenment for the development of low-carbon cities in China under the premise of emphases and local conditions. Low-carbon cities are urban development models that respond to climate change and the environmental problems caused by cities, using urban space as a carrier, using construction, transportation, energy, consumption and production as elements to achieve low-carbon emissions and carbon treatment in the context of proper planning and effective operation of society. The development of low-carbon urban planning in our country started late and presented some problems, such as unclear concepts and standards for low-carbon cities, incomplete accounting of gas emissions and lack of data, lack of interest-driven, unsmooth connection with other parts of urban and rural planning, and conflict between some planning and development. Without a good integration of content, goals and ideas into the overall planning, development and layout of cities, there is a need to increase practice, research, guidance and regulation of low-carbon cities. Li Yanxue et al. conducted research on the application of hydrogen energy and cities and buildings, building on some cases, building hydrogen energy and intelligent communities, introducing the use of hydrogen fuel cells, building hydrogen pipeline networks to transport hydrogen, using hydrogen fuel cells and intelligent networks to meet the needs of daily life, and achieving further intelligence and low carbonization (see below).

![Image](network)

Figure 2. Diagram of the change of hydrogen energy literature and histogram of the change of hydrogen energy building literature (picture from the network)

2.3. Summary
By studying and summarizing the literature on hydrogen energy and low carbon cities at home and abroad, this paper expounds the current situation and problems of hydrogen energy and low carbon cities in China, and analyzes the necessity of developing hydrogen energy and low carbon cities according to their literature.

3. Strategies and Ideas of Hydrogen Energy Application in Low Carbon Cities

3.1. Development of appropriate policies and regulations
Develop standards and documents for low-carbon cities and hydrogen energy applications; draw lessons from Japan, the United States and Germany's hydrogen energy development model, although different national conditions, but have formulated the corresponding policy documents, so that all cities and all areas of the city are valued, and need to improve the corresponding laws and regulations to ensure.

3.2. Increased publicity and industry benefits
In addition to some coercive measures, it is necessary to increase the publicity of hydrogen energy and low carbon cities, popularize their safety, importance and advantages, and increase their wide recognition. In addition, cities and industries that are active in implementing and corresponding policies need to be supported in order to mobilize the initiative of cities, industries and people to
promote the development of hydrogen energy and low-carbon cities.

3.3. Reasonable Planning
Formulate reasonable special urban planning and hydrogen energy system, connect with its overall planning and other urban planning, avoid conflicts with other urban and rural planning and interests, define targets and gas emission standards, and guide hydrogen energy and low carbon standards to all fields of the city to form a complete and reasonable and efficient system.

3.4. Technology upgrading and domain integration
Improving the technology and equipment for hydrogen production, hydrogen storage, hydrogen transport and hydrogen use is also one of the important factors restricting the development of hydrogen energy. Because China has issued some policies in recent years to guide and encourage the development of hydrogen energy industry, it has made a breakthrough in technology. There is also a lack of integration with other fields, low scope and acceptability, which is not conducive to the development of hydrogen energy and low carbon cities.

3.5. Ideas for application in the construction field
Energy consumption in construction accounts for 34% of total energy consumption in China. To explore the better application of hydrogen energy in architecture and to provide some ideas for the future combination of energy and architecture. The distribution of energy is uneven, and the climate is different in different regions, such as cold areas and hot summer and warm winter areas. The energy consumption of buildings is different. Therefore, hydrogen energy and building can be combined and classified according to energy distribution and different climatic regions, and different strategies and approaches can be developed. Different types of buildings will also have different requirements, applications and priorities for hydrogen energy, such as residential, office, commercial and cultural types of buildings in different time periods and energy use will also be different. The research classification variables for the best energy consumption cases in the United States, such as Lu Yanjie, are the analysis and research of the variables according to the underlying residence, single office and large office buildings and parks. In the earlier literature, there were also studies on the impact of energy-saving technologies on building patterns and layout to maximize energy use and efficiency. These different starting points and angles can provide ideas for the further combination of hydrogen energy and architecture and theoretical research in the later period.

3.6. Summary
Referring to the literature studied, this paper puts forward the application strategies and ideas for the development of hydrogen energy and low carbon cities in China and the integration of the two. It provides inspiration for the application of hydrogen energy in low carbon cities.
4. Application of Hydrogen Energy in Low Carbon Cities

4.1. Application of hydrogen energy in low-carbon cities

4.1.1 the integrity and linkages of functional areas in low-carbon cities
In addition to the cultural, medical, commercial, corporate, educational, residential, leisure and entertainment functional areas required for the normal functioning of low-carbon cities, it is necessary to add low-carbon and hydrogen energy planning to cities and form a complete and effective system to integrate into most areas and areas. Reduce the harmful gas emission of the city, increase the overall green construction of the city, add the complete hydrogen energy industry line, realize the green development of high efficiency and energy saving of the city. Comprehensive utilization and complementarity of hydrogen energy and other energy sources in

4.1.2 low-carbon cities
To realize the mutual conversion and supplement of clean energy in low carbon cities, combine hydrogen energy with other clean energy, because of the clean and efficient hydrogen energy, so use solar hydrogen production, electrolytic water hydrogen production, wind power hydrogen production and other energy to achieve hydrogen energy conversion; hydrogen energy can be used to generate electricity and heat, hydrogen energy to electricity and heat energy conversion. Use solar, wind, water and hydrogen energy and other energy sources to supplement and transform the energy of buildings.

4.1.3 make buildings the productive and output end of energy
Use solar power, hydrogen power generation heating and other forms so that buildings can generate their own electricity and heat. By connecting hydrogen fuel cell vehicles to the power grid and using proton exchange membrane fuel cells to convert hydrogen and oxygen into electricity and water, hydrogen energy vehicles can be allowed to transfer up to 10 kW of DC to AC State Grid through an off-board inverter when stopping. Synchronize with AC grid. Reduce energy burden and reduce environmental impact and efficient use.

4.1.4 Strengthening hydrogen energy infrastructure and natural environment construction
Build a complete hydrogen production, storage, transportation and use of the system, build hydrogenation stations and other infrastructure, the development of hydrogen energy industry chain. Low carbon cities also need a good natural green environment. In the early stage of urban planning, the green ecology of the whole city needs to be integrated into it, rather than the construction of green environment in the late stage of planning. It can better integrate with the overall planning of the city and increase the green health and sustainable development of low-carbon cities.

Figure 4. Overview of hydrogen energy operation system in low carbon cities (self-made by authors)
5. Summary
In order to cope with climate and environmental changes, the advantages of hydrogen energy and the characteristics of low carbon cities have some potential in dealing with gas emissions. Carbon cities is studied and summarized to understand the application prospect of hydrogen energy and the development model of low carbon cities, and to seek the combination points and ideas of hydrogen energy and low carbon cities and buildings from the literature. The research content provides some ideas for the development of hydrogen energy and low-carbon cities in China, as well as the application of hydrogen energy in the field of construction, and is conducive to alleviate environmental pressure and comply with national policies.

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