Analysis of the status quo of solar heating under the background of carbon neutrality

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Abstract. Since 2020, under the market trend of the "carbon peak" and "post-coal reform" era, clean energy heating has ushered in development opportunities. This article mainly introduces the current status of solar combined heat pump, biomass energy, electricity, photovoltaic and other heating methods, compares the differences of various types of energy heating, analyzes the advantages and limitations of solar heating, and puts forward reasonable suggestions.

1 Introduction

As of the end of 2019, according to China's Clean Energy Heating Industry Report, the total heating area in northern my country was 21.1 billion square meters, of which the clean energy heating area was 11.6 billion square meters, and the clean energy heating rate reached 55%. As shown in Figure 1, clean energy heating in northern my country is mainly based on clean coal and natural gas heating, and solar energy and other energy sources account for a very small proportion. Judging from the solar heating data collected in 2020 in Figure 2, the construction of solar heating projects has developed rapidly in the past two years, indicating that solar energy combined with other energy heating has huge market potential^[1].

Figure 1. The structure of clean energy heating in northern China in 2018

Figure 2. Solar heating data in 2020

The report "China's Energy Development in the New Era" also mentioned the need to build a diversified clean energy system, actively promote the diversified use of solar energy, accelerate the promotion of solar photovoltaic and solar thermal applications, and continue to develop the market for solar thermal utilization and solar energy utilization methods. Everyone actively promote the construction of solar heating projects. This is an opportunity period for the development of solar heating. The construction of heating projects combining solar energy with other energy sources has a huge market prospect.

2 Solar heating method

2.1 Traditional solar heating method

Traditional solar heating methods mainly include solar air heating and solar hot water heating. Solar air heating mainly uses air as the medium, and the heat collection efficiency is relatively low. There will be hidden dangers of dust accumulation in the air flow path, but the price is cheap, simple and reliable, and there will be no freezing problems in winter and overheating during non-heating periods. At the same time, the system is maintained and operated. The workload is small, the reliability is high, and the heating effect is not stable during long-term operation, and auxiliary energy support is needed. The heat collection technology of solar water heating system is relatively mature, industry and market support is good, and the system adaptability is good, but there are also thermal stability and instability conditions during long-term operation, and auxiliary energy support is needed^[2].

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2.2 New solar heating method

There are many forms of heating by combining solar energy with other energy sources, mainly using solar thermal and photovoltaic technology combined with other clean energy sources to form a heating system. The more widely used are solar combined heat pump heating systems, solar combined electric heating systems and Solar energy combined with biomass heating system^[3].

The solar combined heat pump heating system is divided into a solar thermal combined heat pump heating system and a solar photovoltaic combined heat pump heating system. The solar thermal combined heat pump heating system is mainly a combination of solar thermal technology, air source heat pump and ground source heat pump. Solar energy, air energy and geothermal energy are all available energy sources. They are all clean energy sources, which can save energy to the greatest extent. At the same time, the operating cost of the combined heating system will also be greatly reduced. The solar photovoltaic combined heat pump heating system is a combination of solar photovoltaic and air source heat pump, which mainly uses photovoltaic power generation to drive the air source heat pump, which is essentially an air source heat pump for heating.

Solar combined electric heating systems can be divided into solar combined electric conversion heating and solar photovoltaic power generation-driven heating equipment. The solar combined power conversion heating system is mainly composed of solar light heating and heating equipment that converts electricity into thermal energy. Solar photovoltaic power generation-driven heating equipment uses solar energy to convert

into electrical energy and uses electrical energy to drive the equipment for heating. Electrically driven heating equipment is mainly an air source, Heat pump and thermal storage electric boiler^[2].

The solar combined biomass heating system is composed of a solar collector and a biomass furnace. It uses solar energy as the main energy source and biomass energy as an auxiliary energy source. When the solar collector cannot meet the heating demand, the biomass boiler runs to compensate Insufficient solar heating.

3 Advantages of solar-assisted heating by other energy sources

3.1 Energy saving and emission reduction, high economic benefits

The main advantage of using solar heating is energy saving and emission reduction, and the economic benefits are high. The energy-saving rate of solar buildings in developed countries in Europe and America is around 75%, and the energy-saving rate of solar buildings in my country is more than 70%. Solar heating also has higher economic benefits. Table 1 is a comparison of the performance of different heating systems. Although the initial capital investment of solar heating is relatively large, the operating cost is relatively low after it is put into operation. Solar heating projects can generally recover the investment cost in 4-6 years. The service life of solar heating projects is about 20 years, so its economic benefits are significant^[4].

Table 1. Performance comparison of different heating systems.

Heating type	Electric boiler heating	Air source heat pump heating	Ground source heat pump heating	Gas boiler heating	Coal-fired boiler heating	Solar energy coupled electric boiler heating	Solar energy coupled air heat pump heating
Investment operating cost per unit building area(yuan/ m ²)	140	250	290	100	30	500	650
Energy consumption per unit area (KWh/year/m ²)	151.6	45.1	37.9	164.1	96	28.9	25.4
Operating cost per unit area/year (yuan/m ²)	76	23.5	19	37.6	47.9	14.2	12.4
Energy calculation unit price (yuan/KWh)	0.5	0.5	0.25	0.5	0.5	0.5	0.5
Environmental protection	high	high	high	high	low	high	high
Safety	high	high	high	high	low	high	high
Whether there is domestic hot water	no	no	no	no	no	have	have

3.2 Solar energy and various types of energy are complementary

Solar energy can be combined with multiple energy sources for heating. This is the second advantage of solar heating project construction. There are many types of solar combined heating, such as solar combined power, solar combined boiler, solar combined biomass, solar combined heat pump, solar combined gas, Solar energy combined with phase change, solar energy combined with soil energy storage and so on. The auxiliary matching of solar energy and other energy sources is particularly strong.

3.3 New solar technology support

The development of the times is inseparable from technological innovation, and the development of solar heating projects is inseparable from technical support. New technologies inject new vitality into the construction of solar heating. Solar thermal and photovoltaic technologies are constantly innovating, and solar thermal utilization is diversified. Development and continuous creation of new products in the construction of heating projects, such as solar heaters, solar heating, cooling and hot water trigeneration, and solar walls.

4 Limitations of solar-assisted heating by other energy sources

4.1 Unstable solar resources

Solar energy resources are easily affected by the seasons. Solar energy resources still have timeliness issues. They are greatly affected by day and night. In extreme weather such as cloudy days, the solar energy guarantee rate is low. Although there are other auxiliary energy sources for heating, it will also affect the heating efficiency of the entire system.

4.2 Lack of standards and specifications for solar heating projects

In recent years, solar heating projects have developed rapidly, and solar photovoltaic and photothermal technologies have continued to innovate. The standards and specifications used in the past have gradually failed to keep up with the development of the project. The standards and specifications for the construction of solar and multi-energy combined heating projects are not yet complete, and the relevant policy guarantee mechanism for solar heating is not yet complete.

4.3 The initial investment cost is relatively large

Solar energy combined with multiple energy heating is a clean and energy-saving heating method, but solar heating equipment and auxiliary energy heating equipment are more expensive, which leads to a large

initial investment in solar heating projects. Although the state has been supporting policies and finances, However, compared with other energy heating systems, the investment is still relatively large, and the cost recovery period is relatively long.

5 Suggestion

5.1 Focus on improving building energy efficiency

When installing solar heating systems, properly improve the building facilities to ensure that the entire building facilities meet the energy-saving standards. The building facilities themselves are part of the system. The thermal insulation treatment of the entire building facilities directly affects the heating load of the building, which is to improve Effective measures for the operating efficiency of solar heating systems^[5].

5.2 Actively encourage advocacy and reduce costs

Solar heating projects have high social, economic and energy-saving benefits. Active promotion of solar heating projects has a positive effect on the economic development of the grassroots. Because of its large investment and long recovery period, market promotion is difficult to promote. The government must play a functional role and strengthen subsidies for solar heating projects. At the same time, the government must strengthen The incentive system for the scientific research and development of solar energy enterprises has continuously reduced the cost of solar heating projects. The government should select representative areas for solar heating, actively promote it, and constantly explore new models and methods for solar energy technology in energy construction^[6].

5.3 Actively improve the standards and specifications of heating engineering

While the development of clean energy heating, it is necessary to continuously improve the construction of clean energy systems, actively improve the standards and specifications of clean energy heating projects, build a clean energy heating information platform based on the construction of clean energy markets, and establish management mechanisms for relevant departments. The government should also increase its support and continuously improve policy support for clean energy heating in accordance with the market environment.

5.4 Build a combined heating, cooling and hot water system

The development of the new era has brought about the structural reform of energy. People put the focus of energy development on clean energy. Solar energy combined with other energy heating has great market

prospects. While developing solar heating technology, we must not only pay attention to the innovation of solar energy technology, but also combine and develop with other energy technologies, such as the combination of solar energy and air energy, and the combination of solar energy and air source heat pumps to form heating, cooling, and hot water. The triple-supply system can achieve cooling in summer, heating in winter and hot water supply throughout the year, and better improve energy efficiency. When installing solar heating, a triple-coupling system should be actively constructed according to actual conditions and capital conditions.

6 The significance of solar heating in buildings

6.1 Alternative to conventional energy

The energy used in human society is mainly coal, oil, natural gas and other conventional energy sources. These energy sources are all non-renewable energy sources, and at the same time they can cause environmental pollution during use. With the development of the economy and society, the scope and amount of use of these conventional energy sources continue to increase, and the consumption of energy continues to grow. Due to the limited conventional energy resources, people must actively take various measures to improve the efficiency of energy use and reduce Energy consumption, using solar energy instead of conventional energy for heating in terms of building energy saving, not only protects the environment but also saves energy use, and effectively promotes sustainable development.

6.2 Protect the environment

The ecological environment in which people live is very important. The use of solar heating in building energy saving can reduce the use of fossil fuels and reduce the emission of pollutants. Better build a clean, comfortable living environment, energy-saving and emission-reducing living environment, and at the same time continuously improve the people's real life needs.

6.3 Solve energy demand in remote areas

People in remote areas are short of energy for living, and there is a phenomenon of burning crops for heating in winter. The use of solar energy resources according to local conditions to provide people in remote areas with winter heating and domestic hot water can solve the problem of energy shortage in remote areas, and also solve local environmental problems, protect the local ecological environment, and improve people's quality of life. It has a good society. Benefits and environmental benefits.

6.4 Improve people's quality of life

Solar heating can solve housing constructions that are not suitable for collective heating and can be installed flexibly. The hot water provided by solar collectors can not only meet the heating load of the room but also provide the hot water needed for life, which greatly increases people's life needs and improves people's quality of life.

7 Conclusion

People pay more and more attention to clean energy heating technologies such as solar energy. The development of clean energy heating is inseparable from the support and innovation of solar photovoltaic and photothermal technologies. The Chinese government has continuously promoted the diversified development of solar energy in policy and finance. The construction of solar heating projects is also moving forward steadily, and solar heating projects have great market prospects in the future. We must continue to explore and actively promote solar and other clean energy heating.

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References

1. Cheng J.Y, Hang J.P, Li L.X., (2020) Thoughts on the development of clean heating during the "14th Five-Year Plan" period. *J. China Construction Metal Structure*, 12:15-17.
2. Yang, J., (2020) Analysis of Applicable Technology Types in Passive Solar Heating Areas. D. Xian, Xi'an University of Architecture and Technology.
3. Wang.M., (2017) Suitability Analysis of Auxiliary Heat Sources for Solar Heating in Northwest Rural Areas. D. Xian, Xi'an University of Architecture and Technology.
4. Yin.B, Zhang.T, Zhang.C.G, Dai.J.P, Li yi.T (2020) Technical and Economical Research on Clean Heating in Northern Rural Areas. *J.*
5. Wang.X.M., (2020) Application status and countermeasures of solar heating engineering. *J. Construction works*, 09:101-102.
6. Liu. F.C., (2016) Energy consumption analysis and environmental impact assessment of solar heating system based on life cycle assessment theory. D. Jinzhou, Liaoning University of Technology.