Academic Journal of Science and Technology
ISSN: 2771-3032 | Vol. 3, No. 2, 2022

Assessment and Rational Utilization Analysis of Regional Solar Power Resources

Jiadong Li

High School attached to the Shandong Normal University, Jinan, China

Abstract: Since the beginning of the new century, the world has been more and more caught in the dilemma of sharp deterioration of the environment and increasing shortage of energy. People have become more and more aware of the importance of new energy and clean energy. Solar power is recognized as an absolutely clean and renewable energy. Developing and utilizing solar power can effectively solve various problems such as energy shortage and environmental pollution. Firstly, this paper elaborates the distribution of solar power resources in China, and introduces the industrial application status of solar photothermal effect and photovoltaic effect in China. Then, the assessment and rational utilization of regional solar power resources are analyzed and discussed. Finally, some problems existing in the solar power industry in China are pointed out, and some suggestions on how to promote the rational utilization of regional solar power resources are put forward: building solar houses, promoting the application of vacuum tube collectors, flat and focused collectors, making full use of solar power generation technology, etc. This paper is expected to provide some reference for related research.

Keywords: Solar power, Assessment of resources, Rational use.

1. Introduction

The maintenance and growth of the global economy can't be separated from the support of energy, and the countries that mainly rely on oil are increasingly aware of the various crises caused by the reduction of the consumption of this non-renewable energy, and must make a transition to a new energy structure in the future [1-2]. For China, the prominent contradiction between rapid economic and social development and resource demand is no longer a brand-new topic. China's traditional energy structure dominated by coal determines the rampant spread of pollution in energy consumption activities [3]. At present, many countries have already begun to develop and utilize solar power and other renewable energy sources [4]. In order to maintain long-term sustainable development, China, a big energy consuming country, is also aware of the importance of developing solar power resources. Therefore, China's energy system is changing to a modern energy structure that is economical, efficient, clean, diversified and safe, and gradually entering a stage of sustainable development, green and low-carbon energy development [5]. Solar power is both a primary energy source and a renewable energy source. It can be used free of charge, without transportation, and will not cause any pollution to the environment. It has unparalleled natural advantages.

How to find a renewable clean energy as a supplement or a partial substitute is an important issue for every national policy maker and new energy manufacturer [6]. In recent years, the photovoltaic industry in China has developed rapidly under the impetus of national large-scale engineering projects, promotion plans and international cooperation projects [7]. As a kind of renewable clean energy, the research, development and utilization of solar power resources are beneficial to alleviate the consumption of primary energy. This is of great significance to China's economic development and environmental protection [8]. At the same time, in order to strengthen the efficient utilization of solar power resources, scientifically and rationally develop and utilize solar power resources, reduce the utilization of non-renewable fossil energy, and further vigorously promote the application of solar power in the region, we must do a good job in the assessment of solar power resources [9]. It is the key to the success or failure of the project to accurately calculate the amount of solar power resources in the developed land and assess them correctly. At the same time, accurately evaluating the solar power resources in the region has a strong guiding significance for the development and utilization of solar power resources in the region. Based on this, this paper elaborates the distribution of solar power resources in China, and introduces the industrial application status of solar photothermal effect and photovoltaic effect in China. Then, the assessment and rational utilization of regional solar power resources are analyzed and discussed.

2. Realistic Situation of Solar Power Resource Utilization

With the growth of scie & tech, more and more countries pay attention to the development and utilization of solar power [10]. Due to the limitation of previous technology, solar power resources are not well developed and utilized. With the rapid growth of new materials and technologies, the problems of scattered solar beams and low conversion rate are gradually being overcome. From the distribution of the total solar radiation in China, the total solar radiation in Tibet, Qinghai, Xinjiang, Inner Mongolia, Shanxi, Hebei, Shandong, Liaoning, western Jilin, Yunnan and eastern Guangdong is very large. The Qinghai-Tibet Plateau has the largest total solar radiation, while Sichuan and Guizhou provinces have the smallest annual solar radiation [11]. Using solar power to generate electricity is a better way to use it.

China's solar thermal utilization industry is at the leading level in the world in terms of scale, quantity, marketization, core technology and national brand. At present, there are two methods of solar power generation. One is that solar power is converted into heat energy, and then electricity is generated in the traditional way, which is called solar thermal power

generation [12]. Another way is to directly convert solar power into electric energy through photovoltaic solar panels, which is called solar photovoltaic power generation. The solar cell is a semiconductor device with this kind of performance. It can directly convert the radiant energy of sunlight into electric energy, and it is very convenient for application, so it is widely valued all over the world. Influenced by the international environment and driven by the international and domestic markets, photovoltaic power generation in China has made rapid progress. China's solar photovoltaic power generation technology is mature and has been widely used all over the world, and the primary task of photovoltaic power station is to analyze and master the change characteristics of local solar power resources. Based on this, this paper analyzes and discusses the assessment and rational utilization of regional solar power resources.

3. Assessment of Regional Solar Power Resources

3.1. Assessment model of regional solar power resources

In order to fully develop and utilize solar power resources, it is necessary to assess solar power resources according to some main indicators. It is estimated that the annual solar radiation energy received by the land surface in China is about 50×1015MJ, and the total solar radiation in all parts of China is 3350~8370MJ/cm2, with a median of 5860MJ/cm2[13]. This distribution characteristic reflects that solar power resources are restricted by climate and geography. Taking the annual total solar radiation as an index, the richness of solar power resources is assessd.

Due to the scarcity of solar radiation observation stations in China and the lack of solar radiation data, at present, there are many climatological calculation methods about solar radiation. This paper adopts the method based on astronomical radiation for calculation. Astronomical radiation refers to the solar radiation that reaches the upper boundary of the atmosphere and has not been attenuated by the atmosphere. Its magnitude is determined by the astronomical position of the sun to the earth and the latitude of each place. Its calculation formula is as follows:

$$G = \left(a_g + b_g \frac{n}{N} \right) R_a \tag{1}$$

$$N = \frac{24}{\pi} \omega_s \tag{2}$$

$$R_a = \frac{24 \times 60}{\pi} G_{sc} d_x \left[\omega_s \sin\varphi \sin\delta + \cos\varphi \cos\delta \sin\omega_s \right] \tag{3}$$

Where a_g and b_g are regression constants; G is the total solar radiation of the day; G_{sc} is the solar constant, with a value of 0.0820. R_a is astronomical radiation, which is estimated by the solar constant, the correction term of the average distance between the sun and the earth, the declination, latitude, the angle of the solar hour and the ordinal number of the day in one year. Sunshine hours is a physical quantity that represents the length of sunlight, and it indicates how much time a certain place's solar power resources can be utilized. There are many meteorological factors that affect sunshine hours, usually the main ones are cloud cover, water pressure, precipitation, etc.

3.2. Assessment of solar power resource richness

The main characteristics of the distribution of solar power resources in China are as follows: the high-value center and the low-value center of total solar radiation are located at 22 ~ 35 north latitude, the Qinghai-Tibet Plateau is the high-value center, and the Sichuan Basin is the low-value center; The annual total solar radiation in the western region is higher than that in the eastern region. Besides, except Tibet and Xinjiang, the south is basically lower than the north. Because there are many clouds, fog and rain in most areas of south China, the distribution of total solar radiation in the area of 30 ~ 40 north latitude is contrary to the general law that solar power changes with latitude. Solar power does not decrease with latitude, but increases with latitude. Assessment of solar resource richness The annual total solar radiation is the index of solar resource richness. According to the resources, it can be divided into four grades, see Table 1 for details.

Table 1. Grade of solar power resource richness

Annual total solar radiation MJ /m^2/a	Abundance
TI≥6300	Abundant resources
5040≤Tl<6300	Rich resources
3750≤TI<5050	Abound resources
TI<3750	General resources

Using the characteristics of solar power daily variation as an index, the daily variation law of solar power resources is assessd. Take the annual average sunshine hours from 9: 00 to 10: 00 local positive solar time as the representative of morning sunshine; Take the annual average sunshine hours from 11 ~ 13 o'clock in positive solar time as the representative of noon sunshine; The annual average sunshine hours from 14 to 15 o'clock in positive solar time are taken as the representative of the afternoon sunshine. In which period of time, the annual average sunshine hours are long, it means that this period of time is the most favorable period for the utilization of solar power resources in a day. Direct radiation ratio refers to the ratio of direct radiation to total radiation. The solar power resources in China can be divided into four grades by using the direct ratio as a measurement index. As shown in Table 2.

Table 2. Form grade of solar radiation

Description of solar radiation	Symbol	Grading threshold
Direct radiation dominance	A	R_x ≥0.6
More direct radiation	B	0.5≤ R_x <0.6
Scatter more radiation	C	0.3≤ R_x <0.5
Scattering dominance	D	R_x <0.3

Taking Lhasa as an example, according to statistics, the multi-year average of direct radiation in Lhasa from 1960 to

2013 was 5,364 MJ/m^2, and the multi-year average direct radiation ratio was 0.72. It can be seen that Lhasa is the dominant form of solar radiation.

4. Suggestions on Rational Utilization of Regional Solar Power Resources

China is experiencing the inevitable pain of pollution in the process of modern industrialization, and its inherent energy structure is not reasonable. Needless to say, the side effects of environmental pollution on local economic development and the impact of social medical costs. Therefore, this paper puts forward the following suggestions for the rational utilization of regional solar power resources:

(1) Build a solar house. Solar house refers to the houses that mainly rely on solar power for heating and air conditioning, and it can be divided into two categories: active and passive. The heating mode of the active solar house is basically the same as that of the heating system using conventional energy, and it costs a lot. When designing a house, the passive solar house is based on the principle of heat transfer. The house is built to acquire and store as much solar power as possible in winter and absorb as little solar power as possible in summer. Combining with architecture is an important way to accelerate the growth of solar power industry and standardize the market. Promoting the application of photoelectric building is an important content to promote building energy conservation. Using solar photoelectric conversion technology to solve the energy demand of buildings, city squares, roads and remote areas, such as lighting and landscape, is of great significance to replace conventional energy and promote building energy conservation.

(2) Popularize the use of vacuum tube collectors and flat plate collectors and focusing collectors. Vacuum tube collector has the advantages of high heat collection efficiency, convenient use, low investment and long service life. According to statistical data, the utilization of solar vacuum tubes in new buildings is nearly 100%, but the design and construction of integrated solar power and buildings are still relatively few. Flat-plate and focused collectors are widely used in rural areas because of their low price.

(3) Actively cultivate relevant technical talents and encourage enterprises to implement talent strategy. Boldly introduce foreign professional and technical personnel, provide first-class technical platform, do a good job in technical protection, concentrate our efforts, and break through various technical difficulties in a planned and step-by-step way.

(4) Make full use of solar power to generate electricity. The region should give priority to the growth of photovoltaic power generation with photovoltaic effect, mainly with urban street lamps, lawn lamps and residential lighting. In projects with suitable conditions, we should make full use of the building's illuminable surface to use photovoltaic power generation technology, which is the main power source of household electricity. If there is a surplus, it can even be connected to the grid for power supply.

5. Conclusions

Over-exploitation and utilization of non-renewable energy by human beings has irrevocably led to the gradual depletion of resources, which has led to global warming and increased frequency and intensity of extreme weather and climate events. Climate change has become an economic and social problem in China, and many natural systems are being affected by regional climate change, especially temperature rise. To avoid a bigger disaster, we must vigorously develop and use renewable energy and reduce greenhouse gas emissions. Solar power has unlimited reserves and ubiquitous characteristics, and its utilization is clean and economical. It is internationally recognized as one of the most competitive future energy sources, and it is also an important part of distributed energy. Therefore, in order to maintain long-term sustainable development, China, a big energy-consuming country, has also realized the importance of developing solar power resources. Based on this, this paper first elaborates the distribution of solar power resources in China, and introduces the industrial application status of solar photothermal effect and photovoltaic effect in China. Then, the assessment and rational utilization of regional solar power resources are analyzed and discussed. Finally, some problems existing in the solar power industry in China are pointed out, and some suggestions on how to promote the rational utilization of regional solar power resources are put forward. In order to provide reference for the development and utilization of regional solar power resources and related scientific research.

References

[1] Mei Man. Discussion on assessment methods of solar power resources in power industry [J]. Science and Technology Innovation, 2019(11):1.

[2] Liang Yulian, Shen Yanbo, Bai Long, et al. Brief introduction of assessment and development potential of solar power resources in South China [J]. journal of applied meteorological science, 2017, 28(4):12.

[3] Liu Chun, Ren Liqing, Li Xuejun, et al. Assessment of solar power resources in northern sandy areas of China from 1990 to 2019 [J]. Plateau Meteorology, 2021, 40(5):1213-1223.

[4] Zhang Jietan, Li Chunlai, Yang Libin, et al. Refined assessment technology of solar and wind energy resources on roofs of regional buildings based on GIS automation [J]. Manufacturing Automation, 2020, 42(6):5.

[5] Yuan Jiangang, Gao Xuna, Chen Jian, et al. Design of information assessment system for solar power resources in urban buildings [J]. Journal of Yangzhou University: Natural Science Edition, 2020, 23(4):5.

[6] Liu Daiyong, Lu Yuwei, Wang Wei. Design and application of solar power resource monitoring system for photovoltaic power station [J]. Water Resources and Hydropower Express, 2022, 43(9):4.

[7] Zhang Jietan, Li Chunlai, Yang Libin, et al. Combined algorithm of automatic solar photovoltaic power resource assessment for numerical weather forecast [J]. Manufacturing Automation, 2019, 41(10):4.

[8] Wang Xiaoyang, Ping Huang Zu, Chen Rongrong. Analysis of assessment results of solar power resources based on PVsyst and Meteonorm [J]. Building Electrical, 2017, 36(7):5.

[9] Huo Yanhua. Analysis of the development trend of solar photovoltaic power generation [J]. Engineering Technology Research, 2022, 3(12):147-148+174.

[10] Chen Yongjun, Du Zhijian, Long Hu, et al. Assessment and analysis of solar power resources of 100MW photovoltaic power generation project in Liupanshui [J]. Journal of Liupanshui Normal University, 2018, 030(003):24-28.

[11] Shen Yingxia, Meng Hongjie, Shi Huiwen. Assessment and utilization of solar power resources in Caofeidian [J]. Industrial Technology and Vocational Education, 2016, 14(4):3.

[12] Bai Su, Gao Yi. Assessment and Development Path of Solar Power Resources in Singapore [J]. China and Foreign Energy, 2021, 26(12):9.

[13] Luo Shuxiang, Niu Yantao, Zhao Peng, et al. Research on refined assessment technology of solar power resources on regional building roofs based on GIS [J]. Building Technology, 2018, 49(9):3.