Advances in Social Science, Education and Humanities Research, volume 347
3rd International Conference on Economic Development and Education Management (ICEDEM 2019)

Application of New Energy Photovoltaic Construction in Coal Mining Subsidence Area

-Taking the Treatment of Coal Mining Subsidence Area in Zaozhuang as an Example

Chen Lei
Coal Economy Academy, Shandong Technology and Business University
Yantai 264005, China
Shandong Collaborative Innovation Center of Energy Economy
Yantai 264005, China

Chen Shuying
School of Computer Science and Technology, Shandong Technology and Business University
Yan Tai, 264005, China

***Abstract*—The photovoltaic construction in the coal mining subsidence area not only improves environmental and resource protection, but also realizes comprehensive treatment of soil erosion in coal mining subsidence areas. This paper analyzes the current situation of Zaozhuang collapsed area, and proposes that application of new energy photovoltaic construction can be conducive to governing this area. According to the location principle of photovoltaic power station, it is estimated that Tengzhou solar energy resources are very rich and the development prospect is very bright. In addition, combined with the analysis of power consumption capacity of Tengzhou Photovoltaic Base, Shandong's overall light rejection rate is controlled within 5%, so photovoltaic construction can be developed. The implementation of this project not only accumulates experience for the settlement of subsidence in Jining City, but also makes the project area a demonstration zone for new energy industry. It will also play a positive role in promoting local tourism and driving the rapid development of the local economy.**

Keyword—Coal mining subsidence area*; *Solar energy*; *Photovoltaic construction

I. INTRODUCTION

Building a clean, low-carbon, safe and efficient modern energy system has become an inevitable trend of energy transformation and development. Vigorously develop renewable energy including wind energy, photovoltaic, and continuously increase the proportion of non-fossil energy in primary energy consumption, which is an important measure to deal with climate change, air pollution, and environmental protection. From the perspective of development methods, at present, China's new energy total installed capacity accounts for 88% of centralized and 12% of distributed. Especially for solar power generation, about 80% of distributed photovoltaic power generation in the country is located in the eastern and central regions. Due to the proximity to the power load center, it should be nearly absorbed and developed rapidly. In the long run, it should further develop [1-2].

Coal mining subsidence refers to the destruction of the original stress balance state of the overlying strata in the goaf after the mining of coal resources. Coal mining subsidence refers to the destruction of the original stress balance state of the overlying strata in the goaf after the mining of coal resources, and the subsequent movement and deformation such as caving, fracture and bending occur. Eventually, the surface forms an approximately elliptical sinking basin that is much larger than the goaf area [3-4]. Coal and land are important natural resources for human survival and development. As China's economy continues to develop at a high speed, the status of coal as a pillar energy industry will not change much in the long term. However, while the rapid development of the coal industry has made great contributions to economic growth and social progress, it has also brought certain negative impacts on the ecological environment and sustainable development of the mining area. The problem of coal mining subsidence is the most prominent contradiction.

As a traditional and important coal energy base in China, Tengzhou City is a typical coal resource city. The coal mining industry laid the industrial foundation of Tengzhou. However, long-term large-scale, high-intensity coal mining has led to the depletion of high-quality coal resources and the formation of large-scale coal mining subsidence areas. It has brought serious problems such as an imbalance of industrial structure, large-scale subsidence of land, and serious ecological damage. Urban sustainable development faces severe challenges. These problems have seriously restricted the urban planning and modern transformation of Tengzhou City. Therefore, it is urgent to speed up the comprehensive management of coal mining subsidence and effectively repair damaged land and ecological environment.

The abandoned land in Tengzhou coal mining subsidence area is large, the solar energy resources are abundant, and the power grid access conditions are good, which provides a broad space for the development of photovoltaic power generation demonstration base. Adopting a diversified three-dimensional development model in the coal mining subsidence area can fundamentally solve the outstanding problems faced by the subsidence area. At the same time, the construction of photovoltaic power stations in difficult-to-manage coal mining subsidence areas can solve the problems of the large area occupied and less available land in the development of the photovoltaic industry.

At present, the implementation of photovoltaic agriculture in coal mining subsidence is another major breakthrough in China's photovoltaic application field and has gradually become a new investment hotspot. “Agricultural photovoltaic Complementary” and “Fishes photovoltaic Complementary” have become two innovative application models for distributed photovoltaic. Photovoltaic power generation has become the main guiding direction of national energy policy because of its remarkable energy, environmental protection, and economic benefits. In view of the abundant solar energy resources in the Tengzhou area, it is feasible to plan to build a photovoltaic power generation base on the abandoned land in the coal mining subsidence area. It can achieve the win-win goal of effective utilization of coal mining subsidence area and new energy development. It has a certain leading role for the management of subsidence land in other parts of Shandong Province. It also has a reference role in the transformation and development of resource-based cities across the country.

II. SELECTION OF VOLTAIC POWER STATION SITE

Photovoltaic power station planning is based on the basic national policy of “very precious, rational use of every inch of land and effective protection of cultivated land” and the basic policy of “developing in protection and protecting in development”. The location of solar photovoltaic power plants is determined according to various factors such as solar energy resources, grid-connected conditions, transportation and construction, and installation conditions, installed scale, hydrological and geological conditions, socio-economic and environmental protection requirements.

The principle of power station planning and location is as follows:

(1)The planned site is selected in a concentrated coal mining subsidence area and meets the requirements of regional land use planning;

(2)The site area has developable solar energy resources;

(3)The site area has good construction conditions such as hydrogeology, access system, and transportation;

(4)Site selection meets environmental and ecological protection requirements to minimize the impact on humans, animals, and plants;

(5)The selection of the plant area should avoid the identified sensitive areas such as natural environmental protection zones, military land, and cultural relics protection, and will not affect the original coal industry in the region.

The original ground structure of the photovoltaic power generation demonstration base in the mining subsidence area of Tengzhou City has mainly cultivated the land. After subsidence, according to its landform type, underground phreatic depth, subsidence depth, and water depth, the subsidence land is divided into three types: light subsidence area, moderate subsidence area, and severe subsidence area. According to the distribution of subsidence areas, based on the basic stability, focus on the selection of photovoltaic power stations with large subsidence area and difficult to realize re-cultivation and reclamation. Select some of the reusable general agricultural land to develop photovoltaic and agricultural greenhouses, photovoltaic and animal husbandry greenhouses to combine farming and animal husbandry. Select the water area in the year to realize the combination of photovoltaic and fishery, and realize the development form of comprehensive breeding of fish, duck, lotus root and water chestnut.

III. TENGZHOU’S SOLAR ENERGY RESOURCES

The annual total solar radiation in Shandong Province is between 4542.61-5527.32MJ/m2. The total annual radiation of Chengwu Station is 4542.61 MJ/m2, and the annual total radiation of Penglai Station is the most, which is 5527.32 MJ/m2, with a difference of about 1000 MJ/m2. The total solar radiation in different parts of Shandong Province varies greatly. The total solar radiation in the southern part of the Jiaodong Peninsula is relatively small, and the Penglai and Longkou areas in the north are larger. It shows the characteristics of the south and the north. The total solar radiation in the northern part of kenli and the estuary is relatively large, and the southwest and Luxi areas are smaller. There are more clouds in the region in summer, which have a significant impact on total solar radiation. The total solar radiation in southeastern Shandong and southwestern Shandong is relatively close. The annual total solar radiation in western Shandong shows a distinct feature of south and north.

The annual total solar radiation in western Shandong shows a distinct feature of south and north. According to NASA's solar radiation data from 1997 to 2016, the total solar radiation statistics of Tengzhou City in 20 years are shown in Figure1.

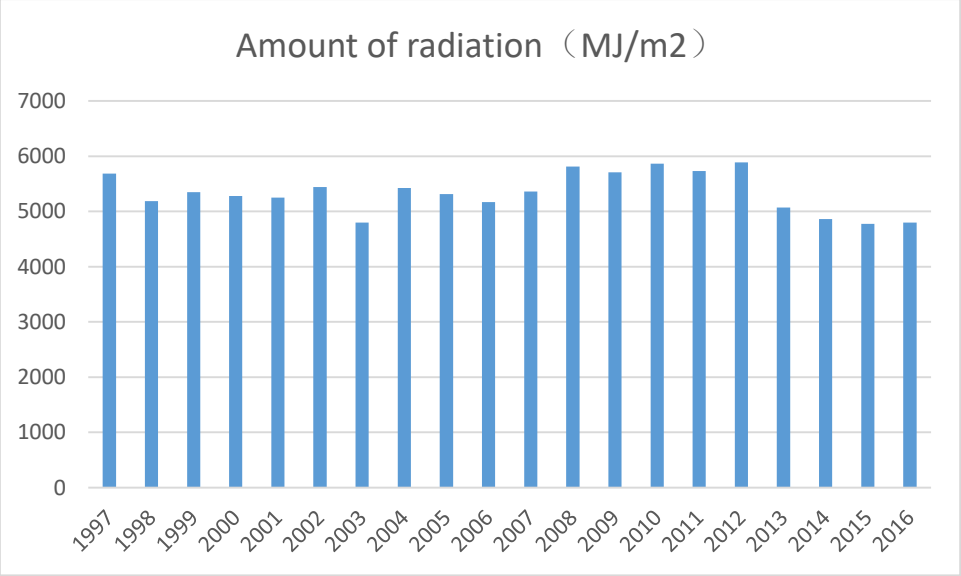

Fig. 1 Annual Total Radiation Statistics of Tengzhou From 1997 to 2016

It can be seen from Table 1 that the distribution of solar radiation in Tengzhou City for many years is basically stable. The numerical interval is stable between 4800MJ/m2 and 5900MJ/m2. The average annual solar radiation in the region is 5339 MJ/m2. The minimum value appeared in 2003, the solar radiation amount was 4800 MJ/m2, which was 10% smaller than the average value of many years; the maximum appeared in 2012, and the solar radiation was 5887MJ/m2, which was 10.26% larger than the average for many years. The difference between the maximum annual and minimum years of solar radiation is 1087 MJ/m2. It can be concluded that the annual variation of radiation in Tengzhou City is small. According to NASA's total solar radiation data from 1992 to 2011, the statistical results of the annual average solar radiation in Tengzhou City are shown in Figure 2

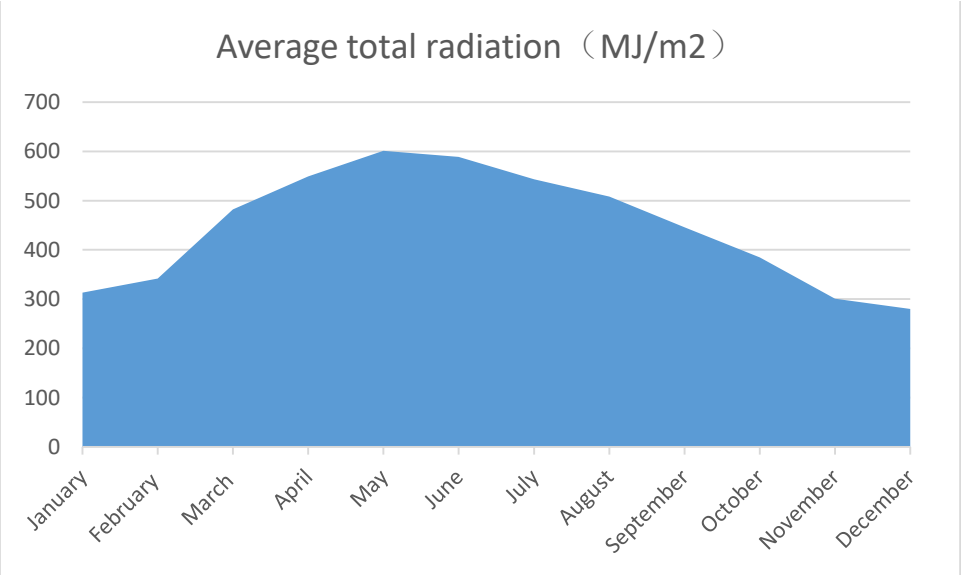

Fig. 2 Statistical Table of Annual Total Solar Radiation of Tengzhou

According to Table 2, it can be seen that the variation of the solar radiation amount of the site is basically the same during the year. The average monthly solar radiation varies from 280 MJ/m2 to 600 MJ/m2. May-June is higher, both about 550MJ/m2, of which the highest in May is 601MJ/m2. From November to January, the lower is below 320MJ/m2, and the lowest in December is 280MJ/m2. The difference between the maximum and minimum values of the radiation is 321 MJ/m2, and the value of the change in the year is large.

The average annual total solar radiation in Tengzhou City is 5339MJ/ m2. Solar resource richness assessment according to the Solar Energy Resource Assessment Method (QX/T8902008),As shown in Table 1, the selected site has abundant solar resources and has good development prospects.

TABLE I RICHNESS LEVEL OF SOLAR RESOURCE

Annual total solar radiation	Resource richness
6300 MJ/m2	Most abundant resources
5040-6300MJ/m2	Very rich in resources
3780-5040MJ/m2	Abundant resources
<3780MJ/m2	General resources

IV. THE STATUS QUO AND RECENT DEVELOPMENT FORECAST OF SOLAR ENERGY DEVELOPMENT IN SHANDONG PROVINCE

Shandong Province is a region rich in solar energy resources. Most of the province is a Class III solar energy resource zone. More than two-thirds of the area has an annual sunshine duration of more than 2,200 hours, and the annual average sunshine hours are between 2099 and 2813 hours. The total annual solar radiation is between 4,600 and 5,600 MJ/m2, of which most of the peninsula, most of the northwestern part of Shandong, and parts of Luzhong have better solar energy resources and are rich in solar energy resources; The southwestern part ,the southeastern part and the northwestern part of Shandong Province have relatively few solar resources, which are resource-available areas. As of the end of 2016, the cumulative installed capacity of photovoltaic power plants in the province reached 4,548 MW.

According to the "Shandong Province New Energy and Renewable Energy Medium and Long Term Development Plan (2016-2030)", the current and future period is a major strategic opportunity for Shandong Province to accelerate the energy production and consumption revolution and promote the construction of ecological civilization. It is also an important period for all kinds of new energy and renewable energy resources from single, decentralized to integrated and integrated application. Therefore, Shandong can vigorously promote the use of solar energy. Shandong Province should give full play to the advantages of abundant solar energy resources, wide distribution, and good development and utilization basis. Focus on providing green power and green heat, and continuously expand the scale of solar energy utilization. Actively promote the integration of solar energy utilization with conventional energy systems. It is estimated that by 2020, the installed capacity of new energy and renewable energy power generation will reach 30100MW. Among them, wind power 14000MW, solar power generation 10000MW, new energy, and renewable energy power generation will rise to an important power source in the power system. As of May 2017, the province's total photovoltaic power plant to be built was about 3,348 MW. In addition, the photovoltaic power generation demonstration base in the coal mining subsidence area of Jining City has obtained the national energy approval of 500MW (planned capacity of 950MW). The photovoltaic power generation demonstration base in Xintai City's coal mining subsidence area has been approved by the National Energy Administration for 500MW (planned capacity is 2000MW). Tengzhou Photovoltaic Base has a planned total capacity of 500MW.

Solar power generation is one of the most technologically and economically valuable ways of utilizing energy. Developing photovoltaic power plant projects can save conventional energy. It also reduces environmental pollution and ecological damage caused by conventional energy consumption. The photovoltaic construction in Tengzhou coal mining subsidence area mainly has the following social and environmental benefits:

(1) The abandoned land area in the coal mining subsidence area is large. It has abundant solar energy resources and good grid access conditions. This provides a broad space for the development of photovoltaic power generation demonstration bases. Adopting a diversified three-dimensional development model in the coal mining subsidence area can fundamentally solve the prominent problems faced by the subsidence area. At the same time, the construction of photovoltaic power stations in difficult-to-manage coal mining subsidence areas can solve the problems of the large area occupied and reduced available land in the development of the photovoltaic industry.

(2) Photovoltaic development and construction in coal mining subsidence areas can bring about market development of related industries, such as optimizing energy structure, promoting technological progress of photovoltaic power generation related equipment, increasing fiscal revenue, providing employment opportunities, and energy saving and emission reduction. The most important thing is that the construction of photovoltaic power stations provides a better way for local governments to solve the problem of coal mining subsidence. At the same time, it provides employment means for residents in coal mining subsidence areas, which can alleviate the people's livelihood problems caused by coal mining subsidence.

V. CONCLUSION

The planned photovoltaic power generation base in the mining area of Tengzhou City has better solar energy resources, convenient external transportation, and excellent development conditions. The development and construction of photovoltaic power generation bases are in line with the principles of sustainable development and the requirements of national energy policies. It can reduce the consumption of fossil resources and reduce the environmental pollution caused by harmful gases such as coal. At the same time, it will play a positive role in promoting local tourism and promoting the rapid development of the local economy.

ACKNOWLEDGMENT

This research is supported by the Ministry of Education Humanities and Social Sciences Research Fund Project Funding the "Technology Monitoring Research on Emerging Cross-domain Based on Multi-source Data: Taking the Field of Nano-Energy as an Example" (No.18YJA630011).

REFERENCES

[1] National Energy Agency, "Revolution Strategy for Energy Production and Consumption" (2016-2030) (public release) 2016, p. 5 12. http://www.ndrc.gov.cn/zcfb/zcfbtz/201704/t20170425_845284.html. (In Chinese)

[2] Chen Lei, Wu Xianyun. The Impact of Intra-firm Collaborative Networks on Knowledge Search [J].China Soft Science, 2019(5):188. (In Chinese)

[3] Xiaofei Wang, Lei Chen, Chuangeng Liu, Yiqing Zhang, Ke Li. Optimal production efficiency of Chinese coal enterprises under the background of de-capacityd Investigation on the data of coal enterprises in Shandong Province[J].Journal of Cleaner Production, 2019(4): 356.

[4] Chen Lei. Research on New and Old Kinetic Energy Conversion of Strategic Emerging Industries [M].China Economic Publishing House, 2019(6):18. (In Chinese)