International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 12 Issue 2 February 2023 || PP 09-17

A Tentative Evaluation Scheme Regarding the Impact of Rural Photovoltaic Power Plants on the Landscape

Qiao Jiang
International Division, Beijing No.2 Middle School, Beijing 100176

ABSTRACT : *To evaluate the impact of photovoltaic power plants on the rural landscape, thispaper, based on a review of relevant studies, aimed to propose a tentative index system frombothnatural and social perspectives. The researcherfurthermoreapplied the system to evaluating the impacts of twophotovoltaic power plants on the rural areas in China so as to identify the system'sstrengths and weaknesses.*

KEYWORDS -*photovoltaic power plant, rural landscape, visual pollution, evaluation, index system*

Date of Submission: 01-02-2023 Date of Acceptance: 11-2-2023

I. INTRODUCTION

Photovoltaic power generation has become one of the new energy sources with the greatest growth potential in the world. According to the forecast of the International Renewable Energy Agency (IRENA), by the middle of this century, the proportion of photovoltaic power generation in global power generation will increase from the current 3-5% to 25%, with the total installed capacity exceeding 8,000 Igawatts (GW) [1], and most of the large-scale photovoltaic power plants will be deployed in rural areas [2]. Compared with the other types of power sources, photovoltaic power generation is likely to produce non-negligible impacts on the environment, especially on vision and soil [3-4]. Therefore, the impact of large-scale photovoltaic power plants on the rural landscape deserves great attention.

At the same time, with the growing importance attached to ecological protection, the opposition against constructing photovoltaic power plants in rural areas is also increasing. According to the International Union for Conservation of Nature, in the past 10 years, the global nature reserves have increased by 42%, and the number has exceeded 250,000 [5]. Many countries in Europe and Asia are speeding up the construction of nature reserves and national parks [6-7], putting forward clear restrictions on industrial construction affecting the landscape, including photovoltaics [8]. China's policy of "rural revitalization" also emphasizes the balance between natural landscape preservation with economic development, requiring the innovative integration of photovoltaics with landscape [9]. In addition, the sprawling of cities has made the public value and desire to preserve rural landscapes more strongly than ever. All the above indicates that construction of large-scale rural photovoltaics should give serious consideration to its potential effects on the natural surroundings, which has become a must for the sustainable development of the photovoltaic industry.

Compared with photovoltaics in cities, the research on their rural counterparts is still inadequate. The present studies mainly concentrate either on the impact of new energy industries on the rural environment, including the visual pollution caused by the installation of large-scale photovoltaic panels [10-15], or the selection of proper sites so as to minimize the negative effects on the landscape [16-17]. Although certain methods have already been adopted in these studies to assess the impact of photovoltaic facilities on the environment [18-24], a comprehensive index system is yet to be established. It is also worth noting that no similar studies have ever been carried out within Chinese rural areas.

II. LITERATURE REVIEW

Photovoltaic power plants have an impact on rural landscapes with their particular layouts, facilities, resulting in visual intrusion. At present, the indicators for evaluating the impact of photovoltaics on rural landscapes generally involve such ones as area size, land usage, wildlife species, etc. [25-30]. The relatively well-known methods of assessment, among others, include the three major landscape resource management systems in the United States and their corresponding evaluation indicators, and the landscape inspection indicators created by Spanish scholar Canas. These systems have been solidly verified in practice and can be used as the sound bases for the development of a more comprehensive assessing index system [31-36].

Meanwhile, rural photovoltaic power plants are different from traditional industrial facilities. Due to their nature of green energy，shape and layout features, they have the potential to become distinctive human landscapes. In fact, some rural photovoltaics have also served as local sightseeing attractions that possess special humanistic values [37-38].

In addition, the photovoltaic power plants in the rural areas of developing countries often play a positive role in boosting economy, promoting employment and assisting poverty reduction. For these reasons, they are in the eyes of local people welcomed constructions rather than visual intrusions.

Therefore, when developing a comprehensive index system, the potential of photovoltaics as human landscapes to be blended with the natural surroundings and psycho-reactions of local residents to the installations should both be taken into consideration whereas these two factors have been more or less ignored in the previous studies.

Specifically, a literature review has suggested the following significant indices to be included in the system. They can be divided into the major indicators and the supplementary indicators. The former is used for assessing the impact on landscape, the latter is used for evaluating social feedback.

2.1 Indices for assessing the impact on landscape

The location of a photovoltaic power station is often the very first index to consider when it comes to evaluating its impact on the landscape as it has the most direct bearings on the local ecology, tourism and humanistic values. Moreover, once the power station is installed, it will inevitably make a visual connection with the environment, giving rise to aesthetic judgments as to its co-existence with the natural landscape. However, different people may have different perceptions of the same phenomenon and exercise various judgments mostly due to individual psychological factors. Therefore, in general the Indices for assessing the impact of a photovoltaic power plant on the landscape mainly involve the above-mentioned three subtypes of items which are physical, aesthetic and psychological indices [39].

2.1.1 Physical index

The physical index covers the physical attributes of a photovoltaic power plant which may exerts impact on the landscape [40]. It primarily consists of five variables: location of the power station, distance to the main road, disturbance to wildlife, size of land occupied and demographic status.

First, the photovoltaic power plant is expected to be far away from locations with high values of landscape perception sensitivity. Otherwise the landscape quality will be affected. Such sites usually include cultural relics, scenic spots, national parks, tourist attractions, etc. Second, the distance between the power station and highways or popular tourist routes should also be reasonable. Because the visual intrusion caused by the photovoltaic panels or other facilities, especially the light pollution, has an ignorable impact on drivers and travelers. The third element is concerned with animals and plants which are important part of the rural ecological landscape. Photovoltaic power plants often occupy large areas, which inevitably disturbs the growth, reproduction and migration of wildlife. Fourth, there should be a cap on the size of land to be occupied. Although the size of land is in proportion to the productivity of a photovoltaic power plant, it should be noted at the same time that if the area is too large, the visual intrusion incurred will also increase considerably. Finally, the demographic status, including the number of residents, visitors and tourists will also determine the intensity of visual pollution. The photovoltaics in sparsely populated areas normally cause visual pollution to a much less degree than in places with dense populations.

2.1.2 Aesthetic index

Aesthetic index assesses the impact of photovoltaic power station from the perspective of visual aesthetics [41]. It mainly evaluates the shape, color, layout and the degree of harmony of the plant with its surrounding landscape. It also examines the extent of visual pollution in relation to scope of visibility, monotony of visual content, etc.

2.1.3 Psychological index

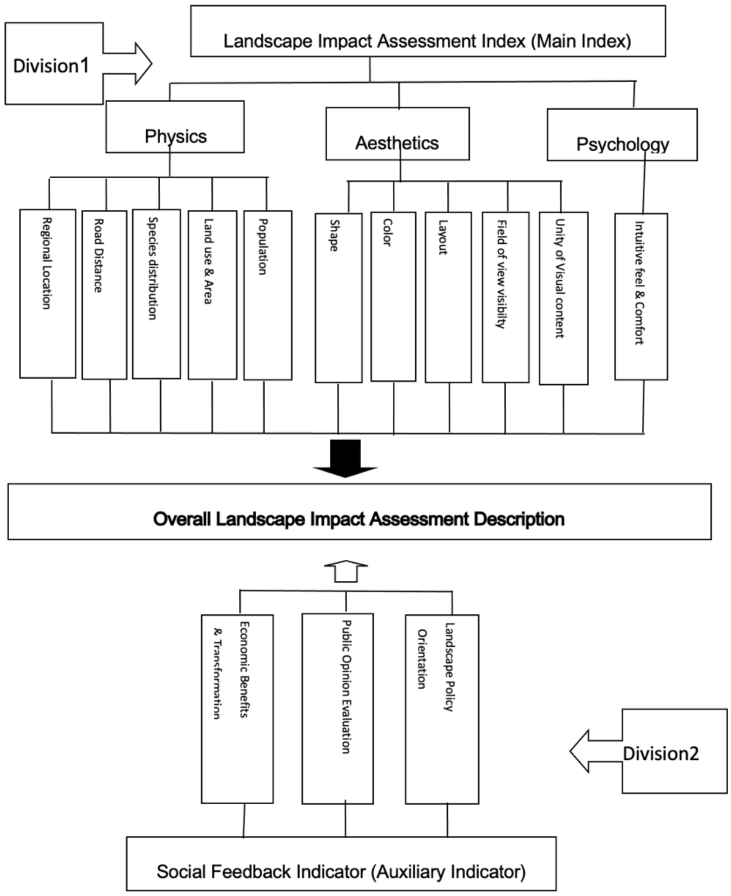
Psychological index is mainly used to assess the public's intuitive feelings of comfort towards the shape, color, and layout characteristics of the power station against the backdrop of natural landscape [42-43].

2.2 Indices for evaluating social feedback

In addition to the impact on landscape, social feedback is another significant dimension that deserves serious attention. This is mainly about the extent to which the power station can offer the so-called "green landscape benefits". One is concerned with economic benefits in terms of enhancing local employment opportunities and sustainable development. The second is the evaluation of public opinions to see whether the plant has gained favorable comments from the public. The third entails the policy orientation and support, examining the possibility of promoting the power station to become a human landscape. These indices are concerned with the green landscape benefits of the power station, which should be adopted alongside with those for assessing the impact on natural landscape.

Below is the diagram of the proposed index system for assessing the comprehensive impacts of a photovoltaic power plant from the perspectives of both natural surroundings and green benefits.

DIAGRAM 1 A Comprehensive Index System for Evaluating the Overall Impact of a Rural Photovoltaic Power Plant



III. CASE ANALYSIS

The above-mentioned index system is proposed based on the literature review, it is therefore necessary to testify it in practice.

The system works as follows. According to the different situations and degrees of impact on the landscape, each indicator is divided into four levels: severe, high, moderate, and low with corresponding values according to a 10-point scale: 10 means severe, 9-7 high, 6-4 moderate, and 3-1 low [44]. A quantitative analysis can then be made to obtain landscape values using an additive value function such as the study by Canas et al [45]. At the same time, the proposed system can allow for a qualitative analysis in which not only a specific description was made for each index but also a summary report for an overall account of the impact on the landscape as well as social feedback. Please refer to the following tables for details.

TABLE 1 Secondary Indices& Grades for Assessing Landscape Impact

Variable	score	sensitivity	Impact
Location *(distance from cultural relics, scenic spots, tourists attractions, national parks, etc.)*			
Within sight(Within 6 kilometers) *	10-7	high	severe or high
Short distance(Between 6-25 kilometers)	6-4	moderate	moderate
Long distance (25 kilometers away) ** Or blocked by terrain, etc. out of sight	3-1	low	low
Traffic *(Distance from expressways, popular tourist routes, etc.)*			
Line of sight(Within 6 kilometers)	0-7	high	severe or high
Longer distance(Between 6-25 kilometers)	6-4	moderate	moderate
Far away (25 kilometers away) or blocked by terrain,etc. out of sight	3-1	low	low
Population *(Number of residents, visitors, tourists, etc.)*			
Densely populated(>100 people/km2) * or lots of tourists passing by (>100 people/day)	10-7	high	severe or high
Medium populated (25 to 100 people/square kilometer) or Many tourists passing by (50-100 people/day)	6-4	moderate	moderate
Sparsely populate (1 to 25 people/square kilometer) or Few tourists passing by(1-20 people/day)	3-1	low	low
Species Distribution *(Wild animals and plants)*			
Unique species**	10***	high	severe
Important habitat for plants or animals	10	high	severe
Abundant species with certain scarce ones	10	high	severe
Abundant species with large populations	9-7	high	high
Many representative species	6-4	moderate	moderate
Few representative species	3-1	low	low
Land Use *(Use of the land occupied by the power station)*			
Agriculture and forestry land	10-7	high	severe or high
Wasteland	6-4	moderate	moderate
Industrial land	3-1	low	low
Aesthetic Features *(Layout, color and shape of the power station, scope of visibility, visual content, etc.)*			
Large-area tiling, single shape and visual content, or inconsistent color with the environment	10-7	high	severe or high
Certain changes in layout, shape and color, but the overall is relatively simple	6-4	moderate	moderate
It has artistic modeling, rich visual content, and the shape, color and environment are integrated	3-1	every low	every low
Psychological Feelings *(intuitive feeling and comfort)*			
Uncomfortable	10-7	high	severe high
Comfortable	6-4	moderate	moderate
Very comfortable	3-1	low	low

** Based on the generally considered limit distance that the human eye perceives light, etc.

* Population density classes based on generally defined internationally

** Based on the IUCN List of Threatened Species

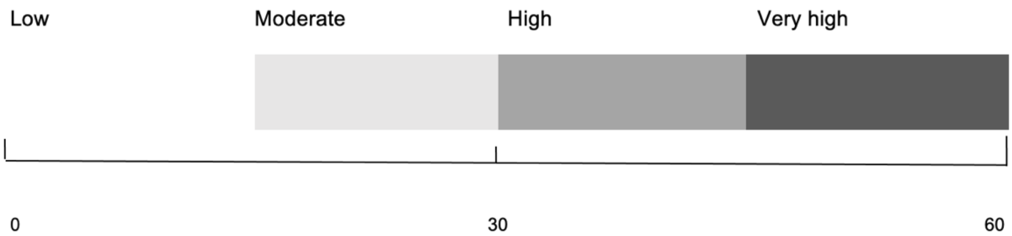
*** If one or more of any single indicator is assigned a value of 10, the overall sensitivity evaluation is high and the impact is serious

TABLE 2 Secondary Indices for Evaluating Social Feedback *

Variable	+-score	impact assessment
Green Landscape Benefits *(Economic development, employment opportunities, policy orientation, public reactions)*		
Effective transformation of economic benefits, local people benefit	+1	positive
Economic benefits have not been effectively transformed, and local people have not benefited	-1	negative
Public opinion positively evaluates the impact of the station landscape	+1	positive
Public opinion negatively evaluates the impact of the station landscape	-1	negative
Policies encourage the construction of humanistic landscapes in power stations	+1	positive
The policy does not encourage the construction of the human landscape of the power stations	-1	negative

* In this evaluation, the plus-point and minus-point items are listed separately, and are listed separately as the auxiliary points of the landscape evaluation score to examine the positive or negative situation of the social evaluation.

TABLE 3 Overall Landscape Sensitivity Score Reference Evaluation



To testify the feasibility of the system, the researcher adopted the method of case study, taking two photovoltaic power stations in China's rural areas as examples, to illustrate the application of the indicators.

3.1 Case one——Zhangjiakou Shiwanzi Power Station (SWZ-GF)

Zhangjiakou Shiwanzi Power Station (SWZ-GF) is attached to the Zhangjiakou Wind and Solar Storage and Transmission Demonstration Project. The power station is located in the Bashang area where the North China Plain and the Inner Mongolia Plateau meet, about 280 kilometers away from Beijing and about 83 kilometers away from the city of Zhangjiakou in Hebei Province. The landscape features the transition from alpine grassland to semi-desert with the well-known scenic belt "Grassland Sky Road". The first phase of the project covers an area of 158 hectares, generating about 40,000 kilowatts of green electricity and further 450 hectares is expected to be covered in the future [46].

First, the 7 secondary indices were employed to measure the impact of SWZ-GF on the landscape.

With regards to location, there are some scenic spots within a radius of 100 kilometers of the power station. One is Yuanzhongdu Archaeological Site Park, 44 kilometers away and the other Zhangbei Great Wall, 43 kilometers away, which are both significant cultural relics. Comparatively far from these sites, the station is not likely to produce vision impact on them. Therefore, the item related sensitivity is low and the value is 3. As for the distance from the traffic, the station is 16 kilometers away from Xingba Expressway, 22 kilometers from the west line of "Grassland Sky Road", and 56 kilometers from the east line of "Grassland Sky Road". The overall sensitivity is low with the assigned score of 3. The population of the area is about 900, with the density below 25 people per square meter, so the sensitivity is also low and the value is 2. In terms of species distribution, the power station is not near the local wetlands and the main vegetation is plateau meadows and semi-desert plants, with no endangered species of animals and plants [47]. The relevant value is thus 2. In addition, the land used is wasteland but will be expanded in the future. Hence the sensitivity is moderate with a value of 5.

In terms of aesthetic features, the overall layout is relatively simple in design and color, which is not well blended with the environment. The major visual contents include photovoltaic panels, wind power turbines and science exhibition halls. The overall sensitivity is high and assigned a value of 7.

To learn about the public's psychological feelings, a questionnaire survey was conducted among a total of 82 high school students, teachers and civil servants*. The results showed that 17% of respondents felt very comfort, 59.8% comfort and 23.2% uncomfortable. Therefore, the sensitivity in this regard is average with a score of 5.

As a whole, four of the seven indicators have low sensitivity with an added-up value of 27, which falls into the category of being moderate. Please refer to Table 4 below for details.

TABLE4Assessment of the Landscape Sensitivity of SWZ-GF Power Station

Index	Score	Sensitivity assessment
Location	3	low (Far from scenic spots and cities)
Distance from Traffic	3	low (Far from highways and main roads)
Population	2	low (sparsely populated with small number of visitors)
Species Distribution	2	low (Few species, no large animal and plant populations, no habitats for birds)
Land Use and Size	5	moderate (Wasteland, subsequent expansion)
Aesthetic Features	7	high (Shape, color and layout relatively simple)
Psychological Feelings	5	moderate (survey result)
Overall evaluation	**27**	**moderate sensitivity**

TABLE 5Indices for Evaluating Social Feedback of SWZ-GF Power Station

Variable	+-score	impact assessment
Effective transformation of economic benefits, local people benefit	+1	positive
Public opinion positively evaluates the impact of the station landscape	+1	positive
Policies encourage the construction of humanistic landscapes in power stations	+1	positive
Overall evaluation	**+3**	**positive**

To supplement the assessment for the impact on natural landscape, the green landscape benefits of the power station was also evaluated based on the social feedback indicators of the system. The annual power generation capacity of the power station is 670,738kWh, and the revenue in 2021 was over RMB 590,000 yuan, two thirds of which was returned to the villagers’ self-raised funds or paid dividends, and the rest was used for the infrastructure construction in the village.As part of poverty alleviation project, nearly 4,000 square meters of carbon sink forest was planted nearby and solar power generation equipment installed on the roofs of villagers for household cooking and heating. As the green power supplier for the 2022 Beijing Winter Olympics, the plant was favorably reported by the social media. Furthermore, the station has been planned as a green power theme park by Zhangbei County, which has the potential to turn into a new tourist attraction. The power station was also rated as one of the first group of national popular science education bases in 2021-2025 by the China Association for Science and Technology [48]. All in all, the social feedback is positive.

To sum up, the comprehensive impact of the power station on the landscape is not high within a reasonable range. Nevertheless, the power station has high sensitivity in the aspect of aesthetic features. It is therefore advisable to further improve its artistic design for better visual effects. This should be given special attention to when planning and implementing its second phase of construction.

3.2 Case two——Shilin Photovoltaic Power Station (SL-GF)

Shilin Photovoltaic Power Station is located inShilin County, Yunnan Province, which is a typical karst landscape of the Yunnan-Guizhou Plateau. With the unique landscape, the county is one of the first national model tourism attractions. The power station is 92 kilometers away from Kunming, the capital city of Yunan Province, 19.1 kilometers from Shilin Scenic Park, a key national scenic spot in China, and 8.7 kilometers from Changhu scenic spot. The power station is also 13.6 kilometers away from ShankunExpressway. The village where the power station is located covers an area of 19.86 square kilometers and has a population of 29,000. The land used for the power station is rocky wasteland with few biological resources. The first phase of the power station occupies a total area of 243.3 hectares with an annual power generation capacity of 195 million kwh. With reference to the relevant indicators, the evaluation of the landscape sensitivity of the power station is illustrated through the following table.

TABLE6 Assessment of Landscape Sensitivity of SL-GF Power Station

Index	Score	Sensitivity assessment
Location	9	very high (Though being far from the scenic spots and cities, the village where it is located is a tourism attraction.)
Traffic	6	moderate (Far from highways and main roads)
Population	3	low (Sparsely populated with small number of visitors
Species Distribution	2	low (Few species, no large animal and plant populations, no habitats for birds
Land Use and Size	5	moderate (Rocky wasteland, but the area is large)
Aesthetic Features	5	moderate (There are certain changes with the ups and downs of the slope, but the overall shape and color are relatively monotonous)
Psychological Feelings	4	moderate (Survey result)
Overall evaluation	**34**	**high sensitivity**

TABLE7 Indices for Evaluating Social Feedback of SL-GF Power Station

Variable	+-score	impact assessment
Effective transformation of economic benefits, local people benefit	+1	positive
Public opinion negatively evaluates the impact of the station landscape	-1	negative
Policies encourage the construction of humanistic landscapes in power stations	+1	positive
Overall evaluation	**+2,-1**	**mixed**

Regarding the social feedback, Shilin County has carried out the pilot construction of photovoltaic poverty alleviation project. Each participating household will directly increase its income by more than 3,000 yuan per year for up to 20 years. A new type of agricultural photovoltaics will also be explored, with crops being planted on the lower land of solar power photovoltaic modules, to achieve the integrated development of agriculture and green power generation. This will help improve the livelihood of local farmers living in rocky desert areas. The power station itself incurred few negative comments, but some media coverage on cutting down trees to clear the land for constructing photovoltaics in certain places of southwest China may have washback effects on the power station. Despite of this, the power station dedicates a special zone for the popularization of science to boost the public's understanding of photovoltaic power generation technology, which demonstrates its potential to generate further social benefits.

Based on the accumulative value of overall evaluation, Shilin Photovoltaic Power Station has a high degree of impact on the landscape. There is also possible tension between the future expansion of the power station and that of the Shilin Tourism Zone, which needs to be taken into consideration. Moreover, the sensitive score of its aesthetic characteristics is also relatively high, indicating that the greening and beautification of the venue proper should be further improved. In view of more large-scale photovoltaic power stations to be constructed in the province, the previous experience and lessons should be timely summarized to offer guidance for later site selection, designing and implementation so as to optimize the balance between the natural and economic landscapes.

IV. IMPLICATIONS AND LIMITATIONS

The paper tentatively put forward an index system for assessing the comprehensive impact of a photovoltaic power plant on the rural landscape and reported its application in two cases, based on which a few implications could be drawn for further considerations.

First, spatial layout and external form are the core elements that affect the evaluation of rural photovoltaic power plants' impact on the landscape. Among the seven secondary items of the above-mentioned index system, five of them are all closely related to the spatial layout, and the rest two to the external form. When it comes to the design of a photovoltaic power station, focus is always put on its generation capacity while its layout and shape are often subjected to being overlooked. Therefore, it is suggested that equal importance should also be attached to such aesthetic features and efforts be made to achieve a harmonious co-existence between the facilities and natural surroundings.

Second, the beautification of surroundings in and around the rural photovoltaic power station demands greater attention. While promoting the artistic designs of photovoltaic panels and power plants themselves, we need at the same time to further explore their potential to get blended with the surroundings. For instance, building vegetated enclosures, making use of hill slopes, sand dunes or other natural features are all possible means that can be tried to alleviate the visual intrusion brought about by the station.

Third, more efforts need to be invested into the research on the evaluation of rural photovoltaics' impact on the landscape. Literature review has indicated that at present the research in this field is still on the preliminary phase. There lack adequate empirical data of rural photovoltaics in different geographic, demographic, economic and cultural settings, and widely recognized assessing scales are yet to be developed.

Therefore both the scope and depth of research await to be expanded so as to enrich the literature on the one hand and strengthen the connection between research and practice on the other. So far, when examining the feasibility of a rural photovoltaic power station, its impact on the landscape is often ignored largely due to weak awareness of the public. Thus more evidence-based research findings will also help to enhance people's awareness of this significant topic. Furthermore, a valid and reliable evaluation system suitable for actual needs is easy to be accepted by all parties concerned who can then work together on creating favorable conditions for constructing cost-effective, efficient and environment-friendly green power plants.

Despite the researcher's efforts to work out an applicable tool for measuring the impact of a photovoltaic power plant on the rural landscape, there is much room for improvement. For one thing, the index system described in the paper is mainly synthesized from the previous studies in the literature and therefore needs to be further consolidated with more empirical data. For another, although it has been put to use in the analyses of two cases in the Chinese rural areas, due to the small sample size, the research findings are not qualified for generalization. Therefore, the validity and reliability of this proposed evaluation scheme need to be further verified in more various contexts in the future.

REFERENCES

[1] 2019 International Renewable Energy Agency (IRENA) report

[2] OECDRegional Statistics (www.oecd.org/topicstatsportal/0,3398,en_2825_497132_1_1_1_1_1,00.html)，and Bloomberg New Energy Finance (www.newenergyfinance.com/)

[3] Environmental Impacts of Renewable Energy Technologies，Ewa Klugmann-Radziemska，2014 5th International Conference on Environmental Science and Technology IPCBEE vol.69 (2014) © (2014) IACSIT Press, Singapore，DOI: 10.7763/IPCBEE. 2014. V69. 21

[4] Renewable and Sustainable Energy Reviews: Environmental impact networks of renewable energy power plants，ViktorSebestyén，University of Pannonia, Egyetemutca 10, H8200 Veszprém, Hungaryjournal(www.elsevier.com/locate/rser)

[5] On May 19, 2021, the "Protecting the Earth Report" jointly issued by the United Nations Environment Programme and the International Union for Conservation of Nature

[6] EU "Nature 2000" communication platform websitehttps://ec.europa.eu/environment/nature/natura2000/platform/index_en.htm

[7] Q&A at the press conference held by the State Council Information Office on December 17, 2020 by Wang Hong, Vice Minister of the Ministry of Natural Resources of China and Director of the State Oceanic Administration

[8]China's "Interim Measures for the Management of National Parks (Draft for Comment)"

[9] In September 2018, the Central Committee of the Communist Party of China and the State Council "Strategic Plan for Rural Revitalization (2018-2022)"

[10] Effects of renewable energy resources on the landscape，Mária SZABÓ1 and Ádám KISS2，Hungarian Geographical Bulletin 63 (1) (2014) 5－16. DOI: 10.15201/hungeobull.63.1.1

[11] Environmental Impacts of Renewable Energy Technologies，Ewa Klugmann-Radziemska，2014 5th International Conference on Environmental Science and Technology IPCBEE vol.69 (2014) ,DOI: 10.7763/IPCBEE. 2014. V69. 21

[12] Environmental impacts from the solar energy technologies,TheocharisTsoutsos, Niki Frantzeskaki, Vassilis Gekas,EnergyPolicy,Volume 33, Issue 3, February 2005, Pages 289-296

[13] Renewable and Sustainable Energy Reviews: Environmental impact networks of renewable energy power plants, Viktor Sebesty, Renewable and Sustainable Energy Reviews, Volume 151, November 2021, 111626

[14] Renewable and Sustainable Energy Reviews: Environmental impact networks of renewable energy power plants,ViktorSebestyén, Renewable and Sustainable Energy Reviews 151 (2021) 111626

[15] Negative environment impact of Solar Energy, Bhanu Mahajan, Environmental Science and Policy,Course Coordinator

[16] Effects of renewable energy resources on the landscape, Mária SZABÓ and Ádám KISS, Hungarian Geographical Bulletin 63 (1) (2014) 5–16. DOI: 10.15201/hungeobull.63.1.1

[17] Renewable Energy in Wilderness Landscapes:Visitors' Perspectives,EditaTverijonaite, Anna DóraSæþórsdóttir, RannveigÓlafsdóttir,C. Michael Hall, MDPI, (http://creativecommons.org/licenses/by/4.0/)

[18] Difficulty and complexity in dealing with visual pollution in historical cities: The historical city of Ibb, Yemen as a case study，A A Q Alwah; Alwah A A Q; Li W; Alwah M A Q; Drmoush A A K; Shahrah S; Tran D T; Xi L B，Institute of Physics Journal

[19] Mitigating Urban Visual Pollution through a Multistakeholder Spatial Decision Support System to Optimize Locational Potential of Billboards，WakilKhydija; Tahir Ali; Hussnain Muhammad Qadeer ul; Waheed Abdul; Nawaz Raheel，Multidisciplinary Digital Publishing Institute

[20] Towards Managing Visual Pollution: A 3D Isovist and Voxel Approach to Advertisement Billboard Visual Impact Assessment，ChmielewskiSzymon，Multidisciplinary Digital Publishing Institute

[21] Visual pollution in natural and landscape protected areas: Case studies from Poland and Slovakia，MagdalenaSzczepańska; Agnieszka Wilkaniec; Lucia Škamlová，QuaestionesGeographicaeVolume 38, Issue 4. 2019. PP 133-149

[22] A Hybrid Tool for Visual Pollution Assessment in Urban Environments，Khydija Wakil; Malik Asghar Naeem; Ghulam Abbas Anjum; Abdul Waheed; Muhammad Jamaluddin Thaheem; Muhammad Qadeer ulHussnain; RaheelNawaz，SustainabilityVolume 11, Issue 8. 2019. PP 2211-2211.

[23] Chaos in Motion: Measuring Visual Pollution with Tangential View Landscape Metrics, Szymon Chmielewski，Land,Received: 21 November 2020; Accepted: 10 December 2020; Published: 12 December 2020

[24] The Impact of Photovoltaic Applications on Urban Landscapes Based on Visual Q Methodology, Ming Lu, Alin Lin, JiyiSun,MDPI, Accepted: 30 March 2018; Published: 2 April 2018(http://creativecommons.org/licenses/by/4.0/

[25] Positive and Negative Impacts of Renewable Energy Sources, Stanislav Vezmar, Anton Spajić, DanijelTopić, Damir Šljivac, Lajos Jozsa, International journal of electrical and computer engineering systems, Vol. 5 No. 2, 2014

[26] Environmental impacts of utility-scale solar energy，R.R. Hernandez , S.B. Easter, M.L. Murphy-Mariscal, F.T. Maestre, M. Tavassoli，E.B. Allen , C.W. Barrows, J. Belnap, R. Ochoa-Hueso, S. Ravi, M.F. Renewable and Sustainable Energy Reviews 29 (2014) 766–779

[27] Application of Landscape Sensitivity Evaluation in Forest Park Planning and Design, Wang Cunlu, Yuan Ying, Cheng Hong, Wei Xiuyuan, Zhao Jun, Journal of Gansu Forestry Science and T echnology, Vol.25No.3, September 2000

[28] On the problem of visual influence in the development of scenic tourism resources, Wang Xiaojun, Geography and Territorial Studies, 1995, 11, Vol. 11, No. 4

[29] The Impact of Tourism on Landscape Vision in Nature Heritage Area: Case of Kanas Nature Reserve,LIUXuling, YANG Zhaoping, CHEN Xuegang
[30] Mitigating Urban Visual Pollution through a Multistakeholder Spatial Decision Support System to Optimize Locational Potential of Billboards，KhydijaWakil , Ali Tahir，Muhammad Qadeer ulHussnain, Abdul Waheed 1 and RaheelNawaz，International Journal of Geo-Informati
[31] Applying Landscape Science to Natural Resource Management,Guy M. Robinson and Doris A. Carson, Ecology and Society Vol. 18, No. 1 (Mar 2013) (11 pages).
[32] USDI Bureau of Land Management． Visual resource management(Supersedes Rel． 8 － 4) . Washington DC: U． S． Government Printing Office，1984．
[33] Laughlin N A，Garcia M W． Attitudes of landscape architects in the USDA forest service toward the visual management system． Landscape Journal，1986，5(2) : 135 － 139．
[34] USDA Forest Service． Landscape aesthetics: a handbook for scenery management． Washington DC: U． S． Government Printing Office，1995．
[35] A contribution to the assessment of scenic quality of landscapes based onpreferences expressed by the public, Canas, E. Ayuga, F. Ayuga, Land Use Policy 26 (2009) 1173–1181
[36] A simplified model to assess landscape quality from rural roads in Spain, Álvaro Ramírez, Esperanza Ayuga-Téllez, Eutiquio Gallego, José María Fuentes, Ana Isabel García, Agriculture, Ecosystems and Environment 142 (2011) 205–212
[37] American tribes inject new vitality into wind power development, Sun Yilin, CNKI
[38] Design of Quanzhou Xiaodao Wind Farm Park with energy as the theme, Xiao Yuwen, CNKI
[39] Same as [35], [36]
[40] Same as【35】
[41] Index of Landscape Disharmony (ILDH) as a new tool combining the aesthetic and ecological approach to landscape assessment, Barbara, Sowiſska-ſwierkosz, Ecological Indicators, Volume 70, November 2016, Pages 166-180
[42] Environmental psychological perspectives on landscape,David L. Uzzell BA, MSc, PhD, AFBPsS, C.Psychol, Landscape Research,Volume 16, 1991 - Issue 1
[43] Aesthetic assessment of the landscape using psychophysical and psychological models: Comparative analysis in a protected natural area, DavidSerranoGiné, María Yolanda Pérez Albert, Amalia VaneskaPalacioBuendía
Landscape and Urban Planning
Volume 214, October 2021, 104197
[44] Same as[22]
[45] Same as[35]
[46] The National Wind-Solar-Storage-Transmission Demonstration Project, see Baidu Encyclopedia entry
[47] Website of Hebei Forestry and Grassland Bureau, http://lycy.hebei.gov.cn/menu/show.php?pid=3138
[48] Website of China Association for Science and Technology, https://www.cast.org.cn/art/2022/2/7/art_51_178747.htm

Qiao Jiang. "A Tentative Evaluation Scheme Regarding the Impact of Rural Photovoltaic Power Plants on the Landscape.” *International Journal of Engineering Science Invention (IJESI)*, Vol. 12(2), 2023, PP 09-17. Journal DOI- 10.35629/6734