Project Evaluation of Intensive Land Use
--- Taking Gansu Province Case 106 PV Project

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Key word： PV Project, Land, Economical and Intensive Use

SUMMARY：

Economical and intensive land use evaluation of construction project is the construction land scale of project organizer, the strength of land use structure, land use, land use efficiency of comprehensive evaluation. At present, the economical and intensive land use evaluation for specific construction projects of related research is relatively small, evaluation result can not reflect the level of economical and intensive utilization of land for construction projects. In this paper, on the basis of multi-factor comprehensive analysis, selection of Gansu Province in 2013-2015 has 106 of the construction of the photovoltaic project as the object of empirical study, using specific projects such as land utilization, input and output data, through the land scale, land use intensity and land use structure, land use efficiency evaluation of four selected 11 concrete evaluation index, build concrete construction of economical and intensive land use evaluation index system, using the Delphi method and analytic hierarchy process (AHP) to measure the index weight, according to the three laws of delta and literature specification data to determine the criteria values, finally the typical pv measure evaluation on the construction project land economical and intensive utilization, and analyzes the evaluation results, some Suggestions. Results show that the land from the unit scale, intensity of land use structure, land use, land use benefit four dimensions to build the evaluation system can reflect comprehensively the construction project of economical and intensive utilization. Through the empirical analysis, 106 pv projects in Gansu Province economical and intensive land use level as a whole is higher, according to the economical and intensive degree of hierarchy, in a low utilization project for 4, appropriate use of 66, moderate utilization of 34, height by using two; Photovoltaic projects in terms of the four evaluation, the overall benefit evaluation of the land scale, land use intensity and land use layer score is relatively high, but there are big differences between the specific evaluation units, individual construction project degree of economical and intensive utilization of land and larger ascension space; The evaluation of land use structure layer overall score is relatively low, through the construction project internal function layout optimization and adjustment of land use structure, and photovoltaic construction project land economical and intensive utilization degree has great room to improve.

摘要：

建设项目土地节约集约利用评价是对建设项目单位用地规模、用地结构、用地强度、用地效益的综合评价。目前，针对具体建设项目土地节约集约利用评价的相关研究相对较少，评价结果不能全面反映建设项目土地节约集约利用水平的高低。本文以多因素综合分析法为基础，选取甘肃省 2013-2015 年已建设的 106 个光伏项目为实证研究对象，利用具体建设项目土地利用、投入产出等数据资料，通过从用地规模、用地强度、用地结构、用地效益四个评价方面选取 11 个具体评价指标，构建建设项目土地节约集约利用评价的指标体系，采用特尔斐法和层次分析法测算各指标权重，依据 3δ 法则及文献规范资料确定各指标标准值，最后对典型光伏建设项目土地节约集约利用情况进行测算评价，并对评价结果进行分析，提出相关建议。结果表明：从单位用地规模、用地结构、用地强度、用地效益四个维度构建的评价体系能够全面反映建设项目节约集约利用情况。通过实证分析，甘肃省 106 个光伏建设项目土地节约集约利用水平整体较高，按照节约集约度等级划分，处于低度利用的项目为 4 个、适度利用 66 个、中度利用 34 个、高度利用 2 个；在具体四个评价方面，光伏建设项目整体在用地规模、用地强度、用地效益评价层分值相对较高，但各具体评价单元之间存在较大的差异，个别建设项目土地节约集约利用程度还有较大的提升空间；项目用地结构评价层得分整体相对较低，通过建设项目内部功能区布局优化、土地利用结构调整，光伏建设项目土地节约集约利用程度有较大的提升空间。

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The conservation and the intensive use of land is the foundation of ecological civilization and a new strategic choice of urbanization. How to improve the level of land conservation and intensive use, to achieve efficient allocation of land resources, is of great significance the sustainable use of land resources. At present, the domestic research of land conservation intensive use mainly concentrats on the regional land conservation intensive use appraisal, and the appraisal technical method has been quite mature [1-7]. From the construction project angle to the land conservation intensive, Li Ruhe (2012) proposed the industrial project land intensive utilization countermeasure; according to the industrial project, administrative office project, medical and health project, educational project, scientific research institution and village classification, Chen Hongwang (2013) evaluated the level of economical and intensive utilization of various types of land in the project. Overall, there are relatively few studies on the evaluation of intensive land use in specific projects, and the evaluation index system is not comprehensive.

The purpose of this paper is to effectively achieve the strict control of land use from the source of land scale, to guide the construction of construction projects to conserve the intensive use of land, and to effectively solve the extensive use of land and waste. Based on the experiences of land conservation and intensive use in typical areas and typical PV projects in Gansu Province in recent years, this paper constructs relevant evaluation index system and evaluates the land-saving and intensive utilization level of specific projects. This project can provide the technical experience reference for the evaluation of land saving and intensive land use of construction projects while enriching the content of the relevant academic research.

1.REGIONAL OVERVIEW

Gansu Province, with long and narrow shape and complex and diverse topology, has in its total area about 55.5% mountain and plateau, 29.6% river valley, and 14.9% Gobi Desert. By the end of 2014, the province's unused land accounted for 54.2% of the land area, through the use of rich unused land resources to develop clean energy, the province's installed capacity of photovoltaic power generation has reached 5168MW, installed capacity ranks first in the country. In this paper, the evaluation of land intensive use of construction projects is studied. A typical PV project is selected as the research object, involving 106 projects, with a land area of 19-270 hm^2 and a total land area of $1.03 \times 10^4 hm^2$.

2. RESEEARCH METHODS

The intensive and economical use of land in the construction project is from the rationality of land use structure, the compact of land use, the comprehensive utilization of land use, the high efficiency of land output, and so on. Land resource consumption, especially the consumption of arable land resources, or more should be unused resources and stock resources to replace.

The evaluation of land conservation and intensive use of construction projects is not only an evaluation of land conservation and utilization or intensive use, but a multi-objective comprehensive evaluation. The specific meaning of land intensive use of construction projects is defined as the following four aspects: (1) The same type of construction projects in the same area of land resources, in the normal production process to meet the requirements of the project, there is the optimal input of land elements of the scale control, to achieve the optimal allocation of land resources. (2) Land intensity and economic development coordination. In the specific stage of economic development, similar projects in the unit investment intensity, vertical and horizontal land use are optimal, with the regional economic development stages of the elements of the combination of coordination. (3) Reasonable land use structure. The same type of construction projects in the internal layout of land, the combination of different types of land resources to achieve the optimal use of land resources to achieve a reasonable allocation. (4) Land use efficiency is outstanding. The output level of construction projects can reach the optimal level of similar projects and improve the land use efficiency.

In this paper, multi-factor comprehensive analysis of the construction project land conservation and intensive use of the level of evaluation. Firstly, the evaluation index system is constructed from four aspects: land use unit scale, land use structure, land intensity and land use efficiency. Secondly, Delphi and AHP were used to determine the weights of each layer of the index system, and the standard values of each index were determined according to the 3δ rule and literature specification data, and then the status values of each index were dimensionless. Finally, the evaluation of land use of the evaluation of the construction of intensive use of the score, the construction of land conservation and intensive use of the existing problems in the analysis.

3. EVALUATION OF INDEX SYSTEM CONSTRUCTION

3.1 Evaluation index selection

The selection of indicators in the evaluation model of construction land conservation and intensive use should be able to fully reflect the law of construction project land use, highlight the land use scale, land input and output, land use structure and so on. Based on the principles of scientificity, operability, availability of data, and dynamic, this paper, based on the existing relevant research, selects 11 specific indicators from four criteria layers, including land use scale, land use structure, land intensity and land use efficiency The evaluation index system is constructed.

The scale of land use criterion reflects the relative rationality of the scale of land use for construction projects under the same technical and economic level. The specific unit-scale land-use index is selected, and the larger the unit-scale consumption index is, the lower the level of land saving and utilization.

The intensity index of land use level reflects the intensity of natural use and economic utilization of construction land. The intensity of investment reflects the economic intensity of land use per unit of construction project, and the building coefficient and floor area ratio reflect the degree of land use from horizontal and vertical utilization level of construction

projects. The greater the index value of land intensity of construction project, the higher the land utilization efficiency of construction project.

The index of land use structure reflects the level of the structural layout of the construction project and the alternative use of land resources. The rational division of the functional division of the project uses the proportion of the proportion of the project function and the proportion of the standard case project to reflect the degree of fit within the rational layout of the land, the specific formula is:

$$\alpha = ave(\left|\frac{\beta_i - \beta}{\beta}\right|)$$

In the formula, α denotes the rule degree of the parcel, ave is the average function, βi is the functional unit specific gravity of i, β is the standard proportion. The proportion of occupied land, the utilization rate of construction land, the rate of afforestation, the proportion of administrative office and living service area reflect the level of unused land and stock construction land, and the consistency of the main function areas. The lower the proportion of cultivated land occupied is, the higher the utilization rate of stock construction land reflects the higher the effective utilization level of construction project land resources. The lower the greening rate, the smaller proportion of administrative office and living service area is, the higher the consistency of construction project land and main functional area.

The land use efficiency guideline layer index reflects the level of input - output of construction project. Unit output level, to absorb the greater the number of labor force, reflecting the construction project land can produce the economic and social benefits.

Table 1 Evaluation index selection of conservation and intensive use land

Target layer	Criterion level	index		Calculation formula
Economical and intensive land use	land-use scale（U_1）	The unit scale uses the area（hm^2/MW）	a_{11}	Total land area of the project / Project construction scale
	intensity of land use （U_2）	investment intensity（wan yuan / hm^2）	a_{21}	Project Investment in Fixed Assets / Total land area of the project
		Coefficient of building	a_{22}	Building base area / Total land area of the project
		plot ratio	a_{23}	Total floor area / Total land area of the project
	land-use structure（U_3）	The utility partition reasonable degrees	a_{31}	The proportion of the project functional zoning and the proportion of the standard case project
		Proportion of cultivated land	a_{32}	Occupies the area of cultivated land / Total land area of the

Target layer	Criterion level	index		Calculation formula
				project
		Use of the existing construction land proportion	a_{33}	Use the area of construction land / Total land area of the project
		greening rate	a_{34}	Green land area / Total land area of the project
		The administrative office space in the Proportion	a_{35}	Administrative office land area / Total land area of the project
	land use efficiency （U_4）	Unit land output level（wan yuan / hm^2）	a_{41}	Annual output value of the project / Total land area of the project
		Unit land carrying labor force（Person /hm^2）	a_{42}	Number of project workers / Total land area of the project

3.2 Weight Determination

The weight of each index has a significant impact on the evaluation results. In order to objectively reflect the reality, this article insists on the combination of qualitative and quantitative methods, combined with Delphi method and analytic hierarchy process, solicits expert opinion to construct the judgment matrix, and assigns the evaluation index weight synthetically.

Table 2 Indicator weight table

Criterion level	index	Weight	The type of indicator	standard value	Remarks
U_1（0.2237）	a_{11}	0.2237	-	6.148 hm^2/MW	3δ rule
	a_{21}	0.1204	+	610 wan yuan / hm^2	3δ rule
U_2（0.2761）	a_{22}	0.0903	+	91.5%	The value of technical specifications
	a_{23}	0.0654	+	1.05	The value of technical specifications
U_3（0.2482）	a_{31}	0.0629	*	0.25	Standard case

Criterion level	index	Weight	The type of indicator	standard value	Remarks
					value
	a_{32}	0.0617	-	100%	Standard case value
	a_{33}	0.0524	+	0.5%	Standard case value
	a_{34}	0.0363	-	0.4%	The value of technical specifications
	a_{35}	0.0349	-	0.5%	The value of technical specifications
U_4（0.2520）	a_{41}	0.1572	+	70 wan yuan / hm^2	3δ rule
	a_{42}	0.0948	+	14 Person / hm^2	3δ rule

Note: In the indicator type, + denotes the positive index, - denotes the inversion indicator, and * denotes the threshold value.

3.3 Evaluation of the value of non-dimensional

3.3.1 Dimensionless method

(1), (2), (3) of the index value of the non-dimensional, due to the limited length of the index value of the current value of the non-dimensional change is to reduce the index value of the differences in the dimension of the evaluation results of the distortion, Nullification of the specific numerical indicators omitted.

$$\text{For negative correlation,} U_i = (1 - \frac{a_i}{A_i}) \times 100 \quad (1)$$

$$\text{For positive correlation,} U_i = \frac{a_i}{A_i} \times 100 \quad (2)$$

$$\text{For threshold indicators,} U_i = (1 - \frac{|a_i - Ai|}{A_i}) \times 100 \quad (3)$$

Where: Ui - the score of the i-th indicator; ai- current value of the i-th index; Ai- the standard value of the i-th index. Individual evaluation index score in the 0 to 100, when greater than 100, the indicators of the degree of achievement score is recorded as 100, less than 0, the indicator of the degree of achievement score is recorded as 0.

3.3.2 Determine Standard Value

The standard value of the index is also called the ideal value or the reasonable value. In this paper, the standard value of the evaluation index is determined by standard case value method, 3δ rule value method and policy criterion value method. 3δ law value method is the statistical analysis, if the variable xN (μ, δ2) distribution, the value of the normal variable x falls (μ-3δ, μ + 3δ) outside the probability of less than 0.003, This event is a small probability event, so the interval (μ-3δ, μ +3δ) as a random variable x the actual range of possible values in the evaluation criteria to determine the standard to 3δ law, based on the corresponding adjustment confidence interval , So as to determine the maximum or minimum standard value of the evaluation index under a certain confidence interval. The value of the standard case is the method of taking the status quo value of the construction project indicator as the ideal value; the value of the policy norm mainly refers to the relevant standard of the existing legal norms as the standard value of the index.

The unit value of land use, investment intensity, unit output level of land, the number of workers to absorb the standard value of indicators based on the use of 3δ law The standard values of the construction coefficient, floor area ratio, greening rate, administrative office and living service area ratio shall be determined by reference to "Land Use Control Index for Industrial Projects" (Guo Zi Fa [2008] No. 24).

3.4 Evaluation Score and Classification

The higher the score is, the higher the level of land conservation and intensive utilization is. The lower the score is, the lower the level of intensive land use will be.

3.4.1 Saving the intensity score

Evaluation of the total score is calculated using the individual evaluation index score weighted sum method:

$$C = \sum_{i=1}^{n} W_i \times U_i \qquad (4)$$

Where: C - land use intensity integrated score; Wi - weight of the i-th indicator; Ui - score of the i-th index; n - number of indicators.

3.4.2 Conservation of intensive use of the level of classification

The intensive conservation degree of the construction project is divided into four levels according to the relevant research results of the intensive utilization degree.

Table 3 Shows the table of the partition table

Economical and intensive degree	Connotation	Economical and intensive degree	Connotation
0~60	Low utilization	75~90	Medium utilization
60~75	Moderate use	90~100	High utilization

4. DATE SOURECS

PV project land conservation and intensive degree calculation, mainly related to the project from 2013-2015 Gansu Province, 106 typical photovoltaic construction projects, including specific construction land area, investment in fixed assets, annual output value, the project layout and other information from the project feasibility study of the project Report, construction project land use status of land type data from the county where the project land use change survey data.

5.CALCULATION RESULTS AND ANALYSIS

5.1 Measurement and non-dimensionalization of index weights

Using the combination of qualitative and quantitative hierarchical analysis method, the evaluation target layer - criterion layer, criterion layer - index layer judgment matrix, calculate the matrix of the largest eigenvalue and corresponding eigenvector, according to the consistency test. The results are shown in Table 1, in which the maximum eigenvalue is 4.0606, CR is 0.0227, and the maximum eigenvalue is 5.1596, 3.0536, 2.000, and CR are respectively the land use structure, land use intensity and land use efficiency. 0.0356, 0.0516, 0.0001, CR <0.1, through the test, the eigenvector is the weight value of the judgment matrix. According to the calculation formula (1), (2) of the index value of the non-dimensional, due to the limited size of the specific dimensionless index values omitted.

5.2 Saving Intensity Estimation

According to the calculation formula of saving intensity (4), the land-saving and intensive utilization degree of 106 PV construction projects is evaluated and the results are shown in Fig.1.

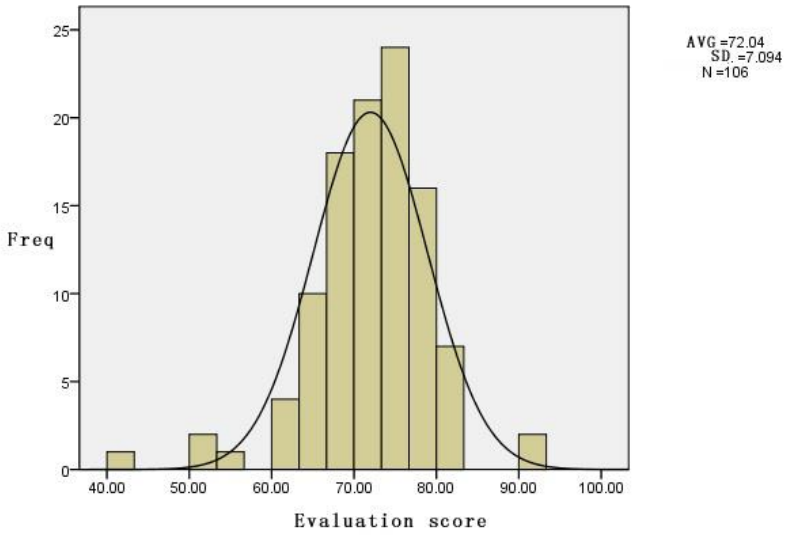

Figure 1 Construction project land conservation and intensive use of equal score results

Through the calculation, the selected 106 PV construction projects have a high land-saving and intensive utilization level, with the maximum of 90.82, the lowest 40.9 and the average 72.04. According to the level of intensive land use of construction projects, there are 4 construction projects with low utilization in the evaluation projects, 66 moderate use, 34 medium utilization and 2 high utilization. The land use intensity of the construction projects is moderate, accounting for about 94.3%.

Table 4 Division of conservation intensive land use

	Low utilization	Moderate use	Medium utilization	High utilization
N of Items	4	66	34	2

5.3 Analysis of Intensive Utilization

Based on the evaluation criteria, the paper analyzes in detail the land saving and intensive utilization level of the evaluation construction project.

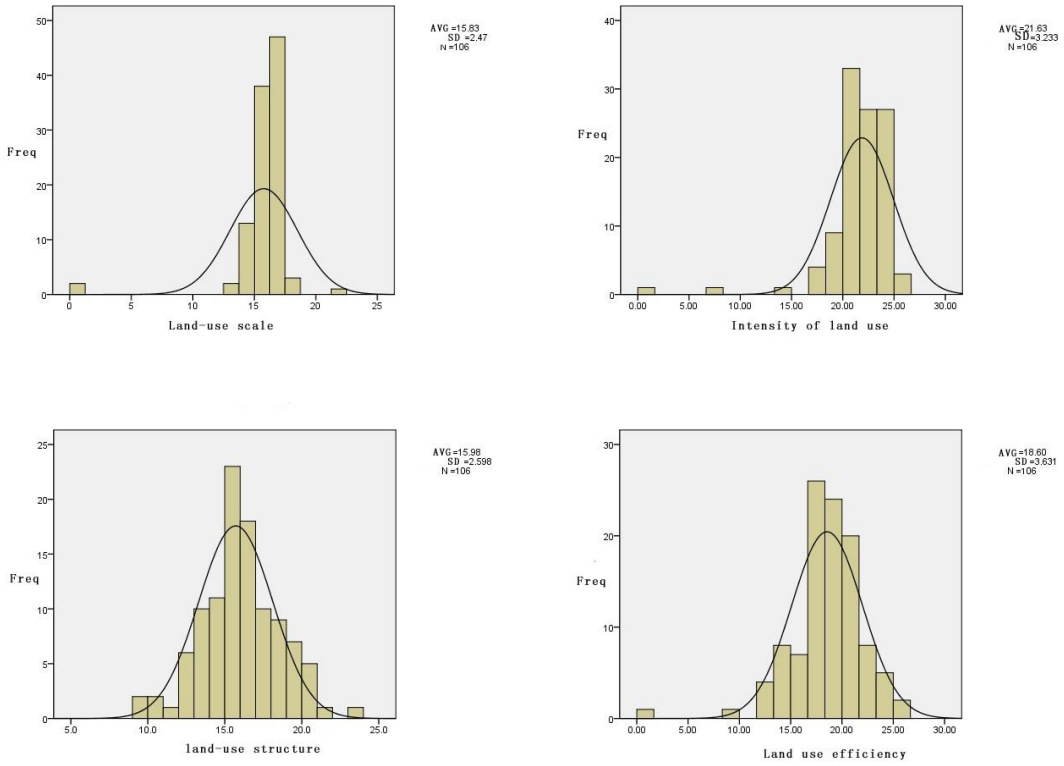

Figure 2 Evaluation of the standard layer measurement scores results

According to the weight of each criterion layer of the evaluation system, the standard value of land use scale, land intensity, land use structure and land benefit standard layer are 22.37,27.61,24.82,25.2 respectively, and the actual value of the evaluation items is

15.83,21.63,15.98,18.60 , Accounting for the proportion of the standard score of 70.08%, 78.34%, 64.39%, 73.80%. In the four evaluation criteria, the overall scale of land use is high, and the standard deviation of each evaluation unit is the smallest, which indicates that the construction project has relatively uniform control standard in the scale of land use, and the evaluation unit has little deviation. The overall score of land use structure layer is relatively low, but the deviation between each evaluation unit is small. This shows that there is a big gap between the status quo of the evaluation project land use structure and the relevant setting standard, which has great room for improvement. The regional conditions are basically the same, so the assessment of individual differences between the smaller points. The land use intensity and the land benefit criterion layer are relatively high, but the deviation between evaluation units is relatively large. This shows that there are big differences between investment and enterprise profit in different projects.

5.4 Conclusions and Recommendations

Land-saving and the intensive use evaluation of the construction project comprehensively considers the land use special evaluation of the land use structure, land intensity and land use, based on the scale control of the construction project land and with the land conservation and intensive use as the guidance. Based on the analysis of the typical PV construction projects in Gansu Province from 2013 to 2015, the authors built an evaluation system of 11 items, including scale of project land use, land intensity, land use structure and land use efficiency, to calculate the corresponding evaluation weight and determine the evaluation standard value. According to the analysis of land use, the evaluation index system of the land conservation intensity of the construction project can be used to evaluate the land use of the actual construction project from the four dimensions of land use scale, land intensity, land use structure and land use efficiency. For the PV project specific measurement results, we recommend:

(1) PV projects in the scale of the land there is a more consistent pattern in the future construction projects to conserve the level of land-intensive use of upgrading, the project should be the overall production process, construction technology to improve and continuously improve the land use of construction projects, PV project land conservation and intensive use of the level.

(2) From the evaluation results, the PV project as a whole in the land structure of the lower score in the specific PV project construction should continue to increase the stock of construction land use, photovoltaic project land within the rational optimization of the functional areas, and continuously improve the construction project Land conservation and intensive use.

(3) PV construction projects in the land intensity, land use efficiency in the evaluation of the unit there is a big difference in the follow-up to continuously improve the level of land conservation and intensive use of construction projects, PV construction projects should strengthen the unity of the production process and strengthen the relevant construction Standard review system to promote the use of new technology to reduce the unit land investment is low, low output photovoltaic enterprises, the overall increase in land use

efficiency of photovoltaic projects.

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