

## Construction of Solar Panel Laying System based on Genetic Algorithm

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### ABSTRACT

Solar power generation is an important energy resource in most countries. It plays an important role in meeting energy demand, improving energy structure and reducing environmental pollution. The main carrier of solar power generation is solar panels, but the utilization efficiency of most existing solar cells is low, which causes serious waste of solar energy. In response to this phenomenon, we propose a Solar Panel Laying System (SPLS) based on genetic algorithm (GA) to construct solar panels, which solves four problems: the determination of the number of battery components, the layout of the panels, the selection of the inverter and the connection of the inverter. In the SPLS, we introduce an improved genetic algorithm and multi-objective optimization solution. Under the double premise that the total amount of solar photovoltaic power generation is as large as possible and the cost per unit of power generation is as small as possible, the quantitative solution of the laying system is realized.

**Keywords--** Genetic Algorithm, Multi-Objective Optimization, Laying System

### I. INTRODUCTION

The energy issue has always been a hot and difficult issue that has attracted the attention of all countries in the world. As the world's energy crisis becomes more and more serious, countries around the world have launched new energy development projects. In order to accelerate the development and utilization of renewable energy such as wind energy, solar energy and biomass energy, countries have invested a large amount of research and development funds, and even included new energy strategies in the country's significant development strategies. Solar energy is a huge non-polluting energy

source on the earth. The solar energy available per second on the earth is equivalent to the heat generated by burning 5 million tons of high-quality coal. China's solar energy resources are equivalent to 1.9 trillion tons of standard coal. It has 960 million kilowatts and currently has an installed capacity of only 6,000 kilowatts. Solar energy is an important energy resource in China and plays a big role in meeting energy demand, improving energy structure, reducing environmental pollution, and promoting economic development [1].

In the practical application of solar energy, the most important part is the laying of solar panels because the rationality of solar panel laying directly affects the conversion efficiency of solar energy. The arrangement of solar panels in traditional solar buildings is not reasonable enough, which wastes space and destroys the building wall. We use mathematical modeling methods to research the optimal laying of solar photovoltaic panels. Firstly, for different types of battery components, we introduce the concept of battery cost performance, and use the cost performance index to select the most economical battery components. Secondly, under the condition of fixed shape and size of the building surface, the improved GA model is used to determine the number of attached battery components. Finally, the multi-objective optimization algorithm is used to solve the model, and the best layout of the panels in the plane is obtained, which achieves the dual goal of the largest total photovoltaic power generation and the lowest unit power generation cost [2].

### II. LITERATURE REVIEW

#### 2.1 Solar Panel

Solar panels are devices that directly or indirectly convert solar radiation into electrical energy

through photoelectric or photochemical effects by absorbing sunlight.

The main material of most solar panels is silicon and the common solar panels are crystal silicon panels and amorphous silicon panels. Crystalline silicon panels can be further divided into polycrystalline silicon solar cells and mono crystalline silicon solar cells. Thin-film solar cells are common in amorphous silicon panels. According to the national standard for the design of photovoltaic power plants in accordance with the regulations of the People's Republic of China: thin solar modules should be used in areas with low solar radiation, large solar scattering components and high ambient temperature. The solar radiation is low and the direct solar component is large. Crystalline silicon photovoltaic modules or concentrating photovoltaic modules should be used in areas with high ambient temperatures.

### 2.2 Genetic algorithm (GA)

GA are computational models that mimic the natural selection and genetic mechanisms of Darwin's biological evolution theory. They are often solutions that use biological heuristic operators such as mutation, crossover, and selection to generate high-quality optimization and search problems[3][4]. A method of searching for optimal solutions by simulating natural evolutionary processes. The GA starts with a cluster of problem solutions, rather than starting with a single solution. This is a great difference between improved GA and traditional optimization algorithms[5]. The traditional optimization algorithm is to find the optimal solution from a single initial value iteration, which is easy to mistakenly into the local optimal solution. The GA starts from the string set and has a large coverage, which is good for global selection[6].

### 2.3 Inverter

Solar AC power generation system is composed

$$\partial_1 = W_0 b_1 - P b_2 \quad (1)$$

Where,  $\partial_1$  is the cost-performance ratio of photovoltaic modules,  $W_0$  is the total power generation in

When calculating the total power generation in N, the total annual  $W_1$  should be calculated:

$$W_1 = E \times S \times \alpha \times t \quad (2)$$

Among them, E is the annual level of total radiation intensity. S is the area of radiation.  $\alpha$  is the

Assuming  $n=35$ , the total electricity generation  $W_0$  in 35 years of life is calculated as follows:

$$W_0 = 10W_1 + 15 \times 0.9W_1 + 10 \times 0.8W_1 \quad (3)$$

### 3.2 Determine the number of battery modules

According to the principle of low solar radiation, large solar scattering component and high ambient temperature, thin film photovoltaic module should be selected in areas with low ambient radiation and large direct solar radiation component. In areas with high ambient temperature, the principle of crystal silicon

of solar panels, charging controllers, inverters and batteries, while solar DC power generation system does not include inverters. The process of converting AC power into DC power is called rectification, the circuit that completes rectification function is called rectification circuit, and the device that realizes rectification process is called rectification equipment or rectifier. Correspondingly, the process of converting DC power into AC power is called inversion, the circuit that completes the inversion function is called inversion circuit, and the device that realizes the inversion process is called inversion equipment or inverter.

Inverter, also known as power regulator, power regulator, is an essential part of photovoltaic system. The main function of photovoltaic inverters is to convert the direct current generated by solar panels into the alternating current used by household appliances. All the power generated by solar panels can be output only through the processing of inverters. Through full-bridge circuit, SPWM processor is usually used to obtain sinusoidal AC power supply system terminal users matching lighting load frequency and rated voltage through modulation, filtering, boost, etc. With inverters, DC batteries can be used to provide alternating current for electrical appliances.

## III. ESTABLISHMENT OF PUSHE MODEL

### 3.1 Determine the product type of the battery module

Assuming that, regardless of the choice of the inverter, the economic benefit of considering only the total radiation of the sunlight level in a given area of 1 m<sup>2</sup> is the cost performance of the photovoltaic module. The calculation formula is:

N years of life,  $b_1$  is the price of electricity, P is the power of modules, and  $b_2$  is the price of battery modules.

conversion rate and t is the time of radiation.

Photovoltaic module or concentrating photovoltaic module should be selected, while different types of panels should be selected in conjunction with local solar radiation conditions. Assuming that each surface can be paved to meet the maximum power generation requirements, a model based on GA is established to calculate the number of different types of batteries used in each building

surface.

(1) The process of determining the maximum number of panels that can be laid by GA is as follows[7].

① **Initialization**

Set the evolutionary algebra counter  $t = 0$ , set

$$d_1 = W_0 b_1 - P b_2 \quad (4)$$

③ **Selection operation**

The selection operator is applied to the group. The purpose of the selection is to directly pass the optimized individual to the next generation or to generate a new individual through pairing to regenerate to the next generation, which is based on the fitness assessment of the individual in the group.

④ **Crossover operation**

The crossover operator is applied to the population. The core function of the GA is the crossover operator.

the maximum evolutionary algebra  $T$ , and randomly generate  $M$  individuals as the initial population  $P(0)$ .

② **Individual evaluation**

The fitness of each individual in the population  $P(t)$  is calculated. The function of fitness:

⑤ **Mutation operation**

The mutation operator is applied to the population. That is, changes in the gene values at certain loci of individual strings in a population. The population  $P(t)$  is subjected to selection, crossover, and mutation operations to obtain the next generation population  $P(t+1)$ .

⑥ **Judgment termination condition**

If  $t=T$ , the calculation is terminated by using the individual with the greatest fitness obtained during the evolution as the optimal solution output. Draw the above process as a flow chart as follows(Figure 1):

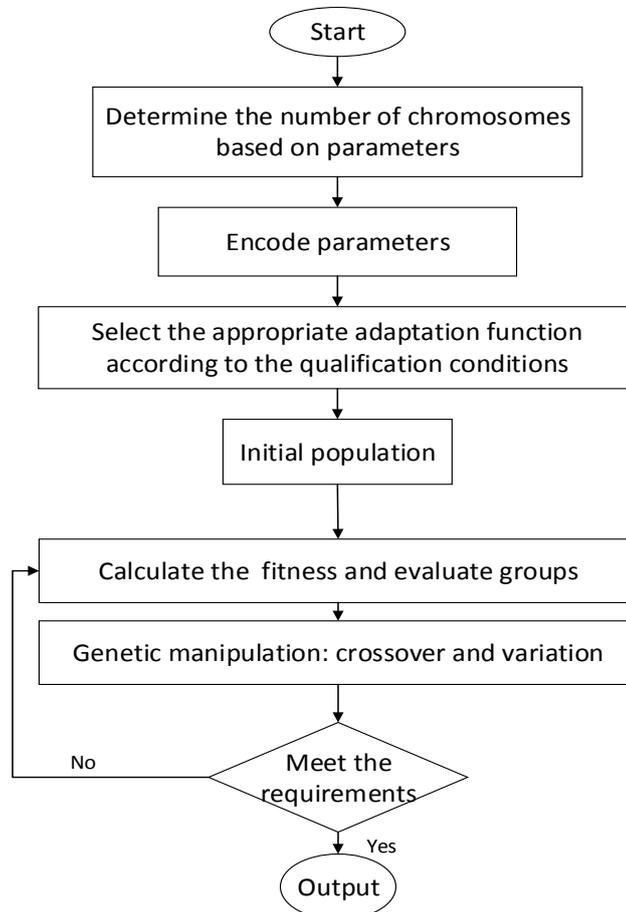


Figure 1 Flow chart of the genetic algorithm

(2) **Improved GA**

After determining the maximum number of batteries used on each side, in order to make full use of the wall area, the maximum total area of the batteries should be taken as the objective function when laying the batteries. The problem of layout generation of the batteries is not a single factor or a single subject, but involves

multi-objective optimization. Because GA judges whether an individual is good or not according to the fitness of the individual, it will result in some recessive individuals being unexpectedly eliminated by some supernormal individuals in the evolutionary process, leading to premature convergence of the population and falling into local optimum; due to improper coding methods and

crossover operator design, the crossover process produces fine individual reduction. There are fewer inferior individuals; the direction of GA is not strong in the search process, which has a certain impact on the search efficiency of GA, so the GA used above is not suitable for directly calculating the layout of batteries, and needs to be improved[8][9].

In view of the above factors that affect the global optimization of GA, we propose an improved GA:

$$P_c = \begin{cases} P_{C1} - \frac{(P_{C1} - P_{C2})(f' - f_{avg})}{f_{max} - f_{avg}}, & f' \geq f_{avg} \\ P_{C1} & f' < f_{avg} \end{cases} \quad (5)$$

$P_{C1}$  and  $P_{C2}$  are fixed values,  $P_{C1} = 0.9$ ,  $P_{C2} = 0.5$ ,  $f_{max}$  is the maximum fitness of the contemporary population,  $f_{avg}$  is the average fitness of the contemporary population, and  $f'$  is the fitness of the current individual.

It can be seen from this that when the fitness of an individual is greater than the average fitness of the population, the individual crosses with a smaller probability of crossover. The higher the fitness, the

$$x_i(t+1) = \delta x_i(t) + (1 - \delta)x_j(t) \quad (6)$$

$$x_j(t+1) = \delta x_j(t) + (1 - \delta)x_i(t) \quad (7)$$

## ② Mutation operator

After the crossover operator is executed, the mutation operator is also needed to fine-tune the individual population to increase the diversity of the population. Like the crossover operator, if the population mutation is determined by a fixed mutation probability in the whole evolutionary process, it will inevitably lead to

$$P_c = \begin{cases} P_{m1} - \frac{(P_{m1} - P_{m2})(f' - f_{avg})}{f_{max} - f_{avg}}, & f' \geq f_{avg} \\ P_{m1} & f' < f_{avg} \end{cases} \quad (8)$$

$P_{m1}$  and  $P_{m2}$  are fixed values,  $P_{m1} = 0.1$ ,  $P_{m2} = 0.1$ ,  $f_{max}$  is the maximum fitness of the contemporary population,  $f_{avg}$  is the average fitness of the contemporary population, and  $f'$  is the fitness of the current individual.

It can be seen that the greater the individual fitness, the smaller the possibility of mutation, the smaller the individual fitness, the greater the possibility of mutation. In this way, good individuals can be copied to the next generation with a greater probability, at the same time, the mode of inferior individuals can be effectively changed, and the speed of optimization can be accelerated. We can randomly select two loci of an individual and exchange their genes so that the mutated chromosome can still be solved and the generation of infeasible solutions can be effectively avoided.

## ① Crossover operation

In order not to destroy the excellent individual mode, adaptive crossover operation is adopted. For individuals with high fitness, we cross with a smaller probability, and for individuals with small fitness, we cross with a larger probability. The adaptive crossover probability is:

smaller the possibility of crossover and the lower the fitness is, the higher the possibility of crossover will be, so that the good model can be effectively avoided being destroyed. According to the crossover probability, the crossover individuals are determined, and the crossover individuals are paired. Because we adopt the floating-point coding scheme, we can randomly generate two individuals of the t-generation population, namely,  $\delta \in [0,1], x_i(t), x_j(t)$ . The formula for cross calculation is as follows:

the unintentional elimination of good individuals. We use adaptive genetic variation to determine the individual variation in the population according to the size of individual fitness. The greater the fitness, the smaller the mutation probability and the smaller the fitness, the greater the mutation probability. The calculation of adaptive mutation probability is as follows:

## 3.3 Layout of solar panels

A and B respectively indicate the length and width of the building surface. A' and B' respectively indicate the length and width of the gap in the plane.  $a_i$  and  $b_i$  respectively indicate the length and width of the i-type ( $i = 1, 2, \dots, n$ ) panel. h denotes the sum of the lengths of all photovoltaic cells in the longitudinal direction and the width direction on the plane.  $m_{i,1}$  and  $m_{i,2}$  respectively indicate the length direction and width of the i-type photovoltaic cell in the plane. The number of directions used;  $m_i$  indicates the number of i-type photovoltaic cells used in the plane. n indicates the number of types of batteries used, and the restrictions on the placement of photovoltaic cells are as follows:

$$l = \sum_{i=1}^n (m_{i,1} \cdot a_i + m_{i,2} \cdot b_i) \quad (9)$$

$$h = \sum_{i=1}^n (m_{i,2} \cdot a_i + m_{i,1} \cdot b_i) \quad (10)$$

$$s = \sum_{i=1}^n (a_i \cdot m_{i,1} \cdot b_i) \quad (11)$$

$$\sum_{i=1}^n a_i \cdot b_i \leq A \cdot B - A' - B' \quad (12)$$

Finish the above formula to get:

$$\left[ \frac{l + A'}{A} \right] = \left[ \frac{h + B'}{B} \right] \quad (13)$$

In addition, the arrangement of the panels must be such that they do not overlap each other, and constraints such as  $asl \leq A$ ,  $h \leq B$ [10][11][12].

### 3.4 Inverter selection

The choice of inverter should analyze the inverter parameters and price. Generally, when the inverter allows the input voltage range to be the same, the price is

$$N \leq \frac{V_{dmax}}{V_{QC} \cdot [1 + (t - 25) \cdot K_V]} \quad (14)$$

Among them,  $V_{dmax}$  is the maximum DC input voltage allowed by the inverter.  $V_{QC}$  is the open circuit voltage of the photovoltaic cell component, and  $K_V$  is the open circuit voltage temperature coefficient of the photovoltaic cell component. According to the national standard, the open circuit voltage temperature coefficient  $K_V = -0.32\%/^{\circ}\text{C}$ .  $t$  is the ultimate low temperature under the operating conditions of photovoltaic modules,  $t =$

$$n = \frac{I_1}{I_2} \quad (15)$$

Among them, the maximum DC input current allowed by the  $I_1$  inverter.  $I_2$  is the short-circuit current of the photovoltaic cell assembly, and the maximum number  $n_{max}$  of the branches that the inverter can be

$$M = N_{max} \times n_{max} \quad (16)$$

Calculation of the total cost matrix of the inverter:

$$\left[ \frac{N_1}{M} \right] \times b_3 \quad (17)$$

$b_3$  is the price of the inverter[14][15].

positively correlated with the maximum DC current allowed to input, so it can be established by the matrix of the total cost of the inverter. Select the inverter with the lowest total cost to maximize economic benefits[13].

Calculate the number  $N$  of photovoltaic modules that can be connected in series with the qualified inverter:

$-20^{\circ}\text{C}$ .

Under the condition that the voltage difference between the parallel photovoltaic modules is less than 10%, and the optional capacity of the inverter is not less than the capacity of the group installation of the photovoltaic modules. The number of branches that the inverter can be connected in parallel is calculated:

connected in parallel is obtained by taking an integer down to  $n$ .

Then the number  $M$  of inverters required for photovoltaic modules is:

**3.5 Calculation of power generation**

Due to the minimum radiation limit that the surface of the photovoltaic cell module should receive when generating electricity, the total surface radiation amount of the single crystal silicon and polycrystalline silicon cells to start power generation is greater than or equal to 80 W/m<sup>2</sup>, and the total radiation amount of the thin film battery surface is greater than or equal to 30

$$E_p = H_A \times \frac{P_{AZ}}{E_S} \times K \tag{18}$$

$H_A$  is the total solar radiation of the horizontal plane.  $P_{AZ}$  is the capacity of the component installation.  $E_S$  is the radiance under the standard condition ( $E_S = 1KW \cdot$

W/m<sup>2</sup>. Therefore, the total amount of radiation that does not meet the conditions should be eliminated when calculating the total annual power generation.

Calculated using the standard method of power generation calculations specified by the state, the current annual power generation  $E_p$  is:

$h/m^2$ ), and K is the comprehensive efficiency coefficient. The calculated formula is:

$$P_{AZ} = N_{max} \times n_{max} \times P \tag{19}$$

The correction of the overall efficiency coefficient K is as follows (Table 1):

Table 1 Comprehensive efficiency coefficient

PV module type correction factor $K_1$	Monocrystalline silicon photovoltaic cell $K_1 = 100\%$ Polycrystalline silicon photovoltaic cell $K_1 = 94\%$ Thin film photovoltaic cell $K_1 = 95\%$
Tilt angle and azimuth correction coefficient of photovoltaic array $K_2$	$K_2 = 80\%$
Photovoltaic power system availability $K_3$	$K_3 = 99\%$
Light utilization $K_4$	$K_4 = 96\%$
Inverter efficiency $K_5$	Shown in Table 2
Collector line loss $K_6$	$K_6 = 96\%$
Step-up transformer loss $K_7$	$K_7 = 98.9\%$
PV module surface pollution correction factor $K_8$	$K_8 = 97\%$
PV module conversion efficiency correction factor $K_9$	$K_9 = 93.3\%$
$K = \prod_{i=1}^9 K_i$	

**IV. APPLICATION OF THE SOLAR PANEL LAYING MODEL**

The model is applied according to the existing panels on the market.

**4.1 Data description**

- ①Parameters of battery panel (Shown in Appendix 1)
- ②Parameters of solar cottage (Shown in Figure 2 to figure 7)

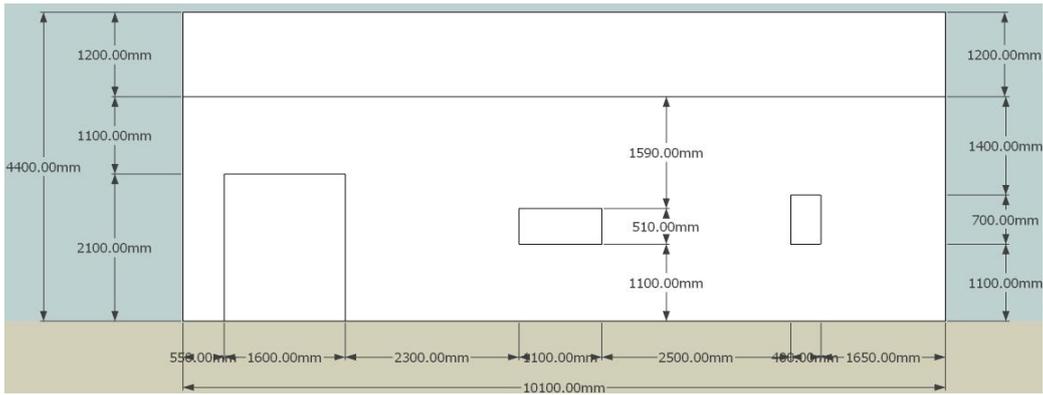


Figure2 The northern side of the solar cottage

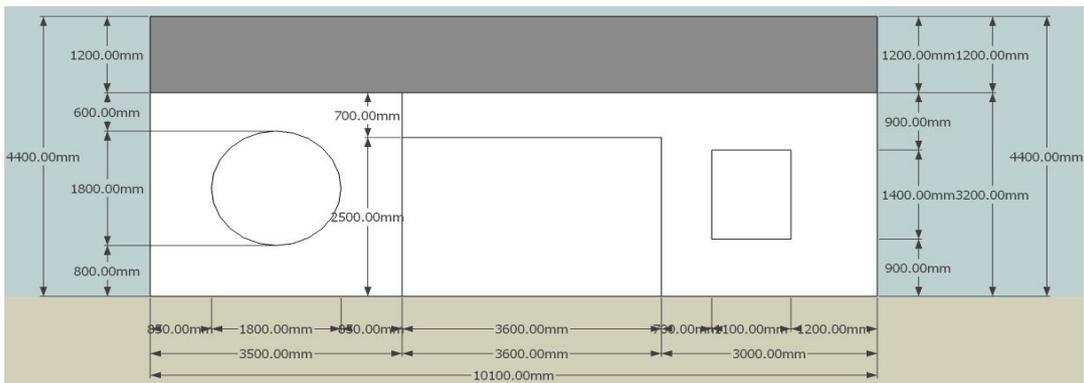


Figure3 The southern side of the solar cottage

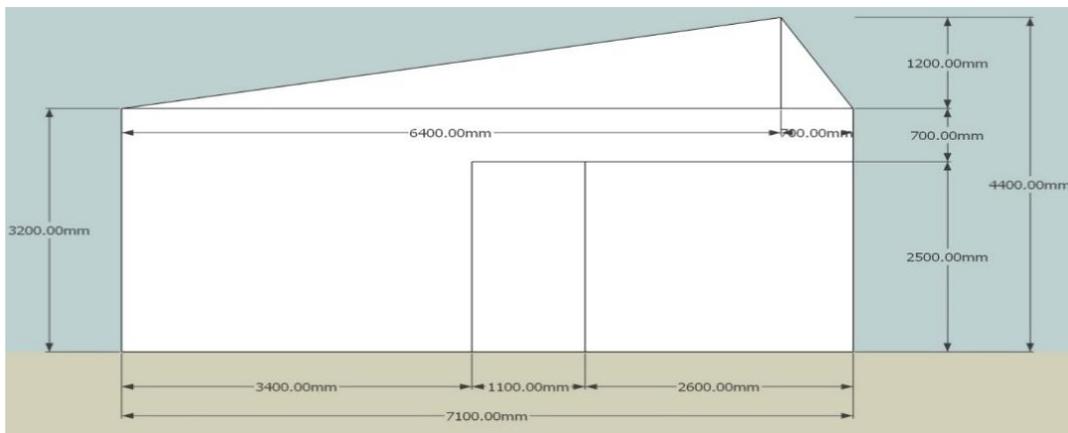


Figure4 East of the solar cottage

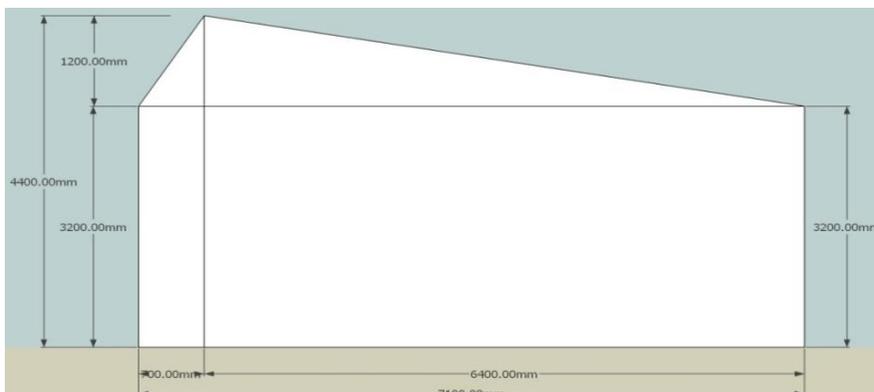


Figure5 West of the solar cottage

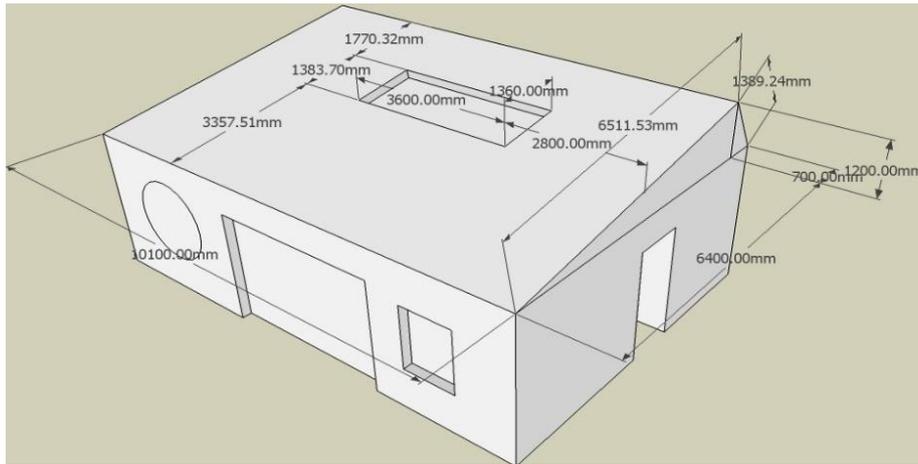


Figure6 Top view of solar cottage

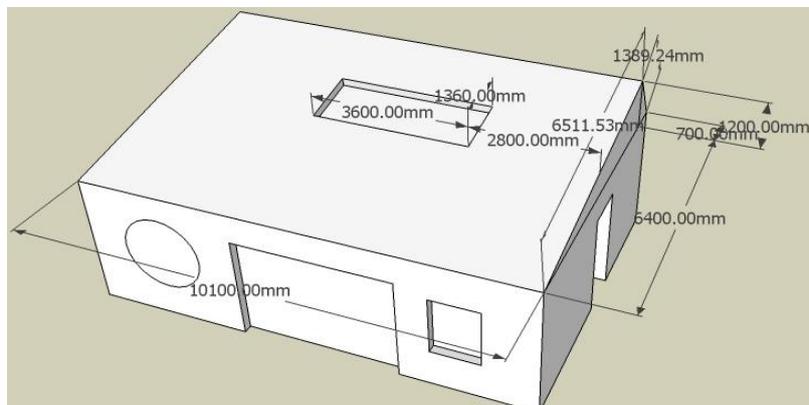


Figure7 Perspective view of solar cottage

③Parameters of inverter(Shown in Table 2)

Table2Inverter parameters and price list

G1	DC input			AC output			G7	G8 (yuan/unit)
	G2 (V)	G3 (A)	G4 (V)	G5 (V/Hz)	G3 (A)	G6 (KW)		
SN1	DC48	24	42~64	AC220/50	4.5	0.8	86%	4500
SN2	DC48	48	42~64	AC220/50	9.0	1.6	86%	6900
SN3	DC48	73	42~64	AC220/50	13.6	2.4	86%	10200
SN4	DC48	115	42~64	AC220/50	22.7	4	90%	15000
SN5	DC220	10	180~300	AC220/50	9.1	1.6	94%	6900

Remarks: G1is the product number.G2 is the ratedvoltage.G3 ratedcurrent.G4 is the allow input voltage range.G5 is the rated voltage/frequency.G6 is the rated power.G7 is the inverter efficiency (80% resistive load) .G8 is the reference price.

4.2 Model solution

(1) Cost-effectiveness of battery components(Shown in Table 3)

Table 3 Cost-effectiveness of battery components

Single/polysilicon battery		Thin film battery	
Product number	Cost-effectiveness	Product number	Cost-effectiveness
A1	1786975.32	B7	1590389.28
A2	1764075.29	C1	742593.04
A3	1984926.41	C2	655624.41
A4	1750012.07	C3	674557.74

A5	1588800.73	C4	620390.11
A6	1601875.40	C5	689440.46
B1	1719894.07	C6	385868.52
B2	1738341.50	C7	385868.52
B3	1696131.39	C8	389038.47
B4	1570316.30	C9	389019.27
B5	1695256.39	C10	438982.69
B6	1612150.87	C11	453683.01

As can be seen from the above table, the most cost-effective of the crystalline silicon battery is the number A3 and its cost performance is:

$$\partial_{1A} = 1984926.41$$

Therefore, the number A3 battery board is selected for the laying of the crystalline silicon battery. The most cost-effective of the thin film photovoltaic cell is the number C1 and its cost performance:

$$\partial_{1C} = 742593.04$$

Therefore, the thin film photovoltaic cell should be selected for the the number C1.

**(2) Number of panels laid**

Based on GA, we use Matlab to solve the number of panels used by different walls. The detailed quantity is shown in the Table 4.

Table 4 The number of panels used by different walls

Metope \ Number	Product number	Quantity
South roof	A3	40
North roof	C1	7
Eastward wall	A3	13
Westward wall	A3	15
Northward wall	A3	13
Southward wall	C1	4

**(3) Product number and quantity of inverters**

Table 5 Number and type of inverter

Project \ Walls	Product number	Quantity	Unit Price	Total Price
South roof	SN4	2	15000	30000
North roof	SN5	1	6900	6900
Eastward wall	SN3	1	10200	10200
Westward wall	SN2	2	6900	13800
Southward wall	SN1	1	4500	4500
Northward wall	SN5	2	6900	13800

**(4) Panel layout and inverter connection (Shown in Figure 8 to figure 13)**

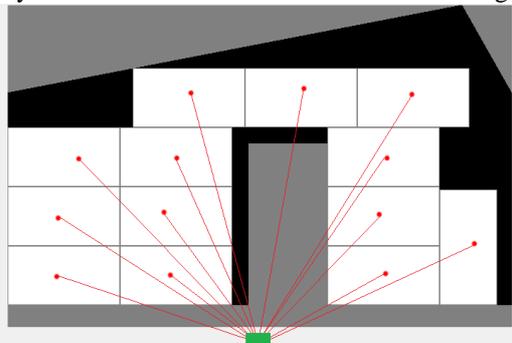


Figure 8 Inverter connection diagram of the east wall

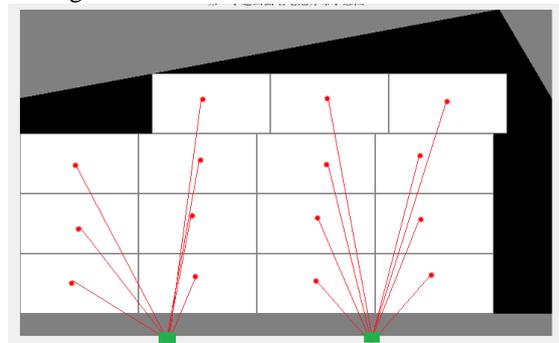


Figure 9 Inverter connection diagram of the west wall

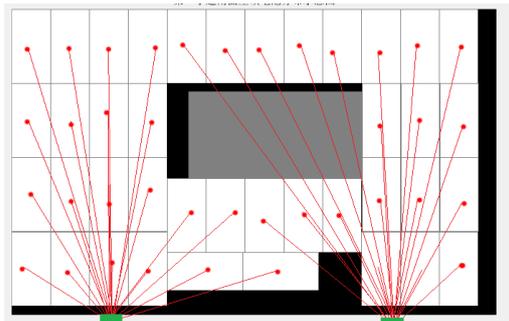


Figure 10 Inverter connection diagram of the south roof

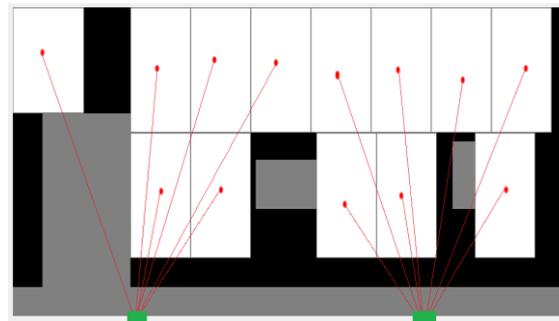


Figure 11 Inverter connection diagram of the north wall

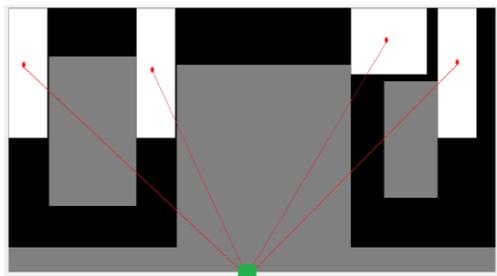


Figure 12 Inverter connection diagram of the south wall

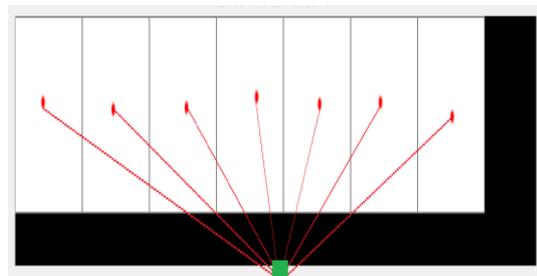


Figure 13 Inverter connection diagram of the north roof

**(5) Economic benefit**

The economic benefits of the cottage photovoltaic battery during the 35-year life cycle Z

$$Z = Eb_1 - C \tag{20}$$

$$C = \sum N_1b_2 - \sum Mb_3 \tag{21}$$

$$E = 10E_p + 15 \times 0.9E_p + 10 \times 0.8E_p \tag{22}$$

Where, E is the total amount of electricity generated in 35 years, and C is the total cost of investment, including the cost of photovoltaic modules and the cost of inverters.

The calculation shows that under the attached condition, the total power generation of the cabin

(current civil electricity price is calculated at 0.5 yuan / kWh):

photovoltaic cells in 35 years is 106 43642179.7 kW, and the investment income under this scheme is 501 8461.1 yuan. If the efficiency of all photovoltaic modules is 100% in 0-10 years, 90% in 10-25 years and 80% in 25 years, the calculation of investment return life T is as follows:

$$T = \begin{cases} \frac{C}{E_p b_1}, & (C \leq 10E_p b_1) \\ 10 + \frac{C - 10E_p b_1}{0.9E_p b_1}, & (10E_p b_1 < C \leq 23.510E_p b_1) \\ 25 + \frac{C - 23.5b_1}{0.8E_p b_1}, & (C > 23.510E_p b_1) \end{cases} \tag{23}$$

The relationship between economic benefits and laying days is calculated, under the program, it can be returned in the third year.

**V. CONCLUSIONS**

The laying system of solar panels based on GA provides a quantitative solution and technical support for

the optimization of the laying of solar panels, which has very important research and application value. With the idea of mathematical modeling and the solution of GA, the optimal laying of photovoltaic panels in plane is realized, and the maximum efficiency of solar energy is utilized in limited space.

The laying system of solar panels based on GA is constructed. Under the premise of maximizing the total

amount of photovoltaic power generation and lowest cost per unit of power generation, the selection of battery module type, the determination of the number of battery modules, the layout of solar panels, the selection and

connection of inverters are realized. GA is used to solve the function of the system, and the convergence is good, and the precision and operation speed are relatively high.

### Appendix 1

Table 6 Parameters of battery panel

product number	Component size (mm×mm)	Open circuit voltage (Voc)	Short-circuit current (Isc/A)	conversion efficiency $\eta$ (%)	Solar irradiance threshold
A1	1580×808×40	46.1	5.79	16.84%	When the irradiation intensity is lower than 200 W/m <sup>2</sup> , the conversion efficiency of the battery is less than 5% of the conversion efficiency.
A2	1956×991×45	46.91	8.93	16.64%	
A3	1580×808×35	46.1	5.5	18.70%	
A4	1651×992×40	38.1	8.9	16.50%	
A5	1650×991×40	37.73	8.58	14.98%	
A6	1956×991×45	45.92	8.64	15.11%	
B1	1650×991×40	37.91	9.01	16.21%	
B2	1956×991×45	45.98	8.89	16.39%	
B3	1482×992×35	33.6	8.33	15.98%	
B4	1640×992×50	36.9	8.46	14.80%	
B5	1956×992×50	44.8	8.33	15.98%	
B6	1956×992×50	45.1	8.57	15.20%	
B7	1668×1000×40	37.83	8.75	14.99%	
C1	1300×1100×15	138	1.22	6.99%	
C2	1321×711×20	62.3	1.54	6.17%	
C3	1414×1114×35	99	1.65	6.35%	
C4	1400×1100×22	115.4	1.26	5.84%	
C5	1400×1100×25	100	1.64	6.49%	
C6	310×355×16.7	26.7	0.35	3.63%	
C7	615×180×16.7	12.6	0.7	3.63%	
C8	615×355×16.7	26.7	0.7	3.66%	
C9	920×355×16.7	26.7	1.05	3.66%	
C10	818×355×16.7	26.7	0.9	4.13%	
C11	1645×712×27	55	1.75	4.27%	

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