Design of solar huts

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Abstract: This problem is a solar hut photovoltaic cell in the attached and overhead two installation methods, the type of photovoltaic cells and array mode and inverter type optimization design issues. In question 1, since the photovoltaic cells are attached to the roof and exterior surfaces, the direction and angle of the battery are uniquely determined by the direction and angle of the attached surface. The problem is translated to optimize the installation of a certain type on a single surface area (array) of photovoltaic cells, so that the total amount of solar photovoltaic power generation as much as possible, and the unit power generation costs as small as possible, which is a multi-objective optimization problem. The problem can be discussed in the ideal environment in a single surface area of the battery installation optimization program, and then the actual environment of the multi-surface optimization. In the solution to Problem 1, the unit on the south of the roof of the battery at the moment to accept the solar energy formula is generated. The definition of and is the moment of direct radiation intensity, for the moment the sun and the south of the roof of the plane where the angle, for the level of horizontal radiation intensity, for the south of the roof and the horizontal angle, the planefor the plane, the center of the heart, the vertical upward direction is the axis of the positive coordinate system, obtained with the sun height angle , the sun azimuth , red angle, angle and the sun when the relationship is generated. The conclusion is only installed in the small roof surface type of battery C11, and the rest of the surface is not installed. 35 years of electricity generation is 77126 degrees, the economic benefits of 16,488 yuan, the recovery period of 21.3 years. In question 2, because the photovoltaic cells in the roof and the external wall surface can be installed overhead, the panel orientation and tilt will affect the efficiency of photovoltaic cells. Therefore, in the optimization scheme of Problem 1, the orientation and inclination of the panel on each surface are further adjusted to calculate the optimum orientation and inclination of the panel on each surface. The problem can be in the ideal weather environment to establish the sun running and the battery board efficiency model, and then the measured environment test. The optimal orientation of the panel is southward, and the optimal angle with the ground plane is 39.89 degrees. The conclusion is only installed in the small roof surface type of battery C11, and the rest of the surface is not installed. 35 years of generating capacity of 82165.2 degrees, the economic benefits of 18,998 yuan, the recovery period of 13 years. In question 3, by the optimization of the above two issues, in the building to meet the requirements of the hut under the design of the various aspects of the cabin and battery installation, and further optimize the total power generation of the hut, economic benefits. The whole model solver is run in MATLAB7.0.

Key words:photovoltaic cell module inverter rated power

1.Problem restatement

In the design of solar huts, the need to build the outer surface of the building (roof and external walls) laying photovoltaic cells, photovoltaic modules produced by the DC power through the inverter into 220V AC power for home use, and the remaining power into the grid. The price of each type of photovoltaic cell is very different, and the actual power generation efficiency or power generation per peak tile is affected by many factors such as solar radiation intensity, light incident angle, environment, geographical distance of the building , the regional climate and weather conditions, installation sites and methods and so on. Therefore, in the design of solar huts, it is important to study the optimal laying of photovoltaic cells on the outer surface of the hut.

Annex 1-7 provides relevant information. Please refer to the data provided in the annex to the following three issues, respectively, to give the outer surface of the cottage photovoltaic cell laying program, so that the whole year the total solar photovoltaic power generation as much as possible, and the unit power generation costs as small as possible, calculate the total amount of electricity generated in the 35-year life period of the photovoltaic cells, the economic benefits (the current civil electricity price is 0.5 yuan / kWh) and the investment recovery period.

In the solution of each problem, are required to be equipped with illustrations, given the outer surface of the cabin battery packs to lay out the array graphics and component connection (string, parallel) diagram, but also to give the battery pack packet array capacity and optional reverse variable list of specifications.

In the same surface with two or more types of photovoltaic cell components, the same type of battery panels can be connected in series, and different types of panels cannot be connected in series. On different surfaces, even the same type of battery cannot be string, parallel connection. Attention should be paid to the combination of packet connection and inverter.

Question 1: According to the meteorological data of Datong City, Shanxi Province, only part of the outer surface of the hut (see Annex 2) is laid out by considering the installation method and the PV module is selected. According to the number and capacity of the battery pack, with the corresponding inverter capacity and quantity.

Question 2: The orientation and inclination of the panel will affect the efficiency of the photovoltaic cell. Please select the aerial type to install the photovoltaic cell and reconsider the problem.

Question 3: According to the requirements of the cottage construction given in Annex 7, please re-design a hut for Datong City, ask to draw the outline of the hut and optimize the laying of photovoltaic cells on the outer surface of the designed hut, giving laying and grouping, optional inverter, calculate the corresponding results.

2.Problem analysis

The problem is that a solar cottage photovoltaic cell in the two installation methods, the type of photovoltaic cells and array mode and inverter type optimization design issues.

In question 1, since the photovoltaic cells are attached to the roof and exterior surfaces, the direction and angle of the battery are uniquely determined by the direction and angle of the attached surface. The problem is translated to optimize the installation of a certain type on a single surface area (Array) of photovoltaic cells, so that the total amount of solar photovoltaic power generation as much as possible, and the unit power generation costs as small as possible, which is a multi-objective optimization problem. The problem can be discussed

in the ideal environment in a single surface area of the battery installation optimization program, and then the actual environment of the multi-surface optimization.

In question 2, because the photovoltaic cells in the roof and the external wall surface can be installed overhead, the panel orientation and tilt will affect the efficiency of photovoltaic cells. Therefore, in the optimization scheme of Problem 1, the orientation and inclination of the panel on each surface are further adjusted to calculate the optimum orientation and inclination of the panel on each surface. The problem can be in the ideal weather environment to establish the sun running and the battery board efficiency model, and then the measured environment test.

In question 3, by the optimization of the above two issues, in the building to meet the requirements of the hut under the design of the various aspects of the cabin and battery installation, and further optimize the total power generation of the hut, economic benefits.

3.Symbol description

Solar elevation angle

Sun azimuth

Angle

Red angle

Datong latitude is

The direct direction of the sunlight and the normal angle of the panel

The azimuth of the panel

The height of the panel

Roof area

3. Model assumptions

3.1 Model assumptions

(1) Do not consider the weather changes, natural disasters and other factors, do not consider the human disturbance factors.

(2) Assume that the energy generated by the solar cottage can be effectively output.

(3) Do not consider the installation of the battery spacing and overhead equipment, wiring, labor hours and other installation costs and costs.

4.Mdel of the establishment and solution

Model one

In the ideal environment, that is, regardless of weather changes, natural disasters and human disturbance and other factors, the establishment of a sun in a year when running, fixed to the tilt and tilt of the panel, the panel received the sum of solar energy of the calculation model.

1, Assuming that the radiation intensity of the sun in the model is fixed, it is assumed that the rays from the sun are parallel and do not take into account the reflection of light;

2, Set the size of the panel (regardless of the thickness);

3, To the diagonal center of the panel as the origin, the sun azimuth and the sun height angle for the polar coordinates of the two directions, the sun height angle is the sun relative to the horizon of the height angle, which is the sun as the geometric center of the disk and the angle of the ideal horizon. The sun azimuth is the angle of the sun in the azimuth, that is, the angle measured clockwise from the north along the horizon. Create a spatial polar coordinate system as shown below

As can be seen from Annex 6, the solar elevation angle is approximated by the following formula:

The sun azimuth angle can also be used to calculate the approximation by the following two formulas,

for the sun's azimuth, for the sun's height angle, for the time angle, for the then sun's declination, for the local geographical latitude (Datong's latitude is).

The normal direction of the panel is set in the coordinate system as, the direction of the sun as is that the light has the wave-particle duality, and the sunlight is regarded as the light quantum state, regardless of the fluctuation factor.

Theorem 1: The efficiency of solar panels to accept solar energy is proportional to the projected area of the panel in the direction of sunlight.

Let the angle between the direct direction of the sunlight and the normal direction of the panel be

Among them

By the projective area formula

The calculation of the model system in 35 years.

In the ideal state, do not consider the cost of the inverter, the efficiency of each battery and the economic results of the calculation of the following table (matlab code see annex), the results from the ideal income from large to small row.

Roof surface battery efficiency

Battery Type	The Ideal Benefits (Yuan)	After 35 Year-Old Battery Cost (Yuan)	The Ideal Income (Yuan)
B5	13252.66	3500.00	9752.66
B2	13578.98	4000.00	9578.98
A2	13786.10	4842.50	8943.60
B6	12605.78	3687.50	8918.28
A6	12518.51	4395.50	8123.01
B1	11328.86	3312.50	8016.36
B7	10686.69	3125.00	7561.69
A4	11550.17	4023.00	7527.17
B3	10041.12	2625.00	7416.12
B4	10291.13	3000.00	7291.13
A3	10203.65	2980.00	7223.65
A5	10469.24	3650.50	6818.74
A1	9188.75	3203.50	5985.25
C11	4275.18	480.00	3795.18
C1	4272.27	480.00	3792.27
C3	4271.80	480.00	3791.80
C2	3843.96	432.00	3411.96
C10	2476.87	278.40	2198.47
C9	2137.57	240.00	1897.57
C8	512.60	57.60	455.00
C7	510.91	57.60	453.31
C6	341.53	38.40	303.13
C5	171.75	19.20	152.55
C4	170.74	19.20	151.54

East to surface battery efficiency

Battery Type	The Ideal Benefits (Yuan)	After 35 Year-Old Battery Cost (Yuan)	The Ideal Income (Yuan)
B5	8564.814864	3500	5064.81486
B2	8775.707524	4000	4775.70752
B6	8146.757568	3687.5	4459.25757
A2	8909.565173	4842.5	4067.06517
B1	7321.520719	3312.5	4009.02072
B3	6489.292243	2625	3864.29224

B7	6906.505489	3125	3781.50549
A6	8090.356356	4395.5	3694.85636
B4	6650.86171	3000	3650.86171
A3	6594.330906	2980	3614.33091
A4	7464.545537	4023	3441.54554
A5	6765.970411	3650.5	3115.47041
A1	5938.424196	3203.5	2734.9242
C11	2762.924438	480	2282.92444
C1	2761.04761	480	2281.04761
C3	2760.743764	480	2280.74376
C2	2484.244003	432	2052.244
C10	1600.730664	278.4	1322.33066
C9	1381.447717	240	1141.44772
C8	331.2778436	57.6	273.677844
C7	330.1854624	57.6	272.585462
C6	220.7218037	38.4	182.321804
C5	110.9979424	19.2	91.7979424
C4	110.3461929	19.2	91.1461929

South to surface battery efficiency

Battery Type	The Ideal Benefits (Yuan)	After 35 Year-Old Battery Cost (Yuan)	The Ideal Income (Yuan)
B5	8682.28805	3500	5182.28805
B2	8896.073269	4000	4896.07327
B6	8258.496769	3687.5	4570.99677
A2	9031.766882	4842.5	4189.26688
B1	7421.941146	3312.5	4109.44115
B3	6578.298001	2625	3953.298
B7	7001.233655	3125	3876.23366
A6	8201.32197	4395.5	3805.82197
B4	6742.083521	3000	3742.08352
A3	6684.777352	2980	3704.77735
A4	7566.927663	4023	3543.92766
A5	6858.771028	3650.5	3208.27103
A1	6019.874364	3203.5	2816.37436
C11	2800.820124	480	2320.82012
C1	2798.917554	480	2318.91755
C3	2798.60954	480	2318.60954
C2	2518.317368	432	2086.31737
C10	1622.685947	278.4	1344.28595
C9	1400.395362	240	1160.39536
C8	335.8215803	57.6	278.22158
C7	334.7142162	57.6	277.114216
C6	223.7491772	38.4	185.349177
C5	112.5203666	19.2	93.3203666
C4	111.8596779	19.2	92.6596779

West to surface battery efficiency

Battery Type	The Ideal Benefits (Yuan)	After 35 Year-Old Battery Cost (Yuan)	The Ideal Income (Yuan)
B5	8682.28805	3500	5182.28805
B2	8896.073269	4000	4896.07327
B6	8258.496769	3687.5	4570.99677
A2	9031.766882	4842.5	4189.26688
B1	7421.941146	3312.5	4109.44115
B3	6578.298001	2625	3953.298
B7	7001.233655	3125	3876.23366
A6	8201.32197	4395.5	3805.82197
B4	6742.083521	3000	3742.08352
A3	6684.777352	2980	3704.77735
A4	7566.927663	4023	3543.92766
A5	6858.771028	3650.5	3208.27103
A1	6019.874364	3203.5	2816.37436
C11	2800.820124	480	2320.82012
C1	2798.917554	480	2318.91755
C3	2798.60954	480	2318.60954
C2	2518.317368	432	2086.31737
C10	1622.685947	278.4	1344.28595
C9	1400.395362	240	1160.39536
C8	335.8215803	57.6	278.22158
C7	334.7142162	57.6	277.114216
C6	223.7491772	38.4	185.349177
C5	112.5203666	19.2	93.3203666
C4	111.8596779	19.2	92.6596779

North to surface battery efficiency

Battery Type	The Ideal Benefits (Yuan)	After 35 Year-Old Battery Cost (Yuan)	The Ideal Income (Yuan)
B5	8775.092	3500	5275.092
B2	8991.163	4000	4991.163
B6	8346.771	3687.5	4659.271
A2	9128.307	4842.5	4285.807
B1	7501.274	3312.5	4188.774
B3	6648.613	2625	4023.613
B7	7076.069	3125	3951.069
A6	8288.985	4395.5	3893.485
B4	6814.149	3000	3814.149
A3	6756.23	2980	3776.23
A4	7647.81	4023	3624.81
A5	6932.084	3650.5	3281.584
A1	6084.22	3203.5	2880.72
C11	2830.758	480	2350.758
C1	2828.835	480	2348.835
C3	2828.524	480	2348.524
C2	2545.235	432	2113.235
C10	1640.031	278.4	1361.631
C9	1415.364	240	1175.364
C8	339.4112	57.6	281.8112
C7	338.2919	57.6	280.6919
C6	226.1408	38.4	187.7408
C5	113.7231	19.2	94.5231
C4	113.0553	19.2	93.8553

As can be seen from the above table, the efficiency of the battery type is constant in each surface. It is best B5, the worst is C4.

Datong measured the environment within 35 years of revenue calculation

The following with Datong year measured data to calculate the surface of the various types of battery efficiency, regardless of the cost of the inverter

Roof surface battery efficiency

Battery Type	The Ideal Benefits (Yuan)	After 35 Year-Old Battery Cost (Yuan)	The Ideal Income (Yuan)
C11	838.3295751	480	358.329575
C1	837.7601057	480	357.760106
C3	837.6679125	480	357.667913
C2	753.7720507	432	321.772051
C10	485.6954606	278.4	207.295461
C9	419.1603874	240	179.160387
C8	100.5166881	57.6	42.9166881
C7	100.1852365	57.6	42.5852365
C6	66.97165269	38.4	28.5716527
C5	33.67911789	19.2	14.4791179
C4	33.48136335	19.2	14.2813634

B3	1968.988198	2625	-656.0118
B5	2598.745556	3500	-901.25444
A3	2000.859144	2980	-979.14086
B4	2018.011783	3000	-981.98822
B7	2095.5795	3125	-1029.4205
B1	2221.503878	3312.5	-1090.9961
B6	2471.898151	3687.5	-1215.6018
B2	2662.734839	4000	-1337.2652
A1	1801.843208	3203.5	-1401.6568
A5	2052.938192	3650.5	-1597.5618
A4	2264.900626	4023	-1758.0994
A6	2454.784834	4395.5	-1940.7152
A2	2703.350075	4842.5	-2139.1499

East to surface battery efficiency

Battery Type	The Ideal Benefits (Yuan) After 35 Year-Old Battery Cost (Yuan)	The Ideal Income (Yuan)	
C11	618.771236	480	138.771236
C1	618.3509105	480	138.350911
C3	618.2828627	480	138.282863
C2	556.3593094	432	124.359309
C10	358.4919218	278.4	80.0919218
C9	309.3823702	240	69.3823702
C8	74.19138863	57.6	16.5913886
C7	73.9467442	57.6	16.3467442
C6	49.43179096	38.4	11.031791
C5	24.85856401	19.2	5.65856401
C4	24.71260134	19.2	5.51260134
B3	1453.310603	2625	-1171.6894
A3	1476.834556	2980	-1503.1654
B4	1489.494922	3000	-1510.5051
B7	1546.74767	3125	-1578.2523
B5	1918.134643	3500	-1581.8654
B1	1639.69248	3312.5	-1672.8075
B6	1824.508546	3687.5	-1862.9915
A1	1329.940851	3203.5	-1873.5591
B2	1965.365146	4000	-2034.6349
A5	1515.274112	3650.5	-2135.2259
A4	1671.723629	4023	-2351.2764
A6	1811.877203	4395.5	-2583.6228
A2	1995.34326	4842.5	-2847.1567

South to surface battery efficiency

Battery Type	The Ideal Benefits (Yuan) After 35 Year-Old Battery Cost (Yuan)	The Ideal Income (Yuan)	
C11	506.274947	480	26.274947
C1	505.9310392	480	25.9310392
C3	505.8753629	480	25.8753629
C2	455.2098797	432	23.2098797
C10	293.3159594	278.4	14.9159594
C9	253.1348162	240	13.1348162
C8	60.70295315	57.6	3.10295315
C7	60.50278653	57.6	2.90278653
C6	40.44479752	38.4	2.04479752
C5	20.3391293	19.2	1.1391293
C4	20.21970352	19.2	1.01970352
B3	1189.090097	2625	-1435.9099
A3	1208.337255	2980	-1771.6627
B4	1218.695891	3000	-1781.3041
B7	1265.539749	3125	-1859.4603
B5	1569.406362	3500	-1930.5936
B1	1341.58664	3312.5	-1970.9134
A1	1088.149699	3203.5	-2115.3503
B6	1492.802047	3687.5	-2194.698
B2	1608.050079	4000	-2391.9499
A5	1239.788271	3650.5	-2410.7117
A4	1367.794336	4023	-2655.2057
A6	1482.467157	4395.5	-2913.0328
A2	1632.577994	4842.5	-3209.922

West to surface battery efficiency

Battery Type	35 Years of The Ideal Benefits (Yuan)	Battery Cost (Yuan)	The Ideal Income (Yuan)
C11	487.527654	480	7.527654
C1	487.196481	480	7.196481
C3	487.1428664	480	7.1428664
C2	438.3535192	432	6.3535192
C10	282.4545089	278.4	4.0545089
C9	243.7612681	240	3.7612681
C8	58.45513098	57.6	0.85513098
C7	58.2623765	57.6	0.6623765
C6	38.94713212	38.4	0.54713212
C5	19.58597408	19.2	0.38597408
C4	19.47097062	19.2	0.27097062
B3	1145.058251	2625	-1479.9417
A3	1163.592689	2980	-1816.4073
B4	1173.567746	3000	-1826.4323
B7	1218.676983	3125	-1906.323
B5	1511.291456	3500	-1988.7085
B1	1291.907868	3312.5	-2020.5921
A1	1047.855662	3203.5	-2155.6443
B6	1437.523788	3687.5	-2249.9762
B2	1548.504202	4000	-2451.4958
A5	1193.879078	3650.5	-2456.6209
A4	1317.145096	4023	-2705.8549
A6	1427.571598	4395.5	-2967.9284
A2	1572.123851	4842.5	-3270.3761

North to surface battery efficiency

Battery Type	35 Years of The Ideal Benefits (Yuan)	Battery Cost (Yuan)	The Ideal Income (Yuan)
C11	563.6804	480	83.6804
C1	563.2975	480	83.2975
C3	563.2355	480	83.2355
C2	506.8252	432	74.8252
C10	326.5744	278.4	48.1744
C9	281.8372	240	41.8372
C8	67.58593	57.6	9.98593
C7	67.36307	57.6	9.76307
C6	45.03075	38.4	6.63075
C5	22.64534	19.2	3.44534
C4	22.51237	19.2	3.31237
B3	1323.919	2625	-1301.081
A3	1345.348	2980	-1634.652
B4	1356.881	3000	-1643.119
B7	1409.037	3125	-1715.963
B5	1747.358	3500	-1752.642
B1	1493.706	3312.5	-1818.794
A1	1211.533	3203.5	-1991.967
B6	1662.068	3687.5	-2025.432
B2	1790.383	4000	-2209.617
A5	1380.365	3650.5	-2270.135
A4	1522.886	4023	-2500.114
A6	1650.561	4395.5	-2744.939

A2	1817.693	4842.5	-3024.807			

Calculated from the actual data, the battery type is better income is C11, C1, C3, C2. Install the battery on the roof surface, the other surface due to the smaller income of each panel, taking into account the higher cost of the inverter, east, south, west and north of the surface is not the installation of the battery.

4.1 Problem (1): According to the meteorological data of Datong City, Shanxi Province, only the attached installation method is selected, the photovoltaic cell module is selected, the part of the outer surface of the hut is laid, and according to the number and capacity of the battery pack, The capacity and quantity of the inverter.

Since the photovoltaic cells are attached to the surface of the roof and exterior walls, the direction and angle of the battery are uniquely determined by the direction and angle of the attached surface. The problem is to optimize the installation of a certain type (array) of photovoltaic battery, so that the total amount of solar photovoltaic power generation as much as possible, and the unit power generation costs as small as possible, which is a multi-objective optimization problem. The problem can be discussed in the ideal environment in a single surface area of the battery installation optimization program, and then the actual environment of the multi-surface optimization.

Consider the viable combination of photovoltaic cells and inverters in the ideal environment (ie, regardless of the influence factors such as climate meteorological changes), where only one type of battery is connected to the same inverter, such as A1 -SN10 indicates that the inverter is SN10 and the battery is A1. Depending on the input voltage and input current of the inverter, the maximum combination of the arrays of the various types of batteries is shown in the following table (part of the data, see Annex *).

Array type

Battery	Array (row * column)	Array Power (w)	Array Area (m ^ 2)	Battery Price (yuan)	Inverter Price (yuan)	Total Cost (yuan)	Component area (m2)	Watts / m2
C5—SN17	6*24	14400	221.76	69120	43750	112870	221.76	649.35
C5—SN18	6*24	14400	221.76	69120	54700	123820	221.76	649.35
C5—SN10	1*123	12300	189.42	59040	63800	122840	189.42	649.35
C5—SN7	1*18	1800	27.72	8640	10200	18840	27.72	649.35
C5—SN9	1*61	6100	93.94	29280	35000	64280	93.94	649.35
C5—SN16	2*29	5800	89.32	27840	35000	62840	89.32	649.35
C4—SN17	5*31	13950	238.70	66960	43750	110710	23.87	584.42
C4—SN18	5*31	13950	238.70	66960	54700	121660	23.87	584.42
C4—SN16	1*38	3420	58.52	16416	35000	51416	58.52	584.42
B1—SN5	1*8	2560	13.08	32000	10200	42200	13.08	195.70
A5—SN5	1*8	2360	13.08	35164	10200	45364	13.08	180.41
B4—SN5	1*8	2240	13.02	28000	10200	38200	13.02	172.11
A1—SN10	2*34	14620	86.81	70176	63800	133976	86.81	168.41
A1—SN17	14*6	18060	107.24	269094	43750	312844	107.24	168.41
A1—SN18	14*6	18060	107.24	269094	54700	323794	107.24	168.41
A1—SN6	1*19	4085	24.26	60866.5	15000	75866.5	24.26	168.41
A1—SN5	1*12	2580	15.32	38442	10200	48642	15.32	168.41
A1—SN4	1*8	1720	10.21	25628	6900	32528	10.21	168.41
A1—SN8	2*8	3440	20.43	51256	15300	66556	20.43	168.41
A1—SN7	2*5	2150	12.77	32035	10200	42235	12.77	168.41

According to the model and Datong measured data, it can be concluded that only the surface of the small roof installed on the battery type C11, the rest of the surface is not installed. 35 years of electricity generation is 77126 degrees, the economic benefits of 16,488 yuan, the recovery period of 21.3 years

4.2 Problem (2):

First, the best orientation of the panel and tilt calculation method:

Method 1 is the use of the problem 1 model, in a variety of orientation using matlab program search the best,

Battery Type	35 Years of The Ideal Benefits (Yuan)	Battery Cost (Yuan)	The Ideal Income (Yuan)
C11	893.0522566	480	413.052257
C1	892.0380403	480	266.01902
C3	891.8738455	480	265.936923
C2	671.2282941	432	239.228294
C10	432.5081239	278.4	154.108124
C9	373.2591459	240	133.259146
C8	89.50934835	57.6	31.9093483
C7	89.21419329	57.6	31.6141933
C6	59.63774878	38.4	21.2377488
C5	29.99099904	19.2	10.790999
C4	29.81490013	19.2	10.6149001
B3	1753.369056	2625	-871.63094
B5	2314.163208	3500	-1185.8368
A3	1781.749892	2980	-1198.2501
B4	1797.024187	3000	-1202.9758
B7	1866.097651	3125	-1258.9023
B1	1978.232354	3312.5	-1334.2676
B6	2201.206555	3687.5	-1486.2934
A1	1604.527711	3203.5	-1598.9723
B2	2371.145179	4000	-1628.8548
A5	1828.125889	3650.5	-1822.3741
A4	2016.876829	4023	-2006.1232
A6	2185.967276	4395.5	-2209.5327
A2	2407.312738	4842.5	-2435.1873

The installation method is described later, the conclusion is that the optimal orientation of the panel is southward, and the optimal angle with the ground plane is 39.89 degrees. Install the battery type on the surface of the small roof only C11, the rest of the surface is not installed. 35 years of generating capacity of 82165.2 degrees, the economic benefits of 18,998 yuan, the recovery period of 13 years.

4.3 Problem (3): According to the calculation result of question 2,

the roof surface and the other four sides are as follows:

Six, the results of the model analysis

In the solution to Problem 1, the unit on the south of the roof of the battery at the moment to accept the solar energy formula is

is the moment of direct radiation intensity, for the moment the sun and the south of the roof of the plane where the angle, for the level of horizontal radiation intensity, for the south of the roof and the horizontal angle, the plane for the plane, the center of the heart , The vertical upward direction is the axis of the positive coordinate system, obtained with the sun height angle , the sun azimuth , red angle, angle and the sun when the relationship is as follows

It is concluded that the battery type is only C11 on the surface of the small roof, and the rest surfaces are not installed. 35 years of electricity generation is 77126 degrees, the economic benefits of 16,488 yuan, the recovery period of 21.3 years.

In question 2, because the photovoltaic cells in the roof and the external wall surface can be installed overhead, the panel orientation and tilt will affect the efficiency of photovoltaic cells. Therefore, in the optimization scheme of Problem 1, the orientation and inclination of the panel on each surface are further adjusted to calculate the optimum orientation and inclination of the panel on each surface. The problem can be in the ideal weather environment to establish the sun running and the battery board efficiency model, and then the measured environment test. The optimal orientation of the panel is southward, and the optimal angle with the ground plane is 39.89 degrees.

It is concluded that the battery type is only C11 on the surface of the small roof, and the rest surfaces are not installed. 35 years of generating capacity of 82165.2 degrees, the economic benefits of 18,998 yuan, the recovery period of 13 years.

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