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CALCULATION OF THE OPTIMAL TILT ANGLES OF THE AUTONOM MINI SOLAR MODULES

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Abstract. *In this work, theoretical calculations were carried out to determine the possible optimal tilt angles of solar modules. It has been shown that to get the maximum amount of energy from a solar panel, a number of rules must be followed, in particular the choice of optimal angle of inclination at different times of the year. Here we should adhere to the geographical latitude of the region. On the other hand, the greatest amount of light should fall on the solar module, while we need to make sure that it is not darkened by other objects, buildings, trees. We must orient the plane of the batteries strictly perpendicular to the sun's rays.*

Key words: *solar module, solar power plant, autonomous solar power plant, DC voltage pulse converter, autonomous voltage inverter.*

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Вычисление оптимальных углов падения лучей для модулей солнечной автономной мини электростанции

Аннотация.*В данной работе мы проводили расчеты для определения солнечной инсоляции для одной автономной солнечной установки. Для определения значения ежедневной инсоляции наклонной площадки необходимо среднемесячное поступление солнечного излучения на эту же площадку, имеющую тот же угол наклона, что и солнечные панели, разделить на количество дней месяца. Анализ распределения интенсивности суммарной солнечной радиации по этим данным показал высокую эффективность использования солнечной энергии, как альтернативного источника, для энергоснабжения зданий и сооружений в течение 7 месяцев (апрель-октябрь).*

Ключевые слова: *солнечный модуль, солнечная электростанция, автономная солнечная электростанция, импульсный преобразователь постоянного напряжения, автономный инвертор напряжения.*

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Avtonom mini elektrostantsiyasiya panelllari uchun quyosh nurining optimal tushish burchagi hisoblash

Annotatsiya*.Quyosh panelidan maksimal miqdordagi energiya olish uchun, yilning turli vaqtlarida quyosh nurining optimal tushish burchagini tanlash muhimdir. Ushbu ishda quyosh modullarining mumkin bo'lgan optimal burilish burchaklarini aniqlash uchun nazariy hisob-kitoblar o'tkazilgan. Buni aniqlash uchun quyosh panellari o`rnatilayotganda mintaqaning geografik kengligini bilgan holda, berilgan hududga tushuvchi oylik quyosh nuri energiyasi miqdori o`lchangan, olingan miqdor oy kunlariga bo`linib, kunlik quyosh radiatsiyasi miqdori topilgan. Natijalar quyosh nurlanishining intensivligini tushish burchagiga bog`liqligi tahlili, 7 oy davomida (aprel-oktyabr) binolar va inshootlarning elektr ta'minoti uchun alternativ manba sifatida quyosh energiyasidan foydalanish yuqori samaradorlikka ega ekanligini ko'rsatdi.*

Kalit so'zlar*: quyosh moduli, quyosh elektr stantsiyasi, avtonom quyosh elektr stantsiyasi, doimiy kuchlanish o`zgartirgichi, avtonom kuchlanish inverteri.*

INTRODUCTION

It is well known [1] that the installation of solar photovoltaic cells requires compliance with certain rules. Fulfillment of these rules completely guarantees to receive the maximum amount of energy and extend the life of the solar power station. There is one of the important factors is the angle of inclination of the solar panels. What should be the direction of the panels and are there strict requirements in relation to the angle of inclination? This issue must be investigated prior to installing and connecting the solar system. Here, the tilt angle of 53 degrees became the optimal value, at which the highest power generation rates were recorded. But, of course, the angle of inclination of the panels must be changed at least 2 times a year. Approximate dates are the days of the spring and autumn of the year.

At the same time, even if we follow all the rules for placing panels, we need to understand that a small percentage of error remains based on weather conditions, local features, as well as partial darkening of the modules, which is not always possible to control. Moreover, the angle of inclination of the sun's rays changes both during the day and at different times of the year. Therefore, the question of what angle the panels should be at to obtain the maximum energy remains relevant. There are solar panels on the market today that rotate and accordingly automatically tilt to collect the maximum amount of sunlight. But this case is very expensive.

The choice of the optimal orientation of solar panels is one of the most important factors in the practical use of solar stations. The solar modules should be positioned so that the front side is oriented towards the sun as much as possible. As noted in [2], the maximum drop of deviation on the east-west should be not more than 20 degrees, otherwise the effectiveness of the panels fall sharply. The solar panels are positioned at a constant angle relative to the horizon. According to our calculations, for the geographic latitude, the constant angle of inclination of the panel should be approximately 45 degrees [3-8]. To calculate the required area for placing solar panels on flat roofs of industrial buildings, using a system of fasteners, it is necessary to calculate how much space is required to place one panel at an angle of 45 degrees, taking into account the shading from the panel and the minimum angle of the sun, at the considered latitude, of 30 degrees. The layout of solar panels at an angle of 45 degrees, taking into account shading, is presented on Figure 1.

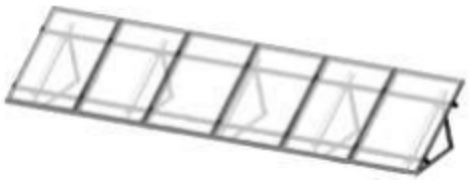

Fig.1 - Layout of solar panels at an angle of 45 degrees, taking into account shading

In this work, theoretical calculations were carried out to determine the possible optimal tilt angles of solar modules.

THE RESULTS AND DISCUSSIONS

It is well known [4] that in order to ensure the conditions for the absorption of solar energy by solar panels, its absorbing surface must be oriented to the south with an angle of inclination, which will be equal to

$$\alpha = \phi - \Delta_c \qquad (1)$$

ϕ- latitude of the area where the power plant is located. Now, according to the formula (1), we will be able to calculate the optimal installation angles of the photocell panels depending on the season. The corresponding calculations are shown in Table 1 .

Table 1 - Optimal angle of installation of photocells

Month	Jan	Feb	March	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Degree	26.73	35.2	46.1	56.21	67.31	70.65	68.98	60.87	51.34	37.96	30.01	25.12

Accordingly, we have drawn up a graph of the dependence of the optimal coal of photovoltaic modules depending on the season, according to table 1. According to the figure 2, the optimal angle of inclination of solar panels for full autonomous supply of the electric charging station will be 45 degrees, which is shown by the approximation on the graph.

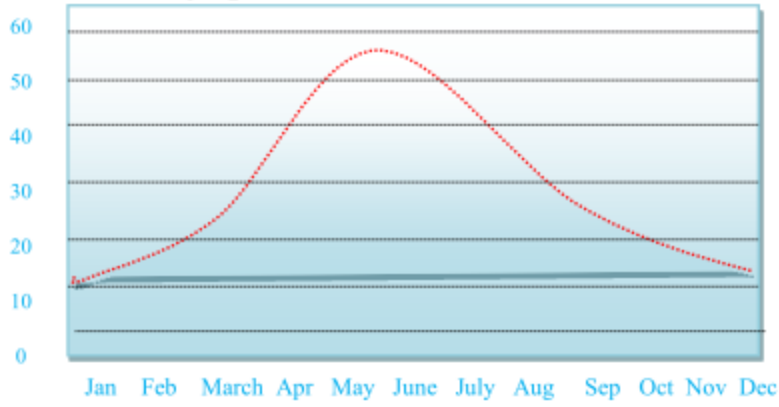

Fig.2. Optimal angle of installation of photocells

Now let's find the hourly sunlight angle for a tilted surface with a southerly orientation. The calculation will be carried out for the winter month, since this is the most unfavorable month. Thus, we have

$$\Omega = \arccos\{-\tan(\phi-\alpha)\cdot\tan\Delta\} = \arccos\{-\tan(45-90)\cdot\tan(22.10)\} = 91.60^{o} \text{ (градус)} \quad (2)$$

where ϕ is the latitude of the area, degrees; α is the angle of inclination of the solar battery surface to the horizon; $\alpha = 45^{o}$ degrees, since it is the most optimal for our area, based on the graph shown in Figure 3 . From where it can be seen, in order to maximize the use of this value of solar radiation, it is necessary to ensure the perpendicular position of the solar panels relative to the angle of incidence of the sunbeam.

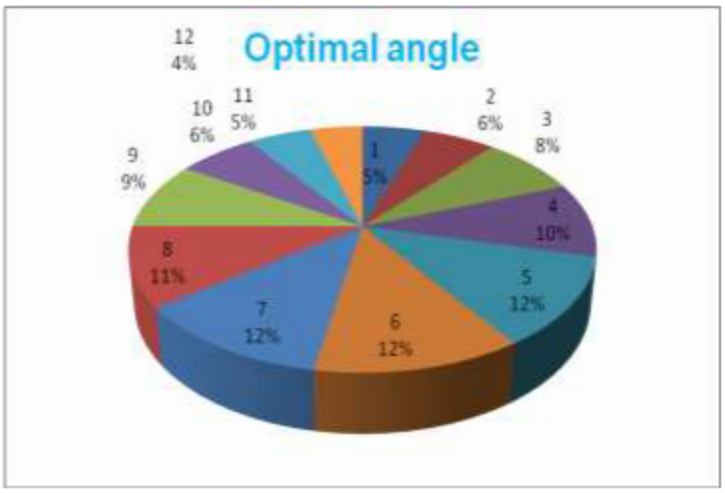

Fig. 3. Optimal angle of installation of photocells

Analysis of the graph above shows that:

- the most favorable months for the use of solar modules are May, June and July, as polar days are observed during these months;
- since from October to March, there is a minimum amount of total solar radiation and the maximum demand for electricity. The power supply of the village is carried out using fuel sources of electricity;
- depending on the total solar radiation in different months, fuel sources of different capacities and different volumes of fuel resources may be needed, due to which money will be saved.

CONCLUSION

To get the maximum amount of energy from a solar panel, a number of rules must be followed, in particular the choice of optimal angle of inclination at different times of the year. Here we should adhere to the geographical latitude of the region. On the other hand, the greatest amount of light should fall on the solar module, while we need to make sure that it is not darkened by other objects,

buildings, trees. We must orient the plane of the batteries strictly perpendicular to the sun's rays.

LITERATURE

1. Akulinin A., Smykov V. Evaluation of the possibilities of solar energy based on accurate ground measurements of solar radiation. Scientific journal "Problems of regional energy" 2008 № 1.

2 . Monitoring the intensity of solar radiation when testing photovoltaic modules. Kharchenko V.V., Tikhonov P.V. // Mechanization and electrification of agriculture-2012.-N 2.- 21-22 p.

3 . V.P. Breusov Technologies for converting non-traditional renewable energy sources. - SPb .: Nestor, 2008 . 106 p.

4. Vissarionov V. I., Deryugina G. V., Kuznetsova V. A., Malinin N. K. Solar energy. - M .: MPEI, 2011 .- 276 p.

5 . Sibikin Yu. D., Sibikin M. Yu. Non-traditional and renewable energy sources. M .: KnoRus, 2012 .- 240 p.

6 . Ivanov G.A.,. Bobyl A.V., Ershenko E.M., Terukov E.I. Features of the operation of a solar autonomous hybrid electrical installation in the North-West Federal District. Technical Physics Journal, 2014, volume 84, issue 10, 63-67s.

7 . Okhotkin G.P. Methodology for calculating the capacity of solar power plants, Bulletin of the Chuvash University 2013 year №3.

8 . Kaziev Z.V., Kucher M.I. Development of ideas about energy, energy and the possibilities of alternative energy, Military Institute of Material Support Volsk, Russia – 42 p.

9 . A.M. Kondakov Alternative energy sources - M .: Priva, 2006 .-- 185 p.

10.Bekmirzaev, R. N., Sultanov, M. U., Holbutaev, S. H., Jonzakov, A. A., & Turakulov, B. T. (2020). Multiplicity outputting of hadrons in cc-interactions at the momentum 4.2 a gev/c with different collision centralities. *ACADEMICIA: An International Multidisciplinary Research Journal*, *10*(10), 900-907.

11. Orishev, Jamshid (2021) "PROJECT FOR TRAINING PROFESSIONAL SKILLS FOR FUTURE TEACHERS OF TECHNOLOGICAL EDUCATION," *Mental Enlightenment Scientific-Methodological Journal*: Vol. 2021 : Iss. 2 , Article 16.

12.Убайдуллаев, С., Уразов, Б. Х., Алкаров, К. Х., Олишев, Ж. Б., & Умаралиев, И. (2014). ВОПРОСЫ МОДЕЛИРОВАНИЯ ПРОЦЕССОВ ЭНЕРГЕТИЧЕСКИХ ОБЪЕКТОВ. *Актуальные проблемы современной науки*, (3), 243-245.