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SOLAR ENERGY FOR POWER SUPPLY OF REMOTE CONSUMERS IN MURMANSK REGION

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Keywords: arctic zone, solar power plants, solar radiation, solar panel, electricity, power.
Abstract. The article discusses the introduction of renewable energy sources in the Arctic regions of Russia to solve energy problems. It emphasizes the growth of generation from RES and reduction of production costs with significant investments. The utilization of solar energy for various needs is considered, taking into account climatic factors. Solar radiation measurements show the potential for solar panels in the Murmansk region. The calculation of solar panel capacity for the Khibiny mountain range is shown, taking into account the rated capacity, insolation and efficiency of solar panels.

СОЛНЕЧНАЯ ЭНЕРГЕТИКА ДЛЯ ЭНЕРГОСНАБЖЕНИЯ УДАЛЕННЫХ ПОТРЕБИТЕЛЕЙ В МУРМАНСКОЙ ОБЛАСТИ

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Ключевые слова: арктическая зона, солнечные электростанции, солнечная радиация, солнечная батарея, электроэнергия, мощность.
Аннотация. В статье рассматривается внедрение возобновляемых источников энергии в арктических регионах России для решения энергетических проблем. Подчеркивается рост генерации из ВИЭ и снижение себестоимости при значительных инвестициях. Рассматривается использование солнечной энергии для различных потребностей, с учетом климатических факторов. Измерения солнечной радиации показывают потенциал для солнечных батарей в Мурманской области. Показан расчет мощности солнечных батарей для горного массива Хибины с учетом номинальной мощности, инсоляции и коэффициента полезного действия солнечных панелей.

In the regions of the Arctic zone of the Russian Federation, an effective direction for solving local energy problems is the introduction of distributed generation and renewable energy sources (RES) [1]. The study of opportunities for the use of renewable energy sources has shown that high indicators of increasing the volume of generated energy from RES with a simultaneous reduction in their production costs resulted from the attraction of significant investments [2].

The use of technologies based on solar energy has recently aroused increased interest to meet various energy needs: combined heat and power generation, in the use of hot water for domestic needs, in air conditioning in buildings [3].Increasing the accuracy of calculations of electricity generation by solar power plants in the northern territories for power supply to remote consumers from the energy system is determined by taking into account the climatic features of the regions [4].

The total annual solar radiation per horizontal surface under actual cloudy conditions [5] at the observation stations in the Murmansk Oblast is: in the area of Dalnye Zelentsy observation station – 700 kWh/m^2, in the area of Khibiny observation station - 800 kWh/m^2, in the area of Umba observation station – 840 kWh/m^2. To calculate power generation, measurements of solar radiation by the Khibiny meteorological station were made. The total (direct and diffuse) average monthly solar radiation (kWh/m^2) is presented in Figure 1.

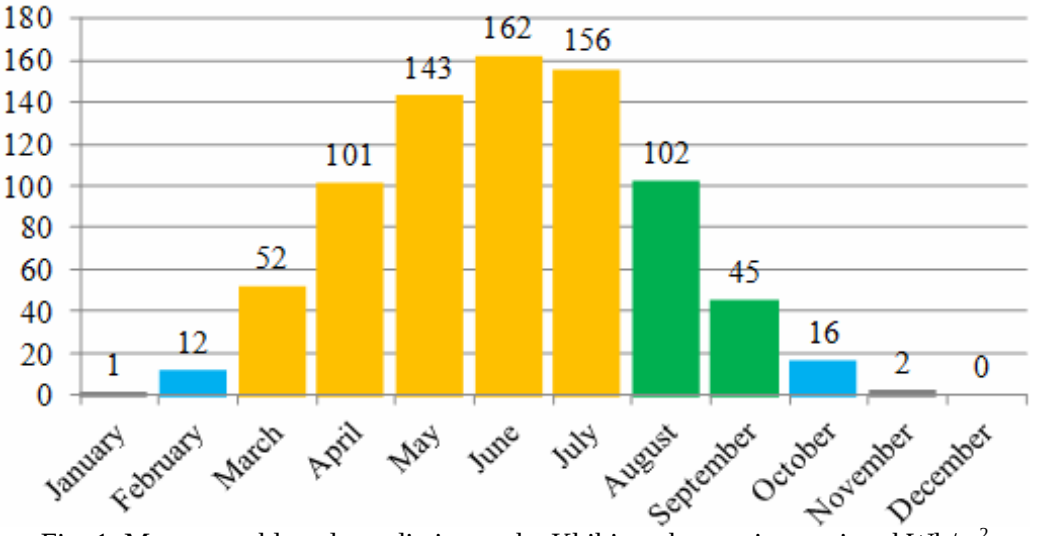

Fig. 1. Mean monthly solar radiation at the Khibiny observation station, kWh/m^2

Let's calculate the capacity of solar panels for the Khibiny area of Murmansk region. The calculation was made according to the formula:

$$W_{s.b} = W_m \cdot P_{s.b}\, \eta \,/\, P_{max}\ ,\ \text{kWh} / \text{m}^2\ ,$$

where $W_{s.b}$ – solar panel power generation per month, kWh/m^2; W_m – solar insolation per month, kWh/m^2; $P_{s.b}$ – solar panel nominal power, kW; P_{max} – maximum insolation power of a square meter of the earth surface in the measurement area, (kW/m^2); η – efficiency ratio.

The total average monthly solar radiation in the area of the observation station in June is W_m = 162 kWh/m^2, the nominal capacity of the solar panel is 1 kW. Table 1 shows the calculations of solar panel capacity at an efficiency ratio of 15%.

To maintain a basic and comfortable level of electricity consumption (30-70 kWh/month) from April to August, solar panel capacities of 1,8 kW or more are required. Consideration of climatic factors is critical in the design and operation of energy systems. Adaptation of solar power plants to specific climatic conditions optimizes their performance and ensures sustainability even in the harsh climate of northern regions.

Table 1. Calculation of solar panel generation for the Khibiny region

Nominal power, W	March	April	May	June	July	August	September
400	3,5	6,7	9,8	10,	10,4	6,8	3
500	4,3	8,4	11,9	13,5	13	8,5	3,8
600	5,2	10,1	14,3	16,2	15,6	10,2	4,5
800	6,9	13,5	19,1	21,6	20,8	13,6	6
1000	8,7	16,8	23,8	27	26	17	7,5
1200	10,4	20,2	28,6	32,4	31,2	20,4	9
1400	12,1	23,6	33,4	37,8	36,4	23,8	10,5
1600	13,9	26,9	38,1	43,2	41,6	27,2	12
1800	15,6	30,3	42,9	48,6	46,8	30,6	13,5
2000	17,3	33,7	47,7	54	52	34	15
2500	21,7	42,1	59,6	67,5	65	42,5	18,8
3200	27,7	53,9	76,3	86,4	83,2	54,4	24

average mode 10-30 kWh/month; base mode 30-50 kWh/month; comfort mode 50-70 kWh/month

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