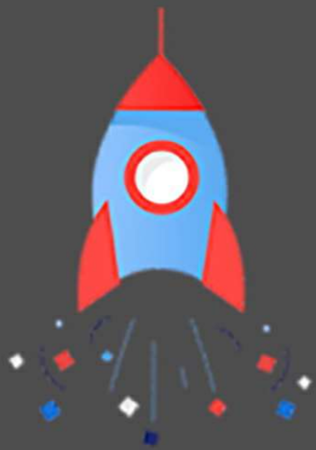

SUSTAINABLE DEVELOPMENT:
MODERN THEORIES AND BEST PRACTICES

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Sustainable Development: Modern Theories and Best Practices

Materials of the Monthly International Scientific and Practical Conference (May 31 - June 1, 2022)

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The collection consists of materials from the Monthly International Scientific and Practical Conference "Sustainable Development: Modern Theories and Best Practices". They represent scientific research results in such scientific areas as financial and economic, managerial and legal, social and cultural, ecological and technical, educational and pedagogical issues of sustainable development on local, regional and international levels.

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CONTENT

MANAGERIAL AND LEGAL ISSUES OF SUSTAINABLE DEVELOPMENT

SOCIAL AND CULTURAL ISSUES OF SUSTAINABLE DEVELOPMENT

ENVIRONMENTAL AND TECHNICAL ISSUES OF SUSTAINABLE DEVELOPMENT

REGIONAL FEATURES OF SUSTAINABLE DEVELOPMENT

INTERNATIONAL COOPERATION FOR SUSTAINABLE DEVELOPMENT

EDUCATIONAL INSTITUTIONS AND PEDAGOGY FOR SUSTAINABLE DEVELOPMENT

ENVIRONMENTAL AND TECHNICAL ISSUES OF SUSTAINABLE DEVELOPMENT

DETERMINATION OF THE INSTALLED ELECTRIC CAPACITY OF THE GRID SOLAR POWER PLANT AT THE EDUCATIONAL INSTITUTION

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Today, issues of sustainable energy development are relevant at the international, national, and local levels. Due to the Russian-Ukrainian war, the energy supply problems have become urgent for Ukraine. Considering the situation in the national energy market, the increase in electricity prices almost to the level of the feed-in tariff pushes electricity consumers to produce and consume green energy on their own, i.e., become prosumers. In this context, educational institutions can show the example of a green energy transition, such as replacing electricity consumption from the grid with the electricity of its own generation. For example, it could be the construction of a grid solar power plant (SPP) with the location of solar panels on the enclosing structures of the campus buildings. Such a power plant should be integrated into the institution's power supply system and operate to partially or fully supply electricity to its current collectors [1].

One of the main problems is to determine the installed electrical capacity of the SPP. Its calculation should consider the location of solar panels on the enclosing structures of buildings (roof, walls, etc.) and the intensity of solar generation, which depends on the climatic conditions of the campus. Determining these features makes it possible to form hourly forecast graphs of daily solar generation. For example, when the panels are stationary on roofs with an installed capacity of 10.2 kW in climatic conditions of Sumy, Ukraine, the average annual electricity generation is about 9800 kWh. Equipping the SPP with an automated tilt adjustment system will generate additional 1700 kWh / year. The total yearly average electricity generation can reach up to 11,500 kWh. However, panels equipped with a tracking system create shadow areas due to their rotation. It significantly reduces electricity generation in the shaded areas of the panels. To solve the problem, solar panels must be placed at a distance from each other to avoid shadow areas. The calculation shows that the placement of panels in compliance with this condition reduces the use of space by 18%. Therefore, the number of solar panels and the SPP's installed capacity will decrease, provided that all panels are located on the same roof area. In this case, the average amount of electricity generated by an SPP per year will be about 9450 kWh.

The electricity balance of energy consumption is calculated based on statistical data and daily schedules of electricity consumption and their "spectrum," i.e., the determination of hourly schedules of electricity consumption by individual consumers or their groups. The results of the statistical data analysis of electricity consumption by the buildings show that the power consumption varies during the day. The maximum value of electricity consumption falls on the period from 11.00 to 15.00 with a clear peak at about 12.00-13.00. It is observed both on weekdays and weekends. The range of maximum values of electricity consumption depends on the season and day of the week. For the most part, the daily peak maximum power consumption of current collectors practically does not decrease below P kW regardless of the season (with some exceptions). Daily schedules of electricity consumption by current collectors of educational buildings are identical in their trends and dynamics. Comparisons of daily hourly schedules of electricity generation by SPPs with daily schedules of electricity consumption by current collectors of educational buildings show their correspondence. It allows us to determine the maximum installed capacity of the solar panels' array *Pmax* kW, at which the current collectors will entirely consume all the electricity generated by the SPP without feeding energy to the external greed. Then it is technically possible to include the SPP in the electrical grid of the educational institution without installing a feed-in tariff and additional equipment for the electricity consumption metering point. Selection of technical parameters, the offered package, and operating modes of SPP allows cutting terms of introduction and capital cost.

As an example, consider the technical and economic indicators for the educational institution grid SPP project with an installed capacity of *Pmax* 30 kW in the climatic conditions of Sumy, Ukraine. The current average electricity tariff for an educational institution is UAH 6.2 / kWh. Operating costs for the SPP's maintenance are about 1000 UAH / year (preventive equipment inspection by staff twice a year). The total cost of equipment and its transportation, installation, and commissioning can range from 654,000 UAH to 820,000 UAH. Given these data, the simple estimated payback period of the SPP project will be: (1) 2.5 years with an average investment cost of SPP implementation of UAH 700,000 and an estimated annual energy generation of 45,560 kWh (700,000 / 45,560 x 6.20 = 700,000 / 282,472); (2) 2.9 years with investment cost for the SPP's introduction of UAH 820,000 and the estimated annual energy generation of 45,560 kWh (820,000 / 45,560 x 6.20 = 820,000 / 282,472); (3) 2.3 years with investment cost for the SPP's introduction of UAH 654,000 and the estimated annual energy generation of 45,560 kWh (654,000 / 45,560 x 6.20 = 654,000 / 282,472). Given that the standard lifecycle of solar panels is more than 25 years, after the third year, the SPP will bring only a net profit to its owner and guarantee the energy independence of the educational institution.

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