THE ECONOMIC AND ENVIRONMENTAL IMPACT OF TRANSITIONING TO ALTERNATIVE ENERGY

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Annotation: The paper addresses the possibility of using renewable energy sources for mechanical plant power supply. The area climatic conditions are given an assessment. The possibility to install alternative energy facilities at the plant is studied. Solar panels are proposed as alternative sources. The required equipment is selected and the calculation of the number and capacity photovoltaic cells is made. Conducted technical and economic calculations serve the basis for efficiency evaluation of installed photovoltaic cells. The purpose of the paper is to evaluate the effectiveness of alternative energy facilities integration into the power supply system of an industrial enterprise. The computation of the solar panel true power is made taking into account the table of solar insolation. The number of solar modules, inverters and other equipment connected to them has been calculated based on the area of building roofs. The economic effectiveness is estimated on the basis of the calculated payback period of the installed equipment. Assessment of Irkutsk climatic conditions has shown that the area under investigation has a relatively high potential for the development of solar energy. Therefore, this work gives a detailed consideration of the integration of solar modules into the power supply system of the industrial enterprise. Their actual power, which directly depends on solar activity and averages 80% of the capacity rate, is calculated. The calculated annual amount of power received from solar panels has showed that renewable energy facilities can make a significant part in enterprise power supply. According to the estimates obtained, the economic effectiveness of their use today is quite low. However, trends in reducing the cost of the solar panels themselves and other auxiliary equipment, as well as growth of electrical energy price make these power sources effective in the near future. The conducted study clearly shows that it is quite possible to integrate alternative energy facilities into the power supply system of an industrial enterprise, and they will be able to make a significant part of its power consumption. In view of expected drop of equipment costs and growth of electricity prices, the renewable sources will become cost-effective.

Keywords: renewable energy sources, solar energy, wind energy, integration, energy potential, effectiveness, power supply systems

This research was carried out as part of a diploma project on the topic "Design of a power supply system for a mechanical plant." According to the project, the plant is located in Irkutsk, therefore, the climatic features of the area are taken into account during the design. The initial data contains a general plan of the enterprise with the location of workshops on the territory of the plant, as well as a statement of electrical loads of the enterprise, containing detailed information about consumers. The plant is supplied with electrical energy from a power grid substation. Electrical system design power supply (SES) included: determination of the location of the main step-down substation of the plant and transformer substations (TS) of the workshops and their capacity, selection of the voltage of the external and internal power supply system, technical and economic calculations, selection of the power supply scheme and selection of equipment. In addition to everything, lightning protection and grounding were calculated, the coverage area of which can also extend to solar modules. According to the calculation results, the calculated active power of the low-voltage load of the mechanical plant is 13.7 MW. Renewable energy sources (RES), such as solar panels and wind power plants, were considered as an additional source of power supply. Climatic resources were preliminary assessed, showing the energy potential of renewable energy sources in the conditions of a given area. The issue of synchronizing the renewable energy system with the general grid was studied separately. Next, the number and power of these installations were calculated, which allows us to evaluate the effectiveness of their use at a mechanical plant. The article describes in detail the integration of alternative energy sources into the solar power system of an industrial enterprise, and also evaluates their economic efficiency by calculating the payback period.

In many developed and developing countries of the world, renewable energy sources make up a significant share of the energy balance. Currently, with the active development of industry, coal and oil and gas resources are being depleted quite quickly, and waste from the combustion of fossil fuels is released into the atmosphere and creates various environmental problems. Therefore, the transition from traditional energy sources to renewable energy resources is gaining momentum and becoming increasingly important globally. According to the results of various studies, a gradual transition to alternative sources is predicted in the near future. Such a transformation takes a long time, but plans for the transition to renewable energy sources are already being developed for large cities, regions and even entire countries. Despite global trends, in Russia renewable energy is still at the initial stages of development, although the formation of the renewable energy industry can have a significant positive impact on the Russian economy. Thus, due to renewable energy sources, new companies and jobs can be created, new opportunities for the development of settlements not connected to centralized power supply systems.

Many regions of our country are promising in terms of using solar energy. The Irkutsk region also has enormous potential for the development of solar energy. For example, in Irkutsk (52 degrees north latitude) the level of solar radiation reaches 1340 kWh/m2, which is a fairly good indicator. In order to fully assess the prospects for installing solar panels in Irkutsk, let us turn to Table 1, which presents data on the amounts of direct solar radiation incident on a horizontal surface in a clear sky.

The table shows the amount of solar radiation per hour, per day, month and year. The table shows that the highest solar activity will be achieved in June at noon in clear weather and it is 2.81 MJ/m2 per hour interval. The rest of the time, this activity varies depending on the season and time of day. So, the Irkutsk region has a relatively good potential for the development of solar energy, which means that the installation of solar panels at the plant in question remains relevant.

Conditions and prerequisites for installing solar panels in a mechanical plant. Let's consider the possibilities of using solar installations at a mechanical plant. In order to reduce electricity consumption, solar panels are installed at the plant. Solar panels will be located only on the roofs of workshops and other buildings, since access roads, warehouses and other objects may be located in other possible places on the plant territory. It is believed that the roofs of buildings are located horizontally and, therefore, the roof area will be equal to the area of the building. In addition, placing solar panels on the ground may be ineffective, since in this case shadows from fences and workshops located nearby may fall on them. Therefore, the location of solar panels on the roofs of workshops will allow achieving the maximum possible power of solar panels the area of the buildings is indicated. It can be seen that the plant's workshops have sufficient roof area to install the required number of solar modules. At this enterprise, two groups of buildings can be divided into two groups:

- energy-intensive production workshops with their own transformer substation;
- non-industrial buildings that consume significantly less power and do not have their own transformer substation (gateway, plant management, etc.).

It is assumed that solar panels will be located on the entire available roof area of the production workshops to cover most of the electrical load schedule of the enterprise. However, at the same time, the daily load schedules of the workshops are taken into account so that the generation power from solar panels does not exceed the load power of the workshop and so that energy is not output back to energy system. Such a restriction on the development of solar installations was adopted in order not to break the existing system of relations in the electricity and capacity market, when its participants have a certain established status as a consumer or supplier of electricity. In addition, the occurrence of reverse flows might require a revision of the organization of protection and automation in the plant's power supply system, at the external supply substation, as well as the solar power plant itself. When the supply of electricity from

the power system decreases due to power from solar panels, the previously selected transformer power, throughput. The cable capabilities and switching devices have not been revised. This somewhat worsened the economic efficiency of solar panels, however, it was necessary due to the fact that solar energy is unpredictable and cannot be considered as guaranteed, so its full redundancy is required. The energy system serves as such a backup source. On the other hand, due to the connection of the solar installation system with a centralized network, it was decided to abandon the use of batteries for solar installations as additional backup. This will significantly reduce the cost of the solar installation system. Synchronization of renewable energy sources with a centralized grid. To synchronize and connect to the power supply network of a solar panel plant, grid-tied inverters are used, which are devices that convert direct voltage from renewable energy sources into alternating voltage.

The actual power of solar panels is on average 75-85% of its rated power. This depends, first of all, on climatic factors, as well as on the tilt angle (the angle between the horizontal plane and the solar panel) and the orientation of these modules to the south (for the northern hemisphere). Solar panels achieve their greatest efficiency when they are aimed at the sun and their surface is perpendicular to the sun's rays. Solar panels are located on the roofs of the plant's workshops in a fixed position, so they are not located at right angles to the sun's rays throughout the day. In this case, an angle of inclination of the panels themselves is selected that will ensure that they remain at right angles to the sun's rays for the longest possible time.

The article discusses the possibility of installing alternative energy sources to partially replace the electricity received by a mechanical plant from a centralized power supply system. For this purpose, the possibilities of using solar panels and wind power plants were considered. The potential for the development of solar energy and wind energy in the city of Irkutsk was assessed. The results of the assessment of climatic conditions showed that the use of wind generators is irrational due to low average annual wind speeds, so the issue of installing wind generators is not being considered. At the same time, due to the increased solar activity in the region under consideration, the use of solar panels to power the plant is relevant. The design features of the workshops make it possible to install a sufficient number of solar panels on the roofs, which will make it possible to cover a significant part of the workshop load schedule during the daytime.

To implement a system of solar installations at the enterprise, the issue of synchronizing them with the network was considered, which was resolved by choosing three-phase network inverters. A calculation was made of the total number of solar panels and the energy they generate. To completely eliminate the return of electricity to the power system, a comparison was made of the load of the workshops and the power received from the panels. The cost of solar installations was calculated, taking

into account installation, and their payback period was determined, which was 23 years, which indicates a rather low efficiency of the project.

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