

## SUSTAINABLE WATER SOLUTIONS FOR RURAL AREAS USING SOLAR HYBRID SYSTEMS

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**Abstract:** The issue of water supply in rural areas has remained a pressing problem for many years. The limited availability of Water Resources and their uneven distribution, as well as natural disasters and climate changes, make it difficult to ensure the stability of the water supply. These problems limit the ability of the villagers to obtain sufficient water needed for health, agriculture and daily life. Therefore, the creation and application of sustainable and environmentally friendly water supply systems is important for the development of rural areas. Solar hybrid systems are seen as an effective solution for precisely these purposes.

**Key words:** solar hybrid systems, problems, agriculture, water supply, solar panels, generators.

Solar hybrid systems are complex systems that combine solar energy with other energy sources to ensure continuity and stability of energy supply. These systems typically include elements such as solar panels, batteries, generators, or wind turbines. For water supply in rural areas, such systems are used in water pumping, treatment, storage and distribution processes. Their main task is to get the energy necessary for the water supply from an environmentally friendly and reliable source. One of the greatest advantages of solar hybrid systems is that they do not harm the environment. Energy obtained by activating conventional energy sources, such as fuels, pollutes the air, reduces natural resources, and negatively affects the global warming process. Solar energy, on the other hand, is a source of clean, unlimited and renewable energy, and

its use helps to maintain an ecological balance. This is especially important in rural areas, close to the natural environment.[1]

The use of solar hybrid systems to ensure the stability of water supply in rural areas is widely used in the efficient use of water pumps. Electricity generated by solar panels is used to power water pumps. This is especially important in cases of non-availability or unreliability of electrical networks. With the help of accumulators, solar energy is stored, and water pumps can work even at night or at times when there is not enough sun. These systems provide continuity of water supply and provide comfort for the villagers. In addition, solar hybrid systems are also widely used in water treatment processes. In rural areas, water sources are often contaminated, necessitating their treatment for use as drinking water. Water treatment equipment that uses solar energy, such as ultraviolet radiation, membrane filtration, or other environmentally friendly technologies, can be effectively treated. This serves to improve health and sanitation, preventing water-borne diseases. Another important aspect of solar hybrid systems is the possibility of their modularity and expansion. Depending on the needs and conditions of rural areas, the size and composition of the system can be easily changed. For example, if a small-scale system is sufficient for a small village, it is possible to increase the system elements for large areas. This makes it a great convenience for the implementation of water supply projects in different regions of different scale. Also, the installation and maintenance of solar hybrid systems is simple and relatively inexpensive, and local residents can participate in these processes. This will help create jobs in rural areas and promote the local economy. For long-term operation of systems, regular technical control and repair is necessary, these processes can be carried out by local specialists. In this way, the systems not only improve the water supply, but also strengthen the socio-economic situation of rural areas.[2]

The use of solar hybrid systems in rural water supply is also of great social importance. As a result of the satisfaction of the need for water, the quality of life of the population improves, the level of health increases, and favorable conditions for Education, Labor activity are created. Especially for women and children, the need to

go long distances to get water is reduced, which allows them to focus their time and energy on other important activities. At the same time, the improvement in water supply will contribute to the development of agricultural activities, since there will be a sufficient supply of water for irrigation. However, there are also some limitations of solar hybrid systems. For example, the dependence of solar energy on daytime and weather conditions can reduce the efficiency of the system. The inability of solar panels to generate enough energy on cloudy or rainy days affects the operation of the system. There may also be high initial investment costs, causing financial difficulties for some rural areas. However, in the long run, these costs justify themselves at the expense of energy savings and environmental benefits. Therefore, it is necessary to widely implement these systems through financial support and government programs.[3]

When creating sustainable water solutions, it is important to integrate solar hybrid systems with other energy sources. For example, when used in conjunction with wind power or biogas systems, the reliability and efficiency of the system increases. This allows for continuity of water supply in rural areas. At the same time, the use of solar hybrid systems in combination with water conservation and effective management strategies will help to manage water resources steadily in rural areas. In combination with water collection, storage and recycling technologies, these systems can meet the water needs of the villagers over a long period of time. In the future, further improvement of solar hybrid systems and integration with other sustainable energy sources will be an important factor in improving the quality and stability of water supply in rural areas. As a result of technological development, the efficiency of solar panels increases, the capacity and service life of batteries are improved, which ensures that systems are more reliable and efficient. At the same time, the widespread use of solar hybrid systems is ensured by improving the skills of local residents, the development and financial support of the maintenance system.

Solar energy is considered one of the most favorable and clean energy sources for mankind. This source of energy is presented endlessly by nature, and its use plays an important role in reducing the environmental problems of mankind. One of the greatest



advantages of solar energy is its environmental friendliness. Conventional energy sources, such as fuels such as coal or oil, pollute the air, release harmful gases, and accelerate the global warming process. However, solar energy is clean and safe, and no harmful exhaust gases are produced by its use. This helps maintain ecological balance and protects human health. Another important aspect of solar energy is its renewable nature. The sun shines from the sky every day, and this source of energy is constantly present independently of human activity. This reduces the risk of running out of energy resources and guarantees sustainable energy supplies to future generations as well. Therefore, the use of solar energy has long-term economic and environmental benefits. With the help of solar energy, energy independence is also ensured. In many countries, imported fuels for electricity and Heat Supply require significant costs. Solar power, on the other hand, is a local source, and by using it, the dependence on external sources is reduced. In rural areas and remote areas in particular, it is possible to organize independent power supply using solar panels. It contributes significantly to the improvement of the quality of life of those living in these areas, development in education, health and other social sectors. Solar power systems are also very flexible technologically. They come in a variety of sizes and capacities and can be widely used from small households to large industrial enterprises. This makes it possible to adapt the energy supply to different needs. Also, the installation and maintenance process of solar panels is relatively simple and inexpensive. They have a long service life and produce efficient energy for many years.

The use of solar energy is also economically beneficial. Although initial investments are required, in the long run the cost of generating electricity using solar energy is greatly reduced. Because sunlight is free and no charge is required to use its energy. This significantly reduces energy costs for families and businesses. Solar energy also contributes to social progress in society. With the improvement of electricity supply in remote and undeveloped areas, people will increase their standard of living, new jobs will appear and development will occur in important areas such as education, health. This serves to promote the welfare of the community as a whole. In

general, solar energy is a source of sustainable, clean and economically beneficial energy for humanity, and its widespread use is an important factor in solving environmental problems. Through the use of solar energy, we can not only improve our quality of life, but also leave a healthy and clean environment for future generations. Therefore, the development and wider use of solar energy should be a priority for every person and society.[4]

### **Conclusion:**

In summary, solar hybrid systems are an effective and environmentally friendly solution to ensure a stable water supply in rural areas. Among their advantages are energy independence, Environmental Protection, economic savings and contribution to social development. At the same time, for the widespread introduction of systems, it is necessary to provide financial support, maintenance and improve the skills of local residents. In the future, further improvement of solar hybrid systems and integration with other sustainable energy sources will be an important factor in improving the quality and stability of water supply in rural areas. This serves to improve the quality of life and preserve the environment of the villagers.

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