

## **MODERN TECHNOLOGIES FOR UTILIZING RENEWABLE ENERGY SOURCES**

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Renewable energy has made significant progress, but moving from isolated projects to widespread deployment and scaling of these technologies to meet global energy demand is a complex task that requires overcoming a number of significant barriers. This connection of renewable energy sources is not only about building a sustainable and environmentally friendly energy system of the future. The transition to renewable energy sources involves the comprehensive development of various technologies, each with its own advantages and limitations. The most promising activities are presented below.

One of the fastest-growing areas is the use of solar energy to generate electricity and heat. Significant developments are taking place in the field of solar energy, and modern photovoltaic converters, or solar modules, have evolved significantly. From the original solid and relatively inefficient crystalline silicon plates, we are moving toward thinner, more flexible, and more efficient solutions. In addition to conventional silicon, new materials such as perovskites are being actively researched, which have achieved great success and can significantly improve the efficiency of solar energy conversion.

The kinetic energy of air is being successfully harnessed to generate electricity and represents a mature and competitive alternative to conventional energy sources. Modern wind turbines are complex engineering structures designed to harvest energy from the wind reliably and efficiently. A characteristic trend is the enlargement of wind turbines and the development of offshore areas to improve the stability of power generation and take advantage of stronger and more stable winds.

One of the most original and reliable methods of generating electricity is the use of hydropower. Today, hydropower development is moving toward the modernization of existing hydropower plants to increase their

efficiency and reduce their impact on the environment, as well as toward the development of small-scale hydropower plants characterized by their small scale and more careful management of aquatic ecosystems.

The conversion of biomass and other organic matter into energy is an important component of a sustainable energy system. However, the use of biomass requires strict adherence to sustainable management principles to avoid negative environmental impacts. One promising area is the production of biogas from certain wastes, which can simultaneously solve waste disposal problems and produce valuable fuel.

Unlike many other renewable energy sources, geothermal energy provides a stable energy supply regardless of the season and weather. Geothermal energy is extremely reliable because geothermal power plants can operate continuously and regardless of the weather. The development of geothermal energy is linked to improvements in drilling and operating technologies, as well as the development of new methods for using geothermal energy for heating and cooling [1].

Despite significant achievements in the field of renewable energy sources, their widespread implementation faces a number of serious challenges:

- integration into the existing power grid;
- developing an efficient energy storage system;
- attracting investment;
- creating a favorable policy environment;
- addressing public acceptance and overcoming NIMBYism (a phenomenon when residents of a certain area oppose new construction projects or changes in their surroundings).

Modern technologies for the use of renewable energy sources provide advanced innovation efficiency, which provides a path to a sustainable future. Continuous improvement of technologies, cost reduction and increased scale of renewable energy development make it possible to create an environmentally friendly, reliable and affordable energy system for future events. To achieve this goal, it is necessary to make efforts of scientists, engineers, politicians, businessmen and the whole society.

## **References**

1. Technology: Renewable Generation // International Renewable Energy Agency (IRENA). – URL: <https://www.irena.org/Energy-Transition/Technology> (date of access: 02.04.25).