

## **RENEWABLES**

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Renewable energy sources (RES) have gained attention worldwide as solutions to the growing environmental crisis caused by fossil fuels. Unlike traditional sources such as coal, oil, and natural gas, renewable energy relies on naturally replenishing processes and does not deplete resources or contribute significantly to greenhouse gas emissions. Using renewable energy is often associated with modern technology, but harnessing the natural elements has ancient roots. For thousands of years, human societies utilized wind and sun to meet basic needs: wind drove boats and powered mills, while the sun provided warmth and aided in early cooking and lighting methods. However, over the past five centuries, societies have increasingly depended on cheaper and more abundant fossil fuels. While these non-renewable sources fueled

unprecedented growth, they also accelerated climate change, pollution, and ecosystem degradation.

Solar energy is one of the most popular renewable sources today. It uses photovoltaic (PV) panels or mirrors to concentrate sunlight and generate electricity. When sunlight hits a PV cell, it creates an electric current that can be used immediately, stored in batteries, or stored in thermal accumulators for future use (U.S. Department of Energy, 2023a). Solar technology has improved significantly in efficiency and cost-effectiveness, and with increased availability, solar power is one of the most accessible renewable sources globally.

Wind energy is another widely utilized RES, generated by converting wind currents into electricity. Wind turbines capture the kinetic energy from air movement – originating from the sun’s uneven heating of the Earth’s atmosphere, combined with the planet’s topography and rotation – turning it into electricity (U.S. Department of Energy, 2023b). The result is a clean, sustainable energy source that is available as long as solar radiation continues to influence wind patterns. Wind energy systems are increasingly common in both onshore and offshore applications, as offshore turbines can take advantage of stronger and more consistent winds to generate large amounts of energy efficiently.

Hydropower is another long-established renewable energy source, converting the flow or fall of water into electricity. Typically, hydroelectric power plants use water flow to drive turbines that then activate generators, channeling this electricity into the grid. Variants include tidal power installations, which harness ocean tides and currents to generate power (U.S. Department of Energy, 2023c). As water moves consistently through the natural water cycle, hydropower provides a reliable and renewable energy source that can adjust rapidly to energy demands.

Biofuels represent an emerging field within renewable energy, relying on organic materials like biomass, biogas, and biodiesel. Biofuels offer a sustainable solution by transforming waste products and organic matter into fuel. Advanced biotechnology now allows for the production of biofuels from various renewable resources, using microorganisms to produce fuels with minimal environmental

impact (Elsevier, 2023). This technology, while relatively new, holds considerable potential for reducing carbon footprints and supporting circular economies.

Geothermal energy is yet another valuable RES, harnessing heat from beneath the Earth's surface for diverse applications, including electricity generation, heating, and cooking. Geothermal power plants are categorized into three types: dry steam, flash steam, and binary cycle plants. Each type is suited to different geological and environmental conditions, providing adaptable solutions that make geothermal energy a highly versatile source (Lund, 2023). Unlike other renewable sources that depend on weather conditions, geothermal energy is a constant resource, providing a reliable supply of energy throughout the year.

The continued development and integration of renewable energy sources are essential to mitigating the effects of climate change, preserving natural resources, and promoting sustainable economic growth. With improvements in technology, supportive policies, and growing environmental awareness, renewable energy stands as a foundation for a cleaner, more resilient future.

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