

The future of renewable



Tags

Sustainability

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Renewable energy is energy produced from Earth's natural resources, those that can be replenished faster than they are consumed. Common examples include solar power, hydropower and wind power. Shifting to these renewable energy sources is key to the fight against **climate change**.

Today, a variety of incentives and subsidies help make it easier for companies to lean on renewable resources as a stable source of power to help alleviate the climate crisis. But the next generation of clean energy requires more than just incentive, it needs innovative technology to improve energy efficiency and power generation to help the world reach **net-zero** emissions.

Solar

Converting sunlight to electrical energy happens in two ways—solar photovoltaics (PV) or concentrating solar-thermal power (CSP). The most common method, solar PV, collects

sunlight using solar panels, converts it to electrical energy and stores it in batteries for a variety of uses.

Due to decreasing material prices and advancements in installation processes, the cost of solar power has dropped almost 90% over the past decade, making it more accessible and cost-effective.¹ Fueling this further is the next generation of solar PV technology that's producing lighter and more flexible, powerful and efficient solar panels that can generate electricity even during periods of low sunlight.

Solar energy generation relies on energy storage systems (ESS) for consistent distribution—so as generation capacity increases, storage systems must keep pace. For example, flow battery technology is being improved to support grid-scale energy storage. A low-cost, reliable and scalable form of ESS, flow batteries can hold hundreds of megawatt hours of electricity on a single charge. This enables utilities to store energy long-term for periods of low- or non-production, helping to manage load and create a stable and resilient power grid.

Extending ESS capabilities becomes increasingly important to [decarbonization](#) efforts and a clean energy future as renewable power capacity expands. According to the International Energy Agency (IEA), in 2023 alone, renewable energy increased its global capacity by 50%, with solar PV making up three-quarters of that capacity. And in the period between 2023 to 2028, renewable electricity capacity is expected to grow by 7,300 gigawatts with solar PV and onshore wind usage expected to at least double over current levels in India, Brazil, Europe and the US through 2028.²

Wind

Humans have been using wind power to generate mechanical and electrical energy for generations. As a clean, sustainable and cost-effective source of power, wind energy offers immense potential to increase the renewable energy transition across the globe with minimal impact to ecosystems. Based on the IEA forecast, wind electricity generation is expected to more than double to 350 gigawatts (GW) by 2028³ with China's renewable energy market increasing 66% in 2023 alone.⁴

Wind turbines have evolved from small-scale, such as windmills for household use, to utility-scale for wind farms. But some of the most exciting developments in wind technology are in offshore wind power generation, with many offshore wind projects navigating into deeper waters. Large-scale wind farms are being developed to harness stronger offshore winds to potentially double offshore wind power capacity. In September 2022, The White House announced plans to deploy 30 GW of floating offshore wind power

by 2030. This initiative is set to provide 10 million more homes with clean energy, help lower energy costs, support clean energy jobs and further reduce the country's reliance on fossil fuels.⁵

As more clean energy is integrated into power grids, forecasting renewable energy production becomes crucial to managing a stable, resilient electric supply. [Renewables forecasting](#) is a solution built on [AI](#), sensors, [machine learning](#), [geospatial data](#), advanced analytics, best-in-class weather data and more to generate accurate, consistent forecasts for variable renewable energy resources like wind. More precise forecasts help operators integrate more renewable energy technologies into the electricity grid. They improve its efficiency and reliability by better projecting when to ramp production up or down, reducing operating costs. For example, Omega Energia [increased renewables utilization by improving forecasting accuracy](#)—15% for wind and 30% for solar. These improvements helped boost maintenance efficiency and minimize operating costs.

Hydropower

Hydropower energy systems use water movement including river and stream flow, marine and tidal energy, reservoirs and dams to spin turbines to generate electricity. According to the IEA, hydro will remain the largest clean energy provider through 2030 with exciting new technologies on the horizon.⁶

For example, small-scale hydro uses mini-and micro-grids to provide renewable energy to rural areas and areas where larger infrastructure (such as dams) may not be feasible. Using a pump, turbine or waterwheel to convert the natural flow of small rivers and streams into electricity, small-scale hydro provides a sustainable energy source with minimal impact to local ecosystems. In many cases, communities can connect into a centralized grid and sell back excess power produced.

In 2021, the National Renewable Energy Laboratory (NREL) placed three turbines made of a new thermoplastic composite material that's less corrodible and more recyclable than traditional materials into New York City's East River. The new turbines generated the same amount of energy in the same amount of time as their predecessors but with no discernable structural damage.⁷ Extreme condition testing is still necessary, but this low-cost, recyclable material has the potential to revolutionize the hydropower market if adopted for widespread use.

Geothermal

Geothermal power plants (large-scale) and geothermal heat pumps (GHPs) (small-scale) convert heat from the Earth's interior into electricity using steam or hydrocarbon. Geothermal energy was once location dependent—requiring access to geothermal reservoirs deep under the Earth's crust. The latest research is helping to make geothermal more location agnostic.

Enhanced geothermal systems (EGS) bring the necessary water from below the Earth's surface to where it isn't, enabling geothermal energy production in places around the globe where it wasn't previously possible. And as EGS technology evolves, tapping into the Earth's inexhaustible supply of heat has the potential to provide limitless amounts of clean, low-cost energy for all.

Biomass

Bioenergy is generated from biomass which consists of organic material such as plants and algae. Although biomass is often disputed as truly renewable, today's bioenergy is a near zero-emission source of energy.

Developments in biofuels including biodiesel and bioethanol are particularly exciting. Researchers in Australia are exploring converting organic material into sustainable aviation fuels (SAF). This could help reduce jet fuel carbon emissions by up to 80%.⁸ Stateside, the US Department of Energy's (DOE) Bioenergy Technologies Office (BETO) is developing technology to help reduce the costs and environmental impacts of bioenergy and bioproduct production while improving their quality.⁹

Technology to support the future of renewable energy

A clean energy economy relies on renewable energy sources that are vulnerable to environmental factors and as more are incorporated into power grids, technology to help manage those risks is crucial. IBM Environmental Intelligence can help organizations boost resiliency and sustainability by anticipating potential disruptions and proactively reducing risk throughout operations and extended supply chains.

Author



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Footnotes

- 1 [Fossil fuels ‘becoming obsolete’ as solar panel prices plummet](#) (link resides outside ibm.com), The Independent, 27 September 2023.
- 2 [Massive expansion of renewable power opens door to achieving global tripling goal set at COP28](#) (link resides outside ibm.com), International Energy Agency, 11 January 2024.
- 3 [Wind](#) (link resides outside ibm.com), International Energy Agency, 11 July 2023.
- 4 [Renewables—Electricity](#) (link resides outside ibm.com), International Energy Agency, January 2024.
- 5 [New Actions to Expand U.S. Offshore Wind Energy](#) (link resides outside ibm.com), The White House, 15 September 2022.
- 6 [Hydroelectricity](#) (link resides outside of ibm.com), International Energy Agency, 11 July 2023.
- 7 [10 Significant Water Power Accomplishments From 2021](#) (link resides outside ibm.com), National Renewable Energy Laboratory, 18 January 2022.
- 8 [To power a future built for life](#) (link resides outside ibm.com), Jet Zero Australia, accessed 11 January 2024.
- 9 [Renewable Carbon Resources](#) (link resides outside ibm.com), Office of Energy Efficiency and Renewable Energy, accessed 28 December 2023.

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