

True cost of renewable energy

It is anticipated that energy demand will increase by 56% by 2040 (Rahman et al., 2022). If the same policy of reliance on fossil fuels is continued, increasing energy demand will increase greenhouse gas emissions. Consequently, mitigating climate change is necessary to avoid these outcomes. Renewable energy sources play a crucial role in achieving carbon neutrality, reducing global warming and climate change, and meeting the Paris Agreements' 2 °C target. Renewable energy sources are considered to be affordable, sustainable, and free-obtained energy. Figure 1 depicts the various renewable energy sources and their proportional contribution to electricity production.

Share of renewable energy sources in electricity generation in gigawatt% from a total of 2587.6 gigawatts. The largest contributor to electricity production is hydropower. Solar and wind energy together account for 50% of the total electricity share. Geothermal, ocean, and biomass-based power plants account for slightly more than 6%.

Utilizing renewables is crucial for decarbonizing the energy sector and combating climate change, but solar, hydropower, and wind availability depends on weather conditions and future climate changes. In addition, less research has been conducted on the environmental effects of using renewable energy sources. Therefore, this review was conducted to discuss (i) the most widely used renewable energy sources, (ii) the needs and costs of renewable energy, (iii) the impacts of climate change on renewable energy sources and their future prospective under climate change scenarios, and (iv) the potential environmental impacts caused by renewable energy sources and the most environmentally friendly renewable sources.

Almost 80% of the global population lives in countries that are net importers of fossil fuels (IRENA^d, 2022). Due to their dependence on foreign fossil fuels, approximately six billion people are vulnerable to geopolitical shocks and crises (AaH et al., 2021). In contrast, renewable energy sources are available in all nations, but their full potential has yet to be realized. The International Renewable Energy Agency (IRENA) estimates that by 2050, 90% of the world's energy can and should come from renewable sources (IRENA^b, 2018).

In addition, the excessive use of fossil fuels and non-renewable energy sources contributes to global warming by emitting large quantities of greenhouse gases (Chen et al., 2022a). Controlling greenhouse gas emissions from energy production and consumption is crucial to combating climate change. To achieve the Paris Agreement's goal of limiting global temperature rise to 1.5 °C-2 °C by 2100, energy systems require rapid, immediate, and sustained innovation and the effective use of renewable energy across all sectors (Fawzy et al., 2020). The demand and growth of renewable energy in the transportation, buildings, industrial, and power sectors are summarized in Table 1 based on the critical energy use sectors identified by the IRENA.

This section examines the need for renewable energy in four key sectors across multiple nations. The research demonstrates that policy, technology, finance, and culture influence the use of renewable energy. Therefore,

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global support for adopting renewable energy and developing policies to promote sustainable development will need to be strengthened in the future.

Renewable energy is energy that is derived from natural resources. In order to achieve carbon neutrality, the global share of renewable energy is projected to increase from 14% in 2018 to approximately 74% in 2050, requiring an eightfold annual increase. Renewable energy can be evaluated from the perspective of sustainability and its technical characteristics, such as integration with other resources, energy efficiency, and operating costs (Bortoluzzi et al., 2021). These factors assist policymakers in selecting a specific renewable energy source to meet market demand. Identifying the most viable renewable energy source is essential; consequently, defining the renewable energy resource is vital.

Renewable energy types. Various renewable energy sources can be used to produce energy that can replace fossil fuels and as a tool for climate change mitigation strategies. The most common energy sources are solar, wind, geothermal, hydropower, and biomass. Hydrothermal is the leading energy source, with the capacity to generate 1,150 gigawatts of electricity

In 2021, bioenergy power generation grew by an additional 10.3 gigawatts, compared to the 9.1 gigawatts added in 2020. Away from these resources, geothermal power additions were modest in 2021, and only 110 megawatts of concentrated solar power capacity added to the grids. Therefore, the share of renewables growth for the total power generation capacity reached 81% in 2021, making renewables account for at least half of all new net energy additions worldwide since 2012 (IRENAa, 2022).

By 2021, over 843 gigawatts of solar photovoltaic systems had been installed worldwide, representing a 21-fold increase in solar energy since 2010. In addition, 133 gigawatts of newly installed systems were established during 2021 alone, which was a 13% increase from 2020. These new capacity additions were the highest among all renewable energy sources that year (IRENAa, 2022).

In summary, the costs of solar energy are primarily influenced by technology, climate, and national policies; consequently, with advanced technology and favorable renewable energy policies, the costs will continue to decline in the future.

The average LCOE for newly constructed projects in Europe decreased by 29% between 2020 and 2021, from 0.092 to 0.065 dollars per kilowatt-hour. Between 2010 and 2021, the global average installed costs decreased by 41%, from \$4876/kilowatt to \$2858/kilowatt. Increasing developer experience, product standardization, industrialization, regional manufacturing and service hubs, and economies of scale have contributed to price reductions. These declines have also been aided by deployment and, in many cases, manufacturing policies that have facilitated growth (IRENAa, 2022).

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