Renewable Energy: The Path to Global Sustainability and Climate Resilience

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Abstract. Because of the abrupt climate change and the gradual depletion of oil and gas resources, there is an extreme need for transitioning into green energy. In this area, this research paper aims to search for alternative forms of energy like solar energy, wind energy, hydro energy, geothermal energy, and biomass energy. This regards their importance in supporting a sustainable future from an economic, social, and environmentally responsible perspective. Along with it, this research paper will help in attaining Sustainable Development Goal 7 and Sustainable Development Goal 13. Based on the study, there are great advantages in the use of renewable energy sources. These include the reduction of pollution in the environment and the enhancement of energy security. The use of renewable energy faces a variety of challenges, like high initial investmentand a lack of adequate access to new technologies.

Keywords: Renewable energy, climate resilience, sustainability, SDGs, energy transition, decarbonization.

1 Introduction

A rise in global temperatures and natural ecosystems has been shrinking dramatically, changing the environment drastically. Climate change is proving to be today's biggest threat since it not only affects the environment but also has unfavorable effects on the economy and health of human beings. The current energy sector is still dependent on fossil fuels that are releasing approximately 75% of emissions globally; according to the International Energy Agency [1]. Increasing urbanization and a growing population worldwide make it difficult and unsustainable to continue relying on fossil fuels.

According to the Intergovernmental Panel on Climate Change, it is extremely important to ensure warming below 1.5°C till 2030; a reduction in emissions of 45% must be achieved. [3]. However, the UN expects a rise of 35% in global energy demand by

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2040 [6]. These numbers clearly display the need for an increase in reliable and clean energy resources.

Long-term alternatives needed to be adopted, like solar, wind, hydro, biomass, and geothermal energy, which will aid in minimizing pollutants, optimizing energy security, and promoting economic growth. However, with the help of technological advances, fossil fuels still account for 80% of the world's total primary energy, as stated by the World Bank [7]. As per the World Health Organization, fossil fuels not only deteriorate the environment but also lead to extreme air pollution, causing seven million deaths every year[9]. With the closer adoption of clean energy resources, positive effects could be seen not only on human beings but on the environment as well. According to the International Renewable Energy Agency (IRENA), by 2030 employment of over 38 million will be created using renewable energy resources [2].

2 Global Renewable Energy Capacity and Growth Trends

The international community has shown a massive inclination towards renewable energy sources, with advancements in technology and increased concerns for the environment. According to a report published by the International Energy Agency (IEA), international additions of renewable energy for electricity generation stood at 507 GW in 2023, which marked a two-decade peak [1]. Solar energy is considered for generating 75% of new capacity additions. A balance between economic expansion, social equality, and sustainable development is needed. Renewable energy sources contribute to all the above-mentioned goals by providing power that is renewable, vast, and commercially viable. Reducing greenhouse gas production and ensuring access to electricity can ensure that energy security translates into understanding and promoting equity in society.

The biggest strength of renewable energy is its ability to be easily executed. Regions can generate their own power by solar energy projects being done on a local basis, community support for wind farm projects, or hydro projects, thus reducing their dependence on fossil fuels. Moreover, it enhances equity, providing energy for places that could not have accessed it [11].

3 Renewable Energy Technologies

3.1 Solar Energy

The usage of solar energy relies on the sun's rays for generating either electricity or heating purposes. The major types of solar energy exploitation methods include photovoltaic cells and concentrated solar power plants. Solar energy provides a flexible, expandable, and more accessible means of electricity production. The mean cost of electricity production through solar PV has lowered by 82% from 2010 to 2019, going below the cost of traditional energy sources.

3.2 Wind Energy

The wind energy technique involves converting kinetic energy from wind into electrical energy. Technological development in the turbine has resulted in increasing efficiency, making it one of the fastest-growing renewable energy sources. Long-distance farms will surely be a great potential source since there, wind speed is high and consistent.

3.3 Hydropower

Hydropower uses water in motion to generate electricity. Small-scale hydropower schemes are much valued for rural energy and community development.

3.4 Geothermal Energy

Geothermal energy uses the heat that is found beneath the earth's surface for either heating or for power generation. It increases the list of more reliable and cleaner energy sources; the availability is reduced to the geographically restricted areas of tectonically active zones.

3.5 Biomass Energy

It provides a way of utilizing waste streams without relying on fossil fuels. Sustainability in the production of biomass and preventing deforestation are still major issues.

4 Economic Growth

Reinforcement of the economy of any country: Clean energy resources are very important as they help in job creation, innovation, and security. Clean energy requires higher employment compared to fuel resources; the effect will be job creation on a higher scale per megawatt produced. As per the report of the International Renewable Energy Agency (IRENA), globally over 12 million jobs were created in the clean energy industry in 2020, with an estimated return on investment [11]. Apart from increasing job creation, renewable energy projects are boosting local economies through investments and technological advancements. The leading investors in renewable energy include Germany, China, and America; these countries are today exhibiting the economic gains of switching to new energy resources [11]. Prospective future estimates indicate that both solar and wind energy are estimated to comprise 96% of new renewable energy resources [11]. (Fig. 1)

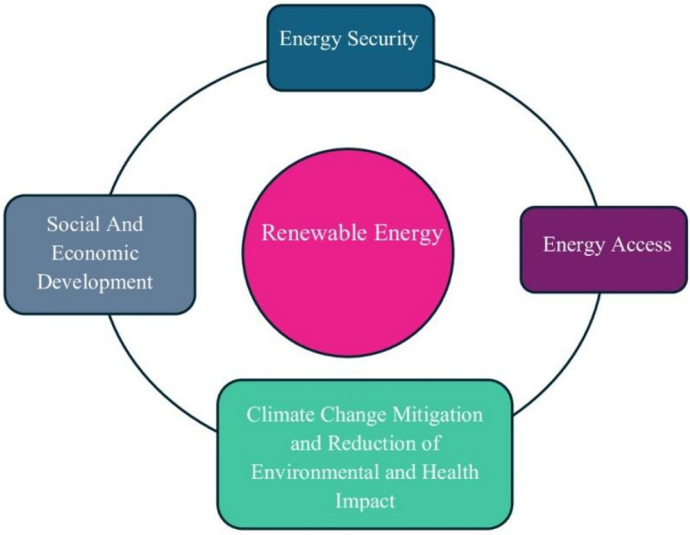

Fig. 1. Chance of renewable energy sources (Source-A review of renewable energy sources, sustainability issues and climate change mitigation)

5 Climate Change Mitigation and Renewable Energy

The need for renewable energy is required at a global level for the mitigation of climate change. In fact, according to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), a rapid and broad-based transition to fossil fuels is necessary to meet the 1.5°C target. Energy conservation and the appropriate consumption of energy can effectively help in the reduction of emissions in key sectors like electricity, transport, and industry. It has been mentioned in the Working Group III report of the IPCC that developing clean growth and achieving net-zero targets would need the vast potential offered by solar power, wind energy, hydropower, and geothermal energy, which will slow down emissions. Research also shows that RE not only helps to decrease pollution levels but also increases energy security, imbalance of supply, and helps to create green economic growth. By the enhancement of clean production, reduction in dependence on conventional fossil fuels, and increased levels of environmental resilience, RE increases sustainable development levels. Some challenges, such as use, land use, and discharge levels of RE technologies, need to be managed.

Furthermore, renewable energy serves as a connection in the context of economic development and the mitigation and protection of the environment. Considering developing countries, community-based renewable energy programs have the capability to empower communities and reduce energy poverty in rural areas. On the global front as well, the same trends apply. Many countries like Portugal, Sweden, Spain, Germany,

Ireland, and Greece today incorporate renewable energy in their overall plans regarding the mitigation of global warming.

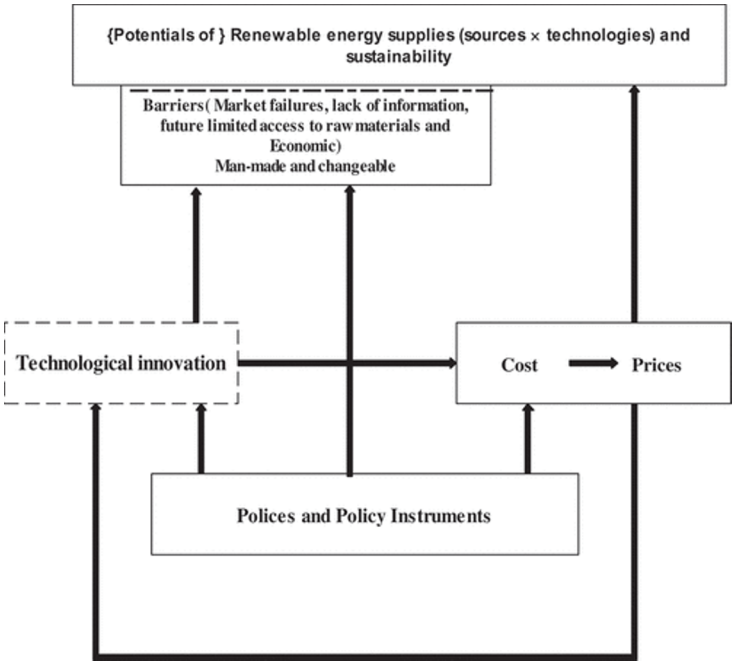

Fig.2. Interlinking of factors influence renewable energy supplies and sustainability, adapted from [12] [13]

6 Challenges and Barriers for Renewable Energy Adoption

Although the spread of renewable energy sources was observed at a rapidly increasing rate, certain issues associated with infrastructure, investment, and social aspects continue to slow down their adoption at the global level. Certainly, clean electric energy set a new all-time high in 2023; however, the current global progress is not equivalent to the IPCC 1.5°C goal [3], [4]. Although there has been a rapidly rising spread of renewable sources at a higher rate than at any point before, investment and accessibility associated with affordability continue to differ across regions [5], [8].

6.1 High Upfront Costs

The development of a renewable resource infrastructure requires a large initial investment, especially for remote wind farms, solar facilities, and storage batteries. Though the number of solar cells and offshore wind turbines has been down more than 80% since 2010 because of a decline in the global financial incentives [2], [6], there are challenges for the developing countries seeking sufficient financing [1]. The private

investors are more aware, due to a lack of effective risk management tools and instabilities of the exchange rate [7].

6.2 Grid Infrastructure Challenges

Another great challenge comes from aging populations coupled with poor transmission infrastructure. Many of Africa, South Asia, and certain countries in South America lack an efficient transference infrastructure which can support high volumes of renewable energy [2], [6]. As solar and wind energies are climate-dependent in their production levels, a more efficient grid infrastructure, smart metering, and storage are needed for a stable system. Without such enhancement, renewable energies would be ineffective, contributing towards slower processing of new projects integrating into the grid infrastructure [7], [8]. Infrastructure upgrades in this respect are key toward optimizing renewable energy deployment [1], [5].

6.3 Policy and Regulatory

Uncertainty in government regulations is an obstacle for both investors and developers [1], [5], [10]. There is a lack of transparent frameworks in most countries, making it difficult to attract reliable investments. The constantly changing nature of policies, subsidies, auctions, and grid connections, impairs the confidence of the investors [1]. For the development of renewable energy, effective, anticipated government regulation is very important [10].

6.4 Social and Environmental Concerns

However, massive renewable energy schemes have also encountered opposition in local communities in connection with land usage and the disruption of habitats and wildlife caused by the schemes themselves [4], [5], [9], [11]. For instance, wind energy projects and hydropower schemes may disturb habitats and wildlife and therefore encounter stiff opposition in local communities.

Addressing such concerns requires community engagement, involvement, and proper compensation, as well as a comprehensive habitat review in the affected environment and affected communities [9]. Engagement in planning permits communities to benefit equally from the benefits associated with clean and environmentally sustainable energy sources [11].

7 Renewable Energy and the Sustainable Development Goals

Renewable energy is crucial in advancing various Sustainable Development Goals by promoting economic opportunities and environmentally and socially sustainable well-being. Sustainable Development Goal 7: “Affordable and Clean Energy” targets achieving universal access to “modern, reliable, and sustainable energy” [6]. By 2023, Example; in sub-Saharan Africa, electricity access has risen to 92%, still, approximately 666 million people still do not have access to electricity.

7.1 RRs also provide for several other SDGs as follows

SDG 1 (No Poverty). In a remote region, the local energy systems induce local businesses to flourish and produce job opportunities and carry out economic development. [5] [6] [10]. They also serve vulnerable groups and enhance access to essential facilities like irrigation systems, communication networks, and cottage industries [5] [7].

SDG 3. Good Health and Well-being. Replacing conventional biomass and fossil fuel with renewable energy helps to clean air indoors and outdoors; it saves lives because it obviates millions of premature deaths every year [9]. Air pollution in dwellings causes more than 4 million deaths in a year and can be alleviated with clean cooking in rural settings and with renewable energy for lighting and powering appliances in urban areas and homes around the world [9].

SDG 5 (Gender Equality). Renewable energy is safer, saves time for women to gather fuel, and helps women acquire education and livelihood opportunities [6], [11]. Findings have shown that an integrated renewable project can contribute to increasing gender equality [11].

SDG 13 (Climate Action). Expand and enhance renewable energy sources stands higher among the best methods for lowering greenhouse gas emissions and improving resilience to climate change [3], [4], [5]. The IPCC Sixth Assessment Report reveals renewable energy sources and energy efficiency as essential approaches to staying below 1.5°C [3].

Despite these advantages, financing in developing nations is still critically low compared with the requirements. The 2023 financing was only at USD 21.6 billion, with much lower amounts required to realize goal 7 of the SDGs by the year 2030 [6], [8]. The Renewables 2024 report by the IEA highlights the importance of extending public and private financing, extending finance instruments, with increased policy clarity [1], [5].

Renewable energy promotes sustainable development and connects with economic, environmental, and social aspects. The link between the expansion of renewable energy sources and the SDGs enhances and promotes climate change and equitable energy transition globally [4], [11].

8 Analysis and Discussion

Countries are increasingly adopting renewable forms of energy, leading to a significant shift in the pace of energy transformation. Globally, wind and solar energy together can account for nearly 90% of electricity generation [1], [8]. Practicing clean energy not only prioritizes environment but also helps in achieving economic advantages such as

job creation and technological growth due to reduced environmental degradation [2], [5].

It has been seen that renewable energy sources proved the most economical solution for generating electricity worldwide, outperforming fossil fuels in terms of cost and scalability [5], [8]. Renewable sources are essential in the reduction of emissions. Combining energy efficiency and electrification of end-use sectors, renewable energy sources can cut two-thirds of the world's energy-related CO_2emissions, making them essential for the strategy of zero [3], [4].Along with the climate mitigation benefit, renewable energy can increase energy access and generate job opportunities, as well as promote economic growth [2], [11].

Many issues need to be addressed, like high upgrade costs, inadequate transmission networks, and policy uncertainties. Lack of financial support obstacle developing nations in slowing the transition [1], [5], [6], [10]. About developing markets, lack of transmission capacity and policy conduciveness adversely affect investments in these countries [7].

Innovation, good governance, and equity will help in reducing the gap regarding renewable energy. Cooperation between the developed and developing countries is very crucial, for example, the Paris Agreement and the Sustainable Development Goals, in ensuring a smooth transition takes place in the world of energy [3], [4], [6].

9 Conclusion

The above study reveals that for sustainable development and climate protection, renewable energy is the solution (Fig. 2)It helps in decreasing greenhouse gas emission, enhancing security, promoting economic growth, and protecting the environment. The renewable sources not only help to reduce pollution and energy efficiency but also contribute to generating low carbon emissions and creating jobs in these sectors. Thus, it promotes goal 7 (Affordable and Clean Energy) and goal 13 (Climate Action) and ultimately achieves upgraded health and better quality of life related to gender equality and to combating poverty [6], [9], [11].

The obstacles in growth especially in developing countries are the high price of starting, lack of grid infrastructure, and unreliable policies, which still exist and are applied [1],[5],[6],[7]. To gain investment in clean energy technologies, higher levels of global cooperation, enhanced economic support, and reliable policies.

To achieve sustainability in future years, it is mandatory now to focus on the use of renewable energy sources [1], [2]. The development of an equitable, and sustainable future needs, strong institutions and investments. To attain these needs collaborative efforts and strong commitment are required.

References

1. Polzin, F., Migendt, M., Täube, F.A., Von Flotow, P.: Public policy influence on renewable energy investments — A panel data study across OECD countries. Energy Policy 80, 98–111 (2015).

2. Sellers, D., Le, T.T.: Trends in global renewable energy capacity deployment: Drivers and policy impacts. Renewable and Sustainable Energy Reviews 156, 111958 (2022).
3. Creutzig, F., Agoston, P., Goldschmidt, J.C., Luderer, G., et al.: The underestimated potential of solar energy to mitigate climate change. Nature Energy 2(9), 17140 (2017).
4. Hausfather, Z., Peters, G.P.: Emissions — the 'business as usual' story is misleading. Nature 577, 618–620 (2020).
5. Stevens, L., Bazilian, M., Howells, M., et al.: Global renewable energy status: Trends, drivers, and barriers. Renewable and Sustainable Energy Reviews 170, 112988 (2023).
6. Pachauri, S., Spreng, D.: Measuring and monitoring energy access: Supporting a learning agenda. Energy for Sustainable Development 49, 34–38 (2019).
7. Peters, G.P., Andrew, R., Davis, S.J., et al.: Carbon dioxide emissions continue to grow amidst slowly emerging climate policies. Nature Climate Change 11, 189–195 (2021).
8. Huenteler, J., Zhang, F., Heuser, P.: Reinforcing the global photovoltaic manufacturing value chain: Implications for capacity expansion. Energy Policy 149, 112024 (2021).
9. Landrigan, P.J., Fuller, R., Acosta, N.J.R., Adeyi, O., et al.: The Lancet Commission on pollution and health. The Lancet 391(10119), 462–512 (2018).
10. Hou, P., Li, J.: United States renewable energy growth and decarbonization trends: 2010–2023. Renewable and Sustainable Energy Reviews 185, 113546 (2024).
11. Andish, F.: Renewable energy: A pathway to sustainable development. ResearchGate (2024).