

Renewable Energy and the Future of India

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Abstract:

The progress of a nation depends upon its power to supply energy to the country and its ability to meet the crises of other countries. The development of a country also depends upon its capability to protect the planet from environmental pollution and degradation caused by the activities carried out in the country itself. This paper aims to find how far India has progressed and what the prospects are for India with respect to the use of renewable energy resources. The paper also attempts to find how India has been taking measures to control and resist environmental pollution by shifting towards environmental pollution. The paper highlights the merits and demerits of renewable energy sources and the challenges to be met for proper utilization of renewable energy sources and advancement in the country's future developmental projects. The goals adopted to enhance the future development of India with the help of renewable energy sources have been brought to light. The move towards a green revolution, marked by keeping the utility of renewable energy in tune with the preservation of human health and the nation's natural green strategy, has been focused on in this paper.

Introduction:

The word "energy" derives from the Greek "energeia" and is believed to appear first in the work of Aristotle in the fourth century BC. However, over time, energy came to refer to the capacity or power to do work. In conformity with the law of energy conservation, which states that energy can be converted or transformed but not created or destroyed, energy gets transformed into many forms. It exists in different forms like potential, kinetic, thermal, chemical, electrical, nuclear, bio-mass energy and others. The sun is the prime energy source since the core particle of energy is born and created in the heart of the sun, and it also radiates solar energy that makes life possible on Earth.

Energy is one of the most essential components for the functioning of the living and nonliving domains of the universe. Broadly differentiated into two categories called renewable and non-renewable energies, the management of different types of energy supply is contrived to meet the demands of the growing population. In a country like India, alternative energy is

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highly required to meet the needs of the massive growing population. The dreadful fear of exhaustion of conventional energy sources in the future and the *hazardous influences of burning fossil fuels* that are leading to massive environmental pollution and impacting the global ecosystem by the emission of greenhouse gases and also increasing carcinogenic elements in the environment have led technologists and scientists to focus on the mass generation of renewable energy sources globally (Azarpour et al., 2012).

Modernization and advancement in society and civilization are not possible without a sufficient energy supply, and for this reason, the use of alternative, renewable and sustainable energy is the need of the hour. However, it is essential to find out first whether a country like India can afford to maintain quality sustainable means for the production and storage of renewable energy to cater to the demands of the vast population uninterrupted. It is also important to find out whether Renewable energy can solve all the problems related to power generation. Abbas Azarpour comments *that a common misconception of renewable energy (RE) is that it could serve as a holistic solution to the problems associated with the disreputable yet reliable fossil fuel and nuclear energy* (Azarpour et al., 2012).

Increased demand for renewable energy may lead to the Green Energy revolution:

In keeping with India's goal of securing 500GW renewable energy capacity by 2023 (Wikipedia Contributors, 2019), the installed renewable energy capacity is being monitored to experience a positive upsurge curve. Various plans and projects are being initiated to improve the upsurge of renewable energy. In the near future, India will most likely witness an upsurge in using renewable energy to produce green hydrogen. For the most part, green hydrogen is generated by renewable energy. The greener hydrogen is produced, the more renewable energy will be required, automatically increasing renewable energy supply and conservation to meet the high demand for renewable energy. Green energy produced from renewable energy produces green ammonia, a main ingredient of synthetic fertilizer and is also used for long-duration grid energy storage and seasonal energy storage (Khan et al., 2018).

The Ministry of New and Renewable Energy (Hydrogen Division) under the Government of India has taken the initiative to maximize the production of Green Hydrogen and its derivatives in India under the National Green Hydrogen Mission on 28th June 2023 (*Ministry of New & Renewable Energy - Government of India*, n.d.). In this regard, the Solar Energy Corporation of India (SECI) has been directed to implement an agency for the implementation of this scheme and cater to the demand for power supply in the form of solar energy and wind energy as the most effective renewable energy sources for the purpose. Most importantly, the mission has gained the approval of the Honourable Minister of Power and New and Renewable Energy in India. Since numerous governments have adopted policies to promote the commercialization of green hydrogen, its production is expected to increase significantly in the future. Along with this, the demand and increase in the production of renewable energy supply and sources will undoubtedly witness tremendous upsurge in the coming days in India. About the future of green

energy, Sanjukta Banerjee (2019) has declared *that these have no adverse effect on the planet and won't replenish.*

Another attempt to focus attention on Renewable energy is celebrating World Wind Day annually on June 15th (Figure 1). The words *"The development of wind energy will play an important role not only in solving the problem of electricity supply but also in solving the economies of nations and environmental sustainability around the world"* ring a note of optimism (Abdurahmonov et al., 2022).

However, there are constraints to make it a smooth path of progress. Most renewable energy sources, such as solar and wind, are intermittent in nature. They depend on weather conditions, meaning they may only sometimes be available when demand is high or at certain times of the day. This intermittency challenges grid stability and requires energy storage solutions to balance supply and demand effectively. The availability and suitability of specific renewable resources vary depending on the location. For example, solar power may be more viable in sunny regions, while wind power may be more feasible in areas with consistent wind patterns. Developing efficient and cost-effective energy storage technologies is crucial to address the intermittency of renewable energy sources. Storage technologies like batteries and pumped hydro are being used, but advancements are still needed to store large amounts of energy for extended periods (Inhaber, 1979; LeninBabu and GowriManohar, 2023).



Figure 1. Wind energy has evolved successfully as an essential source of renewable (alternate) energy across the planet (Photo credit: Saikat Kumar Basu).

Still, it can be noted that the renewable energy sector will become a significant driver of job creation and economic growth in India in the future. Investments in non-conventional energy projects will lead to new employment opportunities in the manufacturing, installation, operation, and maintenance of renewable energy infrastructure in India in the future. Nath and Sen support this view and assert that *it greatly influences economic growth, job creation and energy security* (Nath and Sen, 2021). It will stimulate local economies and foster innovation in the clean energy sector in the coming days.

Renewable energy can revolutionize the telecom sector:

Renewable energy is revolutionizing the mobile sector. On the other hand, the mobile sectors are investing in renewable energy infrastructure (solar panels and wind turbines) (Figure 2) to reduce their reliance on conventional energy sources. Telecom industries in India have begun to utilize renewable energy sources like solar power. They are taking initiatives to build solar tower sites to minimize carbon usage in the industrial sectors in the coming days. By initializing renewable energy like solar power and wind power, the mobile sectors will mitigate environmental pollution and fight climate change caused by burning fossil fuels. So far, the prolonged consumption of conventional energy resources like fossil fuels and their extractions has proved to be more challenging and costly; because of that, a shift towards renewable energy has become more popular. Bansal has carefully pointed out *this factor; the increasing depletion rate of conventional energy sources has emphasized renewable energy sources such as wind, micro-hydro, biogas, etc.* (Bansal et al., 2003) (Figure 3).



Figure 2. Mobile sectors invest heavily in wind turbines for a steady supply of green energy like wind energy (Photo credit: Saikat Kumar Basu).

Using renewable energy in the mobile and telecom sectors is expected to eliminate the need for costly grid infrastructure and reduce transmission losses to the minimum level shortly. H. Inhaber has aptly highlighted the problems and difficulties of using unconventional energies. *The risk from nonconventional energy sources derives from the large amount of material and labor needed, along with their backup and storage requirements* (Inhaber, 1979). Using renewable energy in the telecom industry will lead to long-term energy savings and will also act as a safeguard against future energy price fluctuations.



Figure 3. A model micro-hydro project from Lethbridge, Alberta, Canada (Photo credit: Saikat Kumar Basu).

Many renewable energy sources have reached or are appropriating cost parity with conventional energy sources, making them economically viable options for power generation. Adopting non-conventional energy resources aligns with several Sustainable Development Goals (SDGs) set by the United Nations, including affordable and clean energy, climate action, and promoting sustainable industrialization and innovation. V. Siva Reddy has rightly observed *that using renewable energy sources is one of the crucial components of sustainable development* (Reddy et al., 2013).

Conventional energy sources, especially coal and oil, are significant sources of air pollution. Burning these fuels releases harmful pollutants, including particulate matter, sulfur dioxide, nitrogen oxides, and volatile organic compounds, contributing to respiratory illnesses and other health problems. Shifting to cleaner, non-conventional energy sources will improve air quality

and public health. Fossil fuels are finite resources and their reserves are depleting over time. Depletion of conventional resources is also pinpointed in the quoted words, *widespread shortages of the traditional fuels on which an estimated one-half of the world's population relies for cooking and other energy needs* (Hughart, 1979). The finite nature of fossil fuels necessitates a more effective transition towards sustainable and renewable energy sources to ensure a stable and secure energy supply in the future of India.

Though the costs of renewable energy technologies have decreased, they can still be higher than traditional fossil fuel-based energy sources. The initial investment and installation costs may pose challenges for developing countries or regions with limited financial resources. Some non-conventional energy sources, like solar and wind, have lower energy densities than fossil fuels. This means larger installations will be needed to generate the same amount of energy, impacting land use and requiring more substantial infrastructure investments. For procuring sufficient renewable energy, A. Aravani emphasizes the need for proper *Supply infrastructure, technology readiness, human resources capabilities and geographic elements* (Iravani et al., 2017).

More advancement in renewable energy technologies is essential to increase efficiency and reduce costs. However, research and development in this area may need more funding constraints and technological barriers. The public's perception and acceptance of non-conventional energy sources can influence their implementation. Some people may be concerned about certain renewable energy installations' aesthetics, noise, or perceived health effects.

The availability and suitability of specific renewable resources vary depending on the location. For example, solar power may be more viable in sunny regions, while wind power may be more feasible in areas with consistent wind patterns. Inconsistent or inadequate policies and regulations can hinder the growth of renewable energy in the future. Supportive policies, incentives, and long-term planning are crucial to encouraging investments in clean energy (Gielen et al., 2019). Despite various challenges, efforts to address them are ongoing, and technological advancements and supportive policies are gradually overcoming these obstacles. As renewable energy is becoming more integrated into the energy landscape, the benefits of clean, sustainable power generation are likely to outweigh the challenges and bring many benefits in the future, and the contribution of the telecom sector in fighting the challenges is undeniable. K A. Khan observed *that the renewable energy sector has one huge advantage over fossil fuels because it is highly ecologically acceptable compared to fossil fuels* (Khan et al., 2018).

Building economic prosperity by enhancing the efficiency of renewable energy sources and own supply chains:

As per the International Energy Agency (IEA) declaration, a global renewable energy capacity growth of 107 gigawatts (GW) is estimated in 2023. The IEA has also estimated an expected increase of electric vehicles by 35 % this year. For this reason, photovoltaic solar

panels, wind turbines and lithium-ion batteries for renewable energy storage require an enormous manufacturing boost. Besides, a massive increase in the production of rare Earth minerals has become highly necessary. Hence, the demand for production and increasing manufacturing capacity of solar panels, wind turbines and lithium-ion batteries, supposed to be the catalysts for a green energy revolution, are fuelling a gold rush in the present scenario.

The untapped rare Earth minerals have become the best choice for countries around the world to build their supply chains and try to reserve lithium and cobalt as much as possible. China has been able to establish a monopoly market power in this regard. However, developing countries rich in rare Earth minerals are trying to grab maximum profit by harnessing a complete process of domestic energy supply rather than exporting the primary raw materials to China, the US, and other countries. As per the report by ABC News, India is set to establish regional renewable energy value chains rather than meeting the demands of the international interest. The report by Anupam Nath and SIBI Arasu in Associated Press and ABC News on July 19th, 2023, says that India wants to expand its critical mineral mining operations. The report also says that plans are set for India to propagate and maintain its clean energy infrastructure in a complete cycle from beginning to end. Recent times have witnessed the increased efficiency of solar panels with the application of a layer of chromium on them. This mineral is also used in wind turbines and batteries as renewable energy sources. Increased efficiency of the renewal energy sources (Figure 4) is undeniably resulting in higher energy output yield to meet India's growing population's demands.



Figure 4. Micro-hydro projects are growing fast as an affordable and sustainable alternative renewable energy resource (Photo credit: Saikat Kumar Basu).

For sixty years, the dusty mountain, rich in minerals at Kaliapani, a village in the Jajpur district of Odisha, has been a mining site for chromium, used as a coating on solar panels and wind turbines for higher yield of renewable energy. Other minerals like Lithium, Cobalt and Nickel, used in solar panels, wind turbines and batteries for increasing the output of renewable energy, are also being discovered in India at an accelerating rate for building improved green infrastructure in India to meet the escalating demand in the country and bolster mineral supply chain for the production of renewable energy worldwide. Umair Shahzad said, *“The most significant feature of renewable energy is its plentiful supply.” It is infinite* (Shahzad, 2012). Increased efficiency of the sources of renewable energy supply due to the use of mineral coatings produced in the country itself will continue to enhance the supply of renewable energy in India and aid in developing its socio-economic conditions in the future. In the words of Naruttam K. Roy, *Power is the most significant criterion of development, and the level of development of a society is measured by the amount of power consumed* (Prospects of Renewable Energy Source, nd). In the same vein, Mohamed M. Khalil (2022) has also observed *that renewable energy resources can be recreated and renewed, and the world cannot run out of them.*

Conclusion:

As the world faces environmental challenges and seeks long-term sustainability, a growing emphasis on transitioning towards renewable energy sources to mitigate climate change and ensure a more sustainable future is inevitable. India's mission to increase the production of Green Hydrogen will likely escalate the demand for renewable energy. Utilization of renewable energy in the telecom industry can succeed in reducing reliance on conventional energy and thereby fight environmental degradation and climate change in the long run. By embracing non-conventional energy resources and accelerating their deployment, India can address the challenges posed by climate change, promote environmental sustainability, improve energy security, and pave the way towards a more prosperous and resilient future for all Indians.

Though it is essential to have advancements and a better future for renewable energy, it must be remembered that the cost factors for availing the opportunities for harnessing such renewable energy are huge and prove challenging for countries like India, where people are still struggling with sustainable living concerns. However, one cannot shrug that the environmental issues and the health hazard conditions become alarming due to the negative influences of such advancements where by-products and residues emerged from such developmental projects as mining, causing greater damage to the local and neighboring villagers and the environment. Chronic exposure to chromium leads to health problems, toxicity, land impoverishment, damage to agriculture, and potential environmental degradation.

The mission of building up whole supply chains domestically to reap maximum utility in the generation of renewable energy and bringing about the green energy revolution should, thus, most essentially focus on the fact that India must take care and resist the harmful impacts on

environmental degradation so that the Indians will not have to depend on anyone for fulfilling our economic and climate goals in the future.

Last, the wide range of renewable energy uses, from the minor household activities of day-to-day life to its innovative use in space research exploration, is a step forward in India's developmental goals. The use of solar panels on all four sides of Chandrayaan 3 Lander to ensure that it continues to draw solar power and remains active, even if it lands in a wrong direction or tumbles over, is a milestone concerning the present status of India's use of renewable energy source. Such more advanced technological uses of renewable energy sources in space studies will likely lead India to a bright future by winning over its significant challenges.

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