World Journal of Environmental Biosciences

Available Online at: **www.environmentaljournals.org**

Volume 12, Issue 4: 1-7

https://doi.org/10.51847/bAMKAPPZGe

ISSN 2277- 8047

Application of Green Energy Technology for Environmental Sustainability

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ABSTRACT

Currently, the need for power consumption is important to develop cities and industries. There are numerous traditional methods of receiving power for needs, but they are threats to environmental pollution. This is why we need to focus on alternative methods of receiving power. Green energy can be considered an effective means of promoting the amount of energy needed for industries, urban territories, and businesses without damaging the environment. Green energy is typically derived from renewable energy technologies such as solar, wind, geothermal, and hydroelectric electricity. The best option for improving environmental sustainability and having no negative effects on the nation's economic growth is renewable energy. Notably, one of the primaries aim of sustainable growth is to assure the availability of energy sources for future generations while spending as little money and emitting as little pollution as feasible. Green energy has, therefore, attained the aims of sustainability, i.e., they are the least costly, most effective means to increase the sustainability of a nation's productive sector, people's standard of life, and the environment. The main focus of this work is the production, utilization, and implementation of green energy sources globally. We are alone responsible for saving the planet from extinction because we are the ones who pollute it. The article primarily focuses on the advantages, necessity, and need for green technology for a brighter future.

Keywords: *Green energy, Environmental protection, Renewable energy source, Solar energy, Geothermal energy, Hydroelectric energy*

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Received: 30 August 2023
Accepted: 27 November 2023

INTRODUCTION

The 18% of the world's total energy is provided by renewable energy sources (RES) (Lund, 2014). However, the majority of that comes from the conventional heating and boiling of biomass. As a result, when traditional renewable energy sources are eliminated, so-called 'new energy sources' provide just 2.4% of total global energy (Aswathanarayana *et al*., 2010). Biomass, hydropower, geothermal, solar, wind, and ocean energy are all part of RES. Primary, pure, and unlimited sources of energy are renewable resources (Dincer, 2001; Bilgen *et al*., 2004). Alternative energy sources are another name for RES (Fridleifsson, 2001). The primary renewable energy sources are listed, along with examples of how to use them are shown in **(Figure 1)** (Shahabuddin *et al*., 2016; Bhandarkar *et al*., 2021). The idea of green energy has evolved over the past three decades into a strategic method of generating sustainable energy for the entire planet, but it has grown enormously in recent years. Clean energy sources obtained from natural resources are referred to as "green energy," which generates less environmental impact than conventional energy technology (Bhowmik *et al*., 2017). The main aim of this work is to produce green energy that leaves no carbon impact, which is a significant step toward a future that is more environmentally friendly.

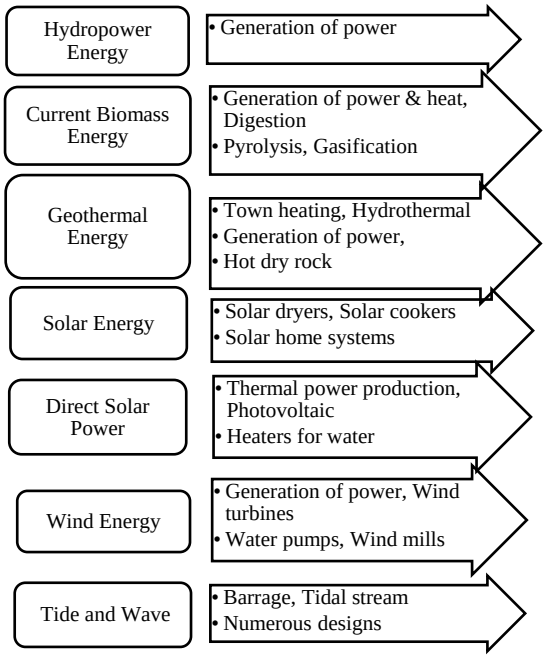

Figure 1. The Use of Renewable Energy Sources

If its utilization meets our energy, transport, and industrial

needs, we will be able to significantly lower the environmental pollution. Therefore, this part is designed to converse (i) the extensively used renewable energy sources, (ii) production and utilization of green energy, (iii) power the future by renewable energy sources, (iv) green energy impact on environmental sustainability, (v) green companies and their collision on the environment.

Renewable energy sources

Renewable energy resources are said to be self-sufficient energy sources that can be obtained and utilized for an endless time period. In ecology, the consumption of fossil fuels has created an unacceptable position. "Every single nation must build their own resource assets, in line with its energy supply and using methods that are commercially viable, culturally fair, and with minimal negative impacts." The world's future will depend heavily on renewable energy sources, which may be classified into three categories: renewable resources, nuclear resources, and fossil fuels. According to the International Renewable Energy Agency (IRENA), by 2050, 90% of global energy will come from sources that are renewable (IRENA, 2018). Renewable energy sources are recognized as sustainable, affordable, and free. The establishment and execution of green energy projects can reduce migration to metropolitan areas by creating jobs in rural regions (Bergmann *et al*., 2008). The decentralized harvest of renewable energy is one strategy to meet the energy needs of rural and small-scale areas in a reliable, affordable, and environmentally friendly (Ravindranath & Hall, 1995). **(Figure 2)** Depict the different renewable resources and their relative contribution to the production of power (Rahman *et al*., 2022). Additionally, using fossil fuels and non-renewable resources excessively results in the air being filled with a considerable amount of greenhouse gases, which adds to global warming (Chen, 2022). So, it is important to produce green energy that can substitute fossil fuels and serve as a tool for measures to mitigate climate change. Consequently, the concept of green energy is closely related to renewable energies, which are often considered to be a source of power with minimal negative effects.

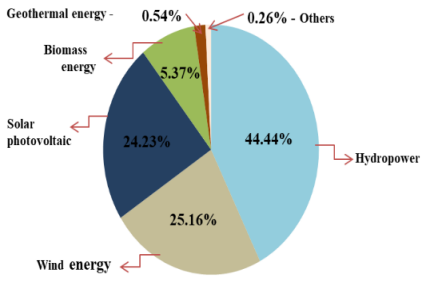

Figure 2. Renewable energy sources account for Giga Watts% of power generation out of a total of 2587.6 Gigawatts.

Renewable energy sources are of five types. The literature-reported categories of renewable energy technology **Solar energy-** Energy produced by the sun's light or thermal energy.

1. **Wind energy-** Energy generated via wind turbines.
2. **Hydro energy-** Energy generated by harnessing the natural flow of water and the tide.
3. **Geothermal energy-** Energy generated by harnessing heat produced by the earth itself.
4. **Biomass energy-** Energy produced by burning biofuel, such as plant manner (Karunathilake *et al*., 2019).

Production and utilization of green energy

Green energy sources are usually replenished organically. They also frequently avoid digging and drilling actions that might be harmful to ecosystems. So, solar, wind, and hydroelectric power come under the category of green energy (Chel & Kaushik, 2018). Solar photovoltaic isolated, solar photovoltaic grid-connected, and thermal solar energy will come under solar energy obtained from sunlight (Bortoluzzi *et al*., 2021; Pang *et al*., 2022). They are rapidly expanding clean energy sources around the globe (Campos-Guzmán *et al*., 2019). Wind turbines, also called windmills, come under wind energy obtained from wind, which is used to create power for housing and manufacturing use (Konneh *et al*., 2019). Water may be used to generate hydropower by transforming its potential energy into kinetic energy (Çolak & Kaya, 2017). A brief discussion about the production and utilization of green energy sources:

Solar energy

The major source of power and the closest star to the earth is the sun. Solar power is free and can be utilized wherever the sun's rays fall; even in cloudy weather, some electricity can be generated (Yazdani *et al*., 2018). Despite numerous benefits, it is worth mentioning because solar panels are simple to install and without moving components. Light energy is transformed into electrical energy via solar power, as shown in **(Figure 3)**. A.H. Becquerel, a French scientist, discovered in 1839 that the current between two electrodes in the electrolyte rises when the electrodes are exposed to light. This discovery led to the creation of photovoltaic cells (Pagliaro & Konstandopoulos, 2012).

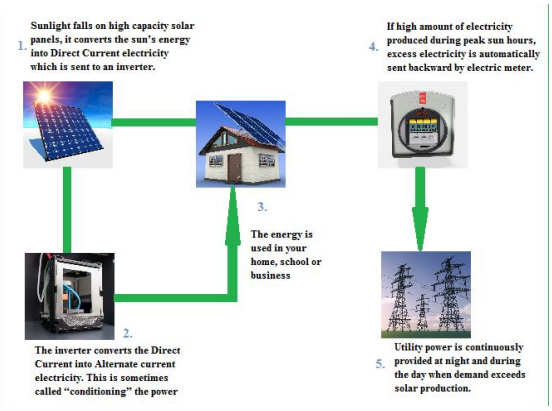

Figure 3. Sunlight passing through the photovoltaic cells.

An additional benefit of P.V. cells is their silent operation, which allows them to power not just a single home but even a whole neighborhood. It is used to heat buildings and industrial processes, produce solar hydrogen fuel and for lighting and cooking, as well as for hot water

Wind power

The largest renewable resource is wind energy. It increases every year from 20 to 30 percent. By 2050, it is anticipated that

wind energy will provide 12% of the world's electricity, saving 2.8 Giga tons of CO2 equivalent emissions annually. A comparison between wind energy use with other energy sources is shown in **(Figure 4)**.

Wind power requires numerous local wind forecasts to be able to utilize wind farms (https://www.ucsusa.org/resources/environmental-impacts-renewable-energy-technologies).

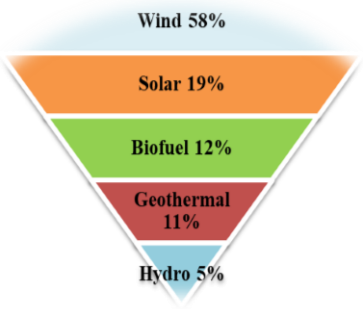

Figure 4. As compared to other energy sources, use of wind energy.
Source: The 2016 Annual Report on Jobs and Renewable Energy. International RENEWABLE ENERGY AGENCY

Another abundant source of renewable energy that may be captured using turbines is wind. The blades of the turbines are rotated by the wind passing through them, which creates power (Brumme, 2014). Throughout history, wind power has played a significant role. Ancient Egyptians made use of favorable winds to sail ships upstream and downstream in the River Nile. In the Middle Ages, the use of windmills significantly increased, as shown in **Figure 5**. They were developed by several scientists, and as time went on, they became steadily more integrated. Wind turbines are of 2 types- Horizontal and vertical axis turbines. It is the chief energy source to produceelectricity.

Figure 5. Shows a Medieval windmill, A Current windmill, and An Ancient Persian windmill.
Source: the wind is a form of nontraditional energy

There are offshore and onshore wind turbines, whereas offshore wind energy is operated without using much land. However, offshore wind farms cost more to build than onshore wind farms due to building technologies and grid connection issues (Msigwa *et al*., 2022). A crucial component of the system that transforms wind power into electrical power is the wind turbine. Wind Energy Conversion System primarily consists of three components: (a) gear systems that adjust their speed in response to the wind, (b) control boards, inverters, and rectifiers that regulate how the windmill operates as a whole, and (c) a transformer and filters for efficiently distributing the electrical energy produced to the grid (Jaiswal *et al*., 2022). Having these features shows that wind energy is abundant, affordable, and free of harmful pollutants and greenhouse gas emissions; it is the most environmentally friendly method of producing power.

Hydropower energy

The most industrially developed kind of renewable energy is hydroenergy, sometimes referred to as hydroelectric power. A dam is typically used to regulate the supply of water by creating a huge reservoir. The rotation of a water wheel caused by this water flow produces energy (Luis *et al*., 2013). The potential energy of water is converted into kinetic energy to produce hydropower, as shown in **(Figure 6).** Globally, hydroelectricity produces around 1150 Gigawatts, which makes it the biggest clean energy source. Among all green energies, the most reliable energy is hydropower because it is easy to create power by controlling a water source.

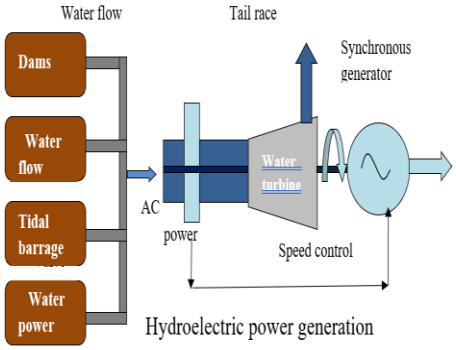

Figure 6. Hydroelectric power stations: These convert hydro energy to electrical energy.
Source: Electropaedia's Battery and Energy Technologies

Winds, which originate from differences in air pressure, create wave energy, which is a converted form of solar energy. In relation to the earth, when there are significant fluctuations in sea level during periods of high and low tide, that is tidal energy. Both are coming under hydropower. But the production of hydropower is still far behind (Baus, 2017).

These are the green energy sources that are environmentally friendly in nature, with no global warming and emission of greenhouse gases.

Power the future with renewable energy sources

Energy is the crux of the climate problem and the key to the answer. Burning fossil fuels like coal, oil, and gas to produce power and heat accounts for a sizable portion of the greenhouse gases that coat the world by trapping solar heat. Fossil fuels are the largest contributor to global climate change, with 70% of greenhouse gases and 90% of all CO_2 emissions (Shahzad, 2012). Emissions must be cut in half by 2030 and eliminated entirely by 2050 if the worst effects of climate change are to be avoided. To do this, we must stop relying on fossil fuels and

make investments in alternative forms of energy called renewable energy sources obtained from natural resources of sun, wind, water, earth, etc.

Benefits of renewable energy sources

- Utilized both commercially and domestically.
- Provides many job opportunities.
- No negative impact on the environment.
- No harm to human and animal health.
- They are clean energy sources since they don't release air pollutants like carbon dioxide.
- The infrastructure is more adaptable and less reliant as a result of the local nature of energy generation from sources like solar and wind power.
- The availability of the correct circumstances, such as frequent and bright sunshine, makes it simple to develop a quick and efficient energy solution. Therefore, the efficiency of green energy is somewhat location-dependent.
- Because they require less reworking and processing than, say, solar panel manufacture, wind farms are now thought to be the most effective green energy source

Green energy options additionally come with the benefit of not requiring significant extra energy expenditures because they frequently employ easily renewable energy sources, like wind. In contrast to wind power, which provides an 1164% return on its initial energy intake, coal has a total efficiency of usable energy that is just 29% of its original energy value. Green energy is a crucial pillar for reducing climate change after acquiring each nation's targets and policy plans. Thus, it has been asserted that a strategy based on green energy may achieve global climate targets without having an impact on economic development or well-being (Aktar, 2020). Renewable energy was discussed as a requirement for sustainable development at the World Summit on Sustainable Development in 2002, in The Johannesburg Plan of Implementation (WHO, 2022).

Green energy impact on environmental sustainability

Recent years have seen a growth in the importance of environmental sustainability as a way to ensure the long-term viability of society by maintaining a healthy ecosystem (Cui *et al*., 2022). Promoting sustainability, reducing greenhouse gas emissions, and minimizing the environmental carbon footprint have been made possible by utilizing affordable, widely available, and renewable resources to produce energy, chemicals, and fuels (Jaiswal *et al*., 2022). Environmental sustainability is impacted by the use of green energy resources and financial development, and it results in a close link between the two. The financial sector encourages green funding and energy supply innovation to cut emissions, which helps to reduce energy pollution (Fareed *et al*., 2022). The developed and developing countries are implementing policies to ensure environmental sustainability without impeding economic development. G.E.s are inexpensive and accessible. Utilizing G.E.s offers a form of energy production that is free or accessible at extremely cheap cost (Sharma *et al*., 2022). Another advantage for emerging nations is increased access to green, renewable energy sources (Donastorg *et al*., 2017). Decreased energy costs for the general public and business entities. Monthly power bills can be reduced by using sustainable green energy sources (Obama, 2017). Some G.E.s are regarded as clean energy sources as well. One of its most significant benefits is that a sizeable portion of renewable energy sources also meet the criteria for green energy and clean energy (Shahsavari & Akbari, 2018). One of the numerous environmental and economic benefits attained via the usage of clean and green energy is lower levels of air pollution (Levenda *et al*., 2021). By lowering the amount of primary pollutants generated during the creation of energy (Androniceanu *et al*., 2020), G.E.s reduce the costs of electricity provision over the long run A large supply of green energy also reduces dependency on foreign fuels and the associated costs, both financially and environmentally (Yasmeen *et al.*, 2022). Unlike fossil fuels like oil or coal, which must be obtained and transported, green and clean energy supplies naturally replenish themselves (Denholm *et al*., 2021). As a result, a large expense that would have been expended is avoided (Rodrigues *et al*., 2022). G.E.s aid in waste reduction (Pata, 2021). The exploitation safety of G.E.s is quite good (Crivellari & Cozzani, 2020).

There is no way to emphasize how crucial clean energy is to our future. But some of the more important ones are as follows:

- To enhance global health
- There will be fewer floods and droughts.
- The economy benefits from the use of wind energy and other renewable energy sources.
- Green energy generates employment
- A more reliable source of income is coming from renewable resources.

Green power is significantly more environmentally friendly - Just in 2019, the power produced by wind turbines prevented the CO2 emissions of an estimated 42 million cars. Because wind energy doesn't require any burning of fossil fuels to operate, it also aids in reducing emissions of nitrous oxide and sulfur dioxide

Policy proposals for a future of green, sustainable energy

Notably, in order to increase the appropriate supply of green energy, both developed and developing countries must put the following strategies into practice**:**

- Stronger commitment to green power
- Administrative encouragement for green power
- Assistance with institutions and technical aspects of green electricity
- Public awareness of the role that green power plays in attaining sustainable developmental objectives.
- Increasing Intergovernmental and International Cooperation (Aktar *et al*., 2020).

By offering price signals, the green energy market's expansion can be sped up (Sen & Ganguly, 2017).

Green companies and their collision on environment

Green energy is a low-cost option for supplying the energy needs of many parts of the world. The accessibility of green energy, particularly in developing nations, will improve as costs come down. Today, green energy is used in many different ways, from power generation to thermal housewarming Heating and cooling of buildings – includes solar water heaters, cooling systems, fuelled boilers, etc.

- Industrial processes - using renewable electricity for the chemical, steel, and iron industries.
- Transport - Both renewable electricity and biofuels are used. Automotive electrification to replace fossil fuels.

The use of recycled and small-scale packaging, green waste management, and supply chain expansion are all examples of sustainability measures that many major corporations are embracing. Companies of all sizes are able to provide value for clients who wish to "go green" thanks to new technology like energy-efficient appliances, inexpensive solar panels, eco-friendly cleaning products, and electric automobiles (Gran Ben, 2014). Tesla was founded as a green invention business with the primary goal of creating a car that emits absolutely no emissions. Due to the company's tight collaboration with other renewable energy partners globally, Tesla automobiles help promote renewable energy Tesla cars are powered by a lithium-ion battery that is charged via solar panels. A power wall is "a residence battery filled with current generated by solar panels or the grid" and is marketed by Tesla in close partnership with Tree House. Fronius and Solar Edge are two other Tesla partners. These P.V. businesses and Tesla have teamed together "to jointly create a P.V. backup and stores solution for the world residential solar marketplace. "Other big companies promoting green energy are Siemens, Panasonic, Toyota, and DONG Energy (Holder, 2016).

Clean energy investments have proven to be enormously cost-effective as well as interesting. Utilizing energy from renewable sources will assist in advancing technology while lowering expenses. For the coal firms, this will be a major concern. Since there are still more companies and they are low-priced in favor of developing and underdeveloped nations, they stay in control and enjoy government support. Strong incentives commencing international and non-governmental organizations and the dissemination of knowledge about environmental problems and how to protect them will compel nations to include renewable resources in durable planning, transform framework, enable education for all, and embrace sustainable development. So the fact is

"**Renewable Energy Resources are the Unavoidable Green Energy**
Resources - which powers the safer future."

CONCLUSION

The section was devoted to clean, renewable energy sources that are abundant in nature. Some have been around for a while and have been making gradual market growth. The fact that green energy boosts national economies is another benefit of renewable energy that contributes to sustainability. With a cleaner alternative to many of the energy sources used today, green energy is probably going to play a role in the future of the planet. These readily available renewable energy sources not only benefit the environment but also provide employment and seem to be financially feasible as they expand. Fossil fuels must go extinct because they cannot meet our energy demands in a way that is sustainable. We can build a totally sustainable future for our energy supply without damaging the planet we all share by creating a range of green energy alternatives. Green energy's abundant supply may benefit the nation by supplying more sustainable energy in the future, enhancing energy security for all citizens, minimizing adverse effects on people and the environment, and minimizing international disputes over energy resources. Therefore, it is crucial to limit the consumption of energy derived from fossil fuels and switch to green energy in order to ensure global sustainability. Nevertheless, the shift to green energy should be supported, given the crucial role it plays in limiting the global crisis and attaining sustainability. It is strongly advised that renewable energy sources be combined with conventional sources, and to create a reliable system, storage technologies are combined with two or more resources in a hybrid architecture. Regulatory agencies should develop the relevant regulations and standards for hybrid systems. Investments will become economically possible with the help of effective legislation and tax incentives, which will also have positive social effects in addition to the economic ones.

ACKNOWLEDGMENTS: Dr. K.R. Padma, G, Sai Sindhu and Dr.K.R.Don drafted the paper. All the authors approved and are thankful to the Department of Biotechnology Sri Padmavati Mahila Visvavidyalayam (Women's University), Tirupati-India. and the Department of Oral Pathology and Microbiology, Sri Balaji Dental College and Hospital, Bharath Institute of Higher Education and Research (BIHER) Bharath University, Chennai, Tamil Nadu.

CONFLICT OF INTEREST: None

FINANCIAL SUPPORT: None

ETHICS STATEMENT: None

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