



# Ecofriendly Renewable Energy Solutions and Sustainable Practices to Protect Climate Damage and Make Resilient Future

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## Abstract

The urgent need to combat climate change and foster a sustainable future has prompted a global shift towards eco-friendly renewable energy solutions and sustainable practices. This paper explores the multifaceted aspects of this transition, delving into renewable energy technologies, sustainable practices, and their collective role in safeguarding the environment for future generations. Through the examination of various renewable energy sources, including solar, wind, hydropower, and geothermal, along with a focus on energy efficiency, sustainable transportation, circular economy, and afforestation, this paper highlights the pivotal role these strategies play in mitigating climate damage and ensuring a resilient future. The integration of these eco-friendly approaches is essential in achieving a sustainable, low-carbon society.

**Keywords:** Ecofriendly, renewable energy, sustainable practices, hydropower, geothermal, climate change

## 1.0 Introduction:

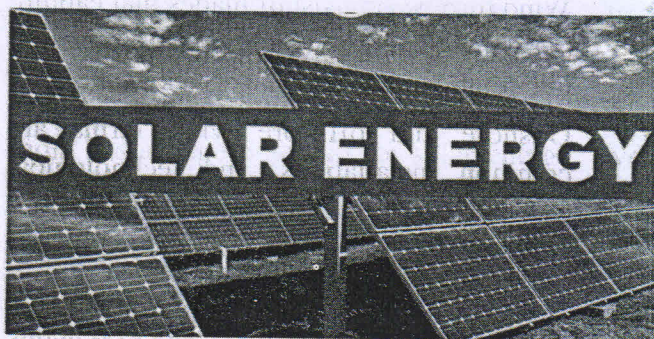
In recent years, climate change poses a significant threat to the planet's ecosystems, economies, and societies. There is urgency to address climate change and its devastating effects on our planet have become increasingly evident. The burning of fossil fuels, deforestation, and unsustainable agricultural practices have led to rising temperatures, extreme weather events, and disruptions in ecosystems. To combat this global crisis, there is an increasing recognition of the need to transition from fossil fuels

to eco-friendly renewable energy solutions and implement sustainable practices. This paper provides an in-depth analysis of the key elements of this transition, emphasizing the importance of collectively working towards a resilient and sustainable future and various aspects of this transition, exploring renewable energy technologies, sustainable practices, and their collective impact on safeguarding our environment for future generations.

## 2.0 Renewable Energy Technologies

Renewable energy technologies are innovative and sustainable solutions designed to harness naturally occurring sources of energy. These technologies offer a clean and environmentally friendly alternative to conventional fossil fuels, which contribute significantly to greenhouse gas emissions and climate change. Here are some of the key renewable energy technologies:

**2.1 Solar Energy:** Solar energy, harnessed from the sun's rays, is one of the most promising renewable energy sources available today. Photovoltaic cells



*Figure 1: Solar Energy through Photovoltaic Plates*





convert sunlight directly into electricity, while solar thermal systems utilize mirrors or lenses to concentrate sunlight for heating purposes. Solar panels have seen significant advancements in efficiency and affordability, making them a viable option for homeowners, businesses, and communities [1].

- ❖ Solar energy is derived from the sun's radiation and can be harnessed using photovoltaic (PV) cells or solar thermal systems (Fig. 1).
- ❖ Photovoltaic cells directly convert sunlight into electricity, while solar thermal systems use mirrors or lenses to concentrate sunlight for heating purposes.
- ❖ Solar energy is abundant, widely accessible, and has experienced significant advancements in technology, making it a leading renewable energy source.

**2.2 Wind Power:** Wind turbines convert wind energy into mechanical power, which is then transformed into electricity. Modern wind turbines, both onshore and offshore, have become more efficient and powerful, contributing to a significant share of the global renewable energy capacity. Advances in turbine technology and site selection have increased the feasibility of wind power projects in various regions [2].

- ❖ Wind power harnesses the kinetic energy of the wind to generate electricity through wind turbines.
- ❖ Wind turbines consist of blades that capture the wind's energy, which is then converted into rotational motion that drives a generator.
- ❖ Onshore and offshore wind farms are common installations, and technological improvements have increased efficiency and capacity.

**2.3 Hydropower:** Hydropower harnesses the energy of flowing or falling water to generate

electricity. It is a mature and reliable renewable energy source, accounting for a substantial portion of global electricity generation. While large-scale hydroelectric dams have been controversial due to their environmental impact, smaller-scale run-of-the-river projects and micro-hydro systems offer more sustainable alternatives [3].

- ❖ Hydropower systems utilize the energy of flowing or falling water to generate electricity.
- ❖ Dams, run-of-the-river systems, and micro-hydro installations are among the various types of hydropower technologies.
- ❖ While large-scale dams have raised environmental concerns, smaller-scale projects can offer sustainable alternatives.

**2.4 Geothermal Energy:** Geothermal energy taps into the Earth's natural heat, extracting it from the ground to generate electricity or for direct heating and cooling purposes. This technology is highly reliable and provides a consistent source of energy. Geothermal power plants have a low environmental impact and can operate around the clock, making them a valuable asset in the transition to renewable energy [4].

- ❖ Geothermal energy taps into the Earth's natural heat, providing a reliable and consistent source of power.
- ❖ Geothermal power plants extract heat from the Earth's crust, converting it into electricity or for direct heating and cooling applications.
- ❖ This technology is considered environmentally friendly and is not dependent on weather conditions or time of day.

**2.5 Biomass and Bioenergy:**

- ❖ Biomass refers to organic materials, such as





agricultural residues, wood, and algae that can be converted into energy.

- ❖ Bioenergy encompasses various technologies, including biogas production, anaerobic digestion, and biofuels.
- ❖ These processes involve converting biological materials into heat, electricity, or fuel, offering a sustainable alternative to fossil fuels.

## 2.6 Ocean and Tidal Energy:

- ❖ Ocean energy harnesses the power of tides, waves, and thermal gradients in the ocean to generate electricity.
- ❖ Tidal energy technologies utilize the natural rise and fall of tides to drive turbines and generate power.
- ❖ While still in the early stages of development, ocean and tidal energy hold promise for coastal regions.

## 2.7 Hydrogen Fuel Cells:

- ❖ Hydrogen fuel cells convert hydrogen and oxygen into electricity, emitting only water vapor as a byproduct.
- ❖ While hydrogen production often relies on fossil fuels, advancements in electrolysis and renewable hydrogen production methods hold potential for a clean energy future.

Renewable energy technologies are at the forefront of efforts to combat climate change and transition towards a more sustainable energy system. They offer a pathway to reduce greenhouse gas emissions, enhance energy security, and create a resilient and sustainable future for generations to come. Continued research, development, and widespread adoption of these technologies are critical in achieving a low-carbon and environmentally responsible energy landscape.

## 3.0 Solar Energy

The energy produced by the Sun in the form of heat and light is known as solar energy. It is one of the

most widely available renewable energy sources. It is one of the most important non-conventional energy sources since it is abundant and free. Solar energy can be obtained directly by solar radiation or indirectly through wind, biomass, hydro, and marine sources. People have been harnessing solar energy since ancient times. They used magnifying glasses to concentrate the Sun's light into beams. They were

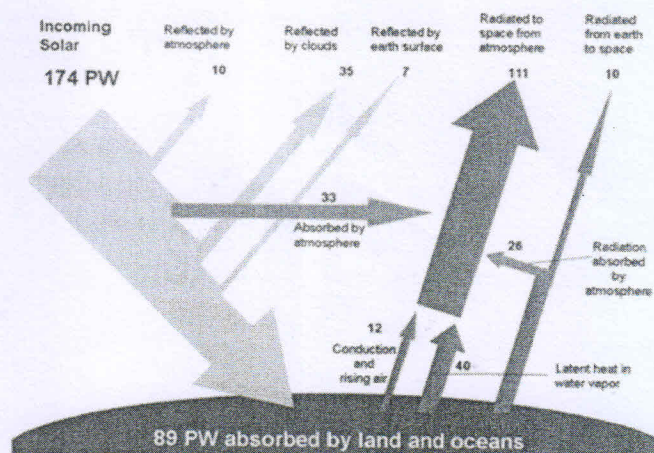


Figure 2: Solar Energy Absorption, Reflection and Radiation able to ignite wood with these beams (Fig. 2).

## 3.1 What is Solar Energy?

Solar Energy is a form of renewable energy that harnesses the power of the sun to generate electricity. It is considered to be one of the most promising sources of clean energy, and its use is growing rapidly around the world. At present, photovoltaic systems are installed to convert solar energy (sunlight) into electricity. The system comprises solar cell panels. The panel comprises a number of solar cells. A typical solar cell develops a voltage of 0.5-1 V and can produce about 0.7 W of electricity when exposed to the Sun.

## 3.2 Solar Energy Potential in India

India has a huge potential for solar energy. Every year, India enjoys around 3000 hours of sunshine. India's geographical surface receives around 5,000 trillion kWh of incident energy annually, with the majority of areas receiving 4-7 kWh per square metre each day. Solar photovoltaic power may be





efficiently harnessed in India, offering enormous scalability. According to the National Institute of Solar Energy, India has a solar potential of roughly 750 GW, assuming that solar PV modules will cover 3% of the country's wasteland. Rajasthan and Gujarat have the greatest potential for solar energy.

### 3.3 Solar Energy Present Status in India

According to data presented in Parliament, 61GW of solar energy had been installed as of October 2022. Additionally, India has set a lofty goal to reach 175 GW of renewable energy capacity by the end of 2022, of which 100 GW was to come from solar energy, and 500 GW by the end of 2030. The largest expansion strategy for renewable energy exists right now.

India ranked third globally and second in Asia for new solar PV capacity. In terms of overall installations, it came in at number four (60.4 GW), passing Germany (59.2 GW) for the first time. Rajasthan and Gujarat, which accounted for 53% and 14%, respectively, of installations as of June 2022, were the top states for large-scale solar, followed by Maharashtra with 9%.

Between 2016 and 2019, China, the USA, and India were the top three countries in the installation of solar power facilities.

### 3.4 Solar Energy Challenges

There are certain challenges of solar energy that need to be overcome:

**3.4.1. Greater Production Costs Per Unit:** Although the price of solar energy has decreased significantly, the cost of small solar power projects is still higher than that of other sources. The building of big solar parks is being facilitated by the Union Government.

**3.4.2. Basic Obstacles:** Acquiring huge parcels of land is a challenge for major solar parks. High transmission and distribution losses, grid integration, and other issues are additional difficulties. Due to the intermittent nature of solar energy and the issue of load balancing, grid

integration is difficult (e.g., high load during the night but non-availability of solar power at night).

**3.4.3. Environmental Concerns:** The construction of large solar parks has resulted in disputes with the local populace and problems with the protection of biodiversity. For example, in Rajasthan and Gujarat, some projects have been put on hold because the transmission lines encroach upon the habitat of the critically endangered Great Indian Bustard.

**3.4.4. Slow Growth:** Despite a large increase in installed solar capacity, solar energy's contribution to the nation's electricity output has not increased at the same rate. Rooftop solar project capacity increase has been especially poor (less than 20% of objective by October 2022).

**3.4.5. Financial Restrictions:** Because initial investments in solar rooftop projects are typically quite substantial, residential customers and Small and Medium Enterprises (SMEs) must consider their financial capabilities. The lack of creative financing options that offer larger quantities at cheaper interest rates and longer terms is a major problem.

**3.4.6. Reliance on Imports for Solar Equipment:** At the moment, India is unable to make polysilicon or solar wafers. India purchased solar cells and modules worth roughly US\$ 76.62 billion from China alone during the fiscal year 2021-22. This made up 78.6% of all imports into India (2021-22).

**3.4.7. Waste Management:** By 2050, it is predicted that India would produce 1.8 million tonnes of solar waste. Solar cell producers are not required to recycle or dispose of garbage from this industry under India's e-waste regulations.

**3.4.8. WTO Restrictions:** At the World Trade Organization, the Domestic Content Requirement (DCR) rule for India has been challenged in court (WTO). DCR requires the use of domestically produced solar cells and modules that adhere to the specifications and testing guidelines established by the Ministry of New and Renewable Energy (MNRE).





#### 4.0 Government Initiatives to Boost Harnessing Solar Energy

There are many government initiatives to harness renewable energy especially solar energy:

- ❖ As part of the National Action Plan on Climate Change, the Jawaharlal Nehru National Solar Mission was launched in 2010.
- ❖ **Rooftop Solar Scheme:** By mounting solar panels on home roofs, the Rooftop Solar Scheme intends to harvest solar energy.
- ❖ **The Atal Jyoti Yojana:** For the installation of solar street lighting (SSL) systems in states with fewer than 50% of homes connected to the grid, the AJAY plan was introduced in September 2016. (as per Census 2011).
- ❖ Solar module producers are asked to submit bids for the construction of solar manufacturing facilities as part of the central government's Rs. 4,500 crores (US\$ 616.76 million) solar manufacturing project.
- ❖ The National Solar Mission is a significant effort by the Indian government and state governments to encourage environmentally friendly development and address the country's problem with energy security.
- ❖ In order to make it easier for solar project developers to set up projects using a plug-and-play paradigm, the Production Linked Incentive (PLI) scheme "Development of Solar Parks and Ultra-Mega Solar Power Projects" was launched in December 2014.
- ❖ A programme for grid-connected solar rooftops has been introduced, for 40,000 MW of rooftop solar (RTS) projects' combined capacity to be reached by 2022
- ❖ **SRISTI Scheme:** To encourage rooftop solar power projects in India, the Sustainable Rooftop Implementation of Solar Transfiguration of India (SRISTI) scheme.
- ❖ **International Solar Alliance:** The ISA was

created as a cooperative initiative between France and India to coordinate efforts against climate change by deploying solar energy technologies.

#### 5.0 Sustainable Practices

**5.1 Energy Efficiency:** Improving energy efficiency is a cornerstone of sustainable practices. This involves adopting measures to reduce energy consumption in buildings, transportation, and industrial processes. Implementing energy-efficient technologies, such as LED lighting, high-performance insulation, and efficient appliances, can lead to significant reductions in greenhouse gas emissions [5].

**5.2 Sustainable Transportation:** Transitioning to eco-friendly modes of transportation is vital in combating climate change. Electric vehicles (EVs), powered by electricity generated from renewable sources, offer a promising solution. Additionally, investing in public transportation, cycling infrastructure, and walkable communities can further reduce emissions associated with commuting [6].

**5.3 Circular Economy:** The concept of a circular economy emphasizes the reduction, reuse, and recycling of resources to minimize waste and environmental impact. By redesigning products and processes, and promoting sustainable consumption patterns, we can reduce the strain on natural resources and lower emissions associated with production and disposal [7].

**5.4 Afforestation and Reforestation:** Preserving and restoring forests play a crucial role in mitigating climate change. Trees act as natural carbon sinks, absorbing CO<sub>2</sub> from the atmosphere. Afforestation (planting trees in previously barren areas) and reforestation (restoring existing forests) efforts can help counteract deforestation and contribute to carbon sequestration [8].

#### 6.0 Conclusion





The transition to eco-friendly renewable energy solutions and the adoption of sustainable practices are fundamental steps towards protecting the climate, resilient future and safeguarding our earth planet. The advancements in renewable energy technologies provide viable alternatives to fossil fuels, while sustainable practices offer a comprehensive approach to reducing emissions and conserving natural resources. Collaborative efforts at all levels-individual, community, and global-are essential in achieving a sustainable, low-carbon society that can withstand the challenges posed by climate change and we can pave the way towards sustainable future for generations to come. It is our collective responsibility to take action now and secure a better tomorrow.

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