

THE ROLE OF GREEN ENERGY IN COMBATING CLIMATE CHANGE: OPPORTUNITIES AND CHALLENGES FOR A SUSTAINABLE FUTURE

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Abstract

Green energy, also known as renewable energy, has emerged as one of the most promising solutions to the global climate crisis. This paper explores the main types of green energy technologies—including solar, wind, hydroelectric, geothermal, and biomass—and evaluates their potential to reduce greenhouse gas emissions while meeting growing energy demands. Drawing from recent studies and real-world examples, the analysis highlights both the significant environmental and economic benefits of transitioning to renewables and the technical, financial, and policy-related challenges that remain. As a student examining sustainable development, I argue that with continued innovation and supportive government policies, green energy can play a central role in achieving net-zero emissions by mid-century. This paper concludes with recommendations for future research and practical steps that students, policymakers, and communities can take to support the green energy transition.

Keywords: *Green energy, policy, solar, wind*

Introduction

Climate change is no longer a distant threat—it is a present reality affecting ecosystems, economies, and human lives across the globe. According to the Intergovernmental Panel on Climate Change (IPCC), human activities have already caused approximately 1.1°C of global warming, and without rapid reductions in emissions, we risk surpassing the critical 1.5°C threshold. Traditional fossil fuels—coal, oil, and natural gas—remain the dominant sources of energy worldwide, accounting for over 80% of global energy consumption and the majority of carbon dioxide emissions.

Green energy offers a viable alternative. Defined as energy derived from natural processes that are replenished at a faster rate than they are consumed, renewables produce little to no greenhouse gases during operation. In the United States, states like California and Texas have already made substantial investments in solar and wind power, demonstrating that large-scale deployment is possible. This paper examines the current state of green energy technologies, their advantages, limitations, and the path forward. As an environmental studies student at Northern Arizona University, located in a region rich in solar and wind potential, I have a particular interest in how these technologies can be scaled responsibly while considering local ecosystems and communities.

Types of Green Energy Technologies

1. Solar Energy Solar power harnesses energy from the sun using photovoltaic (PV) cells or concentrated solar power systems. Costs have dropped dramatically—by more than 89% since 2010—making solar one of the cheapest sources of new electricity in many regions. Utility-scale solar farms and rooftop installations are expanding rapidly. In 2023, solar accounted for a growing share of new U.S. electricity generation. Advantages include modularity and the ability to deploy in diverse locations, from deserts to urban rooftops. However, intermittency (solar only produces when the sun shines) requires energy storage solutions like advanced batteries.

2. Wind Energy Wind turbines convert kinetic energy from moving air into electricity. Both onshore and offshore wind farms have seen significant growth. Offshore wind, in particular, offers stronger and more consistent winds, though it faces higher installation costs and potential impacts on marine life and shipping routes. The U.S. has excellent wind resources in the Midwest and along coasts. Technological improvements, such as larger turbine blades and better materials, continue to increase efficiency.

3. Hydroelectric Power Hydroelectricity, generated by damming rivers or using pumped storage, is one of the oldest and most reliable forms of renewable energy. It provides baseload power and can help balance the grid. However, large

dams can disrupt ecosystems, displace communities, and release methane from reservoirs. Smaller run-of-river projects offer a lower-impact alternative.

4. Geothermal Energy Geothermal taps into the Earth's internal heat. It provides constant, reliable power with a small land footprint. Iceland and parts of the western U.S. (including areas near Northern Arizona) have significant potential. Challenges include high upfront drilling costs and the risk of induced seismicity in some locations. Enhanced geothermal systems (EGS) are expanding the accessible resource base.

5. Biomass and Other Emerging Sources Biomass involves burning organic materials or converting them into biofuels. When sourced sustainably, it can be carbon-neutral. Emerging technologies like green hydrogen (produced via electrolysis using renewables) and tidal/wave energy also show promise but remain in earlier stages of commercialization.

Advantages of Green Energy

The benefits extend far beyond emission reductions. Economically, the renewable sector creates jobs—often more jobs per unit of energy than fossil fuels. The International Renewable Energy Agency (IRENA) reports millions of jobs worldwide in manufacturing, installation, and maintenance. Environmentally, renewables reduce air and water pollution, improving public health. Socially, decentralized energy systems can increase energy access in remote areas and enhance energy security by reducing dependence on imported fuels.

From a student perspective, the transition also represents an exciting opportunity for innovation in fields like materials science, grid modernization, and policy design.

Challenges and Barriers

Despite progress, several obstacles remain. Intermittency requires significant investment in energy storage and smart grid technologies. Transmission infrastructure must be upgraded to move power from windy or sunny regions to population centers. Initial capital costs, while declining, can still deter investment without policy support like tax credits or renewable portfolio standards.

Land use conflicts arise, particularly with large solar or wind projects that may impact agriculture, wildlife habitats, or scenic areas. Supply chain issues—such as reliance on rare earth minerals for turbines and panels—raise concerns about environmental justice and international dependencies. Public acceptance varies; some communities resist new projects due to visual or noise impacts. Policy uncertainty also plays a role. While the Inflation Reduction Act of 2022 provided major incentives in the U.S., shifts in political priorities can slow momentum.

Case Studies

California's aggressive renewable targets have led to over 30% of its electricity coming from renewables in some years, though it still faces challenges with curtailment and wildfire-related grid issues. Denmark has become a leader in wind energy, exporting technology and expertise. In the American Southwest, projects like the SunZia transmission line aim to connect renewable-rich areas to broader markets. Closer to home in Arizona, utility-scale solar installations on public lands demonstrate both potential and the need for careful environmental review.

Discussion

Transitioning to green energy is not merely a technical exercise but a societal one. It requires balancing rapid deployment with equity considerations—ensuring that frontline communities benefit rather than bear disproportionate burdens. Technological breakthroughs in long-duration storage, advanced nuclear (as a low-carbon complement), and carbon capture could accelerate progress. Interdisciplinary approaches involving scientists, engineers, policymakers, and local stakeholders will be essential. As a student, I see education playing a key role. Universities should expand programs in renewable energy engineering, sustainability management, and climate policy while fostering hands-on research opportunities.

Conclusion

Green energy stands as our best hope for a decarbonized future. While challenges are real, the trajectory of cost reductions, technological maturity, and public support suggests that a clean energy transition is achievable. Continued research, smart policy, and collective action at all levels—from individual choices

to international agreements—will determine the speed and success of this shift. Future generations, including my peers at Northern Arizona University, deserve a planet where economic prosperity and environmental health go hand in hand. By investing wisely today, we can build that sustainable tomorrow.

References

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