

RENEWABLE ENERGY AND ITS ROLE IN MITIGATING CLIMATE CHANGE

*Savita L. Badami**

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ABSTRACT

Climate change is one of the most important global challenges facing humanity in the twenty-first century. Increasing greenhouse gas emissions caused mostly by fossil fuels have led to increased global warming and created serious environmental, economic, and societal problems. Renewable energy has become the main means of lowering carbon emissions and promoting sustainable development. In this article, we will explore the potential of renewable energy in combating climate change in terms of its environmental, economic, and societal implications. This article presents an overview of relevant secondary literature, objectives, methodology, results, problems, and suggestions for future action. The qualitative and descriptive analysis of secondary sources was conducted in order to identify how renewable energy impacts the environment, economics, and society. It can be stated based on the findings that the use of renewable energy technologies, including solar, wind, hydroelectric, geothermal, and biomass energy, can effectively decrease greenhouse gas emissions, enhance energy security, and foster sustainable economic growth. Nevertheless, some problems, like high start-up costs, technological issues, intermittency, and insufficient governmental policies exist.

KEYWORDS: *Renewable Energy, Climate Change, Global Warming, Sustainable Development.*

1. Introduction

The main role of renewable energy in mitigating climate change is to reduce greenhouse gas emissions by replacing fossil fuels such as coal, oil, and natural gas with cleaner energy sources like solar, wind, hydro, and geothermal power. Climate change is one of the biggest challenges being faced by nations across the globe as a result of the rising concentration levels of greenhouse gases in the atmosphere. The primary cause of this challenge is increased pollution, which is caused by activities like burning fossil fuels such as coal, oil, and natural gas. According to various international scientific assessments, the greatest contributor to the world's carbon dioxide emissions is the energy sector.

This challenge can be tackled through the use of renewable energy, which refers to sustainable energy that does not damage the environment since it utilizes naturally replenished sources. Renewable energy technologies consist of solar energy, wind energy, hydropower,

geothermal energy, biomass energy, tidal energy, among others. These technologies have attracted immense attention around the globe since they enable reductions in greenhouse gas emissions without compromising economic growth and energy security.

The current international organizations and governments have been increasingly developing renewable energy technology in an effort to meet their obligations under international laws such as the Paris Agreement. There is a need to shift from dependence on fossil fuel technology to renewable energy to mitigate against global temperature increase and promote sustainable development goals. Renewable energy helps in addressing the environmental challenge while creating employment, improving public health, and promoting energy access in rural areas. In this paper, there will be a critical analysis of renewable energy as part of climate change mitigation measures. Literature gaps, methodologies, opportunities, and challenges in the area of renewable energy will be explored.

* **Savita L. Badami**, Associate Professor, Department of Physics, Government First Grade College, Navanagar, Bagalkot.

2. Objectives of the Study

The main objectives of the current study include:

1. Identifying and discussing the idea of renewable energy.
2. Looking at the connection between renewable energy and climate change mitigation.
3. Discussing the state-of-the-art research on renewable energy technologies and climate policies.
4. Critically assessing the advantages that come with renewable energy use.
5. Determining the challenges that impede the use of renewable energy.
6. Making suggestions concerning policies that could help with improving the renewable energy transition.

3. Research Questions

This research paper will seek to address the following issues:

1. What role does renewable energy play in addressing climate change?
2. Which renewable energy technologies are in use today?
3. How beneficial is renewable energy in terms of promoting sustainable development?
4. What challenges hinder the adoption of renewable energy systems?
5. How can renewable energy transition be promoted through policies?

4. Literature Review

The number of articles devoted to renewable energy and climate change mitigation strategies has increased significantly within the last two decades. Extensive research was carried out to assess the environmental, economic, technological, and policy aspects of renewables. According to a systematic review of energy systems for climate change mitigation, renewable technologies are vital for mitigating climate change. In particular, solar and wind energies are considered key technologies. This study stresses the importance of energy storage technologies, smart grids, and innovative policies for the transition to renewables.

Climate mitigation scenarios research proves that renewables can contribute to lowering the amount of CO₂ emissions while providing sustainable economic growth. Researchers examining different global energy scenarios found out that renewable energy deployment is required for climate stabilization. Studies on the resilience of renewables under climate change state that

renewable technologies both mitigate climate change and are impacted by climate change. The functioning of renewable energy systems may be affected by temperature changes, storms, and other weather factors. Still, the environmental impacts of renewable technologies are less pronounced compared to the effects of fossil fuels.

Policy instruments for renewable energy use were another field of study discussed. Such tools as carbon taxes, renewable portfolio standards, feed-in tariffs, and others proved effective when implemented successfully. Still, researchers point out that the efficiency of policy interventions depends on a number of country-specific factors, including the economic situation and political stability.

Renewable energy can also support sustainable development goals. It helps to alleviate poverty, provides access to energy in rural areas, promotes improvements in public health, and creates job opportunities. The growing affordability of solar photovoltaics and wind turbines has led to the rapid deployment of renewable energy technologies.

One more research topic covered by scholars was renewable energy storage and hybrid systems. According to researchers, hybrid systems combining various types of renewable energy systems and energy storage facilities provide stable energy generation. Studies reveal the effectiveness of such hybrid systems as those combining solar, wind, and hydro systems.

However, numerous studies have gaps, and further research should address them. In particular, most studies conducted research for developed countries. There is not enough information about renewable energy for developing countries. Another gap concerns interdisciplinary studies aimed at assessing the socioeconomic impacts of renewable energy transitions.

5. Conceptual Framework

The conceptual framework for this study is grounded in the association between renewable energy usage and climate change mitigation.

Independent Variable

- Renewable energy technologies (solar power, wind power, hydroelectric power, geothermal energy, biomass energy)

Dependent Variable

- Climate change mitigation (carbon reduction)

Intervening Variables

- Government policies
- Tech innovation

- Economic investment
- Public awareness
- Infrastructure development

The conceptual framework indicates that higher use of renewable energy technologies results in reduced carbon emissions, environmental sustainability, and economic development.

6. Research Methodology

6.1 Research Design: For this research study, a descriptive and qualitative research design is chosen using secondary data. The descriptive research design is considered suitable since it provides an opportunity to investigate renewable energy systems and their contribution to climate change mitigation.

6.2 Sources of the Data: This research makes use of secondary sources which include the following:

- Peer-reviewed journals
- Reports from international agencies
- Publications by government institutions
- Databases on energy
- Climate change reports
- Books by academics

Literature from sources like the International Energy Agency (IEA), Intergovernmental Panel on Climate Change (IPCC), and United Nations, among others, was also reviewed in the study.

6.3 Methods Used in Collecting Data: Data for this research were gathered using systematic literature reviews and analysis of content from scientific papers and policy documents.

6.4 Methods Used in Analyzing Data: Thematic analysis and comparative analyses were used to analyze data collected in this research. Themes such as renewable energy technologies, environmental impacts, policy approaches, and economic impact, among others, were analyzed.

6.5 Limitations of the Study

1. The study uses secondary data mostly.
2. Some new developments in the field of renewable energy may be left out.
3. Room for variations in regional energy policies may affect the results of the study.
4. Statistical analysis has been limited.

7. Types of Renewable Energy

7.1 Solar Energy: Solar energy is amongst the fastest-developing sources of renewable energy. The photovoltaic (PV) method uses

sunlight to generate electrical energy using semiconductors, while the solar thermal method uses sunlight to generate heat energy.

Advantages of solar energy include:

- The abundance of sunlight
- Low greenhouse gas emissions
- Electricity production costs savings
- Little or no need for maintenance

With the continuous decline in the price of solar PV systems, the widespread use of solar energy around the world has been expedited according to researchers who noted significant declines in solar electricity production prices.

Disadvantages of solar energy include:

- Need for sunlight
- High installation costs
- Requires land use

7.2 Wind Energy: Wind energy converts the kinetic energy of wind into electrical energy through the use of wind turbines. They are often established in coastal, plain, and offshore areas.

Advantages of wind energy include:

- Cost-free source of energy
- Low greenhouse gas emissions
- Massive amounts of electricity production
- Labor-intensive energy

Wind energy has now become competitive with traditional fossil fuel energy production.

Disadvantages include:

- Intermittency of the wind
- Noise pollution
- Negative impact on wildlife

7.3 Hydroelectric Power: Hydroelectric power harnesses the flow or fall of water to produce electricity. Currently, hydroelectric power is among the most significant renewable energy sources globally. Pros:

- Generation of reliable electricity
- Long life expectancy
- Energy storage ability

Despite these advantages, large-scale hydroelectric projects may lead to ecological disturbances, community relocation, and alterations to aquatic habitats.

7.4 Biomass Energy: Biomass energy uses organic matter like agricultural by-products, wood, and livestock wastes to produce energy. Biomass energy can be used for producing

electricity, heat, and biofuels. Pros:

- Derived from waste
- Economic growth in rural areas
- Reduction in dependency on fossil fuels

However, excessive use of biomass may result in deforestation and environmental degradation.

7.5 Geothermal Energy: Geothermal energy is obtained from the heat generated beneath the earth's crust and used to produce electricity and heat.

Pros:

- Persistent energy source
- Minimal carbon emissions
- Highly efficient

Cons:

- Limited geographical accessibility
- Expensive explorations

8. Energy and Climate Change Mitigation

Renewable energy is very important for reducing the bad things we put into the air. When we burn fuels, it releases bad stuff like carbon dioxide and methane, which makes the Earth get too hot. Renewable energy is a cleaner way to make electricity.

8.1 Reduction of Greenhouse: Gas Emissions
Renewable energy helps reduce the stuff we put into the air by replacing old ways of making energy that use fossil fuels. If we use renewable energy, it can really lower the amount of bad stuff we release into the air. Solar energy and wind energy make no bad stuff when they are working. Hydropower and geothermal energy are also much cleaner than coal and natural gas plants.

8.2 Energy Efficiency and Sustainability:
Renewable energy systems help us use energy wisely and take care of our resources. Things like grids, battery storage systems, and energy-efficient technologies help us use renewable energy better.

8.3 Reduction of Air Pollution: Renewable energy reduces the bad air we breathe. It lowers the amount of sulphur dioxide, nitrogen oxides, and particulate matter in the air. When the air is cleaner, people are healthier. We spend less money on healthcare for breathing problems.

8.4 Promotion of Sustainable Development:
Renewable energy helps our planet by supporting many things, including:

- Economic growth
- Employment generation

- Rural electrification
- Energy security
- Technological innovation

Countries that are still developing really benefit from renewable energy systems that can give people electricity in remote areas.

9. Economic Impacts of Renewable Energy

Investing in renewable energy helps our economy grow. It creates jobs and stimulates innovation.

9.1 Employment Generation: The renewable energy sector creates a lot of jobs in areas such as making things, installing them, keeping them running, doing research, and managing projects. The solar and wind industries are now some of the top employers in the world.

9.2 Energy Security: Countries that rely on other countries for fossil fuels have energy security problems. Renewable energy helps us be more independent by using resources like sunshine, wind, and water that we have at home.

9.3 Long-Term Cost Savings: Even though renewable energy systems are expensive to set up at first, they are cheap to run and maintain. Over time, renewable energy becomes just as affordable as fossil fuels. Renewable energy is a choice for our planet and our economy.

10. Challenges of Renewable Energy Adoption

Renewable energy adoption has a lot of benefits, but it also faces several challenges.

10.1 High Initial Costs: Renewable energy infrastructure needs a lot of money to get started. Developing countries often do not have the money to invest in renewable energy.

10.2 Intermittency Issues: Solar energy and wind energy depend on the weather. The amount of electricity they generate can change a lot. We need energy storage technologies to keep the grid stable.

10.3 Technological Limitations: Some renewable energy technologies need research to make them better, like improving how well they work and how much energy they can store and send.

10.4 Policy and Regulatory Barriers: Sometimes the rules and policies are not consistent. There are not enough incentives, which can make it hard for people to invest in renewable energy.

10.5 Land and Environmental: Concerns Big renewable energy projects need a lot of land. It can affect the environment, animals, and people who live nearby.

11. Government Policies and International Initiatives

Governments and international organizations play a role in helping renewable energy grow.

11.1 Paris Agreement: The Paris Agreement wants to limit how much the Earth's temperature rises by reducing the things we release into the air. Renewable energy is very important for achieving these goals.

11.2 Renewable Energy Incentives: Governments use ways to encourage people to use renewable energy, such as:

- Feed-in tariffs
- Tax incentives
- Renewable portfolio standards
- Subsidies
- Carbon pricing mechanisms

Research shows that using many of these policies together is very effective in reducing the bad things we release into the air.

11.3 Sustainable Development Goals (SDGs) Renewable energy helps with:

- SDG 7: Affordable and Clean Energy
- SDG 13: Climate Action
- SDG 9: Industry, Innovation and Infrastructure

12. Future Prospects of Energy

The future of renewable energy looks good because technology is getting better, costs are going down, and people are more aware of the environment.

Emerging Trends

1. Making green hydrogen
2. Improving battery storage
3. Smart grid technologies
4. Building wind farms in the ocean
5. Using intelligence to manage energy
6. Hybrid renewable systems

Researchers think that we need to combine energy systems and have good policies to achieve our long-term climate goals.

13. Findings of the Study

The study found some things:

1. Renewable energy reduces the things we release into the air.
2. Solar energy and wind energy are growing fast.

3. Renewable energy helps the economy and creates jobs.
4. Government policies have an impact on renewable energy adoption.
5. We need to innovate and improve energy storage to overcome some challenges.
6. Developing countries need financial and technological help to use renewable energy.
7. We need to work internationally to achieve our climate goals.

14. Recommendations

Based on what we found, we recommend:

1. Governments should make their renewable energy policies stronger.
2. We should invest more in research and development.
3. International financial institutions should help energy projects in developing countries.
4. We should teach people about energy.
5. We should improve energy storage and smart grids.
6. Universities should study energy in a comprehensive way.
7. We should use carbon pricing to reduce our use of fossil fuels.

15. Conclusion

Renewable energy is very important for stopping climate change and helping the environment. Using renewable energy reduces the bad things we release into the air, makes energy more secure, and helps the environment. Solar, wind, hydropower, geothermal, and biomass energy are alternatives to fossil fuels and help us fight climate change. Even though there are challenges like costs and policy problems, technology and government support are helping renewable energy grow worldwide. Switching to renewable energy is not just good for the environment but also for the economy and society. We need to work to achieve our climate goals. Investing in energy, innovation, education, and international cooperation is necessary for a sustainable future.

References:

1. Babatunde, K. A., Begum, R. A., & Said, F. F. (2017). Application of computable general equilibrium (CGE) to climate change mitigation policy: A systematic review. *Renewable and Sustainable Energy Reviews*, 78, 61–71.
2. Cronin, J., Anandarajah, G., & Dessens, O. (2018). Climate change impacts on the energy system: A review of trends and gaps. *Climatic Change*, 151, 79–93.
3. Krey, V., & Clarke, L. (2011). Role of renewable energy in climate mitigation: A synthesis of recent scenarios. *Climate Policy*, 11(4), 1131–1158.
4. Osman, A. I., et al. (2023). Cost, environmental impact, and resilience of renewable energy under a changing climate: A review. *Environmental Chemistry Letters*, 21, 741–764.
5. Peñasco, C., Anadón, L. D., & Verdolini, E. (2021). Systematic review of the outcomes and trade-offs of ten types of decarbonization policy instruments. *Nature Climate Change*, 11, 257–265.
6. Teixeira, R. L. P., Pessoa, Z. S., & dos Santos, Y. C. (2025). Climate adaptation and renewable energy: A systematic literature review. *Revista de Gestão Ambiental e Sustentabilidade*.
7. Wang, Q., et al. (2020). Energy systems for climate change mitigation: A systematic review. *Applied Energy*, 263, 114602.
8. Mardani, A., et al. (2015). Sustainable and Renewable Energy: An Overview of the Application of Multiple Criteria Decision Making Techniques and Approaches. *Sustainability*, 7(10), 13947–13984.
9. Akpahou, R., et al. (2023). Energy planning and modeling tools for sustainable development: A systematic literature review. *Energy Reports*, 11, 830–845.
10. Ahmed, M., et al. (2020). Strategies for mitigation of climate change: A review. *Environmental Chemistry Letters*.