

To what extent does the usage of renewable energy contribute to the betterment of the environment?

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Introduction

This research essay focuses on the various aspects of renewable energy and its potential to positively impact the environment. The chosen research question is: 'To what extent does using renewable energy help the environment and in what ways?'

Why is Researching on this Topic Important?

Since a long period of time, people have been using non-renewable resources, such as, fossil fuels, coal, petroleum, and more. However, unlike renewable resources, non-renewable resources can get depleted and soon, humanity may be left with no more to use. Additionally, the usage of non-renewable resources is depleting the atmosphere and causing contamination of water bodies and so on. To prevent this, another alternative of energy should be thought of. Recently, there had been plenty thoughts on the usage of renewable energy and have it potentially take the place of non-renewable energy sources. Although, no matter how good of a solution this may sound, the usage of renewable energy cannot guarantee anything. Researching on how efficient and sustainable the usage of renewable energy is for the future will help in deciding whether transitioning to renewable energy is worth its costs.

What is Renewable Energy?

Previously, the terms renewable and non-renewable energy were mentioned. What do they actually mean?

Renewable energy is an energy source that never runs out. Nothing is unlimited in this universe, which means that renewable energy also has a limit. However, the amount of renewable energy available to humanity is enough to keep us going for the coming thousands of millennia, until humanity goes extinct. Examples of renewable energy include solar energy, wind energy, geothermal, etc.

On the other hand, non-renewable energy has a quick limit. A few examples are fossil fuels, oils, coal, etc. These resources are extremely efficient, but they run out quickly. Hence the need to search for an alternative as soon as possible.

How does Renewable Energy help the Environment?

Why should Renewable Energy be used?

Renewable energy is efficient when it comes to the usage. It also positively impacts the environment as it does not emit carbon dioxide or other greenhouse gases on usage. This prevents global warming, further contributing against climate change. This will improve public health as air and water pollution will be prevented. It is also inexhaustible, confirming its long-term impact and sustainability. It also has affordable and stable prices. This will be discussed later in this essay, however, as a brief, the usage of renewable energy may have a high initial price but has reasonable and affordable maintenance costs.¹

Comparison to Non-Renewable energy

Renewable resources are almost unlimited and can be considered unlimited compared to non-renewable resources. Currently, almost the entire world is using non-renewable resources. Consider around eight billion people using the same kind of resources that can be depleted quickly. From 2010 to 2022, 34.4% of the world population uses crude oil, 32.3% uses hard coal, 25.7% uses natural gas, 5.6% uses Uranium, and about 2% uses Lignite.² These are all non-renewable sources of energy that people are using. This will cause them to

¹ [Benefits of Renewable Energy Use | Union of Concerned Scientists \(ucsusa.org\)](https://ucsusa.org/benefits-of-renewable-energy-use)

²² [Non-renewable energy production share by source | Statista](https://www.statista.com/statistics/1101112/non-renewable-energy-production-share-by-source/)

exhaust completely in a few decades. This is why it is important to use an alternative source of energy. The best alternative source of energy that society can switch to is the usage of renewable energy.

In what ways does renewable energy help the environment?

One of the major aspects in which renewable energy helps the environment is that it has no greenhouse gas emissions. This indicates a cleaner atmosphere.

Furthermore, the processing of many non-renewable resources such as uranium or crude oil releases toxic fumes and waste that is disposed into the surrounding water bodies. Most factories do this and contribute to water pollution. The usage of renewable sources of energy will prevent the contamination of water bodies.

Usually, the construction of nuclear power plants affects the land surrounding it as well, causing land pollution. All these environmental issues can be resolved with the usage of renewable source of energy.

Types of Renewable Sources of Energy and How they are obtained

The major types of renewable sources of energy are solar energy, hydropower, wind energy, geothermal energy, and biofuel.

Solar energy can be obtained from sun rays using solar panels.

To obtain hydropower, hydropower turbines are used. As water flows through the turbines, they turn. When the turbines rotate, its kinetic energy is converted to electrical energy and is used or stored.

Geothermal energy includes the usage of thermal energy from the Earth. High pressure water is extracted from deep under the Earth's surface. This water, upon reaching the surface, will convert to steam due lowered pressure. This steam is directed to rotate a turbine which will generate kinetic energy, that is then converted to electrical energy for further use.

Wind energy includes the usage wind turbines and follows the same principle as the process of the obtainment of hydropower and geothermal energy. There is not a wind energy, speaking literally, wind rotates the turbines that are constructed on the surface of the Earth. The rotation of these turbines generates kinetic energy which is converted into electricity for further use.

Biofuel is obtained from biomass such as plants or animal waste. Combusting biofuel would result in the conversion of the mass to thermal energy, which run through generators to generate electricity.³

Efficiency of Renewable Energy Sources

The efficiency of renewable energy sources compared to non-renewable energy sources depends on the specific source of energy.

Wind power is considered the most efficient renewable energy source overall, providing an outstanding 1,164% of its original input energy.⁴

Geothermal energy has a high conduction rate of 44.2 terawatts, making it one of the most efficient renewable sources.⁵

Hydroelectric power currently accounts for 7% of total U.S. energy production and is an efficient renewable option.⁵

³ [Biofuel | Definition, Renewable Energy, Types, & Pros and Cons | Britannica](#)

⁴ [The Best & Most Efficient Renewable Energy Sources | Inspire Clean Energy](#)

⁵ [What Are The Most Efficient Forms Of Renewable Energy — Born To Engineer](#)

Solar power has an efficiency range of 15-20%, lower than fossil fuel plants at 40-60%. However, solar is still considered one of the most efficient renewables due to how available it is and how much of it can be stored.^{5 6}

Non-renewable sources like coal have a much lower efficiency, with only 29% of the original energy value being usable.⁶

Based on the above statistics, renewable sources of energy are much more efficient to use and are more environmentally friendly compared to non-renewable energy sources.

Recent Inventions

Solar Paints & Coatings and Windows

Solar paint, also referred to as solar coating or photovoltaic paint, represents a groundbreaking development in renewable energy technology. Unlike traditional solar panels, it has the capability to turn ordinary surfaces into energy-generators.⁷

Semiconducting materials in solar paint absorb photons and release electrons, initiating the photovoltaic process. Nanoparticles, like titanium dioxide, enhance light absorption and electron transport, improving efficiency. The paint base supports these components and adheres to various surfaces while providing environmental protection and durability.⁷

Solar windows are an innovative technology that transforms windows into solar energy-harvesting devices while maintaining their transparency and functionality as windows. These windows are constructed from a special material called solar glass, which enables the conversion of solar energy into electricity. With this technology, tall skyscrapers can effectively become solar farms, generating substantial amounts of electricity.⁸

Floating Wind Farms

A floating offshore wind platform (FOWP) is a concrete, steel, or hybrid substructure providing buoyancy and stability for wind turbines. Unlike traditional foundations, these platforms are anchored and moored rather than founded on the seabed. Floating wind farms consist of turbines on these platforms, stabilized by moorings and the design's mass distribution. Wind turns the blades, and the turbines convert kinetic energy into electricity, which is transported through underwater cables to onshore substations where it is then directed to households.⁹

BECCS

BECCS stands for Bioenergy with Carbon Capture and Storage. This is a device that not only converts biomass into biofuel, but also captures carbon dioxide from the atmosphere and stores it, as suggested in the name. This not only generates biofuel but also cleans the atmosphere simultaneously.

Algae Biofuel Production

Algae Biofuel production utilizes the rapid growth and the high oil content of certain types of algae. This algal feedstock's energy can be converted to different varieties of biofuel and be further used. Their high oil composition can be useful as well, along with biofuel.¹⁰

⁶ [The Best & Most Efficient Renewable Energy Sources | Inspire Clean Energy](#)

⁷ [How Does Solar Paint Work? - A Comprehensive Guide \(microgridmedia.com\)](#)

⁸ [Windows now function as transparent solar panels, here's how | World Economic Forum \(weforum.org\)](#)

⁹ [Floating offshore wind, what is it and how does it work? - Iberdrola](#)

¹⁰ [Algae biofuel: Current status and future applications - ScienceDirect](#)

Underwater Turbines

An underwater turbine generates electricity by harnessing the kinetic energy of moving water currents or ocean tides. Utilizing strong water currents and tides, the turbine's blades rotate, driving an attached generator to produce electricity.¹¹

Deep Direct-Use Geothermal Systems

Deep Direct-Use Geothermal Systems utilize the Earth's geothermal resources to directly provide heating and cooling for residential, commercial, and industrial uses. These systems efficiently meet the thermal demands of buildings and processes, thereby reducing dependence on traditional heating and cooling methods. It is cost efficient as well as the equipment required to convert kinetic energy to electricity is not required as the thermal energy from the Earth is directly used.

How Practical is it to Transition to Environment-friendly devices using Renewable Energy?

Economic Impacts

Job Creation

The renewable energy sector is a major source of employment, with the International Renewable Energy Agency (IRENA) reporting around 13.7 million jobs worldwide in 2022, up from 7.3 million in 2012. The transition to renewable energy is projected to generate over 1.5 million new jobs in the U.S. alone, supported by legislation such as the Inflation Reduction Act.¹²

Cost Efficiency

Renewable energy sources typically offer lower electricity costs than fossil fuels. Wind and solar power systems, once established, have minimal operating costs and no fuel expenses, resulting in stable and predictable energy prices. Households with solar panels can significantly lower their electric bills, which is especially advantageous for electric vehicle owners.¹³

Local Economic Development

Renewable energy projects frequently use local labour and materials, boosting community economies. Investments in these projects can create trust funds that reinvest profits into local businesses, leading to economic growth.¹⁴

Avoided Costs

Transitioning to renewable energy helps avoid the costs associated with fossil fuel emissions, which are tied to health problems and environmental damage. Additionally, shifting to cleaner energy sources can mitigate the economic burden of climate-related disasters, which cost the U.S. billions of dollars each year.^{15 16}

¹¹ [Underwater Turbine | TurbineGenerator](#)

¹² [Green Energy's Impact on the Economy \(business.com\)](#)

¹³ [The Economic Benefits of Renewable Energy | EnergySage](#)

¹⁴ [Social, Economic, and Environmental Impacts of Renewable Energy Resources | IntechOpen](#)

¹⁵ [Green Energy's Impact on the Economy \(business.com\)](#)

¹⁶ [The Economic Benefits of Renewable Energy | EnergySage](#)

Environmental Impacts

Reduction of Emissions

Renewable energy sources generate minimal to no emissions during operation. For example, electricity produced from solar panels results in 96% fewer emissions compared to coal-fired power plants. This transition is essential in preventing climate change and reducing air pollution.¹⁶

Sustainable Resource Use

Renewable energy encourages the sustainable use of natural resources. Projects such as solar and wind farms can coexist with agricultural practices, reducing land use conflicts and helping preserve ecosystems.¹⁷

Biodiversity Considerations

Although renewable energy offers environmental benefits, poorly located projects can pose risks to wildlife and habitats. Thoughtful planning and a strategic approach to site selection are crucial to minimizing ecological impacts.¹⁸

Non-renewable source extraction projects including mining and other land erupting processes would be extremely harmful to life surrounding it. Hence, the usage of renewable sources of energy preserves the eco-system.

Social Impacts

Community Health and Wellbeing

The usage of renewable energy can enhance public health by decreasing air pollution caused by the burning of fossil fuels. This is especially important in regions that heavily depend on coal and oil, where respiratory problems are common.¹⁵ To these regions, the availability of renewable energy will be extremely required.

Energy Access and Equity

Renewable energy technologies can serve remote and isolated communities by delivering electricity where traditional connections are unfeasible. Decentralized solar energy systems and mini grids can empower these communities, enhancing their quality of life.¹⁵

Social Cohesion and Employment Opportunities

The renewable energy sector opens opportunities for employment and community involvement. Installing renewable energy systems often requires the engagement of local stakeholders, strengthening social connections. This collaboration fosters a sense of community and enhances resilience. Ultimately, these initiatives contribute to both economic and social development.^{15 17}

Public Perception to the Transition

Transitioning from devices that use traditional fuels to those which use renewable sources of energy may not be an easy switch for everyone. There can be religious, economic conflicts or even conflicts that are created due to lack of knowledge regarding to what extent the usage of renewable energy sources can contribute to the better of the environment, society, and economy.

¹⁷ [Social, Economic, and Environmental Impacts of Renewable Energy Resources | IntechOpen](#)

¹⁸ [Key Economic Benefits of Renewable Energy on Public Lands | Yale Center for Business and the Environment](#)

Society's willingness to invest in renewable energy is a key indicator of social acceptance. Research indicates that individuals are frequently willing to pay a premium for renewable energy sources, demonstrating a positive attitude toward sustainability and environmental protection.¹⁹

Public perceptions of renewable energy can be based on various factors, including personal experiences, regional significance, and societal trust. For example, perceptions of health impacts and landscape aesthetics can influence attitudes toward renewable energy facilities. Furthermore, major events like the Fukushima nuclear accident have altered public views on energy technologies, including renewable energy. Such events underscore the importance of trust and perceived risks in shaping public acceptance of renewable energy.^{20 21}

Moving on, higher levels of education are also linked to a greater willingness to invest in renewable energy, as seen in regions like Palestine, where educated individuals are more likely to support renewable initiatives when they understand the benefits. However, misconceptions about renewable energy technologies can affect public support negatively. Therefore, effective communication strategies are important for improving public attitudes and encouraging participation in renewable energy initiatives.^{20 21 22}

Public perception of renewable energy varies across regions and cultures due to factors such as local energy needs, resource availability, and the government policies of that region. Engaging local communities in the planning and implementation of renewable energy projects can improve acceptance and persuade society to support the initiative. Public feedback and sentiment analysis are also essential for selecting renewable energy sources that align with community values and needs. This will help prevent any potential conflict that could arise if the selected renewable sources of energy are not aligned with the community that uses them.^{20 22 23}

Challenges and Drawbacks

Technical Challenges

Renewable sources of energy, like solar and wind, requires advanced energy storage solutions to maintain a stable energy supply. Integrating these renewable sources into existing grids presents technical challenges, necessitating upgrades and flexibility in grid management. Moreover, many regions lack the infrastructure for large-scale renewable deployment, making upgrades to transmission lines and smart grid technologies necessary.^{24 25}

Technical Drawbacks

Renewable energy sources like solar and wind depend heavily on the condition of their surroundings. This creates challenges for maintaining a stable energy supply and requiring significant investments in energy storage solutions or backup systems, which complicates infrastructure and increases costs. While the cost of renewable energy continues to decrease, the expenses associated with energy storage technologies, such as lithium-ion batteries, remain a significant barrier, raising environmental concerns related to resource extraction for battery production.^{26 27}

¹⁹ [What is the public perception of renewable energy source? | 5 Answers from Research papers \(typeset.io\)](#)

²⁰ [What is the public perception of renewable energy source? | 5 Answers from Research papers \(typeset.io\)](#)

²¹ [Frontiers | Assessing public perception and willingness to pay for renewable energy in Pakistan through the theory of planned behavior \(frontiersin.org\)](#)

²² <https://academic.oup.com/ce/article/8/2/177/7630402>

²³ [\(PDF\) Renewable energy policy and public perceptions of renewable energy: A cultural theory approach \(researchgate.net\)](#)

²⁴ [What Is the Energy Transition? Drivers, Challenges & Outlook \(sepapower.org\)](#)

²⁵ [Renewable energy transition: challenges and opportunities in the power sector \(decarbonisationtechnology.com\)](#)

²⁶ [Feasibility and Requirements of a 100% Transition to Renewable Energy | American Solar Energy Society \(ases.org\)](#)

Economic Challenges

Transitioning to renewable energy requires significant investments in technologies and infrastructure, with initial costs for installation and energy storage remaining high. Market fluctuations, including changes in subsidies, can affect the financial viability of projects and contribute to the perception that renewables are expensive. If this were the case, then spreading awareness of the benefit of using renewable energy to the environment will no longer have effect on society. Additionally, maintaining affordable electricity prices is essential to ensure that investments do not increase consumer costs, which is critical for public acceptance.^{27 28}

Economic Drawbacks

Despite lower long-term operational costs, the high initial cost for renewable energy infrastructure and grid integration can slow the transition. Ensuring affordability for consumers is extremely important, as public perception often views renewable energy as expensive, even though wind and solar are becoming increasingly cost-competitive with conventional sources of energy.^{27 29}

Societal Challenges

One of the societal challenges to transitioning to the usage of renewable sources of energy is the job displacement as fossil fuel jobs are lost, necessitating significant investment in training and education programs for reskilling workers. Public acceptance is often influenced by misinformation, aesthetic concerns, and perceived costs, making effective communication and community engagement vital. Equity issues must also be addressed, particularly in developing regions or countries that rely on fossil fuels for economic growth, as balancing sustainable development with energy access for all remains a critical challenge.^{27 30}

Societal Drawbacks

The transition to renewable energy can cause job losses in traditional sectors, requiring investment in reskilling and training programs for displaced workers. Misconceptions about the costs and reliability of renewable sources of energy can hinder support, requiring effective communication and spreading of awareness. Furthermore, the transition must address equity, ensuring low-income or underdeveloped communities can afford renewable technologies and benefit from the shift, which is essential for social justice.^{27 29 31}

Conclusion

In conclusion, the use of renewable energy is efficient and can lead to a sustainable future. It offers a cleaner environment and promotes greener decisions. The purpose of this essay was to determine whether transitioning to renewable energy is worth its costs, and there may never be a definitive answer to this question. As time progresses, researchers will develop new methods of harvesting renewable energy that are even greener than our current options. The challenges can be overcome with time, and the benefits to the environment, society, and the economy from using renewable energy sources are invaluable.

²⁷ [Renewable energy transition: challenges and opportunities in the power sector \(decarbonisationtechnology.com\)](https://decarbonisationtechnology.com/renewable-energy-transition-challenges-and-opportunities-in-the-power-sector/)

²⁸ [Challenges and opportunities beyond 2021 – Renewable energy market update – Analysis - IEA](https://www.iea.org/publications/renewable-energy-market-update-2021)

²⁹ [Renewable Energy Transition: Perspective and Challenges \(iisc.ac.in\)](https://www.iisc.ac.in/publications/renewable-energy-transition-perspective-and-challenges)

³⁰ [What Is the Energy Transition? Drivers, Challenges & Outlook \(sepapower.org\)](https://www.sepapower.org/what-is-the-energy-transition-drivers-challenges-outlook)

³¹ <https://academic.oup.com/ce/article/8/2/177/7630402>

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