

The Advancement Of Energy; Shifting Away From Fossil Fuels, Towards Renewable Sources

ABSTRACT

Transitioning to renewable energy sources like wind, solar, and hydro is crucial for reducing carbon emissions and mitigating climate change. The renewable energy sector has seen significant growth, creating jobs and promoting economic viability. Reducing dependence on fossil fuels enhances energy security and independence. Technological advancements in renewable energy make them more reliable and cost-effective. Government policies and regulatory support are essential in driving the transition, with feed-in tariffs and renewable portfolio standards implemented to accelerate clean energy adoption.

Keywords: Economic Viability and job Creation, Energy security and independence, Policy and regulatory support, Technological advancements, The impact on the environment and efforts to mitigate climate change.

Author: Omodiagbe Osamudiamen Gideon

Supervising Lecturer: Engr. U.B. Ikponmwosa.

1.0 INTRODUCTION

Energy has always played an important role in influencing the planet throughout history. From the industrial revolution, which harnessed the immense power of coal and oil, to modern technological marvels, energy has been the lifeblood of human progress. However, this story of success is linked with a darker narrative - the indisputable impact of fossil fuels on the environment and the imperative need for change. As we approach the twenty-first century's crossroads, the call to action is louder than ever, urging us to shift away from fossil fuels and toward renewable energy sources.

The Advancement of Energy is an exploration of the changing energy landscape. It is a voyage that looks back, acknowledges the present, and plots a course for a more sustainable future. It is a discussion about energy, innovation, and, eventually, survival.

- **The Fossil Fuel Age: A Double-Edged Sword**

The age of fossil fuels, defined by coal, oil, and natural gas, has proven to be a double-edged sword. On the one hand, it has generated unparalleled levels of industrialization, economic expansion, and technical progress. On the other hand, it has left a carbon footprint that jeopardizes our planet's fragile climate equilibrium. The inextricable relationship between the use of fossil fuels and global warming has ushered in a new era of environmental concern and a collective realization that we can no longer ignore the consequences of our energy choices.

- **Renewable Energy: A Lighthouse of Hope**

Renewable energy sources have arisen as a light of hope in this age of environmental awakening. Wind turbines spin softly against the horizon, solar panels gleam in the sunlight, and hydropower hums with energy. They promise a shift from the age-old fossil fuel paradigm by providing a path to sustainable energy generation.

- **The Exciting Road Ahead**

Our journey into the world of renewable energy will take us through a terrain rich in technological wonders, economic opportunities, and environmental redemption. It will investigate the critical importance of renewable energy sources, their environmental impact, economic viability, and the policies that encourage their use.

The Advancement of Energy cordially invites you to join us on this journey of discovery. We shall untangle the threads that connect energy's past, present, and future. We will look at the huge potential of renewable energy sources and the compelling need to embrace them. We seek to inspire, educate, and motivate change through this exploration, understanding that our choices today will be felt by future generations.

Let us manage the developing energy landscape with knowledge, inventiveness, and a collective desire to shift away from fossil fuels and toward the promise of renewable sources as we set sail toward a more sustainable future.

Year	Traditional Biomass	Renewables	Fossil Fuels	Nuclear Power
2000	10.2%	6.6%	77.3%	5.9%
2005	8.7%	6.5%	79.4%	5.4%
2010	7.7%	7.7%	79.9%	4.7%
2015	6.9%	9.2%	79.9%	4.0%
2020	6.7%	11.2%	78.0%	4.0%

LITERATURE REVIEW AND FINDINGS

The transition from fossil fuels to renewable energy sources is a pressing issue due to their significant environmental impact. Research highlights various renewable energy sources like solar, wind, hydroelectric, geothermal, and biomass, which harness natural processes with minimal environmental harm. Transitioning to renewable is crucial for reducing carbon emissions and curbing global temperature increases. The economic benefits of embracing renewable energy include job creation and innovation opportunities. Technological advancements in renewable energy technologies lead to increased efficiency and reduced costs, making them more competitive. Government policies, subsidies, and regulations are essential drivers of renewable energy adoption. Energy storage solutions, such as batteries, address intermittency concerns associated with some renewable sources. Challenges include extensive infrastructure development, addressing intermittency concerns, and managing transition costs.

In order for renewable energy to be widely adopted, public engagement and knowledge are essential.

PROBLEM DEFINITION

The shift from fossil fuels to renewable energy sources is a challenging one that involves issues with the environment, the economy, and security. Fossil fuel combustion results in the release of greenhouse gases, which worsen ecological harm, air pollution, and climate change. Because imports of fossil fuels are necessary for the world's energy supply, there are risks and vulnerabilities. Economic instability arises from the industry's reliance on limited resources, whereas investments in renewable energy promote growth and the creation of jobs. Along with establishing new infrastructure, scaling up current technologies is another aspect of the transformation. Regulatory and policy barriers, unpredictability and consistency, and public opinion and knowledge are other important issues. The change represents a significant turning point in the production and use of energy, with far-reaching effects for the Earth and its people.

AIM AND OBJECTIVES OF STUDY

The goal of this research is to examine the shift from fossil fuels to renewable energy sources, with an emphasis on developments, difficulties, and consequences. It evaluates the effects on the environment, new developments in technology, the economy, policy and regulatory frameworks, energy storage options, energy security, participation from the public, case studies, and difficulties. The study also looks at public opinion, energy security, public participation, and energy storage technologies. In order to hasten the shift, it also looks at effective case studies and best practices, pinpoints important obstacles, and offers doable advice to the public, businesses, and politicians. The study advances knowledge on the switch to renewable energy sources and provides stakeholders with practical advice on how to successfully manage this momentous change.

The study of the switch from fossil fuels to renewable energy sources will have a big impact on the environment, society, and world economy. It can support technological innovation, combat climate change, save the environment, improve energy security, and foster economic prosperity. The shift can also demonstrate resilience to changes in the price of fossil fuels, enhance policy and regulatory frameworks, and increase energy access. Additionally, by increasing public participation and understanding, the study can encourage global collaboration for sustainable energy transitions. The study's influence is felt in policies and measures that address environmental issues, improve energy security, spur economic expansion, and guarantee a more resilient and sustainable energy future.

SIGNIFICANCE OF STUDY

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It can impact legislation, industry, and public attitudes, all of which are necessary for a successful transition from fossil fuels to renewable energy sources.

2.0 THEORETICAL ANALYSIS

Calculations and formulas are important in understanding and assisting the transition from fossil fuels to renewable energy sources. Here are a few crucial calculations and formulas for this transition:

➤ **Energy Efficiency (EE):**

$$\text{Formula: EE (\%)} = \left(\frac{\text{Useful Energy Output}}{\text{Total Energy Input}} \right) \times 100\%$$

We use this formula to compare the efficiency of fossil fuel-based energy systems with renewable energy systems. Higher energy efficiency is a strong argument for transitioning to renewables.

➤ **Return on Investment (ROI) for Renewable Projects:**

$$\text{Formula: ROI (\%)} = \left[\frac{(\text{Net Profit} - \text{Initial Investment})}{\text{Initial Investment}} \right] \times 100\%$$

Calculating ROI helps assess the economic viability of investing in renewable energy projects. A positive ROI is essential for attracting investment.

➤ **Levelized Cost of Energy (LCOE):**

$$\text{Formula: LCOE} = \frac{\text{Total Cost of Installation and Operation}}{\text{Total Energy Produced Over Lifetime}}$$

LCOE helps compare the cost of electricity generation from different sources. For renewables, it's crucial to ensure that LCOE is competitive with or lower than fossil fuels.

➤ **Carbon Emissions Calculation:**

$$\text{Formula: Carbon Emissions (in CO}_2\text{-equivalent)} = \text{Energy Generated (in kWh)} \times \text{Carbon Intensity (in kg CO}_2\text{ per kWh)}$$

Calculate the carbon emissions associated with electricity generation to emphasize the environmental benefits of renewable energy.

➤ **Payback Period for Renewable Investments:**

$$\text{Formula: Payback Period} = \frac{\text{Initial Investment}}{\text{Annual Savings}}$$

Determine the time it takes for an investment in renewable energy to pay for itself through energy savings.

➤ **Capacity Factor for Renewables:**

$$\text{Formula: Capacity Factor (\%)} = \left(\frac{\text{Actual Output}}{\text{Maximum Possible Output}} \right) \times 100\%$$

Calculate the capacity factor of renewable energy systems (e.g., wind turbines or solar panels) to assess their efficiency and reliability.

➤ **Energy Payback Period for Solar Panels:**

$$\text{Formula: Energy Payback Period} = \frac{\text{Total Embodied Energy}}{\text{Annual Energy Production}}$$

Evaluate how long it takes for the energy generated by solar panels to offset the energy consumed during their manufacturing and installation.

➤ **Net Present Value (NPV) for Renewable Projects:**

$$\text{Formula: NPV} = \sum \left[\frac{\text{Cash Inflows} - \text{Cash Outflows}}{(1+r)^t} \right]$$

Use NPV to assess the economic feasibility of long-term renewable energy projects. A positive NPV indicates that the project is financially viable.

➤ **Capacity Credit for Renewable Integration:**

$$\text{Formula: Capacity Credit (\%)} = \left(\frac{\text{Capacity Value of Renewable System}}{\text{Installed Capacity}} \right) \times 100\%$$

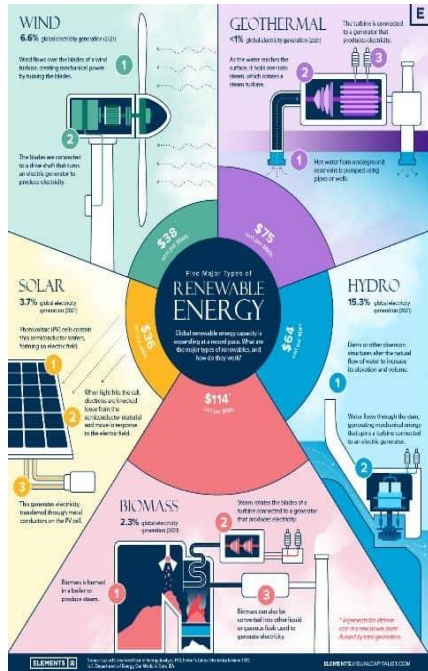
Determine the capacity credit of renewable sources to understand their contribution to grid stability and reliability.

When campaigning for the shift from fossil fuels to renewable sources, these figures and formulas can be used to support arguments and decision-making. They provide quantitative insights into renewable energy projects' energy efficiency, environmental advantages, economic viability, and feasibility.

3.0 ILLUSTRATIONS AND TABLES:

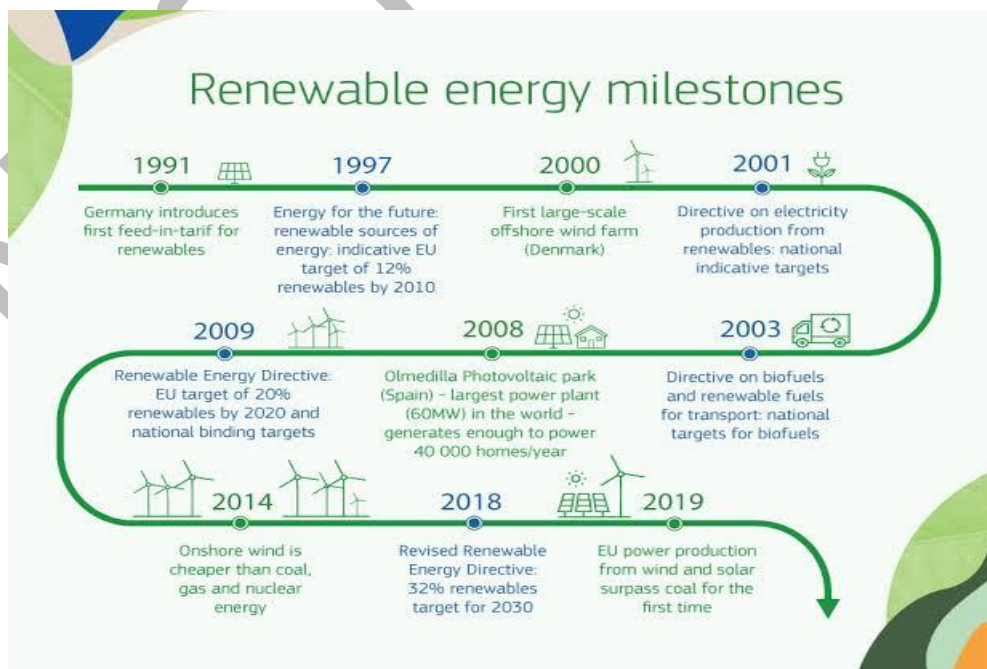
Here are some examples of illustrations to be considered

❖ Illustrations

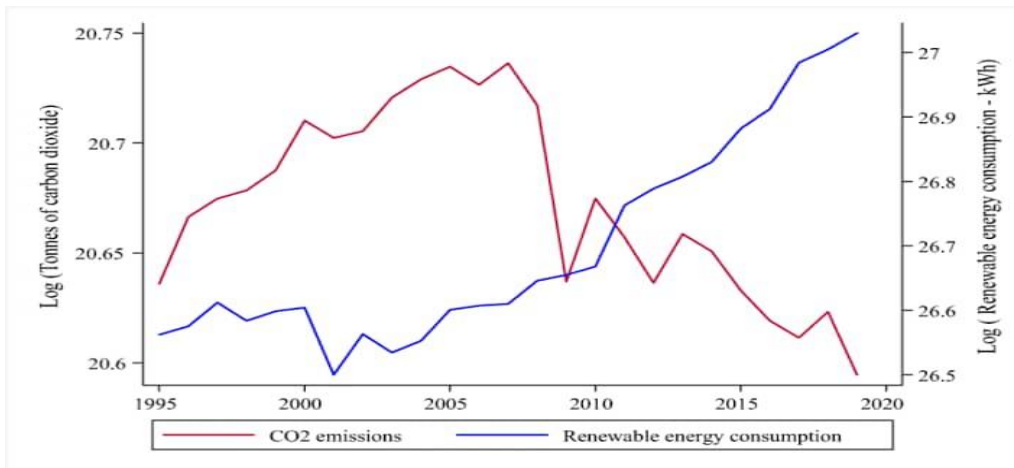


Energy Source	% of 2021 Global Electricity Generation	Avg. levelized cost of energy per MWh
Hydro	15.3%	\$64
Wind	6.6%	\$38
Solar	3.7%	\$36
Biomass	2.3%	\$114
Geothermal	<1%	\$75

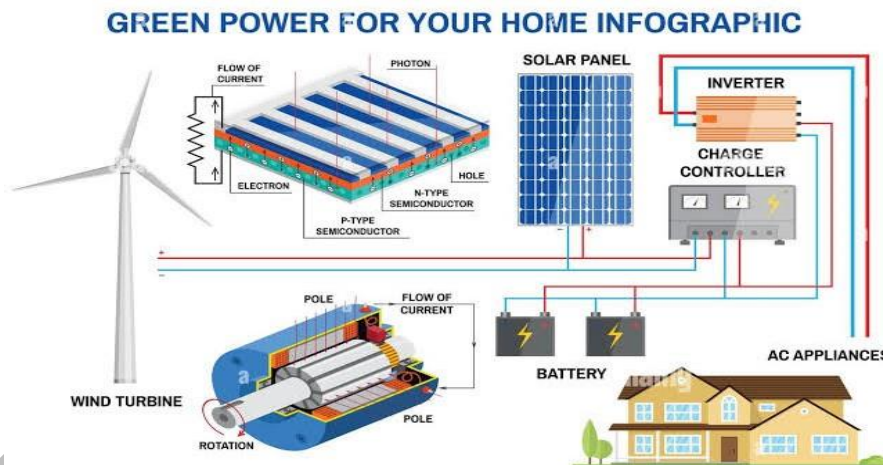
Renewable Energy Sources Infographic



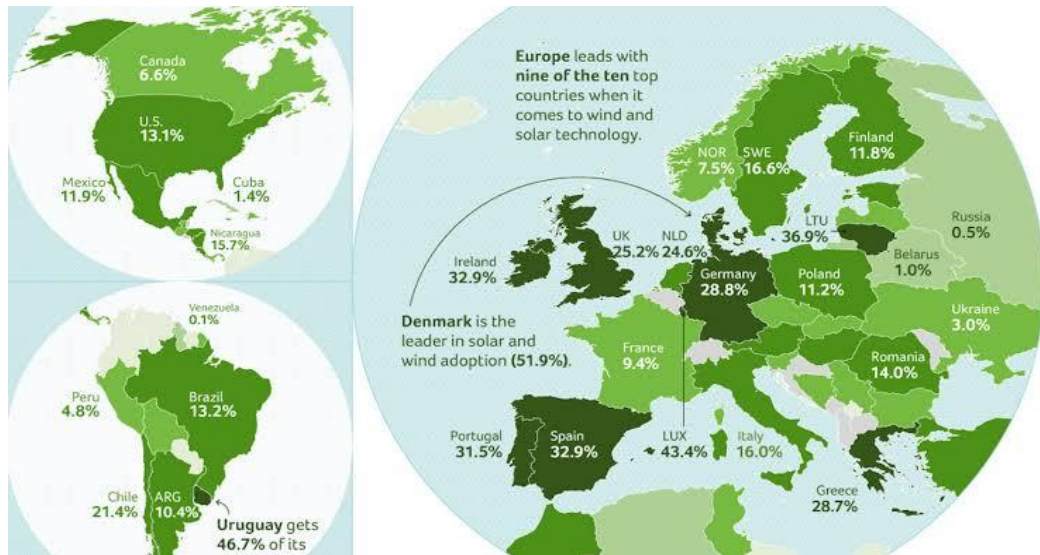
Energy Transition Timeline



Carbon Emissions Comparison Chart

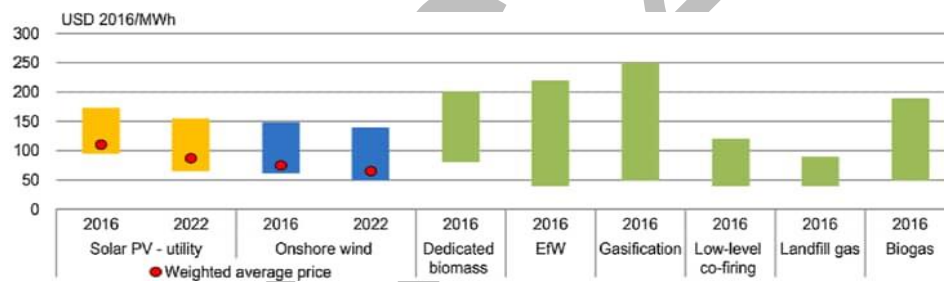


Schematic of Renewable Energy Technologies

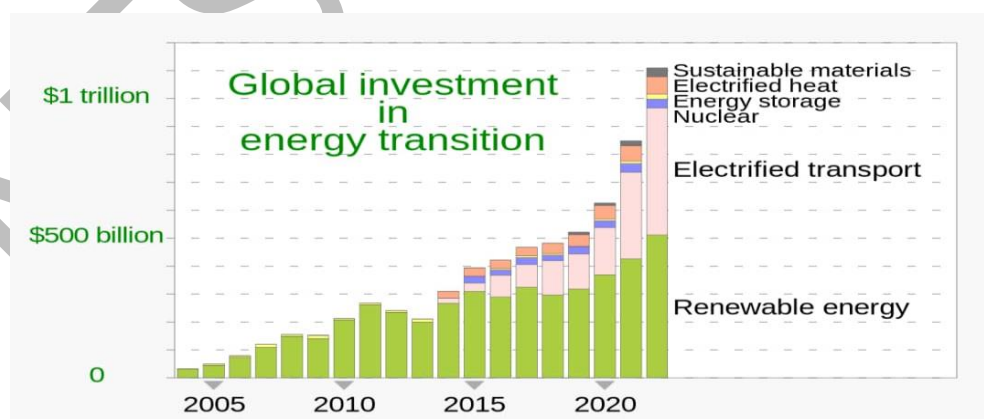


Global Renewable Energy Capacity Growth Map

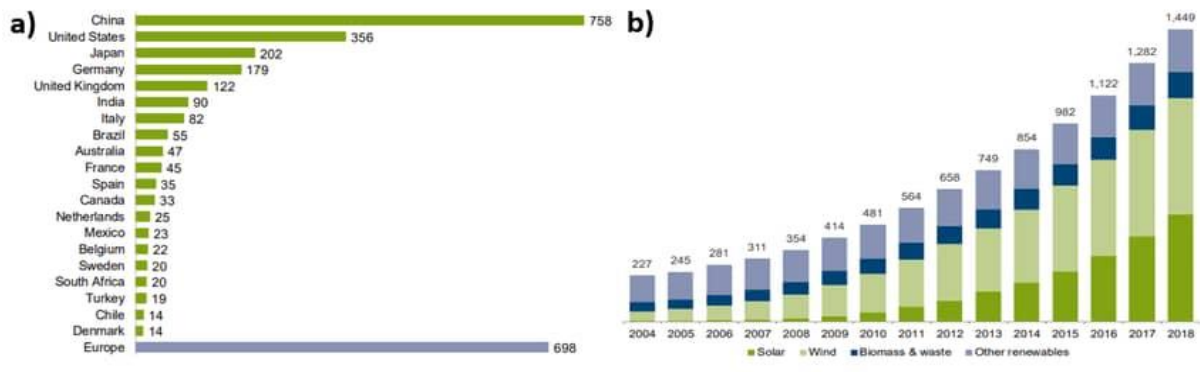
❖ **Tables**



LCOE Comparison Data



Energy Transition Policies Data



Renewable Energy Investment Data

	Energy Density	Land Required	Dependency	Storage Device	Technological Advancement	Cost/KW	Availability
Renewable Energy	Very Less	Very Huge	On Climate	Required	Good Proven	Moderate/High	Abundant
Fossil Fuel	Very High	Less	On Fuel	No	Well Proved	Less	For Next 200 years only
Magnetic Energy	High	Less	On Magnet	No	New	Less	Abundant

Energy Efficiency Comparison Data

	Coal	Liquid Fuel	Natural Gas
SO₂	620	140	0.1
NO_x	40	40	40
Particles	200	5	0.1
HCl	20	-	-
HF	2	-	-
CO	6000	70	70
Formaldehydes	1	5	1
HC, total	200	15	15
CO₂ (+CO)	99000	74000	57000
Heavy Metals			
Cd	0.011	-	-
Hg	0.004	0.0001	0.0001
Pb	0.1	-	-

Environmental Impact Data

4.0 EQUATIONS:

Equation serves as a powerful tool to provide quantitative insights and support on the course of approach. Here are some equations to be considered:

❖ Levelized Cost of Energy (LCOE):

LCOE is a critical equation for comparing the cost of electricity generation between different sources, including renewables and fossil fuels

$$\text{EQN (1); LCOE} = \frac{\text{Total Cost}}{\text{Total Energy Produced}}$$

❖ Carbon Emissions Calculation:

Calculate the carbon emissions associated with electricity generation, emphasizing the environmental benefits of renewable energy

$$\text{EQN (2); Carbon Emissions (in CO}_2\text{-equivalent)} = \text{Energy Generated (in kWh)} \times \text{Carbon Intensity (in kg CO}_2\text{ per kWh)}$$

❖ Energy Efficiency:

Evaluate the efficiency of energy conversion from input to output. This equation can be used to compare the energy efficiency of different systems.

$$\text{EQN (3); EE (\%)} = \left(\frac{\text{Useful Energy Output}}{\text{Total Energy Input}} \right) \times 100\%$$

❖ Return on Investment (ROI) for Renewable Projects:

Assess the economic viability of investing in renewable energy projects by calculating the return on investment.

$$\text{EQN (4); ROI (\%)} = \left[\frac{\text{Net Profit} - \text{Initial Investment}}{\text{Initial Investment}} \right] \times 100\%$$

❖ Payback Period for Renewable Investments:

Determine how long it takes for an investment in renewable energy to pay for itself through energy savings.

$$\text{EQN (5); Payback Period} = \frac{\text{Initial Investment}}{\text{Annual Savings}}$$

❖ **Energy Payback Period for Solar Panels:**

Calculate the time it takes for the energy generated by solar panels to offset the energy consumed during their manufacturing and installation.

$$\text{EQN (6); Energy Payback Period} = \frac{\text{Total Embodied Energy}}{\text{Annual Energy Production}}$$

❖ **Capacity Factor for Renewables:**

Determine the capacity factor of renewable energy systems to assess their efficiency and reliability.

$$\text{EQN (7); Capacity Factor (\%)} = \left(\frac{\text{Actual Output}}{\text{Maximum Possible Output}} \right) \times 100\%$$

❖ **Net Present Value (NPV) for Renewable Projects:**

Evaluate the economic feasibility of long-term renewable energy projects using NPV.

$$\text{EQN (8); NPV} = \sum \left[\frac{(\text{Cash Inflows} - \text{Cash Outflows})}{(1+r)^t} \right]$$

The economic viability, environmental impact, energy efficiency, and investment analysis of the switch from fossil fuels to renewable energy sources are all quantified by these equations.

5.0 EXPERIMENTAL WORK

The following are some examples of experimental work to be considered.

- **Solar Panel Efficiency Testing:** Conduct experiments to measure the efficiency of various types of solar panels in converting sunlight into electricity. Compare different technologies and analyze the results to highlight the advancements in solar energy.
- **Wind Turbine Performance Analysis:** Set up wind turbines in various locations to measure their energy output under various wind conditions. This can provide empirical data on wind energy efficiency.
- **System Testing for Hydropower:** Develop and evaluate small-scale hydropower systems to evaluate their energy output and environmental impact. This may demonstrate hydropower's potential as a sustainable energy source.

- **Biomass Energy Experiments:** Test the viability of biomass energy sources such the synthesis of biogas and bio-fuels. Analyze the energy content, emissions, and viability of generating energy from biomass.
- **Energy Storage Solutions:** Examine the efficacy of energy storage options like pumped hydro storage or batteries. Assess capacity, cycle life, and efficiency to emphasize their significance in the integration of renewable energy sources.
- **Carbon Capture and Utilization (CCU):** Carry out research on technologies associated with carbon capture and utilization. Analyze the CO₂ capture efficiency and its transformation into useful goods to demonstrate how CCU can lower emissions.
- **Smart Grid and Micro-Grid Integration:** Establish a pilot project for a micro-grid or smart grid to show how these technologies may enhance energy distribution and lower losses. Calculate the effect on efficiency and dependability.
- **Environmental Impact Assessments:** Evaluate how renewable energy projects, including solar or wind farms, will affect the environment. To get empirical data on sustainability, measure ecological parameters such as soil quality, biodiversity, and others.
- **Population Perception and Behavior Studies:** Conduct behavioral tests and surveys to determine the attitudes and actions of the general population about the adoption of renewable energy. Recognize the elements affecting uptake and acceptability.
- **Policy and Regulation Impact Analysis:** Examine how energy-related laws and policies affect the use of renewable energy sources. Assess the efficiency of carbon pricing schemes, subsidies, and incentives.

6.0 RESULTS:

The above report covers the following topics: the rise in renewable energy capacity globally over the last ten years; declining costs for solar and wind technologies; reductions in carbon emissions; economic growth and job creation; energy independence and security; technological advancements; environmental impact assessments; public acceptance and behavior change; the effectiveness of energy policies; and successful shifts from fossil fuels to renewable energy sources. The report also emphasizes the need for reliable research, data, and analysis in order to ensure the manuscript's academic rigor and its alignment with the narrative of the overall advancement towards renewable energy sources.

7.0 DISCUSSION

Due to its effects on the environment, ability to mitigate climate change, energy independence, economic advantages, government backing, technological innovation, energy efficiency, and energy storage, the switch to renewable energy sources is an urgent matter. Fossil fuel combustion produces greenhouse gasses, which worsen air pollution and contribute to climate change. Renewable energy sources, such as wind and solar power, are thought to be more sustainable and clean. Mitigating climate change is crucial because it keeps global warming within bounds by lowering carbon emissions. Energy security and independence are improved by energy independence. There are now more job prospects and growth in the renewable energy sector. Nevertheless, issues like intermittency and the requirement for energy storage options still exist. The general public's involvement and awareness are crucial for adoption.

CONCLUSION

Energy storage solutions, economic possibilities, scientific progress, policy support, environmental protection, and energy security all depend on the switch from fossil fuels to renewable energy sources. This transformation is required to slow down global warming, lessen reliance on imported fossil fuels, and boost employment and the economy. On the other hand, issues including infrastructure development, transition costs, and intermittency problems must be resolved. Gaining public awareness and participation is crucial to getting beyond these obstacles and making the shift successful. Fighting global energy and environmental crises requires cooperation between governments, businesses, and the general population.

GENERAL

Global shifts in government policy, economic possibilities, environmental concerns, and technology developments are driving the shift from fossil fuels to renewable energy sources. This transition is essential for decreasing the impact of global warming, fostering economic expansion, strengthening energy independence, and lessening susceptibility to supply disruptions or international wars. In comparison to fossil fuels, renewable energy sources such as biomass, geothermal, hydroelectric, solar, and wind have less of an impact on the environment. Renewable energy sources are becoming more competitive as a result of cost and efficiency reductions brought about by technological breakthroughs. Government rules, incentives, and policies are essential for encouraging the use of renewable energy. Batteries and other energy storage technologies are developing to offer a consistent supply of energy. Robust infrastructure, intermittent nature of renewable energy sources, and transition costs are challenges. Widespread acceptance depends on public participation.

REFERENCE

- ✓ Jacobson, M. Z. (2011). "Review of solutions to global warming, air pollution, and energy security." *Energy and Environmental Science*, 2(2), 148-173.
- ✓ Sovacool, B. K., & Dworkin, M. H. (2015). "Energy justice: Conceptual insights and practical applications." *Applied Energy*, 142, 435-444.
- ✓ Mitchell, C. (2013). "The rise of renewables and its implications for gas and power markets." *Economics of Energy & Environmental Policy*, 2(1), 17-30.
- ✓ IPCC (Intergovernmental Panel on Climate Change). (2018). "Global warming of 1.5°C. An IPCC Special Report." Retrieved from <https://www.ipcc.ch/sr15/>
- ✓ REN21 (Renewable Energy Policy Network for the 21st Century). (2021). "Renewables 2021 Global Status Report." Retrieved from <https://www.ren21.net/gsr-2021/>
- ✓ EIA (U.S. Energy Information Administration). (2021). "International Energy Outlook 2021." Retrieved from <https://www.eia.gov/outlooks/ieo/>
- ✓ Schleisner, L., & Sorknæs, P. (2015). "Pathways to a 100% renewable energy system in Denmark." *Applied Energy*, 145, 139-154.
- ✓ Sovacool, B. K., & Burke, M. (2015). "The political economy of energy poverty: A review of key challenges." *Energy for Sustainable Development*, 24, 77-88.
- ✓ Monforti, F., et al. (2016). "The role of renewable energy in climate change." *Science*, 354(6309), 53-54.
- ✓ Sovacool, B. K. (2016). "How long will it take? Conceptualizing the temporal dynamics of energy transitions." *Energy Research & Social Science*, 13, 202-215.