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Green Energy: The True Path to Sustainable Living

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ABSTRACT

This paper explores the growing importance of green energy as a sustainable solution to the current environmental crisis and depleting non-renewable energy sources. It provides a detailed analysis of various forms of green energy, their potential to replace fossil fuels, and their socio-economic impact. The paper also addresses the challenges of large-scale green energy adoption and proposes solutions to accelerate the transition toward a sustainable energy future. By integrating these strategies, we can build a future where green energy is not only the primary source of power but also a driver of economic growth, environmental health, and social well-being. The True Path to Sustainable Living" explores how renewable energy sources such as solar, wind, and hydro power are essential for creating a sustainable future. The book delves into the environmental, economic, and social "benefits of green energy," emphasizing its role in reducing carbon emissions, conserving natural resources, and fostering a healthier planet. By examining current technologies, policies, and practical applications, it presents a compelling case for adopting green energy as a fundamental aspect

Renewable energy sources currently supply somewhere between 15 % and 20% of world's total energy demand. The supply is dominated by traditional biomass, mostly fuel wood used for cooking and heating, especially in developing countries in Africa, Asia and Latin America. A major contribution is also obtained from the use of large hydropower; with nearly 20 percent of the global electricity supply being provided by this source. New renewable energy sources (solar energy, wind energy, modern bio-energy, geothermal energy, and small hydropower) are currently contributing about two percent. A number of scenario studies have investigated the potential contribution of renewables to global energy supplies, indicating.

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KEYWORDS: *Green energy, renewable energy, sustainability, climate change, solar energy, wind energy, hydropower, energy efficiency*

I. INTRODUCTION

In the face of escalating climate change and dwindling fossil fuel reserves, the urgency for sustainable energy solutions has never been more critical. Green energy, derived from renewable sources such as solar, wind, hydro, geothermal, and biomass, offers a promising alternative that not only reduces greenhouse gas emissions but also enhances energy security and sustainability. This paper explores the various forms of green energy, highlighting recent technological innovations and economic benefits while addressing the challenges associated with their implementation.

By examining the role of policy frameworks and public perception in facilitating the transition to a greener energy landscape, this research aims to underscore the importance of collective action in fostering a sustainable future for generations to come. Green energy is at the heart of all ecological strategies because it affects companies in three vital areas: environmental, economic, and social. Conventional energy sources based on oil, coal, and natural gas have proven to be highly effective drivers of economic progress, but at the same time damaging to the environment and to human health. The potential of renewable energy sources is enormous as they can in principle meet many times the world's energy demand. Renewable energy sources such as biomass, wind, solar, hydropower, and geothermal

can provide sustainable energy services, based on the use of routinely available, indigenous resources.

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II. RELATED WORK

Implementing software that monitors and analyzes energy usage in data centers allows for better management and reduction of energy waste.

1. Sustainable Software Development

Software engineering can contribute to sustainability by creating efficient algorithms that minimize resource usage, such as CPU cycles and memory, which can lead to lower energy consumption. Energy Efficient Data Centers Optimization of Resources a Software solutions can help optimize server loads, manage data storage, and reduce energy consumption in data centers. This includes load balancing, virtualization, and automated.

Smart Applications Software engineering plays a crucial role in developing applications for the Internet of Things (IoT), which can optimize energy usage in homes and industries through smart devices and grids. Energy Management Systems These systems can analyze and manage energy consumption in real-time, allowing users to make informed decisions that reduce waste.

Sustainable Supply Chain & Cloud Computing

Resource Management Software: Software can aid companies in managing their supply chains more sustainably by optimizing logistics, reducing waste, and improving resource efficiency. cloud Computing Cloud platforms often utilize shared resources, reducing the overall energy footprint compared to traditional on-premises solutions. Software engineering plays a role in making cloud services more efficient and scalable. Software solutions that enable virtualization help in reducing the number of physical servers needed, leading to lower energy consumption and reduced environmental impact.

Promoting Green Practices Software can facilitate awareness programs and educational platforms focused on sustainability, helping organizations and individuals understand the importance of going green. Development of software tools that help companies track their sustainability metrics and achieve certifications can encourage more organizations to adopt green practices

Technological Innovations in Renewable Energy

Cost Trends and Investment: Several analyses, including those from the International Renewable Energy Agency (IRENA), reveal that the cost of renewable energy technologies has decreased significantly over the past decade. This trend is supported by increased investments in green energy, demonstrating its growing feasibility as an alternative to fossil fuels. Job Creation: Research conducted by organizations such as the World Economic Forum indicates that the transition to green energy could create millions of jobs globally. Studies show that sectors like solar and wind energy are among the fastest-growing employment areas, highlighting the socio-economic benefits of this transition.

Policy and Regulatory Frameworks

International Agreements: The Paris Agreement and subsequent commitments by various nations have galvanized efforts toward adopting renewable energy sources. Research examining policy frameworks emphasizes the role of government incentives and regulations in facilitating the transition to green energy. Local Initiatives Numerous case studies illustrate successful local initiatives aimed at promoting renewable energy, such as community solar projects and municipal wind farms. These efforts underscore the importance of grassroots movements in advancing sustainable energy solutions.

III. PROPOSED WORK

Maintaining higher and sustainable development is the prime area for the Government strategies throughout the world. This activity requires large amount of substantial and energy inputs are essential for attaining sustainability. Nevertheless, the abundant use of such natural resources has induced serious environmental problems and imposed negative consequences on the human health as well as on productivity by increasing the concentration of greenhouse gasses (GHG) in the air, as they generate huge waste by-products in the process of attaining greater economic activities.

3 Accordingly, these activities also lead to increase the sea level, air temperature, global ocean, and melting of snow and ice sheets as well as exhaustion of the different species throughout the world. These are collectively called as the effect of the global warming and climate change caused by rising the concentration ratio of GHG in the environment. According to Bernstein et al. (2007) and Lau et al. (2010), by 2100, the existence of half of the world's populace, particularly people who are living in the coastal area might be in danger because of increasing global temperature on an average to 6.4°C from 1.10C and rising the sea level by about 16.5 to 53.8 cm respectively.

"Global Climate Change" which is an alarming problem for attaining sustainable development in these days. Although the impact of global climate change is definite on human health and environment, therefore, it is difficult to predict the change and many people start realizing that unpredictable change of global climate is a key barrier for attaining sustainable development, while more than half of the global climate change is caused by the increasing concentrations of GHG emissions and contributed mainly by the energy sector (Climate Group, 2009). As a larger contributor, energy sector stands for roughly two-thirds of all GHG emissions (IEA 2015). In addition, over the decades, Carbon Dioxide emissions (CO2) which is known as the foremost creator of GHG from the energy sector have risen at a higher levels that account for about 55 percent of total GHG emissions (IEA, 2015). As a result, energy-related carbon Dioxide (CO2) has received more consideration everywhere in the world as the most extensive pollutant. According to Wen-Cheng Lu (2017), about 52 percent of annual energy-related CO2 hails from developing nations and it has been anticipated that, in future, a large volume of energyrelated CO2 will be released from there even though now two-thirds of total CO2 come from developed countries that consume energy five times more than the developing countries. Because of higher economic progression and development of the international market, energy consumption will be heightened by developing nations and it increases by about 90 percent of the total expected increase in consumption of global energy.

To be precise, activities related to power generation, deforestation, and transportation, industrial, residential and commercial are the indication of human activities that are strictly correlated to the CO2 emission. In general, CO2 is discharged into the atmosphere from combustion of non-renewable fuels, such as oil, coal and natural gas as sources of energy. The International Panel on Climate Change (IPCC) in such circumstance have specified that, if there is no proper commitment and urgent action is not taken to control the use of fossil fuel coal energy, the CO2 emission will be released in the atmosphere at an unprecedented rate (IEA, 2015). Consequently, the degree of global climate change will be overstated leading to strong long-term effects around the world, which is already escalating at the present time.

The flow of proposed work

Energy Efficiency Improvement

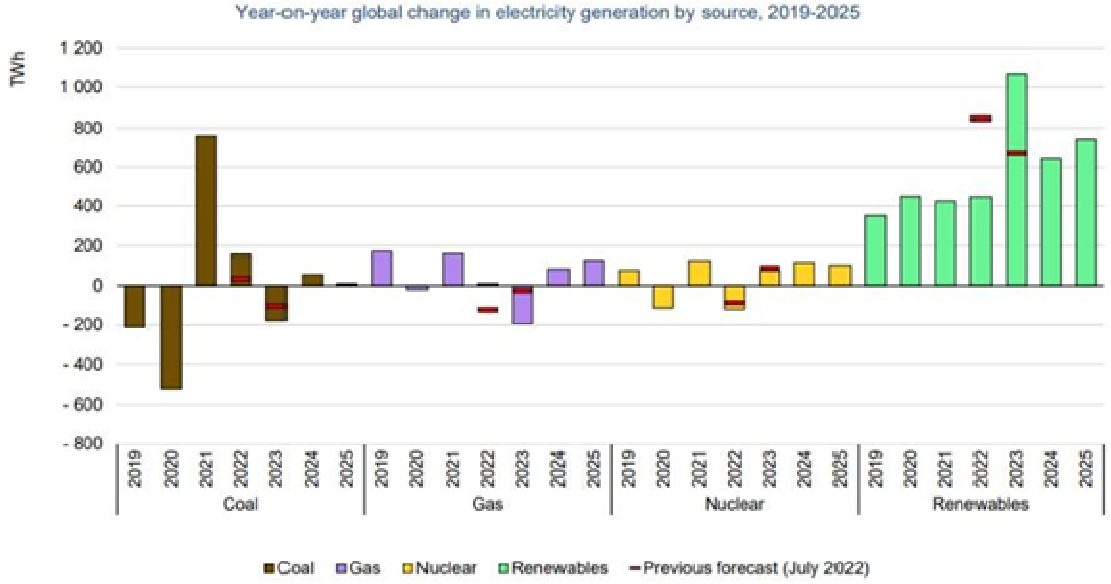
Measures the improvement in energy conversion efficiency (e.g., solar panel efficiency, wind turbine capacity factor) over time.

Energy efficiency is the use of less energy to perform the same task or produce the same result. Energy-efficient homes and buildings use less energy to heat, cool, and run appliances and electronics, and energy-efficient manufacturing facilities use less energy to produce goods.

Energy efficiency is one of the easiest and most cost-effective ways to combat climate change, reduce energy costs for consumers, and improve the competitiveness of U.S. businesses. Energy efficiency is also a vital component in achieving net-zero emissions of carbon dioxide through decarbonization.

The U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) champions clean energy through its technical offices and programs that fund research and development and promote energy efficiency across all sectors of the U.S. economy.

Graph: Global Renewable Energy Capacity Growth (2019-2050)



Year	Carbon Emission (Million Tons)	Energy Penetration (%)
2015	1000	10
2016	950	15
2017	900	20
2018	850	25
2019	800	30
2020	750	35
2021	700	40
2022	650	45
2023	600	50
2024	550	55
2025	500	60

Current Highlights of 2015-2025

As of Aug 2024, Renewable energy sources, including large hydropower, have a combined installed capacity of 199.52 GW.

The following is the installed capacity for Renewables:

Wind power: 47.19 GW

Solar Power: 89.43 GW

Biomass/Co-generation: 10.35 GW

Small Hydro Power: 5.07 GW

Waste To Energy: 0.60GW

Large Hydro: 46.92 GW

India has set a target to reduce the carbon intensity of the nation's economy by less than 45% by the end of the decade, achieve 50 percent cumulative electric power installed by 2030 from renewables, and achieve net-zero carbon emissions by 2070. India aims for 500 GW of renewable energy installed capacity by 2030.

India aims to produce 5 M Tones of green hydrogen by 2030. This will be supported by 125 GW of renewable energy capacity.

50 solar parks with an aggregate capacity of 37.49 GW have been approved in India. Wind Energy has an off-shore target of 30 GW by 2030, with potential sites identified.

Following list of activities in renewable energy will be considered for trading carbon credits under bilateral/ cooperative approaches under Article 6.2 mechanism as assigned under the National Designated Authority for the Implementation of the Paris Agreement (NDAIAPA):

Renewable energy with storage (only stored component)

Solar thermal power Off-shore wind Green Hydrogen .

Tidal energy, Ocean Thermal Energy, Ocean Salt Gradient Energy, Ocean Wave Energy and Ocean Current Energy

Union Budget 2024 Highlights

In the Union Budget 2024-25, The Centrally Sponsored Scheme for Solar Power (Grid) has been allocated INR 10,000 Cr, an increase of 110% from INR 4,757 Cr allocated in the Union Budget 2023-25.

PM-Surya Ghar Muft Bijli Yojana, launched in February 2024 with an outlay of INR 75,000 Cr, has been allocated INR 6,250 Cr.

Production Linked Incentive (PLI) Scheme

The Union Cabinet chaired by the Prime Minister, Shri Narendra Modi has given its approval to introduce the Production-Linked Incentive (PLI) Scheme in High Efficiency Solar PV Modules for Enhancing India's Manufacturing Capabilities and Enhancing Exports – Aatmanirbhar Bharat. 1.

The national programme on 'high-efficiency solar PV modules': Tranche 1: INR 4500 Cr ($550 Mn) Tranche 2: INR 19,500 Cr ($2.37 Bn). The second phase, launched on 21st Sept 2022, is expected to build 65 GW of annual manufacturing capacity. 2. National Green Hydrogen Mission with an outlay of INR 19,744 Cr ($2.4 Bn) targets 5 MMT annual green hydrogen/ ammonia production by 2030. Investors can place their bids till 7th September 2023 to seek incentives. The scheme focuses on Direct employment of about 30,000 and Indirect employment of about 1,20,000 persons; Import substitution of around INR 17,500 Cr every year, and Impetus to Research & Development to achieve higher efficiency in solar PV modules.

Icon INR 24,000 Cr Scheme Outlay

IV. PROPOSED RESEARCH MODEL

Creating a Sustainable World

India's installed non-fossil fuel capacity has increased 396% in the last 8.5 years and stands at more than 207.76 GW (including large Hydro and nuclear), about 46% of the country's total capacity (as of Aug 2024). India saw the highest year-on-year growth in renewable energy additions of 9.83% in 2022. The installed solar energy capacity has increased by 30 times in the last 9 years and stands at 89.4 GW as of Aug 2024. India's solar energy potential is estimated to be 748 GWp as estimated by National Institute of Solar Energy (NISE). The installed Renewable energy capacity (including large hydro) has increased by around 128% since 2014.

Up to 100% FDI is allowed under the automatic route for renewable energy generation and distribution projects subject to provisions of The Electricity Act 2003.

For further details, please refer, FDI Policy

33X 2X+ 42.26%	
Increase in Increase in Wind India's	share in total installed
Solar Power installed capacity from 89.43 GW since 47.19 GW since	21 GW to now at from 2.6 GW to 2014

1. **Energy Efficiency Improvement**
   - Measures the improvement in energy conversion efficiency (e.g., solar panel efficiency, wind turbine capacity factor) over time.
   - **Formula:**

$$\text{Efficiency Improvement}(\%) = \frac{\text{New Efficiency} - \text{Previous Efficiency}}{\text{Previous Efficiency}} \times 100$$

2. **Carbon Emission Reduction**
   - Quantifies the reduction in CO2 emissions as a result of green energy adoption.
   - **Formula:**

$$\text{CO}_2 \text{ Reduction} = \text{CO}_2 \text{ from Traditional Energy} - \text{CO}_2 \text{ from Green Energy}$$

3. **Cost Reduction**
   - Evaluates the reduction in the levelized cost of energy (LCOE) for green energy technologies over time.
   - **Formula:**

$$\text{Cost Reduction}(\%) = \frac{\text{Initial LCOE} - \text{Current LCOE}}{\text{Initial LCOE}} \times 100$$

4. **Energy Penetration**
   - Measures the percentage of total energy consumption that comes from renewable sources.
   - **Formula:**

$$\text{Energy Penetration}(\%) = \frac{\text{Energy from Renewables}}{\text{Total Energy Consumption}} \times 100$$

5. **Public Acceptance Index**
   - Based on surveys and public participation in renewable energy programs. A higher index reflects greater public support and involvement.

6. **Grid Stability and Reliability**
   - Evaluates the reliability of energy grid with renewable energy integration, based on outage

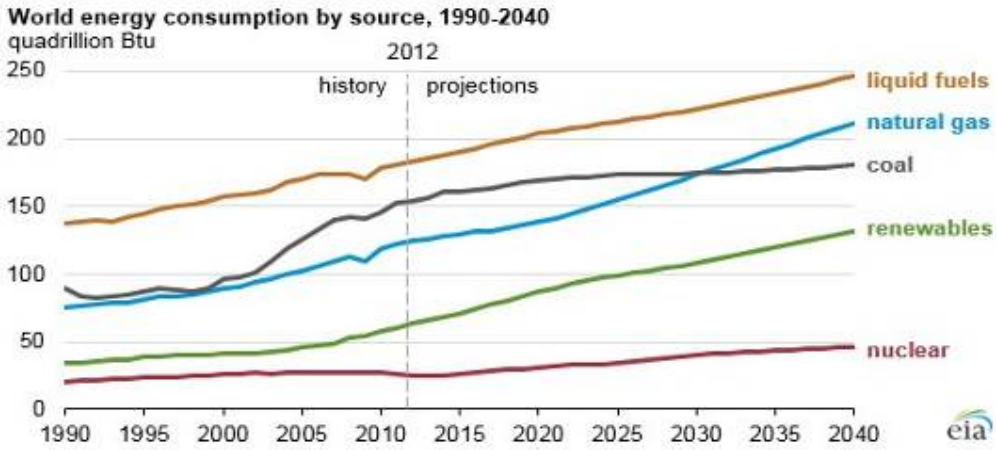


Fig 1. Energy consumption report 1990 TO 2040

V. RESULT ANALYSIS

India is the 3rd largest energy consuming country in the world.

India stands 4th globally in Renewable Energy Installed Capacity (including Large Hydro), 4th in Wind Power capacity & 5th in Solar Power capacity (as per REN21 Renewables 2024 Global Status Report).The country has set an enhanced target at the COP26 of 500 GW of non-fossil fuel-based energy by 2030. This has been a key pledge under the Panchamrit. This is the world's largest expansion plan in renewable energy.

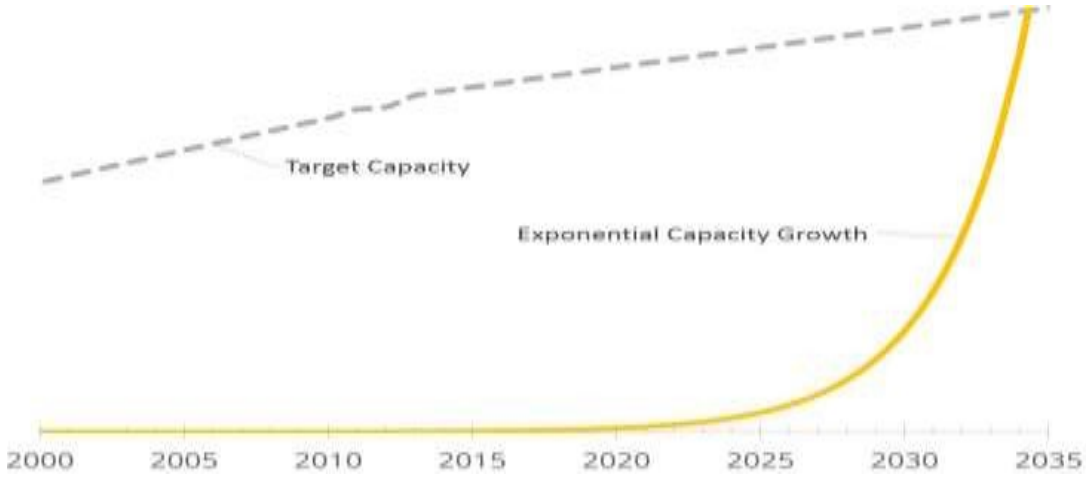


Fig 7. Global renewable electricity generation energy source 1980 – 2020

European Green Deal: The EU is investing heavily in renewable energy, aiming to make Europe the first climate-neutral continent by 2050. This includes increasing renewable energy capacity and improving energy efficiency

Projections

Market Growth:
The global renewable energy market is expected to grow at a CAGR of over 8% through 2030.

Job creation in manufacturing and semiconductor sectors, Environmental Impact:

1. **Solar Energy**: Investing in solar panels or companies that manufacture solar technology. This includes residential solar systems and large-scale solar farms.
2. **Wind Energy**: Supporting wind turbine installations or companies that specialize in wind energy production.
3. **Hydropower**: Investing in dams or companies that generate electricity through water sources.
4. **Geothermal Energy**: Funding geothermal power plants that harness heat from the Earth.

European Green Deal: The EU is investing heavily in renewable energy, aiming to make Europe the first climate-neutral continent by 2050. This includes increasing renewable energy capacity and improving energy efficiency.

Commitments to Net-Zero Emissions United Kingdom: The UK government has committed to achieving net-zero emissions by 2050, implementing policies to phase out coal and support offshore wind projects.

China: China announced plans to reach carbon neutrality by 2060 and is heavily investing in solar and wind energy, as well as electric vehicle production.

Green Hydrogen Initiatives
Germany: The German government is investing in green hydrogen technologies, aiming to become a leader in hydrogen production and usage as part of its energy transition strategy.

Australia: The Australian government is promoting green hydrogen development, supporting projects that aim to export hydrogen to energy-hungry countries.

Sustainable Transportation Policies
California: The state has set ambitious targets for phasing out gasoline-powered vehicles by 2035, promoting the transition to electric and zero-emission vehicles through incentives and infrastructure development. Norway: Norway has become a leader in EV adoption, with government incentives like tax exemptions and access to bus lanes to encourage electric vehicle purchases.

Renewable Energy Targets and Auctions
India: The Indian government is pushing for significant increases in renewable energy capacity, setting a target of 500 GW of non-fossil fuel capacity by 2030.

Support for Energy Efficiency Programs

Canada: The Canadian government is investing in energy efficiency programs for homes and businesses to reduce energy consumption and greenhouse gas emissions.

Japan: The Japanese government promotes energy efficiency in industries and homes, emphasizing smart grid technologies and energy management systems.

International Cooperation and Agreements

COP26 and COP27 Participation: Many governments are actively participating in global climate conferences, committing to enhance their climate action plans and financial support for developing countries to transition to renewable energy.

ENERGY AND INDUSTRIES

Research and Development Funding

U.S. Department of Energy: Increased funding for R&D in clean energy technologies, including advanced nuclear, solar, and battery technologies, to drive innovation in the sector.

IIJA and IRA programs and grants could start tackling transmission issues in 2024. These include the DOE's announced plans to accelerate high-voltage transmission line permitting,58 US$3.9 billion in grants from the Grid Resilience and Innovation Partnerships Program,59 and US$1.3 billion in grants for three interregional grid projects.60 At the beginning of the year, we'll be watching for the DOE's release of additional Transmission Facilitation Program funding and US Federal Energy Regulatory Commission interconnection rule compliance plans, as well as complementary ISO initiatives to reduce interconnection queues.61 We expect to see more corporations participate in Federal Energy Regulatory Commission regulatory filings as transmission constraints jeopardize their renewable targets.62 At the same time, IRA and IIJA boosts to renewable development could significantly exacerbate pressure on transmission bottlenecks in 2024.

Reshoring clean energy: Supply chains shorten and strengthen

A domestic clean energy manufacturing revival is underway as producers reshore to better capitalize on IRA tax credits and meet demand from renewable developers chasing domestic content adders. Since the IRA passed, companies have announced US$91 billion of investments in over 200 manufacturing projects, including US$9.6 billion in 38 solar projects, US$14.4 billion in 27 storage projects, US$1.4 billion in 14 wind projects, and US$54 million in six hydrogen projects, closely tracking investment levels in their respective renewable energy sources.63 These projects' shortened supply chains could increase transparency and resilience while decreasing emissions and exposure to geopolitical vicissitudes

Currently Indian government focusing on green India

"India represents about 17 percent of the world's population, and despite that, our contribution to emissions is about only four percent," he said, adding India today has "no role in causing destruction" to the world.

India is the world's biggest country participating the green world program. also

China is the world's biggest carbon emitter, followed by the US, India, and the EU.

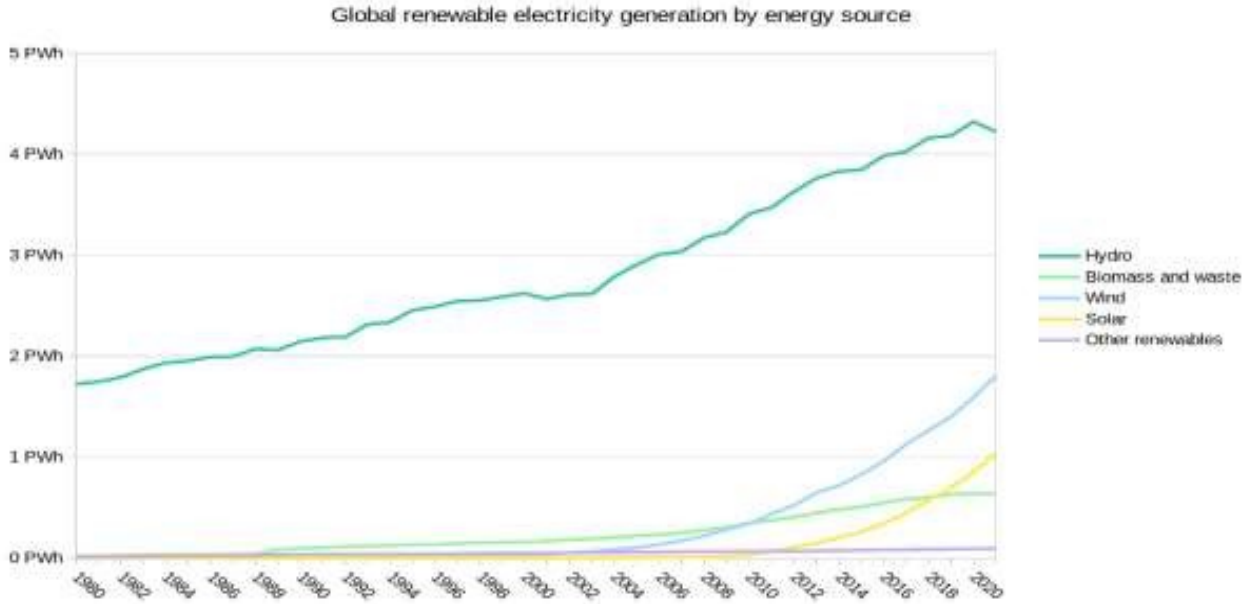
"Our carbon emissions are almost negligible," he said, adding that, like other countries, India could also have opted for carbon fuel-driven growth. But that's not the case.

It's India's tradition for the love of nature, and that is why India is focussing on solar, wind, hydro, green hydrogen, and nuclear energy areas in which they are carrying out investment.

Referring to the impressive digital progress made by India, Modi told Indian Americans that they might have wallets in their pockets here, but people in India have digital wallets. "No one can stop India now. India wants to have maximum mobile devices on 'Made in India' chips," he said.

The prime minister spoke about the remarkable progress made in the education sector. He wants students from across the world to come and study in India. The number of educational institutions has increased manifold

Fig. Experimental results



VI. Conclusion

The transition to a sustainable future of green energy is not merely an option but a necessity in addressing the escalating challenges posed by climate change, resource depletion, and environmental degradation. As the world grapples with the dire consequences of fossil fuel dependency, the shift towards renewable energy sources such as solar, wind, and hydro power offers a viable pathway to achieving energy security and environmental sustainability. This paper has explored various facets of green energy, including technological advancements, policy frameworks, community engagement, and the importance of integrating renewable resources into local economies.

Technological innovation remains at the forefront of the green energy revolution.

Advancements in solar panel efficiency, wind turbine design, and energy storage solutions have made renewable energy more accessible and cost-effective than ever before. The integration of smart technologies, such as smart grids and IoT, allows for better management of energy consumption and distribution, further enhancing the reliability and efficiency of renewable energy systems. These technological developments not only reduce greenhouse gas emissions but also create new economic opportunities, driving job change

In conclusion, the sustainable future of green energy hinges on a multifaceted approach that encompasses technological innovation, supportive policy frameworks, community involvement, and international cooperation. As we move forward, it is imperative that all stakeholders—governments, businesses, and communities—collaborate to create a resilient and sustainable energy landscape. The transition to renewable energy is not just a response to climate change but a transformative opportunity to build a more equitable and sustainable world. By embracing green energy solutions, we can pave the way for a healthier planet and a more sustainable future for generations to come.

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